Team Control Number

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Problem Chosen

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Summary

This paper analyzes the fluctuation of pork prices in China, firstly studies the factors affecting pork prices; then proposes a reasonable pig breeding program and pork import program for the fall of pork prices; for the better supply and storage of pork, The optimal pig breeding program and pork storage strategy were proposed.

Part I: Based on A, the general influencing factors of pork price fluctuation were obtained through literature research and personal life experience. Then the data collected on the Internet were sorted out and the main influencing factors were analyzed by principal component analysis method.

For B, regression curve is obtained by multiple linear regression, the prediction and compared with real data, the discovery and recent existence very big difference, the survey found that pork prices and swine fever, sudden falling pork production factors.

Part ii: according to A, A reasonable breeding plan should include two aspects after analysis.Second, adjust the national pork production and sales of different regions.For aspect 1, the cobweb model was used to analyze the influence of the previous multiple linear regression on the addition of CSFV. For aspect 2, FINKmeans algorithm is selected to cluster into three clusters of low, general and high to realize the regional division of China's pig market.Take heilongjiang province in the low area as an example to draw the pig price evolution curve, use the velocity method to draw the growth rate curve, then use the variation rate to analyze the pig price fluctuation rule in heilongjiang province, and analyze the cause of the fluctuation, so as to give Suggestions to stabilize the pig price in this region.

According to B, the influencing factors of import volume were obtained through investigation. The import volume in 2019 could be predicted by substituting 2019 data into the model, and the import volume in previous years was made into a bar chart. It can be seen that the import volume generally showed a trend of gradual rise in a four-year cycle, with a law of small in the middle and large in both sides.Therefore, it is predicted that pork imports should be reduced in 2020.

Part iii: For A, it was found through investigation that the demand for pork was not only in regional contradiction but also in seasonal contradiction. Combined with the national policies, the model of dividing pork breeding into four regions and carrying out quota production was proposed, and 13.14% of the total annual consumption of pig breeding in northeast China was obtained.In the central pig area, 48.67%;In the coastal pig raising area, it was 28.01%.Southwest pig area for 17.10%, so that the demand for pork regional contradictions and seasonal contradictions were resolved.

For B, ARIMA and VAR models were used to fit the model with the pork price data before 2009, and then the pork price from 2009 to now was predicted. According to the forecast results, the reasons why the government's reserve regulation did not stabilize the pork price on the whole were obtained, so as to optimize the reserve meat

policy.

Key word: Pork price rise, Principal component analysis, Multiple linear regression, FINKmeans algorithm, ARIMA and VAR models

Content

1. Introduction

1.1 Background

In the past few months, the price of pork in China has been on the rise. By early November, the price of pork even tripled to over 40 yuan per kilogram. The incident has sparked heated debate among the public and the government's concern. But fortunately, in the last half month, the price of pork started from the highest and continued to fall. But it is unclear whether the drop in prices means pork prices have been brought under control and will continue to fall to normal levels, allowing people to eat pork again.

It is known to all that pork has always been the main source of meat in China, and the rising price of pork has brought a lot of impact to people. Therefore, the analysis of the cause of the fluctuation of pork price in China can provide basic theoretical support for the stable control of pork price in the future.

1.2 Work

Part I: Analysis of the main factors affecting the fluctuation of pork prices

A: Analyze the general influencing factors of the fluctuation of pork price with the historical data;

B: Explore whether the recent rise in pork prices is highly correlated with the general fluctuation pattern of pork price rises. If not, what are the main factors influencing it?

Part ii: the research of pork price drop

A: When the price of pork is high, put forward A reasonable breeding plan to achieve A drop in the price of pork in A short time;

B: If the pork farming cannot be completed in a short time, a reasonable import scheme is proposed to ensure the relative stability of the domestic pork price.

Part iii: study on the optimal supply and storage strategy of pork

A: When the demand for pork in different regions is relatively stable, the optimal breeding scheme is proposed according to different time zones in different regions;

B: In order to cope effectively with the peak demand for pork in a certain region, an effective pork storage strategy is proposed to ensure the stability of pork price.

2. Problem analysis

2.1 Analysis of question one

For A: Summarize the general influencing factors of pork price fluctuation through literature research and personal life experience, and then process and analyze the collected data. Because there are many influencing factors, principal component analysis model is used to reduce the dimensionality of factors, so that representative factors can be obtained.

For B: The first part B the influence of the calendar year of pork price fluctuations is obtained by A general factors and the factors of the change of the data, using multiple linear regression model to predict the recent pork price, with the recent actual price comparison, if the difference in the allowed range, explain the recent pork price rising pork prices and past the general variation rule of highly relevant; Otherwise, it is necessary to analyze the main influencing factors of recent pork price rise in combination with recent special events.

2.2 Analysis of question two

For A: A reasonable breeding plan should include two aspects: one is to adjust the overall pig raising plan of the pig farmers; Second, adjust the national pork production and sales of different regions. In view of aspect 1, this paper analyzes the effect of multiple linear regression on adding CSFV, and puts forward some Suggestions for the overall plan of pig farmers. Pork prices for 2, different areas in our country the impact factor is not the same, using FINKmeans algorithm partitions, drawn in a certain area in the province as the example pig price evolution curve, draw the growth curve by applying the method of speed, then use the variation rate of pig price fluctuation regularity is analyzed, and analyze the causes of the fluctuation, and the stability in the region's live pig price advice.

For B: The import of pork not only involves price factors, but also involves the diplomatic partnership between countries, the stability of the entire international situation, the supply and demand relationship in the domestic market and related policies. Therefore, this paper established a pork import volume model by ignoring unexpected factors and concretized some abstract factors through some indicators, in order to obtain the change rule of the import volume and make accurate prediction of the pork import volume in 2019.

2.3 Analysis of question three

For A: The breeding plan considering transportation cost, forbidden pig areas and supply-demand relationship should not only consider the factors given in the question, but also involve the geographical conditions, population problems, stability of pig production and demand stability of each province. Therefore, if we want to get a scientific breeding plan, we must simplify the factors to get a more concise model. In this paper, we set up a model by binding the provinces with high pig production into districts and dividing the main pig provinces into four pig districts, in order to meet the demand for pork in each market and maintain the price stability.

For B: Known reserves meat policy in our country, through the study of policy, using ARIMA and VAR model with pork prices before 2009 data fitting model and then predict pork prices since 2009, according to the forecast results are generally not stable government reserves regulation pork prices, and optimize the reserve policy.

3. Symbol and Assumptions

3. 1 Symbol Description

Table 1 Symbol description

Symbol	Description
R	Correlation coefficient matrix
$vec1$	The eigenvector of the correlation coefficient matrix
λ	The eigenvalue
$rate$	Principal component contribution rate
z	The principal components
x	Factors affecting the
$hg21$	The regression equation
$hg1$	Regression coefficient of original data
rmsel	Residual standard deviation

D_t	Virtual variable
$FINs$	Fuzzy interval number
K	Number of target clusters
X_t , Y_t	Time series variable

3.2 Fundamental assumptions

Assumption1:The impact of inflation is not taken into account within the study period;

Assumption2: The labor cost remains unchanged within one year;

Assumption3: The international situation will not change dramatically;

Assumption4: The data collected are authentic and reliable.

4. Model

4.1 Model of question one A

4.1.1 Data acquisition and processing

By searching the public information of China animal husbandry information network (http://www.caaa.cn/) and selecting the data collected from the new century to the recent period (January 2000 to April 2019), the changes of pork prices and various influencing factors in this period were obtained. Due to the large numerical differences among various influencing factors, we made a graph comparing the price of pig grain (mainly corn and soybean meal), the price of piglets, the price of pork substitutes (chicken, beef and mutton) and the labor cost with the price of pork respectively, as shown in the figure (pork price is the main vertical axis).

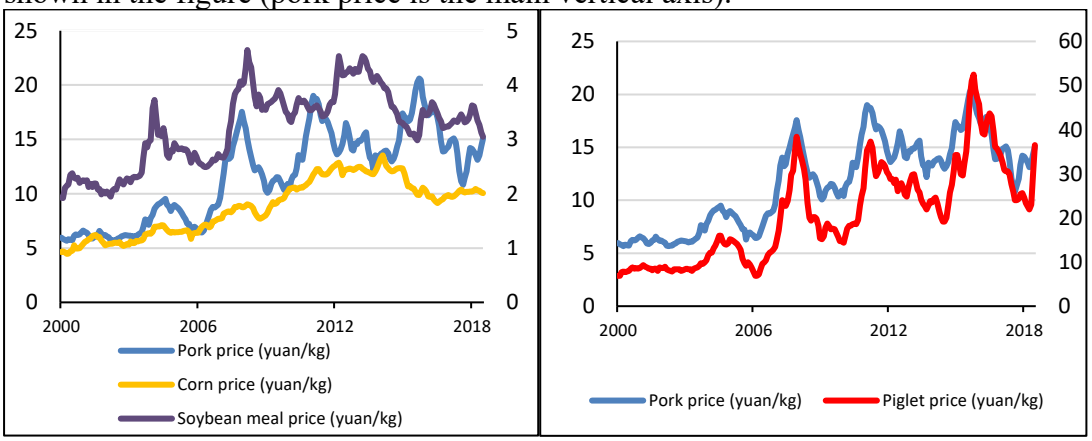


Figure 1 Comparison chart of pork price, grain (mainly corn and soybean meal) and piglet price

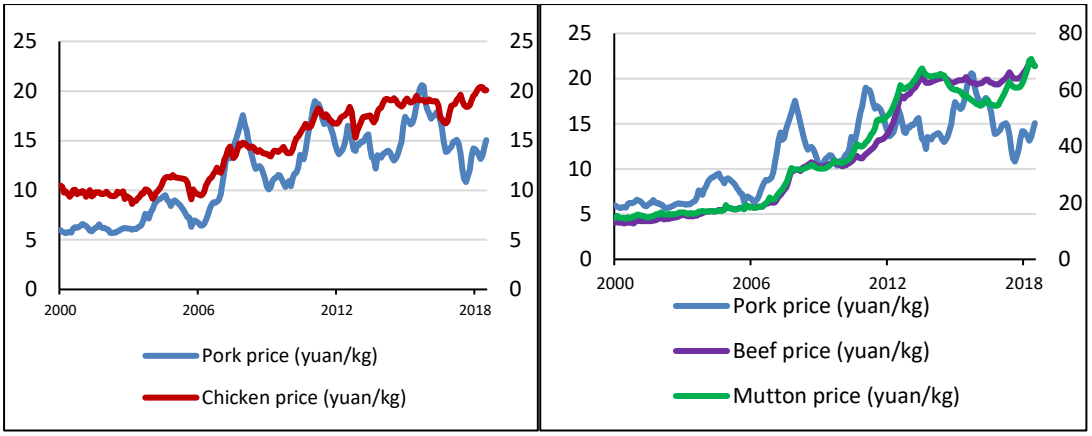


Figure 2 Comparison curve of pork price and chicken, beef and mutton price

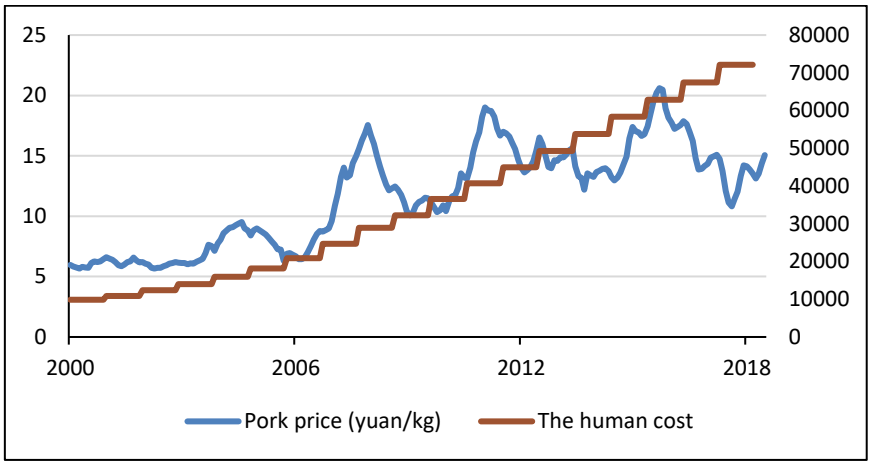


Figure 3 Comparison curve of pork price and labor cost

4.1.2 Establishment and solution of the model

First, the original data were giveless, and then the correlation coefficient matrix was obtained by principal component analysis:

$$R=\begin{bmatrix} 1.0000 & 0.8340 & 0.7204 & 0.9109 & 0.8539 & 0.9090 & 0.8250 \\ 0.8340 & 1.0000 & 0.6472 & 0.7331 & 0.6910 & 0.7353 & 0.6430 \\ 0.7204 & 0.6472 & 1.0000 & 0.8611 & 0.8012 & 0.7743 & 0.8276 \\ 0.9109 & 0.7331 & 0.8611 & 1.0000 & 0.9494 & 0.9546 & 0.9493 \\ 0.8539 & 0.6910 & 0.8012 & 0.9494 & 1.0000 & 0.9867 & 0.9765 \\ 0.9090 & 0.7353 & 0.7743 & 0.9546 & 0.9867 & 1.0000 & 0.9507 \\ 0.8250 & 0.6430 & 0.8276 & 0.9493 & 0.9765 & 0.9507 & 1.0000 \end{bmatrix} \quad (1)$$

The eigenvector of correlation coefficient matrix is calculated as follows:

$$vec1=\begin{bmatrix} 0.3794 & 0.3324 & -0.2341 & 0.7100 & -0.0879 & -0.3895 & 0.1649 \\ 0.3282 & 0.8021 & 0.1820 & -0.4444 & 0.1250 & 0.0455 & -0.0257 \\ 0.3526 & -0.2294 & 0.8561 & 0.1159 & -0.2540 & -0.1083 & -0.0235 \\ 0.3997 & -0.1181 & -0.0018 & 0.2885 & 0.4799 & 0.7158 & 0.0206 \\ 0.3941 & -0.2335 & -0.2401 & -0.3491 & -0.3043 & 0.0649 & 0.7168 \\ 0.3971 & -0.0916 & -0.3262 & -0.0982 & -0.5240 & 0.1717 & -0.6433 \\ 0.3889 & -0.3417 & -0.1230 & -0.2651 & 0.5609 & -0.5370 & -0.2087 \end{bmatrix} \quad (2)$$

7 eigenvalues:

$$\lambda=\begin{bmatrix}6.0344 & 0.4936 & 0.3002 & 0.1119 & 0.0335 & 0.0235 & 0.0030\end{bmatrix} \quad (3)$$

Contribution rate of each principal component:

$$rate=\begin{bmatrix}86.2059 & 7.0515 & 4.2883 & 1.5986 & 0.4782 & 0.3354 & 0.0422\end{bmatrix} \quad (4)$$

Do the cumulative contribution rate accumulation bar chart:

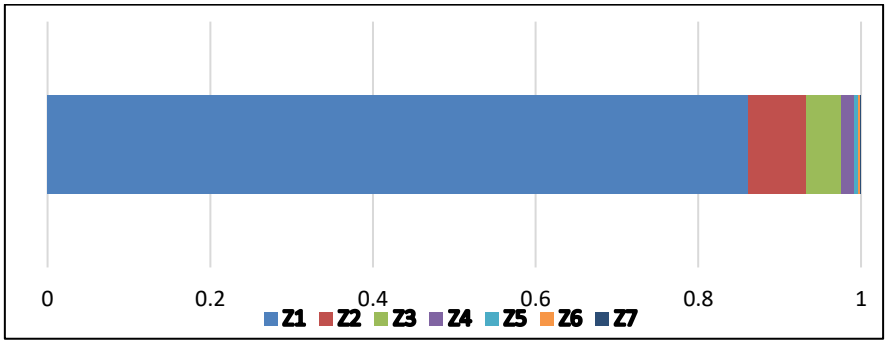


Figure 4 Bar chart of cumulative contribution rate of each component

As can be seen from the figure, the cumulative contribution rates of principal components 1, 2, 3 and 4 are close to 1, so only the first four principal components need to be taken for analysis.

The four principal components are:

$$z_1=0.3794x_1+0.3324x_2-0.2341x_3+0.7100x_4-0.0879x_5-0.3895x_6+0.1649x_7 \quad (5)$$

$$z_2=0.3282x_1+0.8021x_2+0.1820x_3-0.4444x_4+0.1250x_5+0.0455x_6-0.0257x_7 \quad (6)$$

$$z_3=0.3526x_1-0.2294x_2+0.8561x_3+0.1159x_4-0.2540x_5-0.1083x_6-0.0235x_7 \quad (7)$$

$$z_4=0.3997x_1-0.1181x_2-0.0018x_3+0.2885x_4+0.4799x_5+0.7158x_6+0.0206x_7 \quad (8)$$

4.1.3 conclusions

The four principal components are:

$$z_1=0.3794x_1+0.3324x_2-0.2341x_3+0.7100x_4-0.0879x_5-0.3895x_6+0.1649x_7$$

$$z_2=0.3282x_1+0.8021x_2+0.1820x_3-0.4444x_4+0.1250x_5+0.0455x_6-0.0257x_7$$

$$z_3=0.3526x_1-0.2294x_2+0.8561x_3+0.1159x_4-0.2540x_5-0.1083x_6-0.0235x_7$$

$$z_4=0.3997x_1-0.1181x_2-0.0018x_3+0.2885x_4+0.4799x_5+0.7158x_6+0.0206x_7$$

It can be seen from the above formula that the contribution coefficient of x_5、x_7 each component to the principal component is very small, while the contribution ratio of the principal component to the whole is more than 86%. Therefore, x_5 and x_7 can be ignored. Therefore, the main factors influencing the pork price are: the price of corn, soybean meal, piglets, chicken and mutton.

At this time, the expression of principal component is:

$$z_1=0.3794x_1+0.3324x_2-0.2341x_3+0.7100x_4-0.3895x_6 \quad (9)$$

$$z_2=0.3282x_1+0.8021x_2+0.1820x_3-0.4444x_4+0.0455x_6 \quad (10)$$

$$z_3=0.3526x_1-0.2294x_2+0.8561x_3+0.1159x_4-0.1083x_6 \quad (11)$$

$$z_4=0.3997x_1-0.1181x_2-0.0018x_3+0.2885x_4+0.7158x_6 \quad (12)$$

4.2 Model of question one B

In this section, the principal component regression and direct linear regression of

the original data are compared to obtain the best regression equation.

Linear regression was carried out on the principal components of problem A to obtain the linear regression coefficient:

$$hg21=\left[0.3674 \quad 0.0183 \quad 0.6371 \quad -0.4967\right] \tag{13}$$

Therefore, the regression equation is:

$$\hat{y}=0.3674z_1+0.0183z_2+0.6371z_3-0.4967z_4 \tag{14}$$

The regression coefficient equation of normalized variable is:

$$\hat{y}=0.3490\tilde{x}_1+0.0304\tilde{x}_2+0.7283\tilde{x}_3+0.2869\tilde{x}_4-0.1858\tilde{x}_5\ -0.1124\tilde{x}_6-0.0734\tilde{x}_7 \tag{15}$$

Return to the original independent variable, and get the regression equation of principal components:

$$\hat{y}=-1.563347+2.861186x_1+0.181340x_2+0.278670x_3+0.331010x_4-0.025351x_6 \tag{16}$$

Direct linear regression was carried out on the original data to obtain the regression coefficient:

$$hg1=\left[-3.9134 \quad 2.3441 \quad 0.2623 \quad 0.2487 \quad 0.716 \quad 0.0503 \quad -0.1057 \quad -0.0009\right] \tag{17}$$

The regression equation is:

$$\begin{aligned}\hat{y}=&-3.913432+2.344125x_1+0.262271x_2+0.248736x_3\\&+0.716048x_4+0.050350x_5-0.105738x_6-0.000934x_7\end{aligned} \tag{18}$$

In order to choose the better regression equation in the two regression methods, the residual standard deviation of the two regression analyses is calculated as follows:

$$\text{rmsel}=\text{sqrt}\left(\text{sum}\left(\left(\text{hg1}(1)+x0^{*}\,\text{hg1}(2:\ \text{end})'-y0\right).\hat{}2\right)/(m-n-1)\right) \tag{19}$$

$$\text{rmse2}=\text{sqrt}\left(\text{sum}\left(\left(\text{hg23}(1)+x0^{*}\,\text{hg23}(2;\ \text{end})'-y0\right).\hat{}2\right)/(m-\ \text{num})\ \right) \tag{20}$$

Rmsel =0.7561 and rmse2=0.6039 were obtained

Therefore, the difference between equation (19) and equation (20) is that the latter has a smaller mean square error because it is more stable.Moreover, none of the former coefficients passed the significance test.

The regression curve of principal component regression is compared with local real data, and the following figure is obtained:

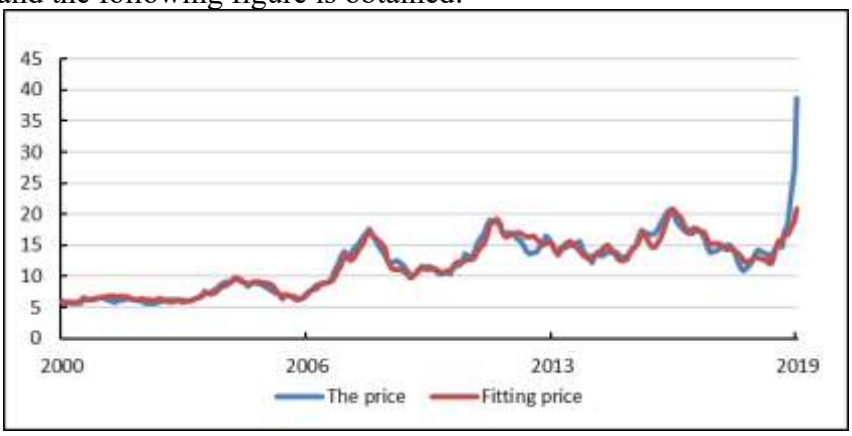


Figure 5 Regression curve vs. real data

It can be seen from the above figure that the change of the real data in a short period of time is much more dramatic than that of the fitting curve. For example, the real data from June 2018 to October 2019 are quite different from the fitting data, as shown below:

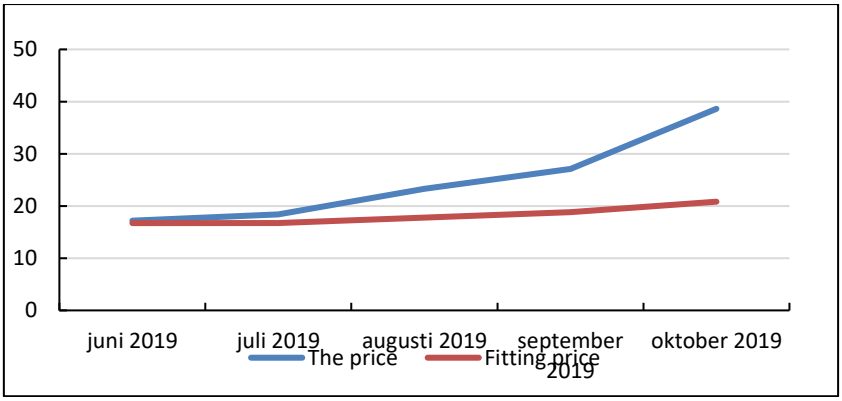


Figure 6 The partial regression curve is compared with the real data

After investigation, it is found that the price of pork is related to the factors of sudden decrease of pork production, such as African swine fever.

4.3 Model of question two A

4.3.1 The price fluctuation characteristic of pig market

The cobweb theory is about the dynamic equilibrium analysis theory of economics, it is the time by introducing the factors of change, the content of the demand for continuous investigation belongs to different times, the interaction between supply and price, using dynamic analysis method is discussed, such as agricultural products, livestock products of this kind of production cycle longer goods after deviating from the equilibrium output and price fluctuation process and its results.

Pig market is a typical agricultural products market.Its supply elasticity is greater than the demand elasticity, and in the absence of external interference in the opposite direction, it will show the characteristics of the scattered spider web, as shown in the figure.

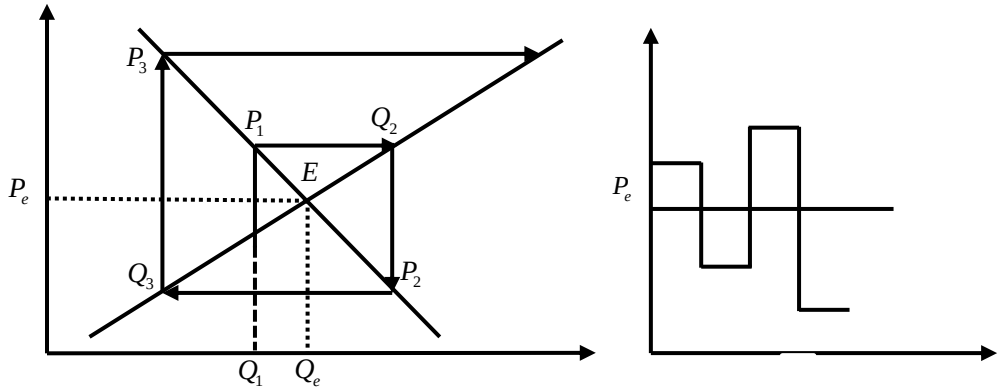


Figure 7 Divergence spider web and feature graph of price fluctuation model

It can be seen that, for the current pig market, relying solely on the self-regulation of the market will not restrain the fluctuation but aggravate it.

4.3.2 The establishment, solution and analysis of the model

According to the above theoretical analysis, hog price is affected by both demand and supply factors. The influence of both supply and demand factors on hog price fluctuation can be expressed by a model, namely the previously established multiple regression model:

$$\hat{y} = -1.563347 + 2.861186x_1 + 0.181340x_2 + 0.278670x_3 + 0.331010x_4 - 0.025351x_6 \quad (21)$$

Considering the impact of natural disasters such as epidemic diseases, we

introduced dummy variables, determined the D_t values of each period through consulting materials, and then combined with the data in the first question, concluded that the regression model with the impact of epidemic diseases was as follows:

$$D_t = \begin{cases} 1, (infected) \\ 0, (No\ outbreak) \end{cases} \quad (22)$$

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + \mu \quad (23)$$

According to the estimation results of this empirical model, it can be seen that the factors at the supply level and the demand level jointly affect the price of pigs, but the main factors that affect the price fluctuation of pigs are mainly at the supply level, while the factors at the demand level have relatively little influence on the price fluctuation of pigs.

The following recommendations are therefore made for the overall plan for pig farmers:

(1) only by establishing a good feed raw material market can the stable development of pig production be guaranteed;

(2) to improve the disordered state of piglet market. The current phenomenon of piglets rising with the price of fat pigs is a great hidden danger to restrict the development of pig industry;

(3) guide pig farmers not to buy and keep reserve breeding pigs;

(4) starting from the production link, improve the living environment of pigs, strengthen the construction of epidemic prevention system, and fundamentally cut off the source of disease.

4.3.3 Pork prices in China are divided by region

Due to the vast territory of China, pig prices in different regions are affected by local conditions such as pig raising cost, household consumption level, ethnic habits and transportation, so the price levels and fluctuations of pigs are also different.Therefore, the pig market in China should first be divided into regions according to the pig price data of each region, and then each region should be studied to finally draw a comprehensive and detailed breeding plan.

Based on the previous research experience of many domestic scholars and combined with the research of this paper, FINKmeans algorithm was selected to take the monthly price time series data of pigs in different regions as the research object and gather them into three clusters of low, average and high to realize the regional division of China's pig market.

4.3.4 Model introducing

FINKmeans converts each set of time series data into FIN by using the algorithm that converts the time series data into fuzzy interval number, and then takes all FINs as input variables of the whole algorithm.

Table 2 FINKmeans clustering algorithm

Algorithm FINKmeans
Step 1: convert time series data into fuzzy interval number Input: raw data Output: number of fuzzy intervals (FINs) Methods: (1) calculate the median of a sequence iteratively (2) from 0 to 1 and then from 1 to 0 correspond to the median at fixed intervals

Step 2: Kmeans algorithm

Input: number of fuzzy intervals (FINs), number of target clustering K

Output: K categories or clusters

Methods:

(1) enter FINs, the variable to cluster

(2) randomly select K elements from input variables as the initial center of K clusters

(3) calculate the measurement distance d between each remaining element and k clustering centers, and measure the small distance$_K$

Cluster into one class, get k clusters

(4) according to the clustering results, the arithmetic mean value of all elements in each cluster was taken as the corresponding new

The clustering center of

(5) repeat (3) and (4) until the clustering result is no longer changed

(6) output the best clustering results

4.3.5 Data collection and description

The data of this study is also from China animal husbandry information network (http://www.caaa.cn/).This paper selected the monthly price data of pigs in 28 provinces, municipalities directly under the central government and autonomous regions of China from January 2003 to July 2018 as the research object.A partial presentation of this data acquisition is shown in figure 3-9.

In particular, China's Hong Kong and Macao region due to a small number of pigs, can be ignored; Taiwan is not considered here; China's xizang region is relatively remote and less pig breeding, more of which is self-production and self-marketing, so it is not considered here.Due to religious belief and other reasons, the number of pigs raised in ningxia and xinjiang is also less, and the price of pork is less volatile, which is also not considered here.

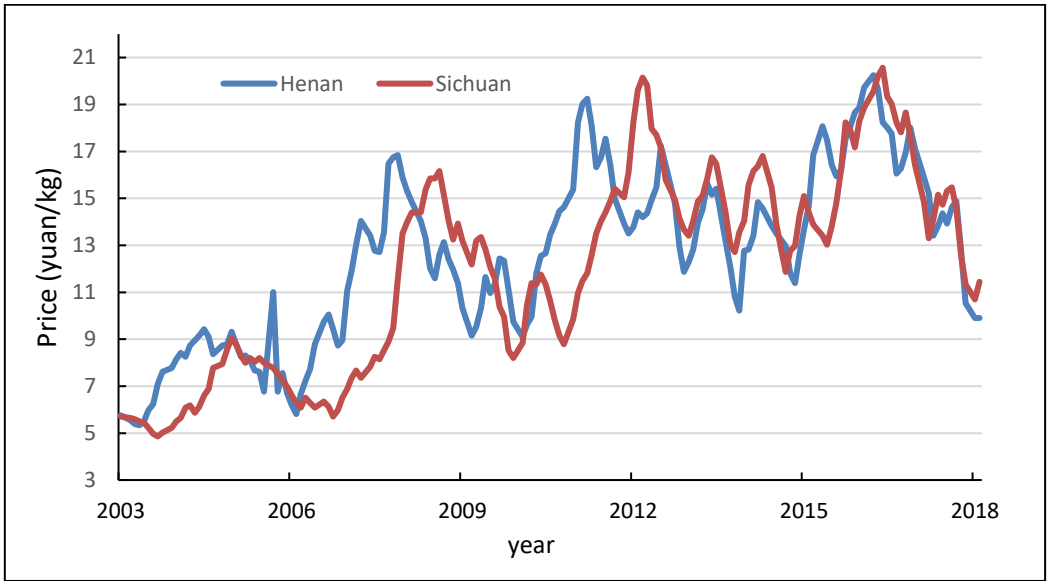


Figure 8 Pork price curves of henan and sichuan provinces

4.3.6 Results analysis

Through FINKmeans algorithm, the time series data of monthly pig price in different regions are taken as the research object, and the three clusters of low, average and high are gathered to realize the regional division of China's pig market. Among

them, Heilongjiang and Jiangsu belong to the low region; Belonging to the general region are Jilin, Liaoning, Hebei, Shanxi, Beijing, Henan, Shandong, Shaanxi, Tianjin, guangxi, chongqing, sichuan, hubei and yunnan provinces.The igh regions are Inner Mongolia, anhui, fujian, guangdong, hainan, guizhou, zhejiang, Shanghai, qinghai, gansu, hunan and jiangxi. The corresponding regional division of China's pig market is visualized as shown in figure 3-10, where green represents low area, red represents general area, blue represents high area, and the unfilled area is not considered.

It can be seen that most of the areas in the high region have a higher economic level, while the low region and general region mainly include some pig provinces or areas with a lower economic level.

Figure 9 China pig market area division

4.3.7 Analysis, causes and countermeasures of hog price fluctuation in low area

This section with a low hog prices evolution curve drawing area in heilongjiang province as an example, using the method of velocity plot of growth rate, found in heilongjiang province pig price volatility, but unable to carry on the variation rule analysis, then use the X - 12 seasonal adjustment method to eliminate seasonal fluctuations and irregular, then decomposition method is used for lower area seasonally adjusted the provinces in the sequence of pig price fluctuation trend decomposition, first of all to do to fit the trend of the time, the trend of selecting the optimal equation, then the unit root test was carried out on the volatile components, demonstrated that volatile components were smooth, Then, the variation rate was used to analyze the fluctuation rule of pig price in heilongjiang province, and the causes of the fluctuation were analyzed, so as to give Suggestions on stabilizing the pig price in this region.

4.3.8 Analysis of evolution of velocity method of low area hog price

In the low area, this paper takes the monthly pig price data of heilongjiang province as an example. In order to reflect the overall fluctuation of pig prices in heilongjiang province, the evolution curve of pig prices in heilongjiang province was drawn according to the monthly price data of pigs in heilongjiang province from January 2003 to July 2018, as shown in figure 4-2.Overall, the price of pigs in heilongjiang province is extremely unstable.However, it is impossible to obtain the cycle and amplitude of price fluctuation of heilongjiang pigs from the growth rate curve.

Therefore, in order to study the fluctuation rule of heilongjiang pigs price, this paper USES trend decomposition method to analyze the fluctuation components.

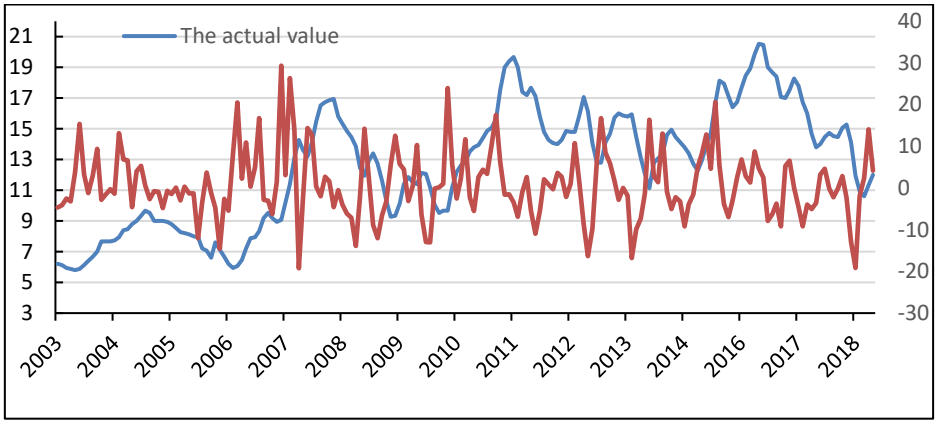


Figure 10 Price evolution curve of hogs in heilongjiang province

4.3.9 Trend fitting of pig price in low area

In order to analyze the fluctuation of pig price, the x-12 seasonal adjustment method was firstly adopted to eliminate the seasonal fluctuation and irregular fluctuation in the price fluctuation sequence, taking the pig price in heilongjiang province as an example, as shown in the figure.On the above basis, trend decomposition method is adopted to decompose the seasonal adjusted fluctuation sequence of pig price. The conventional fitting method was used for trend fitting of seasonal adjusted pig price fluctuation sequence. The optimal trend equation was selected by comparison to eliminate long-term trend, and then the regression residual was tested by unit root.

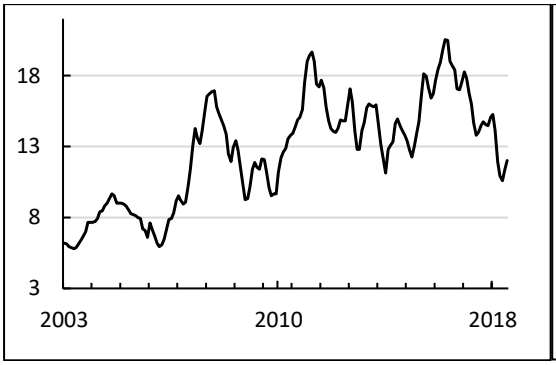


Figure 11 (a) original price sequence of heilongjiang pigs

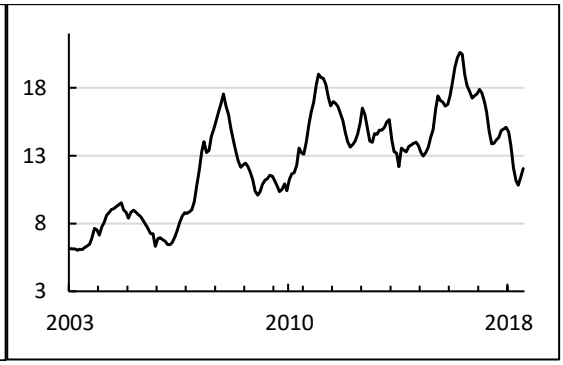


Figure 12 (b) seasonal adjusted price fluctuation sequence of pigs

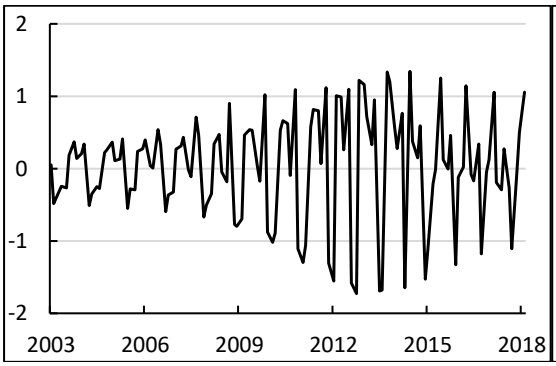


Figure 13 (c) seasonal fluctuations

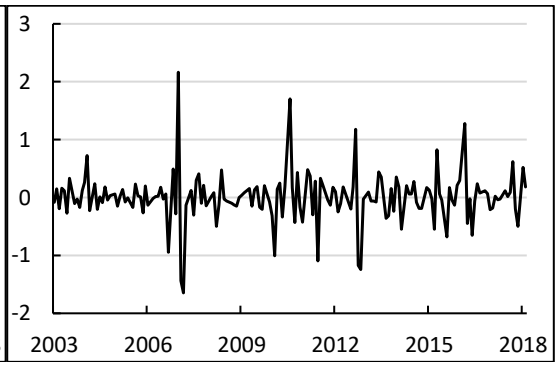


Figure 14(d) irregular fluctuations

According to the goodness of fit, both provinces choose quadratic function as the optimal trend equation, and take heilongjiang province as an example to draw the optimal fitting curve, as shown in figure 15.

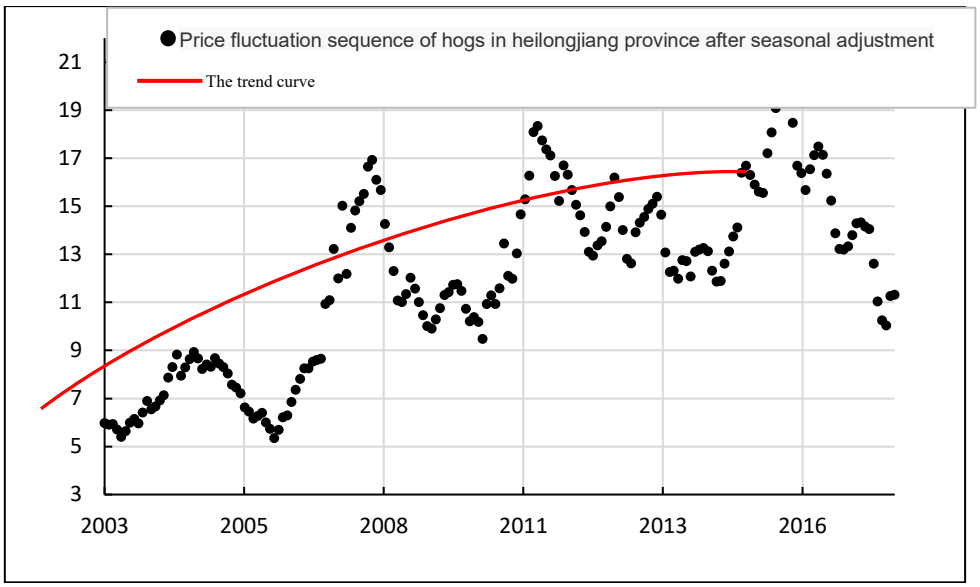


Figure 15 the fluctuation sequence and trend curve of pig price in heilongjiang province after seasonal adjustment

4.3.10 Variation rate curve and fluctuation cycle of pig price in low area

The trend equation and variation rate formula were used to calculate the variation rate of the monthly price of heilongjiang pigs from January 2003 to July 2018, and the curve was drawn to reflect the fluctuation degree of the price of heilongjiang pigs, as shown in figure 16.From the curve of price variation rate fluctuation, it can be seen that the price fluctuation degree of hogs in heilongjiang province is severe and has an obvious periodicity.

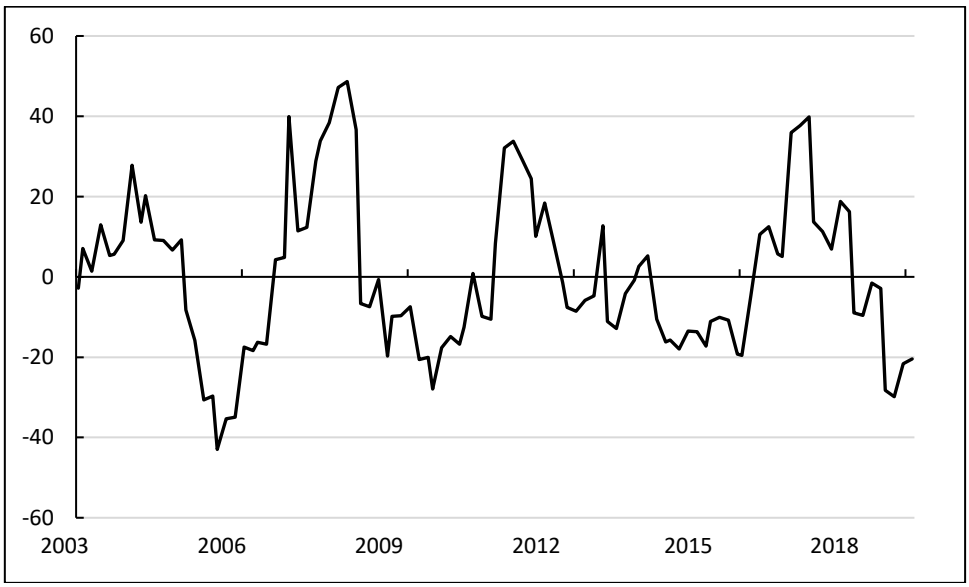


Figure 16 price variation rate fluctuation curve of heilongjiang province

(1) range of fluctuations

The larger the amplitude, the more violent the periodic fluctuation.On the whole, from January 2003 to July 2018, the price of hogs in heilongjiang province fluctuated greatly and the price fluctuation was very unstable.

(2) fluctuation height

It indicates the expansion intensity, or growth intensity, of hog prices per cycle.On the whole, this period of time shows the peak type, which shows that the increase intensity of pig price is relatively large.

(3) wave depth

It reflects the strength of each cycle of pig price contraction, that is, the degree of decline. On the whole, the pig price dropped greatly in this period.

4.3.11 cause analysis and countermeasure suggestions of hog price fluctuation in low area

The low areas include heilongjiang province and jiangsu province, among which heilongjiang province has always been a big agricultural province in China. At the same time, due to the low wage level and consumption level of heilongjiang province, the pig price in the whole country presents the lowest level.From above shows the price fluctuation of pigs in heilongjiang province is very sharp, this is mainly because of heilongjiang province's pork supply only by local pigs supply, pork without introducing external resources, but also shoulder the task of pork supply other provinces, so as long as there is the external environment influence, pork prices will be drastic fluctuations in heilongjiang province, so the pig price will along with the drastic fluctuations.Based on the above analysis, the following Suggestions are put forward in order to bring down the price of pig market in the whole region:

(1) it should give full play to its advantages of pig breeding in geography, resources and market, reasonably plan the breeding area, give good policy subsidies and increase capital investment, so that farmers can expand the breeding scale;

(2) as the main pig producing area, it is necessary to make a complete pig trading plan between this region and other regions in advance, so as to determine the next pig production plan and avoid the impact of large fluctuations in other regions on the stability of the pig market in this region;

(3) introduce good pig breeding scale technology and equipment, so as to ensure a higher pig output rate and meat output, and promote the good development of the pig industry in this region.

4.3.12 The cause analysis and countermeasure suggestion of the fluctuation of pig price in general area

Adopting the same method as the cause analysis of pig price fluctuation in the low area, the cause of pig price fluctuation in the general area is obtained through the analysis of the results: some of the general area is the main producing area of China's pig industry, and some is the main selling area of pork with convenient transportation.The main pig production areas in this region have a relatively low economic level and a large pig breeding scale. For example, the pig supply in henan province is much larger than the demand for pigs in this region.The main pork sales areas in this region, tianjin and Beijing, have low transportation costs due to their superior geographical location and convenient transportation to many pork producing areas. Besides, there are many types of other meat products in tianjin and Beijing, and people have a low preference for pork. Therefore, the overall price level of pigs is relatively low.

The paper analyzes the causes of the fluctuation of pig price in general areas and proposes countermeasures for the price rise:
(1) the government shall do a good job in macro-control, strengthen information guidance, and timely release meat and egg market information;
(2) the government releases reserve meat to lower the price of pork;
(3) strengthen market monitoring and launch daily monitoring system for daily necessities market;
(4) improve and refine the market supply plan.

4.3.13 cause analysis and countermeasure suggestions of hog price fluctuation in high area

Using the same method as the cause analysis of pig price fluctuation in the low area, the cause of pig price fluctuation in the high area was obtained through the analysis of the results.However, the pig industry in areas such as anhui and guizhou is relatively small and needs to rely on the supply from other provinces. However, it is far away from the main pig producing areas, which makes the transportation cost of pigs higher, so the price is also high.

The causes of pig price fluctuation in high areas were analyzed and the countermeasures and Suggestions for price rise were obtained:
(1) improve the transportation conditions between these areas and major pig production areas, and reduce the transportation cost of pigs;
(2) try to develop local resources and conduct proper pig breeding;
(3) to strictly control the supply of pigs before and after the festival;
(4) establish a sound pork reserve policy to prevent the shortage of pigs in major pork producing areas due to diseases and policy changes.

4.4 Model of question two B

4.4.1 Model assumes

(1) the import volume is only related to the price of domestic pork, the price of pork in the international market, the exchange rate of RMB against the us dollar, and the consumer price reduction index.

The international situation will not undergo drastic changes.

4.4.2 model

According to the survey, the import volume is mainly related to exchange rate fluctuation, export price and import price fluctuation.Establish the model according to the influencing factors:

$$\log(PKIMCN) = \alpha_0^{pkim} + \alpha_1^{pkim}\log\left(PKMPCN_t / CPIDCN_t\right) + \alpha_2^{pkim}\log\left(PKIMCN_{t-1}\right) + \alpha_3^{pkim}\log\left(HPPWUS_t * EXRECN_t\right) + \varepsilon \quad (24)$$

Among them, PKIMCN is the import volume of pork;PKEXCN for pork exports;PKMPCN domestic pork prices;Pork price in HPPWUS international market;EXRECN RMB/usd exchange rate;CPIDCN consumer price reduction index; Epsilon is the random error term.

Substitute in the domestic pork price, the international market pork price, the RMB exchange rate against the us dollar, and the consumer price reduction index, and then substitute in the random error term to modify the model. The coefficient of the model can be obtained as follows:

Table 3 Coefficients of the model

Equation 4.1	α_0^{pkim}	α_1^{pkim}	α_2^{pkim}	α_3^{pkim}	Adjust the R^2	D.W	During the estimate
Coefficient values	8.38	0.01	0.75	2.54	0.87	2.14	1995-2008.
T value	2.69 * *	0.01	4.36 * * *	2.38 * *			

Note: * is significant at 10%, ** is significant at 5%, and ** is significant at 1%.

4.4.3 conclusion

According to the survey, the import volume of pig head in the first eight months of 2019 is about 1.13 million tons. Therefore, the import volume of pig head in the last four months is about 1 million tons.

Make a bar chart of imports over the years, as shown below:

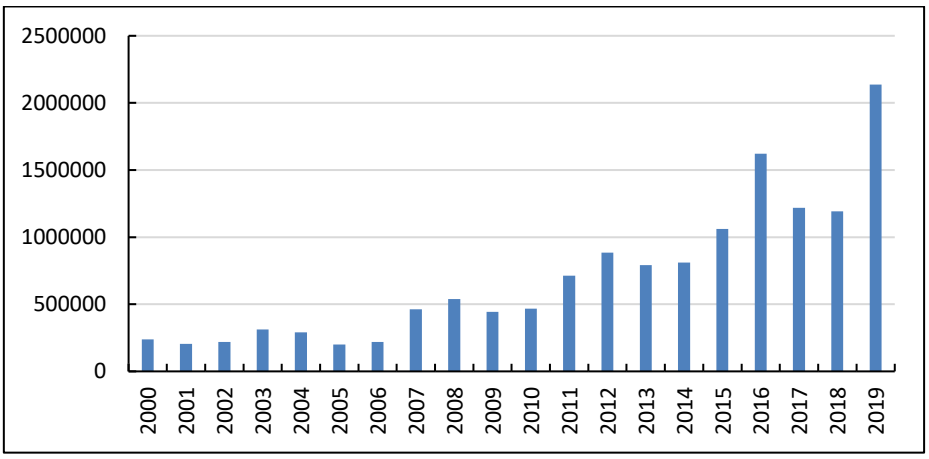


Figure 16 Bar chart of China's pork imports over the years

As can be seen from the figure, the import volume generally shows a trend of gradually rising in a four-year cycle, and shows a law of small in the middle and large at both ends in the cycle. Therefore, it is predicted that pork imports should be reduced in 2020.

4.5 Answer of question three A

4.5.1 Problem analysis

The map of pork price in November 2019 is obtained through the survey, as follows:

Figure 17 Map of pork prices in China

As can be seen from the map, pork prices in each province are significantly different, which is due to the obvious contradiction between the demand of each province and its pork output. Besides, it is known from the previous analysis that pig breeding usually has a certain periodicity, which is usually manifested as a certain seasonality, as shown in the figure.

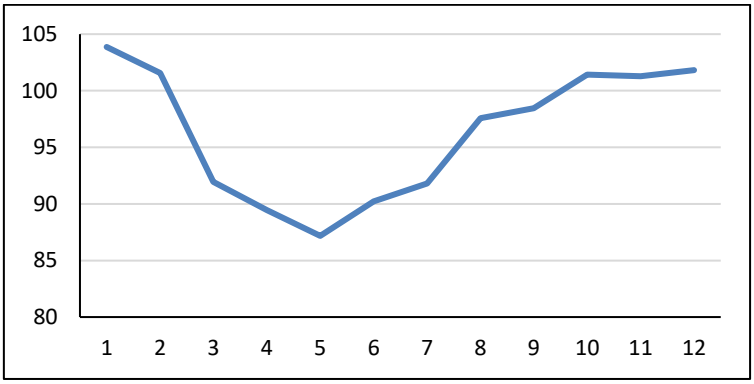


Figure 18 Seasonal index curve of pig price

By the above analysis shows that prices in general are two pigs in the year the trend of high, intermediate low, namely every 1-2 month prices higher, began to decline after march, 5 - July at the bottom, and then slowly recover, on the back high prices before and after National Day, Mid-Autumn festival and maintain this price to the end of the Spring Festival before prices may reach the peak of a year, Spring Festival and then began to fall.This indicates that there is a seasonal contradiction between pork production and demand. At the same time, the output of pork provinces is uneven, which is mainly related to the demand of pork provinces, the area of breeding and the price of pork in each province. In this paper, the annual output of pork in each province over the years was investigated and collected, and the representative data of 1997 and 2008 were compared as follows:

Table 4 Statistics of pork production in different provinces from 1997 to 2008

provinces	Pork production 1997 (tons)	The proportion	Pork production in 2008 (tons)	The proportion	change
liaoning	102.9	2.97%	210.0	4.54%	1.57%
shandong	199.3	5.75%	321.3	6.95%	1.20%
yunnan	136.2	3.93%	219.6	4.75%	0.82%
henan	256.1	7.39%	367.1	7.95%	0.56%
zhejiang	78.4	2.26%	126.9	2.75%	0.49%
guangdong	176.6	5.10%	254.0	5.50%	0.40%
Ji Lin	64.9	1.87%	104.6	2.26%	0.39%
hainan	18.7	0.54%	36.9	0.80%	0.26%
guizhou	92.4	2.67%	134.6	2.91%	0.24%
tianjin	11.8	0.34%	23.5	0.51%	0.17%
xinjiang	11.5	0.33%	22.3	0.48%	0.15%
anhui	158.6	4.58%	217.4	4.71%	0.13%
Tibet	0.7	0.02%	1.2	0.03%	0.01%
qinghai	6.4	0.18%	8.7	0.19%	0.00%
fujian	103.7	2.99%	136.6	2.96%	- 0.04%
gansu	35	1.01%	42.9	0.93%	- 0.08%
shanxi	39.7	1.15%	45.4	0.98%	- 0.16%
heilongjiang	78.8	2.27%	96.6	2.09%	- 0.18%
shaanxi	61.6	1.78%	73.5	1.59%	- 0.19%
Beijing	24.7	0.71%	22.3	0.48%	- 0.23%
hubei	204.1	5.89%	260.4	5.64%	- 0.26%
Shanghai	23.7	0.68%	17.3	0.37%	- 0.31%
chongqing	119.7	3.46%	140.7	3.05%	- 0.41%
jiangxi	162.8	4.70%	198.1	4.29%	- 0.41%
hebei	200.3	5.78%	215.8	4.67%	- 1.11%
Inner Mongolia	68.8	1.99%	64.7	1.40%	- 0.59%
jiangsu	167.2	4.83%	194.9	4.22%	- 0.61%
sichuan	349.3	10.08%	136.2	2.95%	- 7.14%
guangxi	189.9	5.48%	218.1	4.72%	- 0.76%
hunan	313.3	9.04%	370.2	8.01%	- 1.03%
A total of	3464.3	100.00%	4620.5	100.00%	

As can be seen from the above table, shandong, henan, guangdong, anhui, hubei, jiangxi, hebei, jiangsu, guangxi and hunan are the main and stable pork producing areas. The cumulative pork production of these ten provinces accounted for 58.54% and 56.65% of the total national production in 1997 and 2008 respectively. Liaoning, yunnan, zhejiang and jilin provinces have the potential to expand aquaculture. Pork production in sichuan province has fallen sharply, mainly because people prefer fresh pork in recent years and the cost of transporting pork from sichuan to other parts of the country is too high.

By comparison with historical data found that pig is superior to the south, north in this paper, by comparing sichuan and liaoning, sichuan pork production in 2007, particularly big, continuous outbreaks of sichuan province in 2005 from streptococcus suis infected in 2006 to large-scale outbreak of high fever, the sichuan pig productivity hit particularly big, and pork production in liaoning province is in a rising channel, affected by the disease and the market risk is relatively small, on the one hand, because of its climate can withstand the spread of the epidemic and its low cost near the feed

producer can resist market risk. It is foreseeable that in the case of high incidence of epidemic diseases and large market fluctuations, hogs in northeast China and other places still have a lot of room for growth and good prospects for development.

After understanding the national policies, it is found that the national key pig production advantage areas are concentrated in :(1) coastal pig production advantage areas;(2) hog production advantage area in northeast China;(3) pig production advantage area in central China;(4) hog production area in southwest China.The four regions have different development directions according to their location advantages. Pig-producing areas in coastal areas, including 55 base counties in the coastal provinces of jiangsu, zhejiang, guangdong and fujian, guarantee the pig-self-sufficiency rate, establish pig export bases and increase exports. Pig producing areas in northeast China, including 30 base counties in 3 provinces of liaojihei, have taken advantage of their feed advantages to expand the scale of pig breeding, establish large pork processing enterprises for further processing, and guarantee the demand of surrounding big cities. The central hog-producing areas include 226 base counties in seven provinces: hebei, shandong, anhui, jiangxi, henan, hubei and hunan. This area is mainly adjacent to the consumption market of big cities. It constantly improves the level of large-scale and standardized breeding and expands the capacity of slaughtering and processing. Guarantee the market supply of the sales area. In the southwest, there are 126 base counties in five provinces (districts and cities) : guangxi, sichuan, chongqing, yunnan and guizhou. This area is a traditional pig producing area in China. We should improve the standard scale of pig breeding, accelerate the process of improved pig breeding, ensure the consumption in this area, and at the same time, try to expand the marketing channels and increase the income of farmers in raising pigs.

4.5.2 model

This paper selected 2008 pork production as the support to build the model. The three provinces of liaoning, jilin and heilongjiang were selected as the pig raising areas in northeast China. Considering the transportation cost problem and the advantages of stable production in the pig raising areas in northeast China, we decided to supply the pork from Beijing, tianjin, heilongjiang and Inner Mongolia to the pig raising areas in northeast China. Hebei, shandong, anhui, jiangxi, henan, hubei and hunan were selected as the pig raising area in the middle of China. Considering the convenience of transportation and population advantage in the middle of China, the pork supply of hebei, shandong, anhui, jiangxi, henan, hunan, qinghai, xizang, xinjiang, shaanxi and shanxi was decided to be given to the pig raising area in the middle of China. Guangxi, sichuan, chongqing, yunnan and guizhou were selected as the pig raising areas in southwest China. Considering the transportation cost and production instability of pigs in south China, the pig raising areas in southwest China only need to ensure their own supply.Hainan, zhejiang, fujian and guangdong were selected as coastal pig raising areas. Considering the convenience of export and transportation cost, hainan, zhejiang, fujian, guangdong, Shanghai and export were decided to be delivered to coastal pig raising areas.

The model formula is used to calculate the pork consumption of each province. The formula is as follows:

$$Consum = Perconsum \times Num \quad (25)$$

Consum: pork consumption in each province;

Perconsum: pork consumption per capita;

Num: number of provinces (based on the sixth census).

Then, the model formula was used to calculate the proportion of the annual output

of each pig area in the national consumption.

The calculation formula of the models in northeast and central pig areas is as follows:

$$Output = \frac{Consum1}{Tconsum} \times Cor1 \quad (26)$$

In the formula: Output: the proportion of annual scale Output that should be supplied by the pig raising areas in northeast and central China in the national consumption;

Consum1: consumption of supply area in northeast and central pig raising areas;

Tconsum: total national consumption;

Cor1: correction factor (taking into account regional production stability and supply area revisions).

The calculation formula of the model in the southwest pig raising area is as follows:

$$Output = \frac{Consum2}{Tconsum} \times Cor2 \quad (27)$$

In the formula: Output: the proportion of the scale Output that southwest pig raising area should supply to the national consumption every year;

Consum2: consumption in supply area of southwest pig raising area;

Tconsum: total national consumption;

Cor2: correction factor (taking into account regional production stability and supply area revisions).

The calculation formula of the model in the coastal pig raising area is as follows:

$$Output = \frac{Consum3}{Tconsum} \times (Cor2 + \alpha) \quad (28)$$

Where, Output: the proportion of the scale Output to be supplied by the coastal pig raising area in the national consumption per year;

Consum3: consumption of supply areas in coastal pig raising areas;

Tconsum: total national consumption;

Cor2: correction factor (taking into account regional production stability and supply area revisions);

A: exports as a percentage of total national consumption.

4.5.3 model solving

The pork consumption of each province can be obtained by formula 1 as follows:

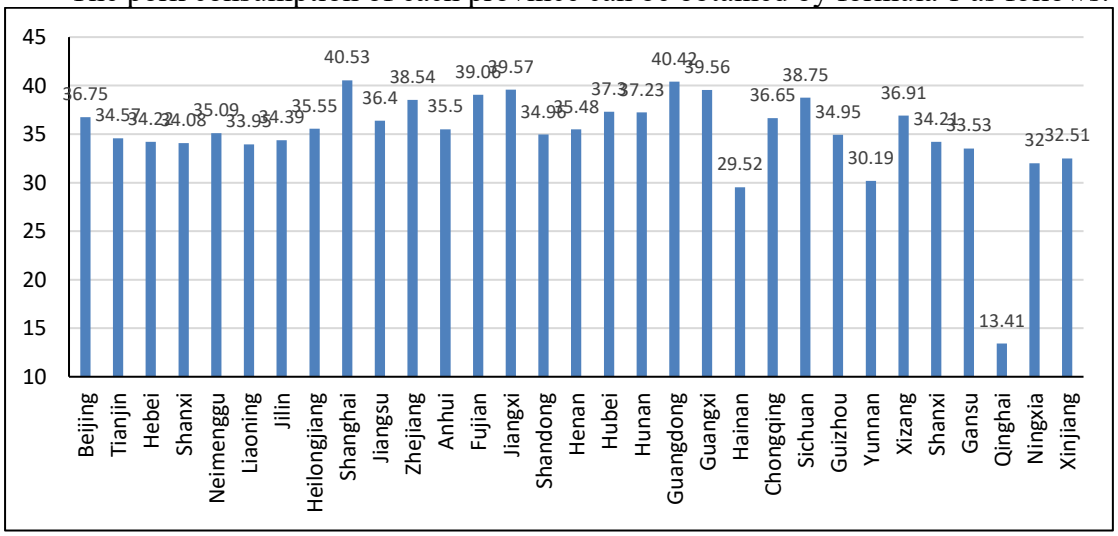


Figure 19 The consumption of supply areas in each pig raising area can be obtained

by integration as follows:

Table 5 Consumption scale of supply area in each pig raising area

Pig area	Northeast pig area	Central pig area	Coastal pig areas	Southwest pig area
Consumption (tons)	578.1488	2141.551	1060.797	658.6066

The correction coefficient and the proportion of export volume are obtained as follows:

Table 6 Summary table of correction coefficient and proportion of export volume

Cor1	Cor2	Alpha.
1.05	1.2	0.2

Formula (2), (3) and (4) were used to calculate the proportion of the annual output of each pig raising area in the national consumption, as shown in the following table:

Table 7 Proportion table of scale output of each pig raising area in national consumption

Pig area	Northeast pig area	Central pig area	Coastal pig areas	Southwest pig area
The proportion	13.14%	48.67%	28.01%	17.10%

4.5.4 conclusion

Finally, the conclusion of an appropriate farming plan was obtained by solving the model:

(1) 13.14% of the total annual consumption of pig breeding in northeast China;The central pig raising area should raise 48.67% of the total annual consumption;The total annual consumption in coastal pig raising area should be 28.01%.Southwest pig raising area should breed 17.10% of annual total consumption;

(2) the total production of the four pig areas is greater than the consumption.This is to prevent swine fever and other factors resulting in a sharp drop in the output of pork market instability; Meanwhile, the surplus production could be used to expand exports and increase the country's pork reserves to prevent local pork shortages.

4.6 Answer of question three B

4.6.1 The ARIMA and VAR models of pork price fluctuation were established

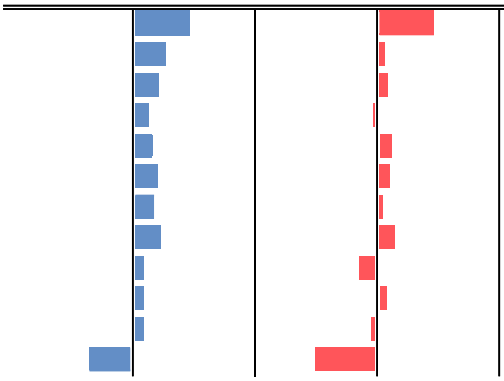
Considering that the government's regulation of pork price by purchasing and stockpiling has only been implemented since 2009, the ARIMA model is used to fit the model with the data of pork price before 2009 and then predict the pork price from 2009 to now.Through the VAR model, the fluctuation factor of pig price was included in the model, and the price data since 2009 were predicted based on this model. The gap between the actual data and the predicted data can obviously be used as the lower limit of the impact of government reserve control on pork price.

(I) prediction by ARIMA model

ARIMA model USES the regularity of time series itself to build the corresponding

data model and make the optimal prediction under the minimum variance.

Pork price has an obvious trend and seasonality. After taking logarithm and going through the first difference and seasonal difference, the autocorrelation and partial autocorrelation of pork price are shown in figure 2. According to the autocorrelation and partial autocorrelation charts of pork price after treatment, the autocorrelation coefficient of pig price after treatment falls into the confidence interval after the 2nd or 3rd stage. Partial autocorrelation coefficient in phase 1 after a significant fall in ci but when K = 12, hog prices autocorrelation and partial autocorrelation coefficient is not zero, as a result, there are two main types of ARIMA model parameter selection, ARIMA (1,1,3) respectively (1,1,1) 12 and ARIMA,1,2 (1) (1,1,1) 12, according to the R2, AIC and SC judgment criteria (for ARIMA (1,1,3),1,1 (1) 12 models, R2, AIC and SC value were 0.598, 3.572, 3396,For ARIMA (1,1,2),1,1 (1) 12 models, R2, AIC and SC values were 0.598, 3.597, 3.45), decided to choose ARI - MA,1,2 (1) (1,1,1) 12 model, in the 12 phase lag, the largest model residual error Q statistic 12 phase lag has a value of 8.4466, concomitant probability is 0.749, shows that residual sequence independent probability is very big, can't refuse sequence independent assumption, through test. Therefore, prediction based on ARIMA(1,1,2)(1,1,1)12 model is feasible and effective. Specific prediction results are shown in figure 20.



autocorrelation	Partial autocorrelation		AC	PAC	Q-Stat	Prob
		1	0.467	0.467	21.402	0.000
		2	0.256	0.048	27.894	0.000
		3	0.198	0.078	31.802	0.000
		4	0.116	-0.014	33.163	0.000
		5	0.150	0.105	35.469	0.000
		6	0.187	0.091	39.084	0.000
		7	0.156	0.024	41.646	0.000
		8	0.220	0.135	46.796	0.000
		9	0.074	-0.135	47.384	0.000
		10	0.075	0.059	47.996	0.000
		11	0.067	-0.024	48.485	0.000
		12	-0.331	-0.508	60.669	0.000

Figure 20 Autocorrelation and partial autocorrelation of pork prices

Where, AC(Autocorrelation), Autocorrelation;PAC(PartialCorrelation), partial autocorrelation; Q-stat;Prob, associated probability.

(ii)VAR model prediction

Sims(1980) proposed a VectorAutoregression (VAR) model. Suppose that there are two time series variables and, as the explained variables of the two regression equations respectively, and the explanatory variables are the order lag values of the two time series variables, forming a binary VAR(p) system: Y_t X_t p

$$\begin{cases} Y_t = \beta_{10} + \beta_{11}Y_{t-1} + \cdots + \beta_{1p}Y_{t-p} + \alpha_{11}X_{t-1} + \cdots + \alpha_{1p}X_{t-p} + \varepsilon_{1i} \\ X_t = \beta_{20} + \beta_{21}Y_{t-1} + \cdots + \beta_{2p}Y_{t-p} + \alpha_{21}X_{t-1} + \cdots + \alpha_{2p}X_{t-p} + \varepsilon_{2t} \end{cases} \quad (25)$$

Where, is time, and are the constant term of the equation, are the coefficients of the lag term, are the coefficients of the lag term, and are the error terms of the equation t β_{10} β_{20} α X_t β Y_t ε_{1t} ε_{2t}

Hog and pork as connected to the upstream and downstream industry chain link, have a certain correlation between the pork and hog prices, therefore, based on prices of live pigs and pork prices between the transmission characteristics of "asymmetry", using VAR model may consider of pork prices in the price of pig, using the same pig

pork price prediction to divest the government support policy on the fluctuation of pork prices of live pigs, simply measure the effect of government regulation and control of pork price policy.According to LR criterion, FPE criterion, AIC criterion, SC criterion and HQ criterion, the breeding cycle of pigs was comprehensively considered, and the lag period was determined to be 15. At this time, the R of the pork price model was 0.772, which was a strong explanation. The specific predicted value is shown in figure 3.[2]

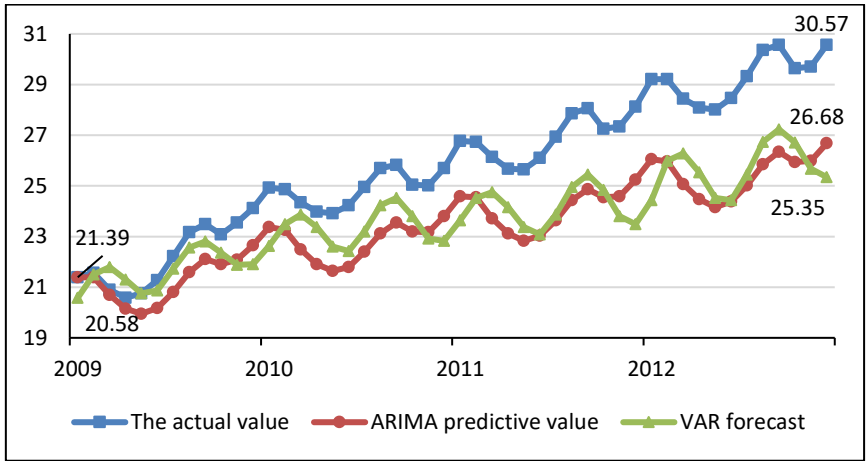


Figure 21 Actual and predicted pork prices from January 2009 to 2012

Table 8 statistics of actual and predicted pork prices from January 2009 to December 2012

The numerical	The mean	The standard deviation
The actual value	25.80292	2.798069
ARIMA actual value	23.3975	1.774719
VAR forecast	23.72521	1.650184

4.6.2 Analysis of model results

As shown in figure 3 and table 2, the actual value of pork prices from January 2009 to December 2012 was generally greater than the VAR forecast value, and the VAR forecast value was generally greater than the ARIMA forecast value. It can be seen that from January 2009 to December 2012, the mean impact range of government reserve control measures on pork prices was [2.08, 2.41], and the mean impact range of standard deviation was [1.02, 1.15]. Therefore, on the whole, the government's measures to control the purchase and storage of frozen meat did not well achieve the goal of stabilizing pork prices and reducing the fluctuation range, but instead raised the mean value and standard deviation of pork prices.

There are three main reasons for this. First, the influence of "expectation" factor, the government's purchase and storage of pork will send a signal of low price to the market, which will lead to a large number of pig farmers selling out of the market, which will aggravate the decline of pork market price and turn the expectation into reality.Second, the government reserve meat purchase and storage cycle is inconsistent with the breeding cycle and the market price fluctuation cycle. At present, the central frozen meat reserve is mainly stored through the frozen meat storage storehouse directly under the central government. As a result, the enthusiasm of large slaughterhouses has not been mobilized yet, which has aggravated the fluctuation of pork price to some extent.

4.6.3 conclusions and recommendations

(1) the implementation effect of the pork reserve policy is not significant, which may be due to the small scale of China's pork reserve, the high cost of pork reserve and the time-lag of the purchase and storage operation.Therefore, it is necessary to expand the scale of pork reserve, promote the current reserve policy to market reserve policy, and reduce the reserve cost.
(2) the change rate of corn price has a great influence on the change rate of pork price. We should stick to the existing corn regulation policy to stabilize the production of corn and reduce the fluctuation of corn price, so as to stabilize the feed cost of pig breeding and solve the worries of pig breeding.
(3) we must improve the transparency of regulation and guide expectations scientifically;
(4) increase the scale of reserve meat, and reasonably coordinate the relationship between the release cycle, breeding cycle and market price fluctuation cycle;
(5) guide slaughterhouse pricing and cooperate to stabilize pork prices.
(6) improve pig production and pork market price monitoring and early warning system.By integrating various domestic and international market factors, more effective indicators should be added to measure the market fluctuation risk, so as to timely give early warning of the fluctuation risk of pig production and pork price, and timely conduct the purchase and storage of pork.

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