Analysis and Forecast of Shrimp Price Based on SARIMA Model

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Abstract—Since the price of shrimp in Ling Jiatang farmers' market in Jiangsu Province is obviously cyclical, this paper will use the monthly data of the price of shrimp in Ling Jiatang, Jiangsu Province from June 2009 to July 2021 to predict the monthly price of shrimp in the next two years based on the ARIMA(p, d, q)(P, D, Q)[12] model, and the results of the empirical analysis show that the model ARIMA(0, 1, 3)(1, 1, 1) [12] has the strongest fit and the highest accuracy, and can predict the monthly price of shrimp in the region for the next two years more accurately. Based on the model and to make relevant policy recommendations for stabilizing local prices.

Keywords-shrimp prices; cyclical price fluctuations; ARIMA model; price forecasting

1 INTRODUCTION

The aquatic industry is one of the first areas to be reformed in China, and aquatic products are an important classification in the diet structure of Chinese residents. Accurate analysis of the aquatic products market and the establishment of a rationalized aquatic system will facilitate the restructuring of the industry as well as economic development. According to statistics, in the past 10 years, China's fish production has increased nearly 9 times, and per capita possession has increased 7.2 times, which is 2 times the world average. From the early days of reform and opening to the present, China has formed a development path of aquatic products with Chinese characteristics. However, due to the price of aquatic products, there is uncertainty fluctuations, making some areas of aquatic products cannot reach a balance between supply and demand. Therefore, the forecast of aquatic products prices plays an important role in stabilizing prices and ensuring the quality of life of residents. Proper nutrition and balanced diet are common needs of today's society. As a major source of high-quality protein, shrimp plays an important role in improving human immunity and physical fitness. The market price of shrimp is an important indicator of the development of this industry as well as the level of consumption, and the unstable market price will inevitably lead to an imbalance between supply and demand in the market thus creating uncertainty in the behavior of interest. Therefore, in this paper, the ARIMA (p, d, q) (P, D, Q) [12] model [1] will be used to forecast the price of shrimp for the next two years, taking advantage of the feature that the price of shrimp has seasonal variation.

Through the available literature, it is found that domestic scholars have conducted extensive research on fish prices, among which Weihua Zhang (2020) et al. use the ARCH class model to study the price volatility of 13 fish species and propose policy recommendations related to the construction of an integrated information platform for the whole aquatic product industry chain

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[2] Wei Xu (2019) et al. analyze the causes of fish price volatility in China based on the background factors of consumption ratchet and fishery transformation, and the results show that fish prices are more volatile compared to other bulk commodities, and thus propose policy recommendations such as increasing supply and improving its added value [3]. Zhenhao Yang (2021) et al. forecasted China's fish consumption price index based on the SARIMA model, and the results showed that the SARIMA model fits better, the forecast results are more accurate, and can effectively explain the seasonality and trend of China's fish consumption price index changes. Based on the collation of existing studies, this paper will take shrimp in aquatic industry as an example, and a total of 146 monthly data of shrimp from June 2009 to July 2021 will be selected as the research object [4]. The ARIMA model method [5] was used to make a forecast analysis of the price of shrimp for the next 2 years. Based on the prediction results, relevant suggestions were made to stabilize the price of shrimp in Ling Jiatang area of Jiangsu Province.

2 CHARACTERIZATION ANALYSIS AND DESCRIPTIVE STATISTICS

2.1 Characterization analysis

Figure1 shows the daily price trends of shrimp in Ling jiatang Farmers' Market, Jiangsu Province, from June 2009 to July 2021. The graph shows that the price of shrimp is significantly cyclical due to climatic, seasonal and geographical factors.

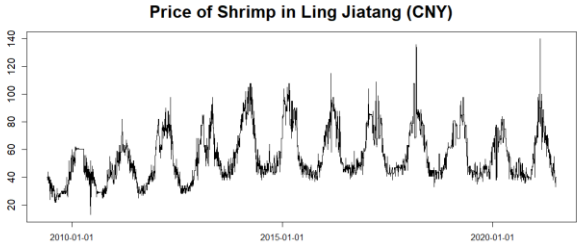

Figure 1 Price of shrimp in Ling Jiatang

2.2 Descriptive statistics

Descriptive statistics of the time series data using R language resulted in the Table1. As can be seen from Table1, there are 146 time series samples of this model, among which the maximum price of prawn is 95.68 yuan/kg and the minimum price is 25.84 yuan/kg. The standard deviation is 17.03, indicating that the time series data is highly volatile.

Table 1 Results of descriptive statistics for monthly data on shrimp

variable	shrimp price (yuan/kg)
Sample size	146

maximum value	95.68
minimum value	25.84
mean value	55.04
median	49.30
Standard error of the mean	1.41
variance (statistics)	289.94
(statistics) standard deviation	17.03
skewness	0.54
kurtosis	-0.66

3 EMPIRICAL STUDIES

3.1 Data sources and model construction

This paper selects data from the monthly data of the price of shrimp in Ling Jiatang farmers' market in Jiangsu Province from June 2009 to July 2021. Through the previous analysis [6], it is known that the price of shrimp has seasonal fluctuations. In order to accurately predict the change of shrimp price fluctuations in the next two years, this paper predicts the monthly price of shrimp by constructing the ARIMA (p, d, q) (P, D, Q) [12] model, let the price of shrimp be SP and the model results are as follows.

For notional brevity, the following operator notation is used in this paper.

$$\varphi_p(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \ldots - \varphi_p B^p$$

$$\emptyset_P(B) = 1 - \emptyset_1 B^s - \emptyset_2 B^{2s} - \ldots - \emptyset_P B^{Ps}$$

$$\vartheta_q(B) = 1 + \vartheta_1 B + \vartheta_2 B^2 + \ldots + \vartheta_q B^q$$

$$\theta_Q(B) = 1 + \theta_1 B^s + \theta_2 B^{2s} + \ldots + \theta_Q B^{Qs}$$

The Box-Jenkins seasonal ARIMA model with non-stationary order p, d, q, seasonal order P, D, Q and period s (multi-pliable seasonal ARIMA model) is denoted as

$$ARIMA\ (p,d,q) \times (P,D,Q)_s$$

Its difference sequence $W_t = \nabla^d \nabla_s^D X^t$ satisfies an ARIMA (p, q) × (P, Q)s model. with period s.

A general multi-pliable seasonal ARIMA model is

$$\varphi_p(B)\ \emptyset_P(B)\ W_t\ = \vartheta_q(B)\ \theta_Q(B)\ w_t$$

The seasonal MA(Q) model is

$$X_t\ = w_t\ + \theta_1 w_{t-s}\ + \theta_2 w_{t-2s}\ + \ldots + \theta_Q w_{t-Qs}$$

$$X_t\ = \theta_Q(B) w_t$$

The seasonal AR(P) model is

$$X_t\ = \varnothing_1 X_{t-s}\ + \varnothing_2 X_{t-2s}\ + \cdots + \varnothing_P X_{t-Ps}\ + w_t$$

$$\varnothing_P(B) X_t\ = w_t$$

3.2 ARIMA (p, d, q) (P, D, Q) [12] model regression results

The principle of ARIMA model time series prediction is to transform non-stationary time series into stationary time series and then regression the dependent variable only to its lag value and the present value and lag value of random error terms. In ARIMA (p, d, q) (P, D, Q) [12], AR is "Auto-regressive" and p is the number of auto-regressive terms. I is difference, d is the number of difference (order) to make it a stationary sequence, MA is the "moving average" and q is the number of moving average terms. (P, D, Q) is the seasonal component that follows the time series, S is the period of the time series, and 12 represents the predicted period in annual units. In this paper, the AIC criterion, BIC criterion and AICc criterion are chosen for ARIMA parameter estimation, which can effectively compensate for the subjectivity of fixing the order according to the auto correlation and partial auto correlation plots, and find the relative best fit model within a limited range of orders, and the effective parameter estimation results are as follows Table 2.

When choosing the best model from a set of available models, the model with the lowest AIC value, BIC value, and AICc value is usually chosen, so based on the regression results it is known that the best model determined according to the AIC criterion is ARIMA (0,1,3) (1,1,1) [12], the best model determined according to the BIC criterion is ARIMA (0,1,2) (1,1,1) [12], and the best model determined according to the AICc criterion is ARIMA (0,1,3) (1,1,1) [12].

From Table 3 it can be seen that comparing the goodness of fit of different models, the seasonal model ARIMA (0,1,3) (1,1,1) [12] has the smallest root mean square error and the best fit for the price of shrimp, so the prediction model for the price of shrimp in Ling Jiatang market in Jiangsu province is ARIMA (0,1,3) (1,1,1) [12].

Table 2 ARIMA model parameter estimation results

AIC Guidelines		**BIC guidelines**		**AICc guidelines**	
p, d, q estimation results	***AIC value***	***p, d, q estimation results***	***BIC value***	***p, d, q estimation results***	***AICC value***
ARIMA(2,1,2)(1,1,1)[12]	863.650	ARIMA(2,1,2)(1,1,1)[12]	883.883	ARIMA(2,1,2)(1,1,1)[12]	864.546
ARIMA(2,1,2)(2,1,0)[12]	875.492	ARIMA(1,1,2)(1,1,1)[12]	880.835	ARIMA(2,1,2)(2,1,0)[12]	876.388

ARIMA(1,1,2)(1,1,0)[12]	881.830	ARIMA(1,1,2)(0,1,0)[12]	945.266	ARIMA(1,1,2)(1,1,0)[12]	882.302
ARIMA(1,1,2)(0,1,2)[12]	864.131	ARIMA(1,1,2)(2,1,0)[12]	892.128	ARIMA(1,1,2)(0,1,2)[12]	864.797
ARIMA(1,1,2)(2,1,0)[12]	874.786	ARIMA(0,1,2)(1,1,1)[12]	877.914	ARIMA(1,1,2)(2,1,0)[12]	875.452
ARIMA(0,1,2)(0,1,2)[12]	864.001	ARIMA(0,1,2)(2,1,0)[12]	889.014	ARIMA(0,1,2)(0,1,2)[12]	864.473
ARIMA(0,1,2)(2,1,0)[12]	874.563	ARIMA(0,1,1)(1,1,1)[12]	891.012	ARIMA(0,1,2)(2,1,0)[12]	875.035
ARIMA(0,1,1)(1,1,1)[12]	879.451	ARIMA(0,1,3)(1,1,1)[12]	879.511	ARIMA(0,1,1)(1,1,1)[12]	879.763
ARIMA(0,1,3)(1,1,1)[12]	862.169	ARIMA(1,1,1)(1,1,1)[12]	878.834	ARIMA(0,1,3)(1,1,1)[12]	862.836
ARIMA(0,1,3)(1,1,0)[12]	880.714	ARIMA(1,1,3)(1,1,1)[12]	883.891	ARIMA(0,1,3)(1,1,0)[12]	881.186
ARIMA(0,1,3)(0,1,0)[12]	934.076	ARIMA(2,1,2)(0,1,0)[12]	950.164	ARIMA(0,1,3)(0,1,0)[12]	934.389

Table 3 Regression results of ARIMA model

AIC criterion (ARIMA(0,1,3)(1,1,1)[12])					
	ma1	***ma2***	***ma3***	***sar1***	***sma1***
	-0.2881	-0.2874	-0.1659	-0.2227	-0.8312
s.e.	0.0978	0.0808	0.0890	0.1154	0.1500
AIC=862.17		AICc=862.84		BIC=879.51	
ME= -0.5635	RMSE= 5.2428	MAE= 3.7582	MPE= -1.6300	MAPE= 6.4891	MASE= 0.6076

BIC criterion (ARIMA(0,1,2)(1,1,1)[12])					
	ma1		***ma2***	***sar1***	***sma1***
	-0.3751		-0.3501	-0.1873	-0.8386
s.e.	0.0821		0.0730	0.1173	0.1523
AIC=863.46	AICc = 863.94			BIC=877.91	
ME= -0.5162	RMSE= 5.3173	MAE= 3.8239	MPE= -1.6223	MAPE= 6.6273	MASE= 0.6182

AICC criterion (ARIMA(0,1,3)(1,1,1)[12])					
	ma1	***ma2***	***ma3***	***sar1***	***sma1***
	-0.2881	-0.2874	-0.1659	-0.2227	-0.8312
s.e.	0.0978	0.0808	0.0890	0.1154	0.1500
AIC=862.17		AICc=862.84		BIC=879.51	
ME= -0.5635	RMSE= 5.2428	MAE= 3.7582	MPE= -1.6300	MAPE= 6.4891	MASE= 0.6076

3.3 Model prediction

From the above analysis, the best model for forecasting the price of shrimp is ARIMA (0,1,3) (1,1,1) [12], based on which the simulated forecasts of the price of shrimp for the next two years were carried out and the results are shown in 0

According to the figure 2, the prediction result of the model is more reasonable, and after the research and facts prove that the prediction effect of the model is highly consistent with the real situation, which proves that the model fits well and the prediction result is more accurate.

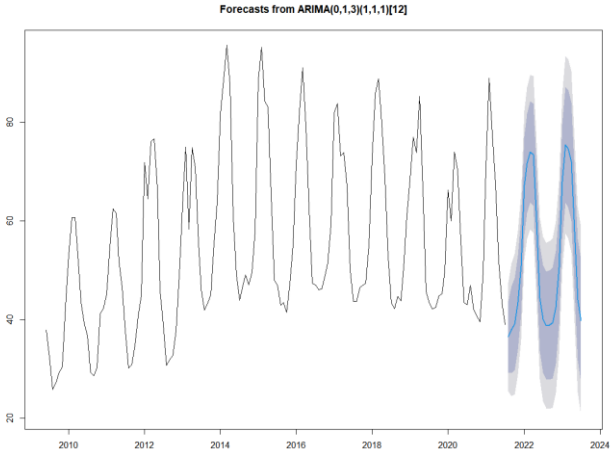

Figure 2 Price forecast of shrimps in the next 2 years

4 CONCLUSION

This paper predicts the monthly price of shrimp in the next two years based on ARIMA model using the price of shrimp in Ling Jiatang Farmers' Market Center, Jiangsu Province for the past 146 months, and the results show that the model ARIMA (0,1,3)(1,1,1) [12] has the best fit and the highest accuracy. Based on this model relevant policy recommendations are provided for local price stability.

(1) Matching the scale of production capacity with market demand

Strengthen the matching between production and marketing of shrimp through big data, cloud computing and other highly sophisticated technologies, and determine the price of shrimp by supply and demand and product quality. The government and other relevant departments should accurately, comprehensively and reliably establish relevant databases, while effective market information should be published regularly and regularly, so that fishermen can accurately judge the form of supply and demand in the market, reasonably adjust the scale of production, and reduce the problems caused by information asymmetry. High-quality scale farming is important, but it is more important that fishermen have efficient access to production information and the ability to negotiate and bargain in the market. This enables different regions to develop unique brand effects based on their own geographical advantages.

(2) Balancing the periodicity of the price of shrimp by linking the patterns of price fluctuations in domestic and international markets

In order to protect the scarce aquatic resources, China generally implemented the fishing moratorium system, which resulted in the obvious seasonal imbalance between the supply and demand of aquatic products. During the fishing moratorium, the production of aquatic products is significantly reduced, leading to the supply on the market can not meet the demand of residents, and in the fishing season, the production of aquatic products sharply increases, and the market will appear the phenomenon of oversupply, so the price of shrimps will appear obvious cyclical fluctuations. According to relevant studies, the international fish market prices have a significant impact on domestic fish prices, so in order to suppress the periodicity of the price of shrimp [7], the government and other relevant departments should be familiar with the linkage between domestic and international fish prices, based on this relationship, to suppress the periodicity of the price of shrimp, while the relevant departments can also promote the development of the fish futures industry Ali balance the periodicity of fish prices, so that The aquatic products market can develop smoothly. At the same time, the relevant departments can further adjust the production structure and variety structure, starting from the market demand, artificial cultivation of shrimps, so as to effectively alleviate the shortage of shrimp supply, but also can weaken the seasonal fluctuation of aquatic product supply.

(3) Vigorously develop the cold chain transportation industry and improve the efficiency of price regulation

In recent years, the market for shrimp has grown steadily and the supply continues to climb, although the size of China's cold chain market is also growing, it is still unable to match the strong demand for transportation. Therefore, it is particularly important to plan the construction of cold chain logistics rationally to make the infrastructure more evenly distributed, reduce transportation costs and improve transportation efficiency. At the same time, the enterprises concerned should also strengthen the information level of the equipment, improve the supervision level of the cold chain transportation process, and realize the standardization and transparency of the product transportation process and the safety of product quality. The new era of Internet + cold chain based on big data has arrived in the cold chain transportation industry. And cold chain logistics integration means that the Internet would be a complete set of modern technology of the Internet used in cold chain logistics industry, through the analysis of large data, improve and optimize the supply chain network and resource allocation, so as to improve the accuracy of the downstream demand and attack.

(4) Predict price in advance, improve price monitoring and management system

Price detection is a basic work of macro-control and price management. Improving the price monitoring system of shrimps will be conducive to better grasping the trend of market changes and judging the development situation The government and other relevant departments should strengthen the shrimp price analysis and forecast, and in-depth analysis of the shrimp price change trend. At the same time, the relevant departments should improve the price monitoring analysis system, regular analysis of the market change in prices, predict the price hot issues and price change trend, so as to detect the analysis of institutionalization, normalization. At the same time, the price forecast of shrimp should be done to ponder deeply and analyze the trend of price change comprehensively. Through the collection of microscopic data, further control of the changes in the market price of shrimps, improve the ability to process data, in addition, the

relevant departments should do a good job in the control of the macro market, improve the price prediction ability, timely understand the trend of the price of shrimps at home and abroad, improve the price sensitivity, more accurate market forecast to weaken the impact of shrimp price cycle on market supply and demand.

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REFERENCES

[1] Han Wen. Application of ARIMA model in price forecasting of agricultural products in Guizhou province--the example of pepper [J]. Anhui Agricultural

[2] Zhang Weihua, Zhang Yingli. A study on the price fluctuation characteristics of fish and fishery products in China[J]. Agricultural Technology and Economics,2020(02):133-142.

[3] Xuwei, HuBingchuan. A study on price volatility of fishery products in China--an analysis of background factors based on consumption ratchet and fishery transformation[J]. Price Theory and Practice,2019(02):72-75.

[4] Yang Zhenhao, Zhang Junbo, Yang Chenxing, Chen Xinjun. Forecasting of China's fish consumer price index based on SARIMA model[J]. Marine Lake and Marsh Bulletin,2021,43(02):131-138.

[5] Luo Changshou, Zhou Liying. Application of seasonal time series model in flat mushroom price forecasting[J]. Guizhou Agricultural Science,2013,41(11):202-204+209.

[6] Jiang Anyin, Cao Ying, Chen Yunxia. Research on cyclical price fluctuations and price forecasting of lamb market in China[J]. Contemporary animal husbandry,2018(27):1-6.

[7] Wang Weiwei. Research on the price fluctuation situation of Chinese aquatic product market [D]. Shanghai Ocean University,2016.