Analysis of the Impact of the “Insurance & Futures” Model on the Price Fluctuation of China's Pig Market

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Abstract: The market price cyclical fluctuation and oscillation "pig cycle" is a typical economic phenomenon in the pig market. In this paper, we use the coefficient of variation method and ARIMA (Auto-Regressive, Integrated, Moving Average) time-series method to analyse the weekly data of local breed pigs, domestic hybrid pigs, exotic hybrid pigs and hog price indexes from 2019 to 2023, and empirically analyse the impact of the "insurance + futures" model on the price of hogs to empirically analyse the degree of influence of the "insurance+futures" model on the volatility of hog prices. It is found that the price change trends of local breed pigs, domestic hybrid pigs, and exotic hybrid pigs are similar, and the "insurance + futures" model has a significant impact on the price fluctuation of exotic hybrid pigs, a weak impact on the price fluctuation of local breed pigs, and a non-significant impact on the price fluctuation of domestic hybrid pigs. During the pilot practice of the "insurance + futures" model, the price volatility of the three types of pigs increased significantly, and the overall pig price showed a downward trend.

Keywords: Pig Price Insurance; Hogs Futures; Price Fluctuations; Time Series Analysis

1. Introduction

In 2013, China started to implement a pilot pig price index insurance policy, which has reduced the financial pressure on the Government, expanded the business of insurance companies, increased the income of farmers and stabilised market supply. However, the policy's regulatory role in the early stages of the pig cycle was limited by its reliance on ex post payouts. By playing the risk management role of hedging against price fluctuations and the price discovery function, the futures market has enhanced market efficiency and stability, and provided market participants with tools to manage price risks and gain returns. The Chinese government has continuously promoted market-oriented policy reforms for agricultural commodity prices. In 2016, it launched a pilot "insurance + futures" model aimed at providing loss compensation for agricultural production entities. Subsequently, in 2017, a new "order + insurance + futures" model was proposed [1], and the policy of promoting the listing of options on agricultural products was implemented in 2018. As the pilot practice of the "insurance + futures" model for agricultural products in China continues to advance, many scholars have conducted in-depth research on the application of this model in the hog market.

In many countries, especially in agriculturally developed countries, hog and pork prices experience cyclical fluctuations, and there is a global "pig cycle" phenomenon. Dean and Heady's [2] study was the beginning of the exploration of the field of the pig cycle, and Breimyer suggested that the supply of hogs is not cyclical but closely related to the supply of corn [3]. Berg and Huffaker used a "diagnostic" model approach to study the cyclical fluctuations of hog prices in Germany, and explored three important factors that form the pig cycle [4]. Chinese scholar Wu Ying found that there is a "spider web disorder" in China's pig market price [5]. Li Binglong [6] explored the causes of pork price volatility in China from three aspects: government macro-control, supply and demand. Lv Jie [7] analysed the annual internal and external patterns of the pig price cycle and its cyclical fluctuations caused by internal transmission mechanisms and external shock mechanisms. Pan Guoyan [8] observed from the production perspective that the efficiency of pig production in the relevant provinces of China has declined slightly in recent years. From the production layout perspective, Cui Xiaonian [9] concluded that large and medium-sized cities as a whole have lost their advantages in large-scale pig farming, while the competitive advantages of the main producing provinces in the Northeast and Southwest have gradually emerged. Liao Pu [10] pointed out that the higher the agreed pig-grain ratio is within a reasonable range, the more obvious the dampening effect of index insurance on price volatility. Li Yaru [11]found that pig profit insurance has the effect of reducing the financial burden of the government, expanding the business scale of insurance companies, increasing the income of farmers, and stabilising the supply of pig market. The "insurance + futures" model has achieved significant results in solving the risk of price fluctuations of agricultural products and protecting the income of farmers [12-13], and has also effectively stimulated the enthusiasm of farmers to "work in agriculture and grow food" [14]. Sun Rong [15] argues that this model gives farmers the incentive to diversify and improve the quality of cultivation, which in turn contributes to the defence of national food security. Zhang Yifeng [16] found that the "insurance + futures" model is applicable to "traditional agriculture" and "new agriculture". Han Dongqing [17] and other scholars study the impact effect of African swine fever on pig prices, and conclude that the impact effect has the characteristics of time lag and stage.

Based on the previous research, this paper reflects the impact of the "insurance + futures" model on the price of hogs with the help of the spread between the predicted price and the actual price of the ARIMA model (Auto-Regressive, Integrated, Moving Average), in order to provide data support and innovative ideas to grasp the impact of the "insurance + futures" model on the price of Chinese hogs and its basic characteristics.

2. Mechanisms of the "Insurance + Futures" Model Affecting the "Pig Cycle"

The innovative model of "insurance + futures" has a far-reaching impact in the field of agricultural price insurance, which is not only an important initiative to improve the agricultural insurance system, but also plays an important role in supporting the structural reform of the agricultural supply side. The pig cycle refers to the cyclical fluctuations experienced by the pork production industry within a certain period of time, which usually involves fluctuations in pork prices, production volume and farming profits. In this study, the cyclical fluctuations in pig prices caused by the "pig cycle" are highlighted.

The "insurance + futures" model is not suitable for all agricultural products, but mainly for situations where supply exceeds demand and prices are highly volatile. . By combining insurance and futures, we can ensure the basic income of farmers and stabilise the market supply, thus mitigating the volatility of market prices. Farmers' decisions on planting and breeding directly determine the supply of agricultural products. If farmers are faced with a higher risk of market price fluctuations, they may choose to reduce the scale of production or switch to other crops, thus affecting the supply in the market. Such changes in supply may lead to fluctuations in market prices, bringing uncertainty and instability to the market. The core concept of the "insurance + futures" model is to enable farmers, co-operatives and other participants to purchase futures price insurance products provided by insurance companies so as to effectively hedge the risks arising from price fluctuations. In addition, insurance companies also cleverly transfer risks by purchasing futures instruments such as over-the-counter (OTC) options in order to hedge against potential losses that may be brought about by a drop in the prices of agricultural products . If the price insurance provided by the insurance company coincides with the period of pig price plunge, the model helps farmers to avoid the risk of price decline and improve farmers' enthusiasm for farming, thus stabilising the pig market price [18]. Futures institutions actively participate in risk transfer and diversification by adopting corresponding hedging strategies , forming a mutually supportive risk diversification network. It can be found that even in the case of capital constraints, futures companies adopting under-hedging strategies can realise fully risk-neutral hedging and gain a certain amount of profit. The government's subsidy of premiums to farmers can enhance the enthusiasm of farming, alleviate the pressure of capital, and then enhance the income of farmers [19]. The advantage of the "insurance + futures" model is that it does not require farmers to provide additional margin, which makes it easier to be widely accepted and adopted. Through the "insurance+futures" model, farmers are able to obtain basic income protection, so that even if the market price falls, they will not fall into financial difficulties because of the price drop . Such protection means that farmers have greater incentives to continue production and will not easily give up or reduce the scale of production . Thus, the guarantee of basic returns helps maintain the stability of market supply and ensures a continuous supply of agricultural products. It should be noted that the "insurance+futures" model is mainly a hedge against the risk of falling agricultural commodity prices, and its function of mitigating price fluctuations is limited. For example, for price fluctuations triggered by factors on the consumer side, the "insurance+futures" model may not be able to fulfil its role in smoothing the market.

"Insurance + futures" is not only an inevitable product of market-based development, but also a new product that meets the needs of modern agriculture. It creates a market-based insurance mechanism by closely linking the agricultural futures market with agricultural price insurance institutions. This helps to provide stability and sustainability support for agriculture without violating the law of market prices and the rules of trade in the international market.Since 2018, the African swine fever epidemic has been spreading rapidly in China, resulting in a huge negative impact on pig production, and the trade in pig products has had a huge economic and social impact [20]. In this case, the role of "insurance + futures" model in regulating the pig market becomes more and more important.

3. Research Methodology and Analytical Framework

3.1 Analysis of the Coefficient of Variation

The coefficient of variation method is a statistical method used to measure the degree of dispersion of data, also known as relative standard deviation. The basic principle of the coefficient of variation analysis method is to use the Coefficient of Variation (CV_t) to measure the degree of dispersion of data. For a series of data, the smaller its Coefficient of Variation, the smaller the degree of variation (deviation) and the lower the risk; conversely, the larger the Coefficient of Variation, the larger the degree of variation (deviation) and the higher the risk. The coefficient of variation method is a statistical method for determining the weights of indicators by calculating the information included in the data to determine the weights of each indicator, which is essentially an objective assignment. For sample data with a large degree of dispersion, the sample data can be monitored and tracked so that the reasons for the large degree of dispersion can be analysed in depth. The calculated prices of equipment and materials with a large degree of dispersion are made closer to real life.

The ratio of the standard deviation to the mean is called the coefficient of variation.

$$CV_t = (Std_t/Me_t) * 100\% \tag{1}$$

where CV_t represents the coefficient of variation of the data, the Std_t represents the standard deviation of the data, and Me_t represents the mean of the data. By calculating the coefficient of variation of hog price data, the risk of price fluctuations can be visualised.A smaller degree of change in the coefficient of variation between 2019-2023 means that the price is more stable and the risk is lower, which is suitable for long-term investment or strategy development; on the contrary, a higher degree of change in the coefficient of variation means a high degree of price fluctuation and higher risk, which needs to be treated with caution. However, due to the actual influencing factors, including swine diseases such as swine fever and the "insurance + futures" policy, the coefficient of variation alone cannot be more accurately determined, so a more accurate forecasting model is needed.

3.2 ARIMA Time Prediction Model Analysis Method

ARIMA model is a classic time series analysis method, ARIMA stands for Autoregressive (AR), Integrated (I), Moving Average (MA), which is used to analyse and predict the change rule of time series data. With the help of ARIMA model, we use the data before the implementation of "insurance + futures" model to predict the regular trend of pig market price, and reflect the impact of "insurance + futures" model on pig market price through the difference between the actual price and the predicted price. ARIMA model:

$$y_t = \mu + \sum_{i=1}^{p} r_i y_{t-i} + \epsilon_t + \sum_{i=1}^{q} \theta_i \epsilon_{t-i} \quad (2)$$

Where y_t is the current value, and r_i is the autocorrelation coefficient, θ_i is the chapter correlation coefficient, ϵ_t is the white noise (random error) term, which represents the part of random fluctuation that cannot be explained by the model.The ARIMA model actually consists of the difference operation combined with the ARMA (p, q) model, i.e., the time series that have reached a smooth state by using differential operations are estimated and analysed by the ARMA model. By observing the ACF and PACF plots of the constructed ARIMA model, we can judge whether there is any unextracted information and the fitting degree of the ARIMA model.

The AR model requires the time series data to be smooth, so the smoothness is first detected by a unit root test (e.g., ADF test), where the probability of the unit root test result (Prob*) of the series if it is less than 0.05 indicates that the series is sufficiently smooth, while greater than 0.05 indicates that the series is non-smooth, and needs to be smoothened by a differencing operation in order to determine the order of the differencing (d) in the ARIMA model. After differencing, autocorrelation (ACF) and partial autocorrelation (PACF) plots were observed to determine the lag order and the appropriate lag order was selected by the truncated tail feature of the graphs. Next, the AR model was diagnosed to check that the residual series fitted to the model complied with the white noise assumption and to ensure that the model met all the assumptions. Finally, the fitted ARIMA model was used to predict the market prices of the three types of hogs between 2021 and 2023, and the predictions were analysed.

4. Empirical Analysis

The research object was selected from the pig breeds carried out, and the variables were mainly selected from five aspects, including three pig breeds, namely, the local breed pigs, domestic hybrid pigs, exotic hybrid pigs, as well as the total pig price index. Wholesale prices were selected for the local breed pigs, domestic hybrid pigs, and exotic hybrid pigs, and the pig price index was selected from Flush iFinD. among them, the exotic hybrid pigs and domestic hybrid pigs were from Brake Agricultural Data, and local breed pigs data were from China Pig Farming Network. The time of taking values is the weekly data from February 2019 to May 2023, in which the weekly data from February 2019 to May 2023 are used in ARIMA time series model analysis. The empirical research process was carried out with the help of EVIEWS software.

4.1 Analysis of the Coefficient of Variation

(1) Descriptive statistics. Table 1 shows the descriptive statistics of the variables, the maximum value of the local breed pigs is 38.996, the minimum value is 10.212, and the standard deviation is 8.682, which is closer to the data of domestic hybrid pigs and exotic hybrid pigs.

Table 1. Descriptive Statistical Results of Hog Prices

variant	observed value	average value (yuan/kg)	maximum values (yuan/kg)	minimum value (yuan/kg)	(statistics) standard deviation (yuan/kg)
local breed pigs	203	23.294	38.996	10.213	8.683
domestic hybrid pigs,	203	23.774	40.826	10.598	8.810
exotic hybrid pigs	203	23.855	40.186	10.635	8.736
hog index	203	138.662	238.933	46.837	55.746

(2) Comparative analysis of pig price fluctuations before and after the implementation of the "futures + insurance" model. The effect of the implementation of the policy is analysed by comparing the changes in price fluctuations of pigs before and after the implementation of the "futures + insurance" model. Specifically, the price standard deviation and coefficient of variation are used to measure the price fluctuation. The reason for using the coefficient of variation is that the price changes over time are so large that the standard deviation cannot accurately measure the degree of dispersion between the two sets of price data.

Formula for calculating the coefficient of variation of hog prices:

$$CV_t = (Std_t / Me_t) * 100\% \quad (3)$$

Where CV_t represents the coefficient of variation of hog price, and Std_t represents the standard deviation of the hog price in time period t, and Me_t represents the average value of the price of live pigs in time period t. CV_t The larger the value, the higher the degree of dispersion of the pig price in the time period, the larger the fluctuation, and the higher the corresponding market risk. The time period is divided according to the implementation time of target price insurance for different pig breeds.

Table 2 shows that the implementation of the "insurance + futures" model is not satisfactory, the overall data of the three types of pigs are close, the risk of price fluctuations is not becoming smaller, but rather there is a significant increase in the situation. Specifically, the coefficient of variation of the local breed pigs from the original 12.703 to 30.175. Similarly, the domestic hybrid pigs, and exotic hybrid pigs situation is similar. On the whole, the volatility risk of pig price index is on the rise, from 9.836 before the implementation of the policy to 33.165. Therefore, it can be seen through comparative analysis that "insurance + futures" does not play a positive role in stabilising the price of pigs.

Table 2. Statistical Table of Fluctuation of Local Breed Pigs, Domestic Hybrid Pigs, and Exotic Hybrid Pigs and Pig Price Index

Variant	Before the implementation of the insurance + futures model		After the implementation of the insurance + futures model	
	(statistics) standard deviation	coefficient of variation	(statistics) standard deviation	coefficient of variation
local breed pigs	4.101	12.703	5.299	30.175
domestic hybrid pigs	4.713	14.385	5.331	29.539
exotic hybrid pigs	4.343	13.178	5.123	28.378
hog index	19.512	9.836	33.371	33.165

4.2 ARIMA Time Series Model Analysis

(1) Descriptive statistics. The results of descriptive statistics are detailed in Table 3.

(2) Plotting time series. The processed sample data into the EVIEWS software for calculation and analysis, the use of software commands to draw China's three kinds of average weekly price of hogs time series chart, due to the three kinds of hogs is more similar to the situation, here we are exotic hybrid pigs as an example. Figure 1 shows that the weekly price of exotic hybrid pigs basically fluctuates between 20-40 yuan, the vibration is frequent and the amplitude is relatively large, indicating that the time series of the weekly average price of pigs in China is intuitively non-stationary, which is consistent with the results shown in the descriptive statistics.

Table 3. Hog Price Descriptive Statistics Results

Variant	observed value	Average (yuan/kg)	Maximum value (yuan/kg)	Minimum (yuan/kg)	(statistics) standard deviation
local breed pigs	79	32.288	38.996	18.879	4.101
domestic hybrid pigs	79	32.764	40.826	19.81	4.713
exotic hybrid pigs	79	32.958	40.186	19.77	4.343

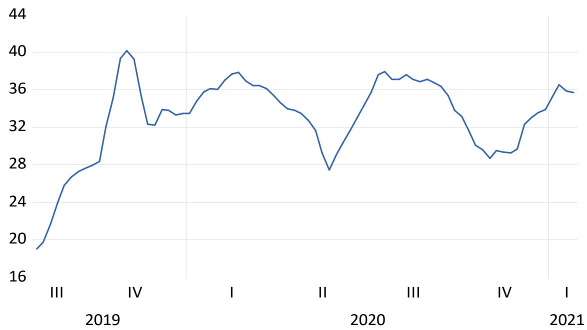


Figure 1. Exotic Hybrid Pigs Weekly Average Price Sequence Diagram

Unit root test of the original series. The unit root test of the original series unit root test to further verify its smoothness, this paper selected Augmented Dickey-Fuller test (hereinafter referred to as the ADF test) method, the test results are shown in Table 4. it can be seen that the critical value of 1%, 5%, 10% test level are -3.519, -2.900, -2.587, are greater than the ADF test statistical value of -4.115, so the original hypothesis is rejected. greater than the statistical value of ADF test -4.115, so the original hypothesis is rejected.

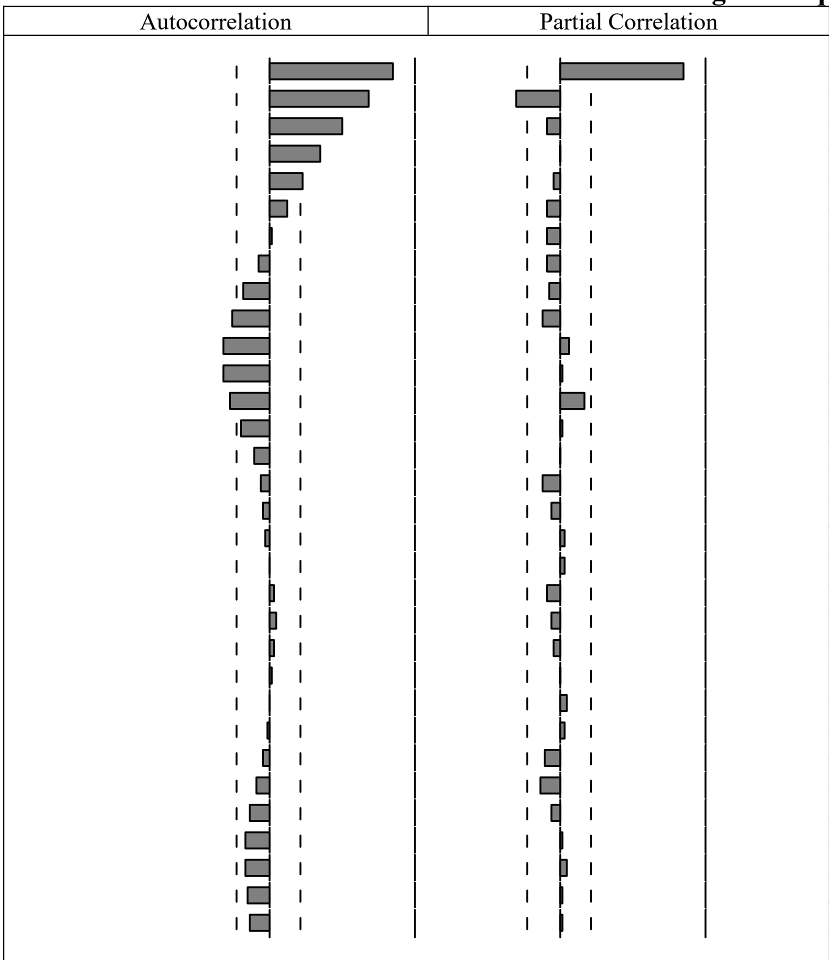
Table 4. ADF Unit Root Test Results of the Original Sequence

Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*
		-4.115	0.001
Test critical values.	1% level	-3.519	
	5 per cent level	-2.900	
	10% level	-2.587	

However, observing the ACF and PACF residual series in Table 5, it is found that the volatility is large and regular, which proves that the original series is not smooth. The ARIMA model can only be built on the basis of the smooth time series, so it is further used to achieve its smoothness with the help of difference operation. Its autocorrelation function (ACF) and partial autocorrelation function (PACF), by observing their trailing and truncated states, it is found that the original series ACF and PACF residual plots show non-good correlation.

(3) Unit root test for difference series. In order to find the non-stationary order of the original time series, ADF test is carried out on its difference series. We start from the first-order difference series unit root test results are shown in Table 6, at this time the original series of the first-order difference series to meet the requirements of the smooth time series.

Table 5. ACF and PACF of Original Sequence



	AC	PAC	Q-Stat	Prob
1	0.882	0.882	63.042	0.000
2	0.710	-0.306	104.43	0.000
3	0.530	-0.087	127.84	0.000
4	0.377	0.014	139.82	0.000
5	0.249	-0.036	145.14	0.000
6	0.135	-0.084	146.72	0.000
7	0.025	-0.095	146.77	0.000
8	-0.081	-0.082	147.35	0.000
9	-0.177	-0.078	150.20	0.000
10	-0.269	-0.116	156.86	0.000
11	-0.319	0.074	166.34	0.000
12	-0.327	0.028	176.48	0.000
13	-0.272	0.172	183.59	0.000
14	-0.190	0.024	187.09	0.000
15	-0.104	0.012	188.17	0.000
16	-0.054	-0.121	188.47	0.000
17	-0.035	-0.063	188.59	0.000
18	-0.017	0.034	188.62	0.000
19	0.015	0.046	188.65	0.000
20	0.041	-0.087	188.82	0.000
21	0.050	-0.053	189.10	0.000
22	0.043	-0.037	189.30	0.000
23	0.022	0.015	189.36	0.000
24	0.007	0.064	189.36	0.000
25	-0.008	0.043	189.37	0.000
26	-0.039	-0.102	189.55	0.000
27	-0.090	-0.134	190.53	0.000
28	-0.138	-0.057	192.90	0.000
29	-0.165	0.030	196.38	0.000
30	-0.167	0.052	199.99	0.000
31	-0.153	0.032	203.08	0.000
32	-0.127	0.017	205.28	0.000

Table 6. First-Order Difference Sequence ADF Unit Test Results

Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*
		-4.804	0.000
Test critical values.	1% level	-3.520	
	5 per cent level	-2.900	
	10% level	-2.587	

In addition, from Figure 2, we can also find that the difference of the monthly average price of hogs is uniformly distributed above and below 0, no trend characteristics, intuitively smooth. Therefore $\mathbf{d=1}$, it is ARIMA(p,1,q). If the first-order difference series is still non-stationary, continue to expand the second-order difference test, and so on. Generally speaking, economic data of the first and second order can satisfy the smoothness characteristics. Through the first-order difference, we get Prob.*= 0.000<0.05 and very close to 0, so we can initially judge that the first-order difference series is a smooth series.

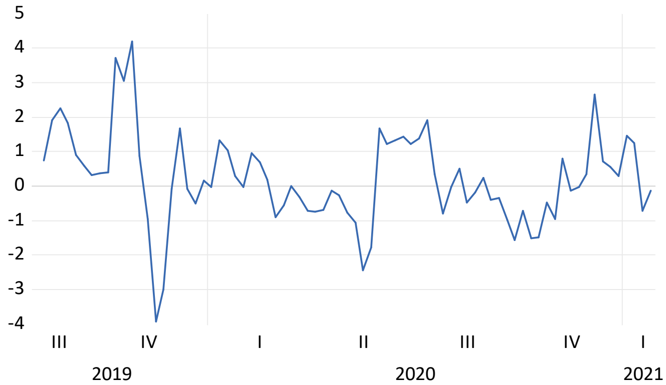


Figure 2. First-Order Difference Sequence ADF Unit Test Results

Table7 shows the residual plots of ACF and PACF, the absolute values of AC and PAC coefficients fall into 95% confidence intervals, and the residual series are smooth and free of autocorrelation, which are white noise series, so the model is a suitable model with sufficient information extraction, and it can be used to forecast the price of Chinese hogs.

According to the principle of AIC and parameter significance, after repeated tests on all possible combinations of the three parameters, ARIMA (3,1,1) was found to have the smallest information criterion and the best modeling effect. The specific results are shown in Table 8, with an R2 value of about 0.428 and an F statistic of 17.525, indicating a very good overall fitting effect of the model.

(4)Forecasting and Discussion. Using the pig price data from February 2019 to January 2021, the retrospective forecasts of the prices of the exotic hybrid pigs, local breed pigs,domestic hybrid pigs, and the yuan under the conventional market trend were made with the help of the ARIMA(3,1,1) model ARIMA(2,1,1) model ARIMA(1,1,0) model from January 2021 to May 2023, respectively, which are shown in Figure 3, 4 and 5, respectively. As can be seen from the figures, the trends of local breed pigs, domestic hybrid pigs, and exotic hybrid pigs are similar.

Table 9 shows that the average prediction deviation is -28.273, -10.847 and -25.378 respectively, which is the net effect of the "insurance + futures" model on the market price of hogs, indicating that in the observation period, under the influence of the "insurance + futures" model, the market prices of local breed pigs, domestic hybrid pigs, and exotic hybrid pigs were reduced by 28.273, 10.847 and 25.378 yuan per kg on average. This is the net effect of the "insurance + futures" model on the market price of hogs. It can be seen that the "insurance + futures" mode has the biggest impact on the exotic hybrid pigs and the smallest impact on the domestic hybrid pigs. and the types of commercial pigs in the market are mainly the exotic hybrid pigs, so the results are reasonable. Since the implementation of the "insurance + futures" model, the prediction deviation from January to April 2021 increased slowly, but from May 2021 onwards, the prediction error increased sharply. As the forecast deviation is gradually increasing, the difference between the actual price and the forecast price is gradually widening, and basically all positive, reflecting the overall pig price continues to go down. Taken together, the trend of increasing deviation peaked in March 2022, and the deviation of "insurance + futures" model for local breed pigs and exotic hybrid pigs once exceeded 30, with the deviation of exotic hybrid pigs reaching 35.254 and that of local breed pigs reaching 31.122, and that of domestic hybrid pigs exceeding 15, with a deviation of 16.722

Starting from May, the market prices of the three types of hogs gradually increased, and the difference between actual prices and forecast prices basically became positive, reflecting the continuous low overall hog prices. May, the market price of three kinds of hogs gradually recovered. Since the implementation of "insurance + futures" model, not only the fluctuation is more intense, but also the price continues to go down.

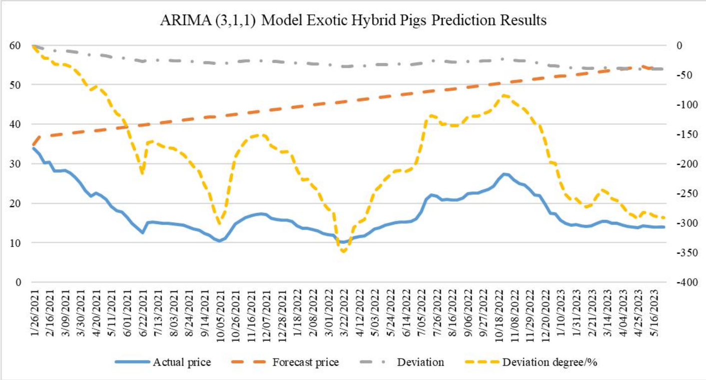
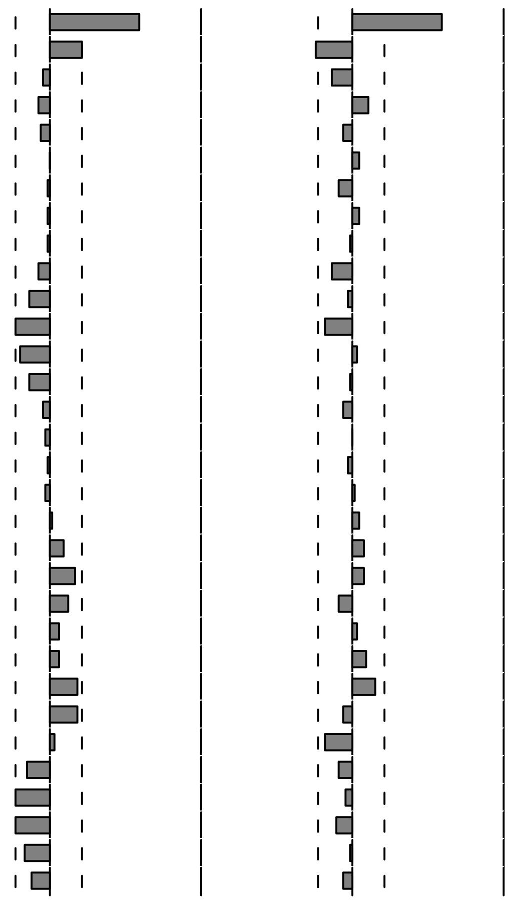


Figure 3. The Prediction Results of ARIMA (3,1,1) Model Exotic Hybrid Pigs

Table 7. Weekly Average Price First-Order Difference ACF and PACF



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.619	0.619	30.710	0.000
		2	0.236	-0.240	35.227	0.000
		3	-0.040	-0.125	35.359	0.000
		4	-0.074	0.118	35.812	0.000
		5	-0.056	-0.050	36.074	0.000
		6	0.013	0.055	36.089	0.000
		7	-0.012	-0.092	36.102	0.000
		8	-0.006	0.052	36.104	0.000
		9	-0.011	-0.003	36.116	0.000
		10	-0.069	-0.139	36.551	0.000
		11	-0.128	-0.026	38.052	0.000
		12	-0.222	-0.179	42.652	0.000
		13	-0.204	0.041	46.625	0.000
		14	-0.128	-0.007	48.215	0.000
		15	-0.048	-0.053	48.438	0.000
		16	-0.021	0.005	48.480	0.000
		17	-0.013	-0.033	48.496	0.000
		18	-0.020	0.017	48.539	0.000
		19	0.025	0.053	48.604	0.000
		20	0.106	0.090	49.801	0.000
		21	0.173	0.083	53.040	0.000
		22	0.129	-0.095	54.880	0.000
		23	0.067	0.034	55.387	0.000
		24	0.080	0.105	56.115	0.000
		25	0.192	0.161	60.424	0.000
		26	0.197	-0.062	65.053	0.000
		27	0.045	-0.188	65.304	0.000
		28	-0.149	-0.082	68.053	0.000
		29	-0.230	-0.040	74.781	0.000
		30	-0.233	-0.101	81.827	0.000
		31	-0.157	-0.003	85.093	0.000
		32	-0.118	-0.058	86.979	0.000

Table 8. ARIMA (3,1,1) Model Estimation Results

Varible	Coefficient	Std.Error	t-Statistic	Prob.
C	0.152	0.241	0.630	0.530
AR(2)	0.415	0.121	3.409	0.001

AR(3)	-0.297	0.110	-2.700	0.008
MA(1)	0.775	0.098	7.868	0.000
R-squared	0.428	Akaike info criterion	2.951	
F-statistic	17.525	Schwarz criterion	3.075	

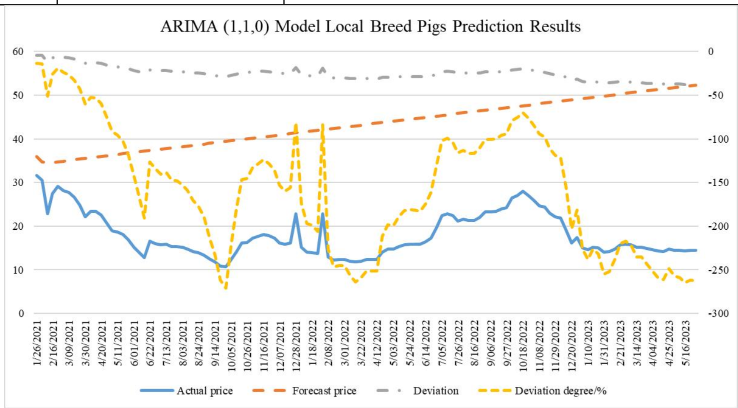


Figure 4. The Prediction Results of ARIMA (1,1,0) Model for Local Breed Pigs

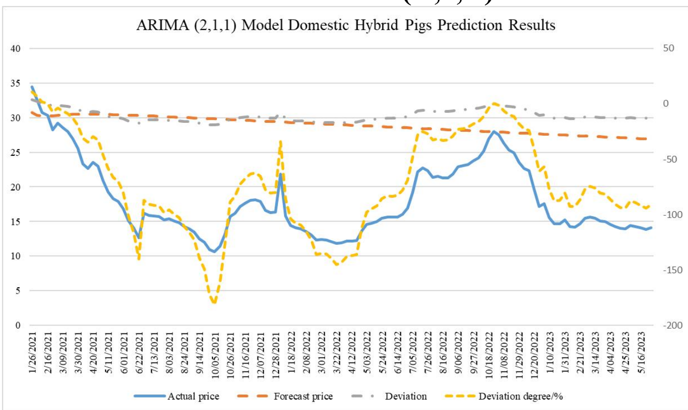


Figure 5. The Prediction Results of ARIMA (2,1,1) Model for Domestic Hybrid Pigs

Table 9. Price Prediction Deviation Table for Exotic Hybrid Pigs, Domestic Hybrid Pigs, and Local Breed Pigs

Pig breeds	Actual price (yuan/kg)	Forecast price (yuan/kg)	Deviation (yuan/kg)	Deviation degree/%
Exotic hybrid pigs	17.59273	45.86603	-28.2733	-182.959
Domestic hybrid pigs	18.07964	28.92747	-10.8478	-72.321
Local breed pigs	17.9252	43.30334	-25.3781	-159.155

5. Discussion

The pilot practice of hog "insurance + futures" model in China has shown that the model has not been able to significantly smooth the price fluctuations in the hog market due to the following reasons: insufficient trading volume in the hog futures market, small coverage of the hog "insurance + futures" pilot programme, a single source of premium, and the impact of swine fever epidemic.

The hog futures market is under-traded. The market is still in the early stage of development with small capacity. According to the data of Dalian Commodity Exchange, since the listing of hog futures in 2021, the average daily position is 37,000 lots, far lower than the average monthly hog spot trading volume of about 4.2 million lots, showing that there is an obvious gap between the trading volume of the futures market and the spot market [21]. In addition, the pilot programme is mainly limited to large-scale agricultural enterprises, and the number of small farmers participating in the futures market through the Agricultural Insurance Scheme is limited, resulting in an imperfect structure of the main participants in the futures market, and the bargaining mechanism has not been brought into full play.

Low pilot coverage. Since the launch of the "insurance + futures" pilot scheme for live pigs, the Daxiangshang has supported 549 projects covering 3.24 million head of spot volume, and as of February 2024, it has realised RMB 611 million in payouts, benefiting 27,000 farmers. 2023, under the support of the "Daxiangshang Farmers' Insurance Scheme In 2023, under the support of the "GCI Agricultural Insurance Programme", 181 projects were carried out in 24 provinces (autonomous regions) across the country, covering 2.11 million pigs in stock and 6,293 small and medium-sized farmers. The estimated payout amount of the 143 projects that have been concluded is RMB 188 million, with a payout rate of 132 per cent [22]. This is despite the fact that China has a stock of 453 million pigs and a coverage rate of less than 2 per cent, suggesting that the model has a low coverage rate.

Single source of premiums. Premiums are mainly dependent on exchange support, and subsidy funds are limited, making it difficult to promote widely. During the pilot process, the trend of premiums being led by exchanges to being shared by multiple parties has basically taken shape, but more government and social funds are still needed[22].

Swine fever epidemic impact. Although the "insurance + futures" model aims to smooth out price fluctuations by protecting farmers' basic income and stabilising market supply, the occurrence of African swine fever led to a reduction in pork consumption and panic selling by farmers, which in turn led to passive penning, affecting the market supply [23] .2023 pork production increased by 4.6% and pig slaughter increased by only 3.8%, while pig stocks fell by 4.1% at the end of the year, indicating that the "insurance + futures" model cannot fully address the impact of swine fever.

6. Conclusions

Based on the weekly data of local breed pigs, domestic hybrid pigs, and exotic hybrid pigs from 2019 to 2023, the analysis of coefficient of variation (ACV) method found that the volatility of local breed pigs, domestic hybrid pigs, and exotic hybrid pigs and hog price indexes has increased significantly since the implementation of the "insurance+futures" model, and the uncertainty in the market has also increased. With the help of ARIMA model, we make retrospective forecasts of the prices of local breed pigs, domestic hybrid pigs, and exotic hybrid pigs from January 2021 to May 2023 under the regular market trend, and find that the prices of three types of hogs, local breed pigs, domestic hybrid pigs, and exotic hybrid pigs, show similar changes under the influence of the "insurance+futures" model. Under the influence of the "insurance + futures" model, the prices of hogs of the three types, namely, local breed pigs, domestic hybrid pigs, and exotic hybrid pigs, show similar trends, and their market prices are all reduced. The "insurance + futures" model had the greatest impact on exotic hybrid pigs and the smallest impact on the domestic hybrid pigs. From the data changes since the implementation of the model, it can be seen that the fluctuation of the price of pigs is more intense, and the overall trend is down. It can be seen that the current market situation does not meet the scope of application of "insurance + futures" model to reduce the fluctuation of market hog prices. The "insurance + futures" model in the market supply exceeds demand, can protect the basic income of farmers, stabilise the market supply, so as to stabilise the market price. However, after the various swine diseases such as African Swine Fever in 2022 and 2023, the emergence of swine diseases will easily trigger consumer panic, leading to a decrease in pork consumption. The "insurance + futures" model is unable to smooth out price fluctuations in the hog market from the consumer side.

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