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Summary

While the rapid growth of pork prices in China in the past six months has attracted the attention of the government and that of a large number of residents. Fortunately, there appeared a certain downward trend recently. But we are not sure if pork prices have come under control,and if pork prices can return to the normal levels. Based on the existing problems and some relevant theories,we construct some mathematical models to analyse the pork price fluctuations in China.

First of all, we analyze the general influencing factors of pork price volatility. Based on the problem description, this paper uses python to crawl the daily soybean meal, corn and pig prices in various provinces of China Pig net from 2018 to 2019. In addition, we also crawl the national pig, soybean meal and corn prices of China Animal Husbandry Information Network from 2000 to 2018 as the basic data to establish an econometric model based on time series. The classical linear regression method is used to deal with the time series. The co-integration test of the model is carried out, and it is proved that there is a long-term stable relationship between the variables by adjusting the time range. At this time It can be considered that the price of soybean meal and corn is the common influencing factor of pig price fluctuation. Secondly, under the condition that the general influencing factors of pork price fluctuation are known, the recent pork price fluctuation is analyzed, and a classical regression model applied to the recent pork price fluctuation is established. The co-integration test is carried out by using the daily pig, soybean meal and corn price data from 2018 to November 2019. The results are not co-integrated, indicating that there are other factors that significantly affect the price fluctuation of live pigs.

For the second question,we divide it into two parts： reasonable farming plan and procurement plan.Pork farming usually has a certain periodicity. When pork prices are high, in order to reduce pork prices in the short term first we can properly sell reserved pork to stabilize pork prices.Second, severely crack down on the behavior of storing goods individually.Third, import pork from other countries.Fourth, provide farmers with information on the supply and demand of various agricultural products in time.In addition, we respectively analyze the pork market, pork production and pork consumption, and thus put forward some relevant countermeasures.When it comes to importing plan, we have pointed out several major importing countries. at the same time,

whether from the total potential import volume or from the import structure, the adjustment and change of the import end situation still mainly stay on the short-term disturbance, and it is difficult to change the established fact that the production capacity of the pig breeding industry in China is shrinking rapidly. The main logic of the shortage of live pigs is expected to continue in the coming period. The upward trend of pork price remained unchanged.

For the third problem, we first use the cobweb model in economics to explain the oscillation of the quantity and price of pork in the market around the equilibrium state. Under the premise that the elasticity of pork demand is relatively stable, the long-term equilibrium relationship of pork market price is obtained by solving the difference equation: when the producer's supply price elasticity is less than the consumer's demand price elasticity, the pork price will finally converge to the equilibrium price; we use the data of pork consumption of 2000-2018 to fit the demand and supply function of pork respectively, drawing to the conclusion that the estimated elasticity of demand elasticity is less than the estimated value of supply elasticity . The fluctuation trend of pork price during the period matches the divergent cobweb model, which also verifies the correction of using demand elasticity and supply elasticity to judge the price fluctuation trend of commodity market, which can provide a reference for producers to develop farming plans. We also established the optimal pork storage model based on storage theory with strict constraints. By solving the model, we obtained the optimal storage cycle, the minimum average cycle cost, and the formula of the maximum pork stock in one cycle, analyzed the variables that affect solution of the model. Finally, we put forward some suggestions on how to improve and correct the existed model.

Key words:Pork price;Price fluctuation;Time series regression;

Influence factors;Cobweb model

Contents

1 Introduction

1.1 Background

Pork, one of the important agricultural products in China, is the main source of meat consumption for urban and rural residents. The price of pork affects the daily consumption expenditure of urban and rural residents. Meanwhile, pig breeding is relatively closed with farmers' income.

A certain degree of cyclical fluctuations in pork prices is normal, but a sharp abnormal wave in pork pricesThe direct benefit of pork producers and the welfare of general consumers will be seriously affected.While the rapid growth of pork prices in China in the past six months has attracted the attention of the government and that of a large number of residents. In less than 160 days, pork prices increased from 14.68 yuan/kg on May 28, 2019 to 40.11 yuan/kg on November 1, 2019 . Fortunately, there appeared a certain downward trend recently. But we are not sure if pork prices have come under control,and if pork prices can return to the normal levels. Study the law of pork price fluctuations and government price control policies can give us more in-depth understanding the pork market, and then we can take effectively measures to decrease price fluctuations in the pork market. Based on the above, we construct some mathematical models to analyse the pork price fluctuations in China.

2 Analysis and Solution of Problem 1

2.1 Problem analysis

The first part contains multiple questions.

First, it is necessary to analyze the general influencing factors of pork price volatility, which uses data from the past few years to more than a decade. Obviously, this is an econometric problem.

At the same time, it is a typical time series problem, so it is possible to establish a time series based econometric model and use the classical linear regression method to process the time series. Later, since the classical regression model was built on stable data variables, we were unable to use non-stationary data on classical regression models.

Therefore, it is necessary to use the cointegration test to prove that there is a long-term stable relationship between the variables. Then, if it can be proved that there is a long-term stable relationship between the variables, it can be explained that the main factor of the model is analyzed, that is, the general influencing factors of the problem are obtained.

Secondly, in the case of the known general influence factors of pork price fluc-

tuations, the recent fluctuations in pork prices are analyzed, and if the general influencing factors previously found can be utilized, a classical regression model applied to recent pork price fluctuations is established, and Proving that the variables are cointegrated, this shows that the recent fluctuations in pork prices are highly correlated with the general fluctuations in pork prices. Finally, if the variables are not cointegrated, you can use the recent situation as a priori knowledge to further analyze the explanation.

2.2 Model establishment

2.2.1 Time series based econometric model

For time series data, it is usually processed using the classical regression model. This requires data variables to be stable, but for most economic variables they are usually unstable. Therefore, the use of classical regression models in time series has been greatly limited. The classical regression method can only be used to prove the long-term stable relationship between data variables, that is, the cointegration relationship between variables. Then, how to prove the stability of the data becomes the primary problem in establishing a time series-based econometric model using classical regression.

Cointegration between variables x, y, that is, long-term stability relationship can be described as

$$Y_t = \alpha_0 + \alpha_1 X_t + \mu_t \tag{1}$$

Among them, μ_t is a random disturbance term, and α_0 and α_1 are coefficients.

Therefore, it can be determined that if there is a long-term stable equilibrium relationship between the variables X and Y, the deviation of Y from the equilibrium position in a certain period is only temporary, for a sufficiently long period of time $t-1$ period $\rightarrow t$ period, the variable X, Y can always meet

$$\Delta Y_t = \alpha_1 \Delta X_t + \Delta \mu_t \tag{2}$$

Therefore, it can be seen that in the case of satisfying the stationary relationship between variables, it is inevitable that the random perturbation term μ_t is a stationary sequence, and the two are mutually necessary and sufficient conditions.

Thus, a stationary test of μ_t can be used to illustrate the smooth relationship between variables, which introduces a cointegration test.

2.2.2 Multivariate regression EG Cointegration test

for the cointegration test between variables, this paper uses the two-step test proposed by Engle and Granger in 1987, namely the EG test.The specific process is as follows:

The first step is to establish a general regression equation using least squares. Estimate and get

$$Y_t = \alpha_0 + \alpha_1 X_t + \mu_t$$

And then use the regression equation to calculate its error $\hat{e}$,

$$\hat{e}_t = Y_t - \hat{Y}_t$$

This results in static regression or cointegration regression.

The second step is to test the monotonicity of $\hat{e}_t$. When $\hat{e}_t$ is a stable sequence, that is, a constant, it can be considered as variable X and variable Y. The interval is (1,1) order cointegration. If $\hat{e}_t$ is a first-order single integer, then the variables are (2,1)-order cointegration, and so on.

For the singleness test of $\hat{e}_t$, the DF test or the ADF test is used. The constructed test model is

$$\Delta e_t = \delta e_{t-1} + \sum_{i=1}^{p} \theta_i \Delta e_{t-i} + \varepsilon_t \tag{3}$$

Its null hypothesis is

$$\Delta e_t = \delta e_{t-1} + \sum_{i=1}^{p} \theta_i \Delta e_{t-i} + \varepsilon_t \tag{4}$$

Its null hypothesis is $H_0 : \delta = 0$, indicating that the error term e^t is a stationary sequence, that is, variable cointegration. Therefore, you need to accept the null hypothesis.

The above original EG test method is used to test the cointegration relationship between two variables. In this problem, it is obvious that the number of variables is greater than 1, and an extended multivariate EG test is needed. However, similarly, the multivariate EG test is basically equivalent. For the two-variable EG test, there is no need for an extended discussion of the multivariate EG test in this problem.

2.3 Model solution

Based on the problem description, this article uses python to crawl the Chinese pig network (https://www.zhuwang.cc) of the daily beans of 2018 and 2019 The price of live pigs in corn, corn and provinces. In addition, the national livestock pigs

from 2000 to 2018 were crawled from China Animal Husbandry Information Network (http://www.caaa.cn/market/index.php?class=241), bean meal, corn prices as the basic data.(The code can be found in the appendix)

2.3.1 2000 Year to 2018 Cointegration test

According to the analysis of the problem, we can first find a model for the establishment of universal volatility factors, and prove the validity of the general volatility model by co-integration test. Therefore, we use long-term data to construct long-term stable relationship between variables through extended EG test method.

Assume that the general fluctuations in the price of live pigs are generated by the prices of raw materials such as bean meal and corn required for breeding. Co-integration tests are carried out on the price of live pigs using the monthly price of bean meal and corn in 2000-2018.

$$\Delta e_t = \delta e_{t-1} + \sum_{i=1}^{p} \theta_i \Delta e_{t-i} + \varepsilon_t \tag{5}$$

Construction statistics are

$$t = \frac{\hat{Y} - Y}{\hat{\sigma}} \tag{6}$$

The co-integration test results for bean meal, corn price and hog price from 2000 to 2018 are shown in the table below.

$t-test$	$p-value$	$value_table$		
-1.299	0.6296	$1\%:-4.2232$	$5\%:-3.1894$	$10\%:-2.7298$

The test statistic here is greater than the critical value, so the null hypothesis should be rejected, that is, the price of soybean meal, corn and live pigs between 2000 and 2018 cannot constitute a long-term stable relationship.

Then, adjust the time range and re-coordinate the test. The results of the cointegration test from 2000 to 2010 are as follows:

$t-test$	$p-value$	$value_table$		
-5.2681	6.3734×10^{-6}	$1\%:-4.3316$	$5\%:-3.2330$	$10\%:-2.7487$

The null hypothesis can be accepted. At this time, the variable soybean meal, corn price and the price of the pig are neat, and they can be considered to be stable for a long time.Therefore, it can be considered that the price of soybean meal and corn is a common factor affecting the price fluctuation of live pigs.

Combined with the previous analysis, it can be found that the cointegration relationship between the variables was destroyed around 2011, that is, there were other factors that affected the fluctuation of subsequent hog prices.By consulting the news materials, it was learned that in March 2011, Shuanghui Company was exposed to the use of clenbuterol, which directly led to the joint efforts of nine departments to carry out a one-year special remediation campaign for lean meat.It is this sudden factor that has affected the subsequent fluctuations in pork prices.

2.3.2 Recent cointegration test

Through the above tests, it was determined that the common influencing factors of pig prices are the price of soybean meal and corn.The above factors can be used to estimate the regression of the 2019 hog price data and make a cointegration test to find out whether the price fluctuation of pigs in 2019 is mainly affected by common factors.

Cointegration tests were performed using daily raw pig, soybean meal, and corn price data from 2018 to November 2019.

$$\Delta e_t = \delta e_{t-1} + \sum_{i=1}^{p} \theta_i \Delta e_{t-i} + \varepsilon_t$$

The test results obtained are as follows:

$t-test$	$p-value$	$value_table$		
-2.0132	0.2808	$1\% : -3.4489$	$5\% : -2.8697$	$10\% : -2.5711$

Therefore, the null hypothesis is rejected, indicating that there are other factors that significantly affect the fluctuation of the hog price.And this reason is also obvious. In August 2018, the first African swine fever appeared in China. Although there was government control, the African swine fever was still getting worse, which seriously affected the supply chain of pork. Serious price fluctuations in pork recently. In the cobweb theory, this phenomenon corresponds to the divergent cobweb model. If no intervention is imposed, the price fluctuation of the pig will increase periodically.

3 Research on the fallback of the pork price

3.1 Farming plan about pork

As is known to us all, Pork farming generally has a certain period. At present, the normal breeding cycle of pigs in China is 150-180 days.Among them, the main

commercial pigs, the Duroc, Changbai and Dabai pig ternary hybrids, have a breeding time of about 160 days, and the pigs with better foreign varieties have a shorter period before being slaughtered.The pigs that use the local varieties for hybridization have a relatively long fattening time, and the average production cycle is about 180-200 days.

At the same time, there is also a widespread economic phenomenon - “the pig cycle”, which refers to the cyclical pork price change cycle of ”high price hurts people, low price hurts farmers”.The cycle of the “pig cycle” can be described as: high meat prices –a large increase in sow stocks –an increase in the supply of live pigs –a drop in meat prices –a massive elimination of sows –a reduction in the supply of live pigs –a rise in meat prices.The high price of pork stimulates farmers' enthusiasm to increase supply. The increase in supply causes the price of meat to fall. The low price of meat has hit the enthusiasm of farmers and caused supply shortage. The shortage of supply has caused the price of meat to rise. It has formed a so-called ”pig cycle.”.

Pork, as a necessity in life, its market demand and supply characteristics determine that the price will inevitably fluctuate periodically, which is spontaneously driven by market forces, it will cause the overall level of market prices to rise, and will give people the consumption, life It causes interference and also greatly affects the stability of pork producers' income.However, this problem spontaneously generated by market forces cannot be solved solely by the market. It is necessary to introduce the role of the government and strengthen the macro management of daily necessities such as pork.

First, in the face of the sharp rise of pork prices in the short term, the government can properly sell reserved pork to stabilize pork prices.In fact, when domestic pork prices fall, the country should buy some pork for storage. When pork prices are out of control, the stock will be thrown out, so that domestic pork prices are easy to control.

Second, severely crack down on the behavior of storing goods individually.As the stock of live pigs has plummeted this year, many larger pig dealers have hoarded large quantities of acquired pork and put it in cold storage for sale. No matter how scarce domestic pork prices are, meat prices cannot rise so fast in a short time. Therefore, it is necessary to crack down on those who speculate on pork prices.

Third, import pork from other countries.To stabilize the price of pork,we may consider importing pork from others,which will be mentioned later.

Fourth, provide farmers with information on the supply and demand of various agricultural products in time.Farmers can produce according to market demand, avoiding the strange situation of oversupply of agricultural products in a while, and the shortage of agricultural products in a while.In this way, the fluctuation cycle of domestic agricultural products will cease to exist.

3.2 Analysis of pork market regulation policy

3.2.1 "Stabilizing the price" policy (buffering stock plan)

The government imposes the upper and lower limits of the circulation price (price stability zone) on the agricultural products that implement the stable price policy.when it is lower than the lower limit,it should be stored;while above the upper limit, the agricultural products are sold.

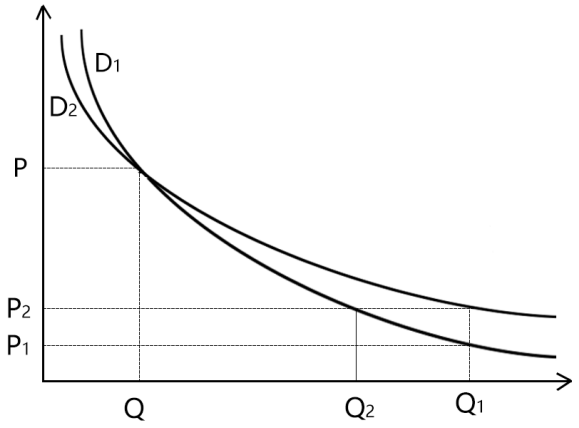

Figure 1: When the market price is below the lower limit of the stable price

Interpretation: When the market price is below the lower limit of the stable price, the economic effect of the stable price policy is shown in the figure. D shows the demand curve of pork under normal circumstances, the equilibrium point of market supply and demand is E, the supply and demand are both Q, and the equilibrium price is P. Suppose there is a large supply of pork in the market because of periodic fluctuations. At that time, the supply of pork was Q1. To sell all the pork of Q1, it can only be sold according to the price level of P1. If P1 is lower than the lower limit of the stable price of pork by the government, the government will intervene to collect and store the pork. Normal consumer demand, coupled with government intervention to collect reserves, the pork The total demand increased, and the demand curve changed to D2. Thus, when the pork supply is Q1, the price determines the delivery point E1 of Q1 and D2, and the price level rises from P1 to P2. at this time, the total supply of pork in the market, that is, the quantity bought by consumers, is only Q2, and the amount of the rest of Q1-Q2 is frozen by the government. The level to which P2 rises depends on the amount bought by the government.

Interpretation: When the market price is higher than the upper limit of the stable price, the economic effect of the stable price policy is shown in the figure. D indicates the demand curve of pork under normal condition. The supply and demand point of the market is E. The supply and demand are both Q and the equilibrium price is P. It is assumed that the pork in the market is suddenly supplied

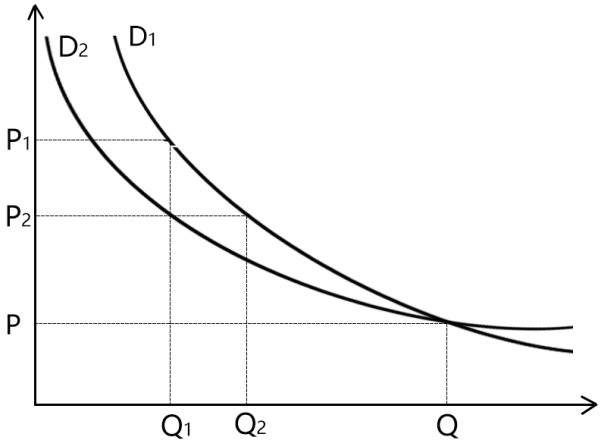

Figure 2: When the market price is above the upper limit of the stable price

under certain factors, the supply amount in the shortage state is only Q1, at this supply level, The price of agricultural products will rise to the price level of P1. If the price of P1 is higher than the upper limit of the government's price of pork, the government will use the reserve meat to increase supply and reduce the price of the pig. The government sell-off to increase supply and change the demand curve to D2 . In this way, when the pork yield is Q1, the price is determined at the intersection E2 of Q1 and D2, the price level is lowered from P1 to P2, and the number of pork that the consumer can purchase is increased to Q2, where the difference between Q1 and Q2 is the amount of the government's reserved meat.

Or we can establish a fund to reasonably determine the range of price fluctuations.When the market price is higher than the upper limit, some money is extracted from the excess as a fund, or part of the fund is subsidized by the consumer;While the price is below the lower limit, the government proposes part of the fund to subsidize the producer.

3.2.2 Circulation organization subsidy policy

The specific subsidy form is the identification and preferential policies of the intermediary organizations engaged in the circulation of agricultural products in the market, the financial support of the relevant breed breeding research institutions, the tax reduction and exemption for the transportation of pork (fresh agricultural products), and the toll-free fees.

The government's subsidy for pork supply and circulation is also to stabilize the pork market, such as financial subsidies and financial support for designated storage and storage companies, technical support and financial subsidies for quality certification and inspection agencies, and the opening of green channels for pork transportation.

3.3 Analysis of pork production regulation

3.3.1 Producer subsidy policy

The main goal is to stabilize market supply and increase pork producer income.

Direct subsidies,which directly increase the income of producers through transfer payments. The specific forms of direct subsidies include production materials subsidies, sales spread subsidies, hog insurance subsidies, tax reductions, and special funds disbursement. Indirect subsidies,which reduce producers' expenditures indirectly and increase their income.

The indirect subsidies include the government's direct acquisition of pork, information service subsidies, farm infrastructure subsidies and regional support.

3.3.2 Establishment of epidemic prevention and control support policy

To expand the coverage, promote technology development, and build a complete system of disease prevention and control.

3.4 Analysis of pork consumption regulation

3.4.1 Subsidy policy for consumers

Direct subsidies("light supplements") are those the government directly gives to market' s pork consumers according to certain criteria;

Indirect subsidies ("dark supplements") are some regulations that the government aims to reduce consumers' actual spending in a certain way, such as setting the maximum price limit for agricultural products.

The subsidy can also be classified as non-target subsidies (all members of society) and target subsidies (a specific group).

3.5 Establish a supply guarantee mechanism for pork production

1. Predicting the annual total demand for pork in advance the state and relevant institutions should publish the national and provincial pork demand forecast data for the year and the province at the beginning of each year through research and analysis.

2. Encourage the development of standardized scale breeding standardized scale breeding can start from scientific feeding and refined breeding, that is, using industrial standard production mode to develop pig breeding industry

3. Strengthen the promotion of improved pig breedingto establish a scientific and effective breeding system for improved pigs, accelerate the market share promotion of elite varieties, pay attention to the combination of variety introduction and improvement.Promote good-quality, disease-resistant, high-performance pigs with large-scale production and improved pork production capacity.According to the number of live pigs and the number of pigs, we support the establishment of improved farms, use government tenders, and operate the company to accelerate the improvement of varieties and improve the quality of the pig market and pork.

4.Increasing the level of insurance subsidies and diversification of insurance products is a fundamental measure to protect the interests of farmers. It can be considered to gradually promote from the policy insurance of the sows to all the live pigs.

3.6 The formation of a perfect pork market system

1. **Establish a thorough market information releasing mechanism**According to the existing system, the relevant functional departments will release the feed price, pig food price, white meat price, piglet price, live pig stock, and sow stock respectively, on a weekly, monthly, and quarterly basis. Remind farmers to regulate the farming structure and avoid market risks.

2. **The integration of industry, academy and research and the mechanism of supply and marketing**To establish technology application integration, the use of industrialized organizational forms, promote the integration of production, education and research, and strengthen the demonstration and promotion of new technologies and new varieties.

3. **Set up a hog price adjustment fund to set up a price adjustment fund specifically for the regulation of the hog market.** When the price of live pigs is too high or too low, the hog market fluctuation cycle can be ironed by appropriate measures such as appropriate storage or subsidy production, subsidies for low-income groups, and alleviate the impact of excessive pork price increases on low-income groups.

4. **Vaccine R&D and prevention mechanisms** To improve the long-term development of vaccine research and development, it is necessary to vigorously develop cold chain logistics, and it is strictly forbidden to transport live pigs across provinces, regions, cities and counties.Strengthen fixed-point slaughter and increase market enforcement.Eliminate the risk of spread of disease caused by long-distance live pig transportation.

3.7 Transfer Passive regulation to Initiative regulation

The support of the government's price control policy should choose the timing of scientific and rational policies, and timely control, active regulation, and scientific

regulation under the premise of mastering information. In the long run, the key strategy for stabilizing prices is to strengthen and expand the pork industry around the technical support, market system and industrial development. If only the pork industry continue to develop steadily and healthily, our pork production and market would be stable, and so do the pork price.

3.8 Pork import from other countries

In the current situation of tight supply of pork and low stock of pigs, it is necessary to rely on pork imports to ensure stocks.China's pork imports account for only about 2% of total domestic consumption, and the overall size is still small. Domestic pork price is an important factor affecting pork imports.When domestic pig prices are high, the spread of domestic and international products will lead to profitable imports, and pork imports will increase significantly, vice versa.

From the perspective of specific import structures (countries), China's pork imports are also facing multiple uncertainties.

1. At the beginning of June, due to the detection of ractopamine (clenbuterol) residues in Canadian pork products, China suspended the pork products of the enterprises involved in China, and in the subsequent follow-up investigation, we found that the official veterinarian attached to the Chinese pork The certificate was forged, so China took emergency preventive measures to suspend the issuance of meat certificates for export to China from June 25.Canada, as the world's third largest pork exporter (after the EU-27, the United States), and China's third largest pork importer (after Germany, Spain), the suspension of pork exports to China will intensify the shortage of domestic pork supply to some extent.

2. The current African swine fever is spreading in Asia. At present, there are 6 cases of African swine fever in China, Vietnam, Cambodia, North Korea, Mongolia and Laos. In addition to foreign countries, the Vietnam pig swine epidemic is also more serious. Since its inception in February 2019, there have been 2813 African swine fever epidemics in Vietnam, and more than 2.9 million live pigs have been culled nationwide, accounting for more than 10% of the national herd. In the first half of 2019, Vietnamese pork imports increased by 670.8% year-on-year. In the past, Vietnam has long been a net exporter of pork. We believe that with the continued spread of the African swine fever epidemic and damage to local base production capacity, Vietnam will turn to the net importer of pork and will also compete with China for pork import resources.

3. With the continuation of Sino-US trade frictions, US pork exports to China have been declining for two consecutive years. After the first talks between the US and China, bilateral trade relations have eased. Follow-up China may increase imports of US agricultural products, and the amount of pork exported by the US. Will change the initial trend, thereby increasing the supply of pork to the domestic market.

Therefore, we believe that whether it is from the total import of pork or the

structure of imports, the adjustment and changes in the status of the import end, the impact on domestic pig prices is still mainly in the short-term disturbance, it is difficult to change the rapid production capacity of China's pig breeding industry. The established fact of contraction, the main logic of the shortage of pig supply is expected to continue in the future, and the upward trend of the pig cycle will remain unchanged.

3.9 Domestic pig prices have entered an upward cycle

As a result,We expect China's pork imports to break through the high level of 2016 in 2019, setting a new historical import record.The United States may contribute to the increase of China's important pork imports in 2019: 1) Since 2016, the US pork export volume has restarted faster, with a total export volume of 2.17 million tons in 2018, a year-on-year growth rate of about 6.3%; 2) US trade friction is the result of a sharp decline in the number of imported US pork in 2018. As Sino-US trade frictions have eased, Sino-US pork trade has rebounded significantly since 2019.Based on the sensitivity of pig prices to the amount of pork that can be actually imported in China from 2019 to 2020, we believe that China's total pork imports in 2019 and 2020 may reach 1.36-2.22 million tons and 2.34-3.2 million tons.

Due to the huge demand for trial production of pork in China, China has added new members to countries that allow pork imports, such as Kazakhstan in Central Asia and Argentina in South America.

4 Analysis and Solution of Problem 3

4.1 Research on optimal supply strategy

4.1.1 problem analysis

In the pork market, there is often a phenomenon in which the price of pork in a certain period is greatly affected by an accidental factor and is much higher than the equilibrium price. Producers have found profits and blindly expand the scale of pork farming, leading to a surge in pork listings in the next period that exceeds the relatively stable demand of consumers. As a result, pork prices fall sharply in the next period, and large producers find pig-breeding is not as profitable as other industries or compress the supply of pork, then there will be a shortage of supply in the next period, which will lead to a rise in pork prices.

Under the circumstances where there is no outside intervention, this phenomenon will continue to circulate. Since consumers' demand for pork is relatively stable and it is difficult to guide their consumption behavior, it is of great significance to find a reasonable supply strategy that can guide the majority of producers to ensure

long-term relative stability of pork prices.

4.1.2 Cobweb model

In economics, the method of using graphic methods to describe the fluctuations of quantity and price of goods is called the cobweb model. The traditional cobweb model theory is a kind of dynamics Equilibrium analysis model proposed by the famous British economist Nicolas Kaldor in the 1930s when he studied how the market price, supply and demand of commodities rise and fall as time goes by.

The cobweb model generally has three forms:

Convergence Cobweb: As time goes by, the actual price k will fluctuate around the equilibrium price in a smaller and smaller range, and finally convergences to the equilibrium price. This is also the ideal state we want to achieve.

Divergent Cobweb: As time goes by, the actual price k will fluctuate around the equilibrium price with increasing amplitude, and finally deviate from the equilibrium price infinitely. As the price fluctuations become larger and larger, the outward divergence will not restore balance.

Closed Cobweb: The actual price fluctuates around the equilibrium price with the same magnitude. Neither further deviations nor closer to equilibrium prices.

In view of the features of this problem, we analyze the convergence conditions of the cobweb model to study What kind of supply strategy can make the price and quantity of pork tend to be stable based on different needs of consumers for pork in different time zones and different regions after long-term shocks.

4.1.3 Model assumptions and symbolic description

The number of pork in the market in a certain period of time is x_k, $k = 1, 2, \cdots$. Here we discrete time into time periods, and one time period is equivalent to a feeding period of livestock.

The price of pork in one period is y_k. Depending on the quantity x_k , Assume

$$x_k = a - \gamma y_k, \gamma > 0 \tag{7}$$

It reflects the consumer's demand for pork, called the demand function, γ is seen as the consumer's demand price elasticity. For the sake of simplicity of analysis, we assume that the function is a linear function. Because the higher the quantity of pork, the lower the price, so we use a falling line to indicate it.

The quantity of pork x_{k+1}in the next period is determined by the price of current period y_k , assume

$$x_{k+1} = b + \beta y_k, \beta > 0 \tag{8}$$

It reflects the producer's supply strategy, called the supply function, β can be regarded as the producer's supply price elasticity; because the higher the price, the larger the output in the next period, so the function is a rising straight line.

The two lines intersect at$P_0(x_0, y_0)$, the equilibrium point, which means that in a certain period of time, there is $x_k = x_0$, there is $y_k = y_0, x_{k+1} = x_0, y_{k+1} = y_0, \cdots$ .That is, the quantity and price of products in the following period will remain at that point forever. Although the interference in the real world makes it impossible for quantity and price to stop at $P_0(x_0, y_0)$, we can find the convergence conditions of y_k under the assumption that the consumers' demand is relatively stable.

4.1.4 Model establishment and solution

Considering the demand function and the supply function,

$$\gamma y_k + \beta y_{k-1} + b - a = 0 \tag{9}$$

It is a first-order constant coefficient linear difference equation. Using the knowledge of the difference equation ,

$$y_k = \frac{a-b}{\gamma+\beta} + (-\frac{\beta}{\gamma})^k \left(y_0 - \frac{a-b}{\gamma+\beta} \right) \tag{10}$$

When $k = 0$,the price is y_0,and $\frac{a-b}{\gamma+\beta}$ is the price of pork at equilibrium. If the price of pork at the beginning of the process $y_0 = \frac{a-b}{\gamma+\beta}$, then there is $y_k = \frac{a-b}{\gamma+\beta}$. That is to say, in the absence of external disturbances, if the price fluctuates from the long-term equilibrium point, the pork price will remain stable for a long time at the equilibrium point.

However, in most cases, the price of pork on the market tends to be unequal to the equilibrium price, that is

$$y_0 \neq \frac{a-b}{\gamma+\beta}$$

. Assume $y_0 < \frac{a-b}{\gamma+\beta}$ From the above formula, we know that the price of pork in the first phase is

$$y_1 = \frac{a-b}{\gamma+\beta} + (-\frac{\beta}{\gamma}) \left(y_0 - \frac{a-b}{\gamma+\beta} \right) \tag{11}$$

at this time y_1 is higher than the equilibrium price$\frac{a-b}{\gamma+\beta}$

For the second period,

$$y_2 = \frac{a-b}{\gamma+\beta} + (-\frac{\beta}{\gamma})^2 \left(y_0 - \frac{a-b}{\gamma+\beta} \right) \tag{12}$$

At this time y_2 is lower than the equilibrium price. It can be seen that in the later periods, the market price is higher than the equilibrium price when k is odd, and lower than the equilibrium price when k is even. Market prices will fluctuate around equilibrium prices, which explains the price oscillations of the cobweb model from a mathematical perspective.

Furthermore, if$\beta < \gamma$, when k approaching infinity , $(-\frac{\beta}{\gamma})^k$tend be to zero, which means $y_k$tends to approach the equilibrium price; if $\beta > \gamma$, when k approaching infinity, $(-\frac{\beta}{\gamma})^k$ tends to be infinity, which means the infinite deviation of y_k from equilibrium prices . Therefore $\frac{\beta}{\gamma}$determines whether the pork price converges towards a long-term equilibrium.

That is to say, under the premise that the demand for pork in a certain area is relatively stable, the producer's supply strategy can be guided by estimating the price elasticity of the demand for pork, so that the pork price can finally converge to the equilibrium price and achieve the Convergence Cobweb model.

4.1.5 Empirical analysis

In order to estimate the supply and demand function and corresponding elasticity of the Chinese pork market, we built a regression model using the nationwide pork consumption in 2000-2018 and the annual average pork price. The data sources are China Animal Husbandry Information Network and China Statistical Yearbook.

The pork demand function is

$$x_k = -84.87547722y_k + 6424.78120877 \tag{13}$$

The estimated elasticity of demand $\hat{\gamma}$=-84.87547722.

The supply function of pork is

$$x_{k+1} = 90.46967737y_k + 3024.35639589 \tag{14}$$

The estimated value of supply elasticity $\hat{\beta}$ is 90.46897737.

The value of $\hat{\beta}/\hat{\gamma}$ is 1.065902, which indicates that the relationship between pork price and pork supply in China is consistent with the divergent cobweb model. The price will be in a long-term shock and gradually deviate from the equilibrium point only if the price is spontaneously adjusted without external influence. **Figure 1** is a scatter plot of China's average price of pork during the period 2000-2018 , clearly showing that the fluctuation of pork prices in China is consistent with the divergent cobweb model, which also confirms that our conclusions obtained from estimated elasticity are reasonable.

Therefore, it is reasonable to predict the trend of price volatility by estimating the elasticity of demand and supply elasticity and judging the relative size of the

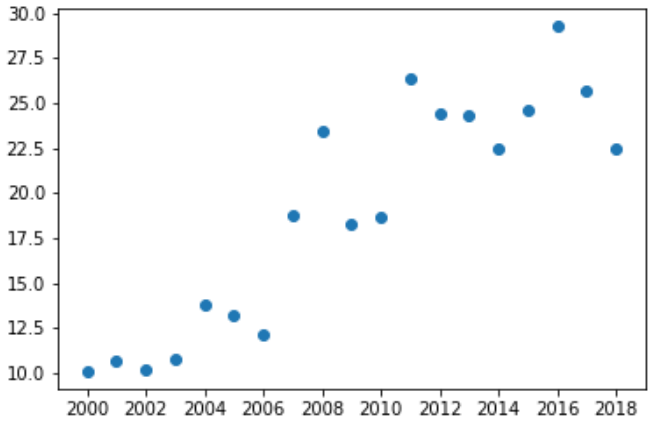

Figure 3:

two, which can be used as a reference to guide producers to choose supply strategy according to market price.

4.1.6 Conclusion

Based on the above analysis, we suggest that local policy makers can estimate the elasticity of demand for pork in the region based on historical data of local pork prices and consumption, and release macro data to pork farmers in time . This can provide a reference for their production plans, guiding producers in the face of price fluctuations not to blindly expand or compress the scale of production, so that the supply elasticity is less than the elasticity of demand, finally pork prices move to equilibrium prices in the long run.

The optimal supply strategy model we established is only the original model simplified under many assumptions, which needs further improvement and verification. When policy makers use it, they can correct the model by more accurately fitting the local supply and demand function of pork, considering the effect of lagging multi-period price on the supply function, and eliminating the inflation factor from price, thus ensuring the effectiveness of policy , providing pork producers with more scientific guidance.

4.2 Research on pork storage strategy

4.2.1 problem analysis

As described in the previously mentioned cobweb theory, due to the lack of accurate market information that can be used to aid decision making, and being susceptible to other producers in the industry, over-reacting to pork prices, like excessively increasing or decreasing supply, resulting in large supplies elasticity

eventually leads to an infinite deviation of the price of pork on the market from equilibrium prices; this also shows that it is difficult to achieve stable pork prices by market regulation alone, and pork prices tend to show strong cyclical fluctuations around equilibrium prices.

The essence of pork price instability comes from the imbalance between supply and demand in the pork market. As market regulators, governments often establish a pork storage system that changes with the pork supply and demand pattern, through timely acquisition of excess pork in the market or releasing stocks at peak demand to ensure that price levels are effectively controlled when there is an excessive imbalance between supply and demand in the market. We hope to find a storage strategy that minimizes the cost in a storage cycle and can effectively respond to supply and demand imbalances. Therefore, the storage theory in operations research is used to demonstrate the optimal storage strategy.

4.2.2 Model assumptions and symbol description

The storage system in operations research is a real-life operating system consisting of three parts: supplement, storage and demand.

First assume that the storage is replenished once in a period t , cost in one storage period includes: storage fee $C1$, relating to the amount of storage and storage time; order fee $C3$, It can be proved that it has nothing to do with the ordering quantity; shortage cost $C2$, relating to the number of out of stock and stock-out time.

The following assumptions are made in a certain demand storage strategy that allows for out-of-stock and long-term replenishment:

1. The demand is continuous and uniform, that is, the demand R per unit time is constant.

2. The replenishment takes a certain amount of time, only the replenishment time is considered, and the purchase is continuous and uniform, that is, the purchase rate P is constant, and$P > R$.

3. Unit storage fee $C1$, unit out of stock fee$C2$, order fee$C3$, regardless of the value of the goods.

4.2.3 Model establishment and solution

According to the model hypothesis, a typical pork storage cycle can be represented by Fig.4.

As shown in the figure, the storage is zero in the [0,t_1] time, and the stock is not replenished, and the maximum stock shortage B is reached at t_1.

In the time [t_1,t_2], satisfying the demand in the rate R. Meanwhile, supplying the shortage in [0,t_1] in the rate $(P - R)$. The shortage is filled by t_2.

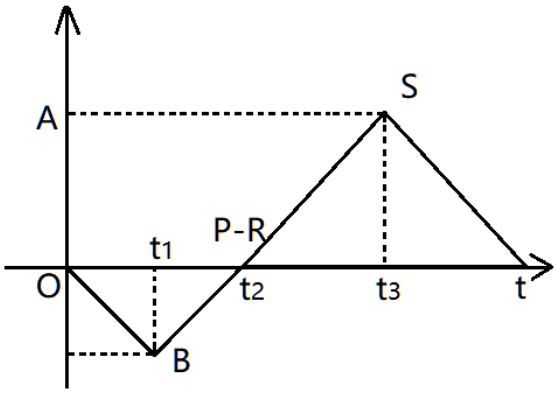

Figure 4:

In the time[t_2,t_3], satisfying the demand in the rate R and expanding the storage in the rate($P-R$), reaching the maximum storage S by $t_3$and stopping replenishing.

In the time[t_3,t], satisfying demand with storage, and the stock reducing in the rate R.

[0,t_1]The maximum shortage$B = Rt_1$,

$[t_1, t_2]$The maximum shortage$B = (P - R)(t_2 - t_1)$,

$[t_2, t_3]$The maximum storage$S = (P - R)(t_3 - t_2)$,

$[t3, t]$The maximum storage$S = R(t - t_3)$.

[0,t]The storage fee$\frac{1}{2}C_1(P - R)(t_3 - t_2)(t - t_2)$, The shortage fee$\frac{1}{2}C_2Rt_1t_2$, The order fee$C_3$.

$[0, t]$The average total fee is

$$C(t, t_2) = \left[\frac{1}{2}C_1(P - R)(t_3 - t_2)(t - t_2) + \frac{1}{2}C_2Rt_1t_2 + C_3\right]/t \tag{15}$$

$$= \frac{(P - R)R}{2P}\left[C_1t - 2C_1t_2 + (C_1 + C_2)\frac{t_2^2}{t}\right] + \frac{C_3}{t} \tag{16}$$

Find the partial derivative of the objective function and make it equal to zero

$$t^* = \sqrt{\frac{2C_3}{C_1R}} \cdot \sqrt{\frac{C_1 + C_2}{C_2}} \cdot \sqrt{\frac{P}{P - R}} \tag{17}$$

The total purchase volumeQ^* in the cycle is

$$Q^* = Rt^* = \sqrt{\frac{2C_3R}{C_1}} \cdot \sqrt{\frac{C_1 + C_2}{C_2}} \cdot \sqrt{\frac{P}{P - R}} \tag{18}$$

The average total cost

$$C^* = \frac{2C_3}{t^*} \tag{19}$$

The point of making up the storage

$$t_2^* = \frac{C_1}{C_1 + C_2} t^* \tag{20}$$

The point of replenishing

$$t_1^* = \frac{P - R}{P} t_2^* \tag{21}$$

The point of stopping replenishing

$$t_3^* = \frac{R}{P} t^* + (1 - \frac{R}{P} t2^*) \tag{22}$$

The maximum storage

$$S^* = R(t^* - t_3^*) \tag{23}$$

The maximum shortage

$$B^* = Rt_1^* \tag{24}$$

Taking into account the special role of the government in the market economy, the goal of optimization is not only to minimize the average cycle cost, but also to consider the impact of the government's procurement, storage and sales strategies on the pork market. Therefore, in order to achieve the goal that the government's pork stocks can effectively meet the demand when the demand for pork reaches a peak in a certain region, we will add the restrictions that the market demand must be met, that is, the shortage of goods is not allowed. In the optimal solution of the model, The restriction is expressed as the out-of-stock cost$C_2 \to \infty$,$t_2 = 0$.

At this point, the original model optimal solution becomes

$$t^* = \sqrt{\frac{2C_3 P}{C_1 R(P - R)}} \tag{25}$$

$$Q^* = \sqrt{\frac{2C_3 RP}{C_1(P - R)}} \tag{26}$$

$$t_3^* = \frac{R}{P} t^* \tag{27}$$

$$S^* = R(t^* - t_3^*) = \frac{R(P - R)}{P} t^* \tag{28}$$

$$C^* = \frac{2C_3}{t^*} \tag{29}$$

4.2.4 Model interpretation

From the formula of the optimal solution with the added restrictions, what we care is the reasonable procurement cycle of pork and it is determined by the demand for pork in a certain area$R$, the rate of pork stock replenishment P, the fixed cost of a single purchase C_3, and the storage cost per kilogram of unit storage time C_1. And reasonable maximum stock S^* is determined by the procurement cycle t^* P, R. The minimum total cost of the cycle is determined by C_3, t^*.

Under normal circumstances, we believe that the demand for pork in a certain region, whether it is at the peak or the trough, is uniform and will not change much; at this time, government workers can increase purchases or purchase in advance. Improve the replenishment rate of pork to extend the storage period of pork, so as to achieve the minimum storage cost that can stabilize the market price under the circumstances where no other variables change; similarly , adopting a more economical transportation method, that is, reducing the ordering cost C_3 will also make the average total cost decrease in one circle.

4.2.5 Model improvement

The optimal storage model we establish based on certain needs is only a specific model simplified under the reasonable assumptions. However, the actual situation and the factors to be considered are often more complicated. First, the demand and rate of pork supplements are often not a certain constant, in reality it is more likely to obey an unknown probability distribution, then we can consider a random storage model with random factors; secondly, we assume that the storage model chooses a timing storage strategy, however, The strategy maker may not purchase in strict accordance with the storage cycle, but purchases when the inventory is below a certain threshold s , and replenishes the inventory to the maximum inventory S , this strategy is called fixed-point storage strategy; sometimes, we can incorporates maximum cost or warehousing constraints to in the model to simulate more complex situations that policy makers may face, establishing an optimal storage model that is closer to the real-world scenario. For more complex models described above, we will not further research due to the limit of time.

4.3 Summary

For the third problem, we first use the cobweb model in economics to explain the oscillation of the quantity and price of pork in the market around the equilibrium state. Under the premise that the elasticity of pork demand is relatively stable, the long-term equilibrium relationship of pork market price is obtained by solving

the difference equation: when the producer's supply price elasticity is less than the consumer's demand price elasticity, the pork price will finally convergence to the equilibrium price; we use the data of pork consumption of 2000-2018 to fit the demand and supply function of pork respectively, drawing to the conclusion that the estimated elasticity of demand elasticity is less than the estimated value of supply elasticity . The fluctuation trend of pork price during the period matches the divergent cobweb model, which also verifies the correction of using demand elasticity and supply elasticity to judge the price fluctuation trend of commodity market, which can provide a reference for producers to develop farming plans. We also established the optimal pork storage model based on storage theory with strict constraints. By solving the model, we obtained the optimal storage cycle, the minimum average cycle cost, and the formula of the maximum pork stock in one cycle, analyzed the variables that affect solution of the model. Finally, we put forward some suggestions on how to improve and correct the existed model.

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Appendices

Appendix A appendix

```
import pandas as pd
import numpy as np
import requests as rq
import time
from datetime import datetime

path = 'C:/Users/zz/Desktop/porkdata/'

def get_data(name, url = 'https://hangqing.zhuwang.cc/zhurou/list-65-'):
    pages = np.arange(25, 92)
    df = pd.DataFrame(columns=['Date', 'Rigion', 'Price'])
    for page in pages:
        fullurl = url + page.astype(str) + '.html'
        # print(fullurl)
        r = rq.get(fullurl)
        content = r.text
        raw = content.split("<p class=\"zxleft31\">")
        time.sleep(1)
        for dayprice in raw[1:]:
            if not "全国各省市猪白条肉价格行情走势" in dayprice:
                continue
            if not "2018" in dayprice:
                continue
            try:
                date = datetime.strftime(datetime.strptime(dayprice.split('全国各省市
                day_url = dayprice.split('"')[1]
                if not 'https:' in day_url:
                    day_url = 'https:' + day_url
                daydata = get_dayprice(day_url)
                daydata['Date'] = date
                df = df.append(daydata)
            except Exception as e:
                print(e)
                pass
            print(df)
        filename = path + name + page.astype(str) + '.csv'
        df.to_csv(filename)
        print(filename)
        df = pd.DataFrame(columns=['Date', 'Rigion', 'Price'])

# 爬取日价格页面1
def get_dayprice(url):
    time.sleep(0.1)
```

```
    if '-1.html' in url:
        return get_dayprice2(url)
    r = rq.get(url)
    day_data = pd.DataFrame(columns=['Rigion', 'Price'])
    content = r.text
    splitstr1 = '<span style="font-family:宋体;">'
    splitstr2 = '</span>'
    if not splitstr1 in content:
        splitstr1 = '<span style="font-size:14px;">'
        splitstr2 = '</span>'
    chaos = content.split(splitstr1)
    for rigion_inf in chaos[1:]:
        try:
            rigion = rigion_inf.split(' ')[0]
            price = rigion_inf.split(' ')[3].split(splitstr2)[0]
            day_data = day_data.append({'Rigion': rigion, 'Price': price}, ignore_ind
        except Exception as e:
            print(e)
            pass
    if '_2' in url:
        return day_data
    day_data = day_data.append(get_dayprice(url.split('.html')[0] + '_2.html'))
    return day_data

# 爬取日价格页面2
def get_dayprice2(url):
    url = url.split('-1.html')[0]
    day_data = pd.DataFrame(columns=['Rigion', 'Price'])
    for pn in range(1, 5):
        curl = url + '-' + str(pn) + '.html'
        cr = rq.get(curl)
        ccontent = cr.text
        chaos = ccontent.split('<span style="font-size:14px;">')
        for cchaos in chaos[1:]:
            try:
                if ' ' in cchaos:
                    rigion = cchaos.split(' ')[0]
                    price = cchaos.split(' ')[3].split('</span></p>')[0]
                    day_data = day_data.append({'Rigion': rigion, 'Price': price}, ig
            except Exception as e:
                print(e)
                pass
    return day_data

>>> get_data('price') # 调用函数开始爬取

import pandas as pd
import numpy as np
import requests as rq
import time
from datetime import datetime

# 爬取玉米价格
path = 'C:/Users/zz/Desktop/corndata/'

```

```
 99 def get_data(name, url='https://hangqing.zhuwang.cc/yumi/list-68-'):
100     pages = np.arange(230, 492)
101     df = pd.DataFrame(columns=['Date', 'Rigion', 'Price'])
102     for page in pages:
103         fullurl = url + str(page) + '.html'
104         r = rq.get(fullurl)
105         content = r.text
106         raw = content.split("<p class=\"zxleft31\">")
107         time.sleep(1)
108         for dayprice in raw[1:]:
109             if not "全国玉米价格行情走势汇总" in dayprice:
110                 continue
111             if not "2018" in dayprice:
112                 continue
113             try:
114                 date = datetime.strftime(datetime.strptime(dayprice.split('全国玉米价
115                 day_url = dayprice.split('"')[1]
116                 if not 'https:' in day_url:
117                     day_url = 'https:' + day_url
118                 daydata = get_dayprice(day_url)
119                 daydata['Date'] = date
120                 df = df.append(daydata)
121             except Exception as e:
122                 print(e)
123                 pass
124             print(df)
125         filename = path + name + page.astype(str) + '.csv'
126         df.to_csv(filename)
127         print(filename)
128         df = pd.DataFrame(columns=['Date', 'Rigion', 'Price'])
129
130 def get_dayprice(url):
131     time.sleep(0.1)
132     r = rq.get(url)
133     day_data = pd.DataFrame(columns=['Rigion', 'Price'])
134     content = r.text
135     chaos = content.split('<tbody>')[1].split('</tbody>')[0].split('<tr>')
136     for rigion_inf in chaos[1:]:
137         inf = rigion_inf.split('<td align="center">')
138         rigion = inf[1].split('</td>')[0]
139         price = inf[2].split('</td>')[0]
140         day_data = day_data.append({'Rigion': rigion, 'Price': price}, ignore_index=T
141     return day_data
142
143 >>> get_data('corn') # 调用函数开始爬取
144
145 path = 'C:/Users/zz/Desktop/beandata/'
146
147 # 爬取豆粕价格
148 def get_data(name, url='https://hangqing.zhuwang.cc/doupo/list-67-'):
149     pages = np.arange(196, 197)
150     df = pd.DataFrame(columns=['Date', 'Rigion', 'Price'])
151     for page in pages:
152         fullurl = url + str(page) + '.html'
153         r = rq.get(fullurl)
```

```
154             content = r.text
155             raw = content.split("<p class=\"zxleft31\">")
156             time.sleep(1)
157             for dayprice in raw[1:]:
158                 if not "全国豆粕价格行情走势汇总" in dayprice:
159                     continue
160                 if not "2018" in dayprice:
161                     continue
162                 try:
163                     date = datetime.strftime(datetime.strptime(dayprice.split('全国豆粕价
164                     day_url = dayprice.split('"')[1]
165                     if not 'https:' in day_url:
166                         day_url = 'https:' + day_url
167                     # get_dayprice()函数与玉米相同
168                     daydata = get_dayprice(day_url)
169                     daydata['Date'] = date
170                     df = df.append(daydata)
171                 except Exception as e:
172                     print(e)
173                     pass
174                 print(df)
175             filename = path + name + page.astype(str) + '.csv'
176             df.to_csv(filename)
177             print(filename)
178             df = pd.DataFrame(columns=['Date', 'Rigion', 'Price'])
179
180 >>> get_data('bean')
181
182 # 由于为避免爬取过程中断连，采用分页下载存储。
183 # 因而需要在爬取过后进行整合。
184
185 # 整合函数
186 def dataCombine(filename):
187     filenames = [x for x in os.listdir(filename)]
188     df = pd.read_csv(filename + filenames[0], index_col=0)
189     for file in filenames[1:]:
190         try:
191             df = df.append(pd.read_csv(filename + file , index_col=0))
192             print(df)
193         except Exception as e:
194             print(e)
195             pass
196     df.to_csv(filename + filename.split('/')[-2] + '.csv')
197
198 >>> dataCombine('C:/Users/zz/Desktop/corndata/')
199 >>> dataCombine('C:/Users/zz/Desktop/porkdata/')
200 >>> dataCombine('C:/Users/zz/Desktop/beandata/')
201
202
203 import matplotlib.pyplot as plt
204 import pandas as pd
205 import numpy as np
206
207 path = 'C:/Users/zz/Desktop/porkdata.csv'
208 data = pd.read_csv(path, index_col=[0])
```

```
data.values

df = pd.DataFrame(['Date', 'Price', 'Rigion'])
temp = data.values[0]
count = 1
for day_inf in data.values:
    if day_inf[0] == temp[0] and day_inf[2] == temp[2]:
        count = count + 1
        temp[1] = str(round(((float(day_inf[1]) + float(temp[1])*(count-1))/ count),
    else:
        df = df.append({'Date':temp[0], 'Price':temp[1], 'Rigion':temp[2]}, ignore_in
        count = 1
        temp = day_inf
df = df.append({'Date':temp[0], 'Price':temp[1], 'Rigion':temp[2]}, ignore_index=True
print(df)
df.to_csv('C:/Users/zz/Desktop/pork.csv')

df = pd.DataFrame(['Date', 'Price', 'Rigion'])
temp = data.values[0]
count = 1
for day_inf in data.values:
    if day_inf[0] == temp[0] and day_inf[2] == temp[2]:
        count = count + 1
        temp[1] = str(round(((float(day_inf[1]) + float(temp[1])*(count-1))/ count),
    else:
        df = df.append({'Date':temp[0], 'Price':temp[1], 'Rigion':temp[2]}, ignore_in
        count = 1
        temp = day_inf
df = df.append({'Date':temp[0], 'Price':temp[1], 'Rigion':temp[2]}, ignore_index=True
print(df)

df = pd.DataFrame(columns=['Date', 'Price', 'Rigion'])
data = pd.read_csv('C:/Users/zz/Desktop/pork2.csv', index_col=[0])
for day_inf in data.values:
    if day_inf[2] == '山东省':
        df = df.append({'Date': day_inf[0], 'Price': day_inf[1], 'Rigion': day_inf[2]
print(df)


fig, axes = plt.subplots(3, 3, figsize=(15, 15))
ps = ['辽宁省', '江苏省', '山东省', '四川省', '河南省', '山西省', '河北省', '吉林省',
for p,ax in zip(ps, axes.ravel()):
    ax.plot(data[data['Rigion'] == p]['Date'], data[data['Rigion'] == p]['Price'])


# view-source:http://www.caaa.cn/market/zs/xml/1/3.xml
series = pd.DataFrame(['Date', 'Price'])
markfile = 'C:/Users/zz/Desktop/00-19market.xml'
# http://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A0D0P&sj=2018
porknum = pd.read_csv('C:/Users/zz/Desktop/porknum.csv')
with open(markfile, 'r', encoding='utf-8') as f:
    content = f.read()
    years = content.split('</series>')
    for year in years:
        chaos = year.split('<point name="')
```

```
264             year_val = chaos[0].split('<series name="')[1].split('年">')[0]
265             y_val = 0
266             for month in chaos[1:]:
267                 # month_val = month.split('" y="')[0]
268                 y_val = y_val + float(month.split('月" y="')[1].split('"')[0])
269             series = series.append({'Date': year_val, 'Price': y_val / 12}, ignore_index=
270         print(series)
271
272
273 xp = np.linspace(price.min(), price.max())
274 predict_y = reg.predict(xp.reshape(-1, 1))
275 plt.plot(xp, predict_y)
276 plt.scatter(price, pork_num)
277 print(reg.coef_)
278 print(reg.intercept_)
279
280 reg = LinearRegression()
281 reg.fit(price[:-1], pork_num[1:])
282 xp = np.linspace(price.min(), price.max())
283 predict_y = reg.predict(xp.reshape(-1, 1))
284 plt.plot(xp, predict_y)
285 plt.scatter(price[:-1], pork_num[1:])
286 print(reg.coef_)
287 print(reg.intercept_)
288
289
290 df1 = pd.DataFrame(['pork_price', 'corn_bean_price'])
291 for day in date:
292     try:
293         df1 = df1.append({'pork_price': pork[pork['Date']==day]['Price'].values[0], '
294     except Exception as e:
295         print(e)
296         pass
297 a_price = df1['corn_bean_price'].values[2:]
298 b_price = df1['pork_price'].values[2:]
299
300 df = pd.DataFrame(['corn', 'bean'])
301 for tp in a_price:
302     df = df.append({'corn': tp[0], 'bean': tp[1]}, ignore_index=True)
303 print(df)
304 df.to_csv('C:/Users/zz/Desktop/zz.csv')
305
306 zz = pd.read_csv('C:/Users/zz/Desktop/zz.csv', index_col=[0])
307 e = b_price - ols.predict(np.matrix(zz.values))
308 adfuller(e)
309
310 # view-source:http://www.caaa.cn/market/zs/xml/1/11.xml
311 series = pd.DataFrame(['Date', 'Price'])
312 markfile = 'C:/Users/zz/Desktop/00-18corn.xml'
313 with open(markfile, 'r', encoding='utf-8') as f:
314     content = f.read()
315     years = content.split('</series>')
316     for year in years:
317         chaos = year.split('<point name="')
318         year_val = chaos[0].split('<series name="')[0].split('年">')[0]
```

```
319             y_val = 0
320             for month in chaos[1:]:
321                 # month_val = month.split('" y="')[0]
322                 y_val = y_val + float(month.split('月" y="')[1].split('"')[0])
323             series = series.append({'Date': year_val, 'Price': y_val / 12}, ignore_index=
324         print(series)
325 series.to_csv('C:/Users/zz/Desktop/cornmarket.csv')
326
327 series = pd.read_csv('C:/Users/zz/Desktop/cornmarket.csv', index_col=[0])
328 corn = series['Price'].values
329
330 # view-source:http://www.caaa.cn/market/zs/xml/1/12.xml
331 series = pd.DataFrame(['Date', 'Price'])
332 markfile = 'C:/Users/zz/Desktop/00-18bean.xml'
333 with open(markfile, 'r', encoding='utf-8') as f:
334     content = f.read()
335     years = content.split('</series>')
336     for year in years:
337         chaos = year.split('<point name="')
338         year_val = chaos[0].split('<series name="')[0].split('年">')[0]
339         y_val = 0
340         for month in chaos[1:]:
341             # month_val = month.split('" y="')[0]
342             y_val = y_val + float(month.split('月" y="')[1].split('"')[0])
343         series = series.append({'Date': year_val, 'Price': y_val / 12}, ignore_index=
344     print(series)
345 series.to_csv('C:/Users/zz/Desktop/beanmarket.csv')
346
347 series = pd.read_csv('C:/Users/zz/Desktop/beanmarket.csv', index_col=[0])
348 bean = series['Price'].values
349 udata = np.matrix([corn, bean]).T
350
351 def adftest(num):
352     lreg = LinearRegression()
353     lreg.fit(udata[:num], price[:num])
354     le = price[:num] - lreg.predict(udata[:num])
355     le.resize(num, )
356     print(adfuller(le))
357
358 print(adftest(12))
359 print(adftest(19))
360
361
362 sdata = pd.read_json('pricedata.txt')
363 sdata_a = np.matrix([sdata['maizeprice'], sdata['bean']]).T
364 sreg = LinearRegression()
365 sreg.fit(sdata_a, sdata['pigprice'])
366 se = sdata['pigprice'] - sreg.predict(sdata_a)
367 print(adfuller(se))
```