Analysis and Forecast of Producer Price Index of Agricultural Products in Heilongjiang Province

Yongjuan Wang(✉), Yan Yao, and Xichun Jiang

Heihe College, Heihe 164300, China
641917127@qq.com

Abstract. The producer price index of agricultural products is an important part of agricultural economic development. Studying the fluctuation trend of the producer price index of agricultural products and forecasting future short-term data can promote the better development of the agricultural product market and stabilize the national economic structure. This paper analyzes the quarterly data of the producer price index of agricultural products in Heilongjiang Province from 2003 to 2021. First, through a simple descriptive statistical analysis of the producer price index of agricultural products in Heilongjiang Province, it is found that the changes of the producer price index of agricultural products are cyclical, and then the seasonal time period is established. A sequential model to forecast the agricultural producer price index for the four quarters of 2022. The forecast results show that in the next period of time, the producer price index of agricultural products in Heilongjiang Province will still have large fluctuations. Finally, reasonable suggestions are put forward to maintain the stability of the market price of agricultural products.

Keywords: Agricultural Products · Price Index · Sequentially · Predict

1 Introduction

Heilongjiang Province is a major agricultural province in China and an important commercial grain base in the country. Agricultural products are known for their high quality and organic safety. The development of agricultural products industry has a huge impact on China's economic development and has played a good role in promoting the innovation and development of agricultural modernization.

The producer price index of agricultural products reflects the changes in the price level and structure of agricultural producers when they sell agricultural products [7]. Through the analysis of the fluctuation characteristics of agricultural product prices in Heilongjiang Province, we can understand the reasons for the changes in agricultural product prices and the impact of the changes in agricultural product prices. To a certain extent, we can take corresponding measures to appropriately change the industrial structure of rural areas, and improve the production of agricultural products. It can help farmers increase income and promote the development of regional economy of agricultural products.

N. Radojević et al. (Eds.): ICAID 2022, AHIS 7, pp. 1003–1011, 2023.
https://doi.org/10.2991/978-94-6463-010-7_101

1.1 The Overall Fluctuation Trend of the Producer Price Index of Agricultural Products

The producer price index of agricultural products is a relative number that reflects the trend and magnitude of changes in the price level of agricultural products sold by producers of agricultural products within a certain period of time. The production price index of a representative product is obtained by taking the geometric average of the individual indices of all the survey units that sell the product. The index is obtained by weighted average. The 2011–2020 agricultural product price index in Heilongjiang Province is compared with the annual data on the production price index of planting, forest products, livestock products, and fishery products, as shown in Fig. 1. It can be seen from Fig. 1 that the overall fluctuation of the price index of agricultural products is not obvious, showing fluctuation changes from high to low and then high. From 2011 to 2016, the price index of agricultural products in Heilongjiang continued to decline. Since 2011, the continuous improvement of agricultural planting area and scientific and technological level in Heilongjiang Province, as well as the continuous growth of people's consumer demand and industrial demand, have caused changes in supply and demand, and ultimately led to fluctuations in the price index of agricultural products. From 2016 to 2019, the consumption of investment and exports remained active, which became an important factor affecting the economic growth of the industry [6]. Since 2019, due to the difficulties in the production, transportation and sales of agricultural products caused by the new crown epidemic, the overall price of agricultural products has risen as a whole.

From the analysis of the four major categories of agricultural products, the production price index of planting industry is consistent with the change trend of the production price index of agricultural products as a whole, because the agricultural products in Heilongjiang are mainly planted. Compared with the changes in the production price index of agricultural products, the production price index of fishery products has little change, while the production price index of forest products fluctuates greatly. From 2018 to 2020, the production price index of livestock products increased rapidly, and the fluctuation range was also very large, while the production price index of planting, fishery and forest products showed a downward or stable trend, indicating that the production price index of agricultural products was affected by animal husbandry during this period. The impact of the producer price index is relatively large.

1.2 The Influence of the Fluctuation of the Producer Price Index of Agricultural Products

Agriculture is one of the important industries of the country. When the production price index of agricultural products changes, it will affect many aspects:

First, the drastic fluctuation of the producer price index of agricultural products affects farmers' income [5]. When the producer price index of agricultural products fluctuates, it means that the price of farmers selling agricultural products has changed. When the producer price index of a certain type of agricultural product fluctuates greatly, the income of farmers will also be greatly affected. Big change. Secondly, the drastic fluctuation of the producer price index of agricultural products affects the economic development of related industries. Many important agricultural products are used in the

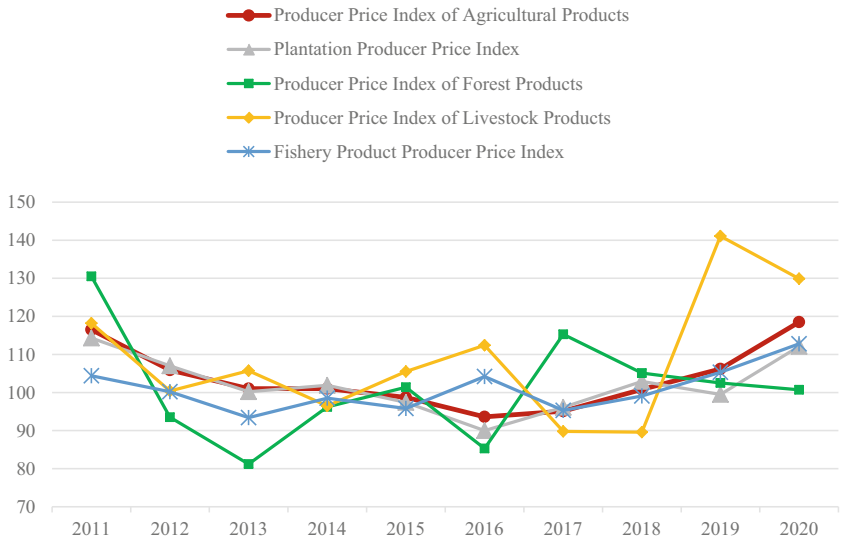

Fig. 1. Change Trend of Producer Price Index of Agricultural Products in Heilongjiang Province

market as raw materials for products produced by many other industries, and changes in the production price index of agricultural products will affect the prices of agricultural products, and changes in the prices of agricultural products will naturally affect the prices of other related products. Finally, the violent fluctuation of the producer price index of agricultural products affects the coordinated development of the industrial structure. All economic activities can be divided into primary, secondary and tertiary industries according to the three-industry classification method. The output value of the primary industry is easily affected by the production price of agricultural products. When the production price index of agricultural products fluctuates, the output value gap between the three industries will be widened, and the proportional relationship between the various industries will also change, resulting in an uncoordinated industrial structure.

2 Forecast of Producer Price Index of Agricultural Products in Heilongjiang Province

2.1 Data Sources

According to the "China Statistical Yearbook", the production price index data of agricultural products in Heilongjiang Province from the first quarter of 2003 to the fourth quarter of 2021 was collected, and Python software was used to predict the production price index of agricultural products in Heilongjiang Province in 2022 with the help of third-party libraries such as pandas, matplotlib, and statsmodels [4].

2.2 Stationarity Test

Drawing a time series diagram, it is found that there is a certain periodic trend in the sequence, and there is no significant linear trend. It can be seen from Fig. 2 that about

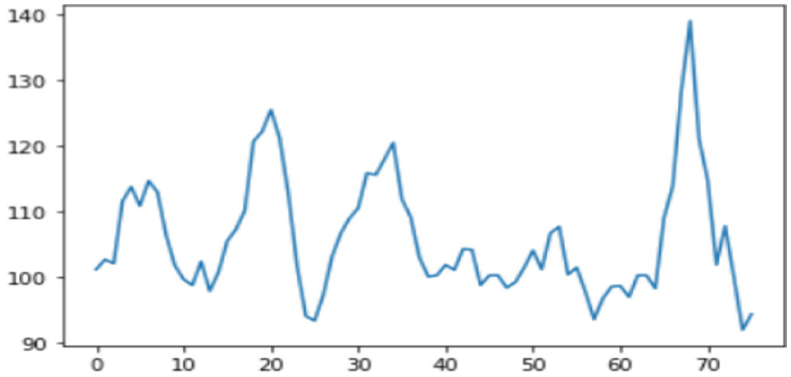

Fig. 2. Raw data timing diagram

Table 1. Unit root test

ADF inspection form							
Variable	Differential order	t	p	AIC	Critical value		
					1%	5%	10%
Value	0	−4.724	0.000	387.375	−3.525	−2.903	−2.589
	1	−5.171	0.000	387.25	−3.537	−2.908	−2.591
	2	−4.544	0.000	395.951	−3.542	−2.91	−2.593

12 quarters constitute a cycle, and the value of the producer price index of agricultural products fluctuates between 90 and 140 in the current quarter, which has a certain stability and can be judged by the unit root test.

It can be seen from the unit root test results in Table 1 that the unit root test (ADF test) for the original sequence, the first-order difference sequence and the second-order difference sequence is close to the critical value of 1%, 5%, and 10%. 0, it can be seen that the series is stationary, then the original series can be selected for time series analysis.

2.3 Model Order Determination and Parameter Estimation

The autocorrelation and partial autocorrelation functions plotted against the original sequence are shown in Fig. 3. In the autocorrelation and partial autocorrelation function graphs, obvious periodicity and obvious tailing characteristics can also be seen, and most of the sequences are located within the upper and lower confidence limits [2].

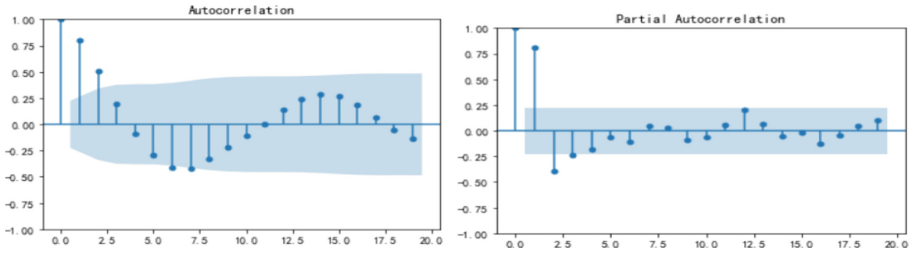

Fig. 3. Autocorrelation and partial autocorrelation functions

For the order determination of the model, the BIC criterion is adopted, and the model is optimal when the BIC function value reaches the minimum. Code show as below:

```
bic_matrix = []
for p in range(pmax):
    temp= []
    for q in range(qmax):
        try:
            temp.append(ARIMA(plist,order=(p,      2,
q) ,seasonal_order=(1,2,1,12)).fit().bic)
        except:
            temp.append(None)
        bic_matrix.append(temp)
bic_matrix = pd.DataFrame(bic_matrix)
p,q = bic_matrix.stack().idxmin()
```

After calculation, the ARIMA (8,0,1,) model is finally selected. The detailed results of the model are as follows:

When identifying the model, a variety of order determination methods were tried, and the optimal parameters were finally determined as shown in Table 2. It can be seen from Table 2 that the Log Likelihood represents the fitting degree of the time series, which is a negative value at this time, and the larger the better. AIC value and BIC value are a standard to measure the goodness of model fitting, and the smaller the value, the better. The Std err column corresponds to the standard deviation of the model, with a smaller value. Although there are many values in the p > |z| column greater than 0.05, the equation is not significant, but from the overall effect, the fitting is good and the model is available. The expression to write the final parametric equation according to the coef column is:

$$y_t = 105.7203 + 0.5824y_{t-1} + 0.2384y_{t-2} - 0.0929y_{t-3} - 0.3454y_{t-4} + 0.1406y_{t-5} - 0.1217y_{t-6} + 0.0909y_{t-7} - 0.1744y_{t-8} - 0.2823y_{t-12} + \varepsilon_t + 0.3944\varepsilon_{t-1} + 0.4044\varepsilon_{t-12} - 19.7156 \sin \varepsilon_{t-2}$$

2.4 Model Checking and Prediction

The error analysis of the model is carried out, and the error results are as follows:

It can be seen from Fig. 4 that the error between the predicted value predicted by the simulation and the actual value is less than 4%, and the model fits well [1]. The effect

Table 2. Model parameter table

Dep. Variable:	Producer Price Index of Agricultural Products				No. Observations:	
Model:	ARIMA(8,0,1) × (1,0,1,12)			Log Likelihood	−222.446	
Data:	Sun,20 Mar 2022			AIC	470.892	
Time:	01:21:21			BIC	501.192	
Sample:	0			HQIC	483.002	
	−76					
Covariance Type:	opg					
	coef	Std err	z	p>|z|	[0.5	0.5]
const	105.7203	1.731	61.084	0.000	105.720	105.720
ar.L1	0.5824	1.162	0.501	0.616	0.582	0.582
ar.L2	0.2384	1.132	0.211	0.833	0.238	0.238
ar.L3	−0.0929	0.245	−0.379	0.705	−0.093	−0.093
ar.L4	−0.3454	0.204	−1.689	0.091	−0.345	−0.345
ar. L5	0.1406	0.368	0.382	0.702	0.141	0.141
ar. L6	−0.1217	0.374	−0.326	0.745	−0.122	−0.122
ar. L7	0.0909	0.359	0.253	0.8	0.091	0.091
ar. L8	0.1744	0.225	−0.774	0.439	−0.174	−0.174
ma. L1	0.3944	1.178	0. 335	0.738	0.394	0.394
ar.S.L12	−0.2823	1.769	−0.16	0.873	−0.282	−0.282
ma. S. L12	0.4044	1.666	0.243	0.808	0. 404	0. 404
sigma2	19.7156	3.213	6.136	0.000	19.716	19.716

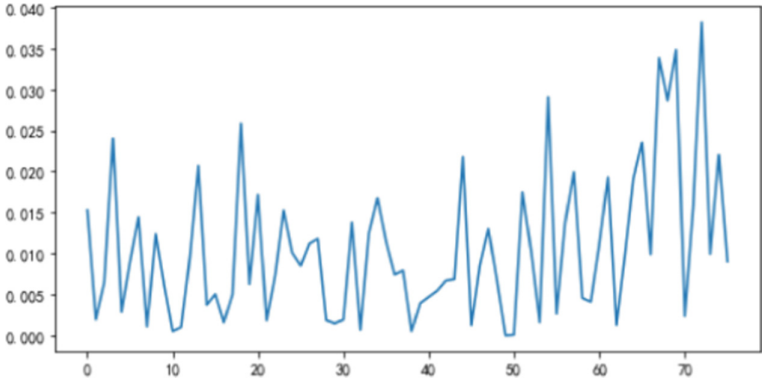

Fig. 4. Fitted residual plot

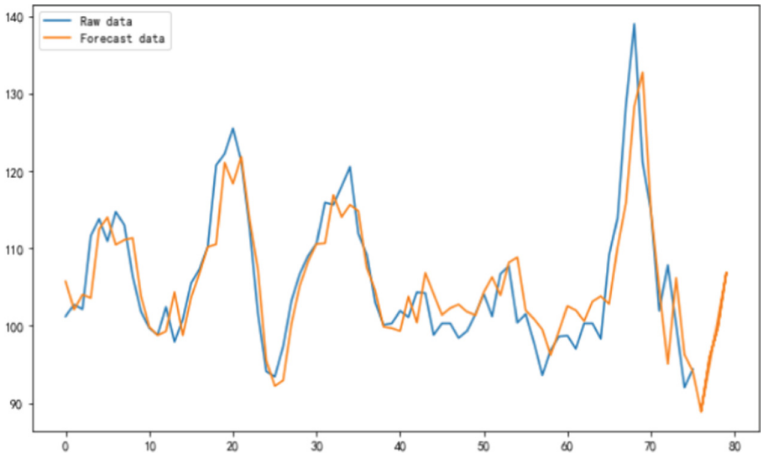

Fig. 5. Prediction timing diagram

Table 3. Predicted values

time	forecast result
Q1 2022	96.021
Q2 2022	99.326
Q3 2022	103.939
Q4 2022	107.458

of data simulation prediction before 2019 is better, and its residual value is relatively stable. After 2019, the residual value fluctuates greatly, and the overall effect is better. Under this model, the price index of agricultural products in Heilongjiang Province in the first quarter of 2022 is predicted, and the results are shown in Fig. 5.

As can be seen from Fig. 5, except for the first quarter of 2008, the third quarter of 2011 and the first quarter of 2021, the prediction results of the model fitting are almost the same as the original data, indicating that the model fitting effect is good. 2008 and 2011 may be due to some policy changes, and 2021 may be due to the impact of the epidemic, so the original value and the predicted value are quite different. From the perspective of changing trends, there will still be large fluctuations in the production price index of agricultural products for a period of time in the future. Through the ARIMA model, the agricultural product price index of Heilongjiang Province is predicted to the next four periods, that is, from the first quarter to the fourth quarter of 2022. The results are shown in Table 3.

3 Suggestion

The changes of the producer price index of agricultural products reflect the trend of the price of agricultural products to a certain extent. Combined with the development of the

agricultural economy and the change trend of the producer price index of agricultural products, the following suggestions are put forward to maintain the stability of the market prices of agricultural products:

Timely announcement of price changes of agricultural products in domestic and foreign markets. The Ministry of Rural Agriculture needs to strengthen the monitoring and analysis of agricultural product market information, and it is necessary to promptly announce changes in the price information of various agricultural products so that farmers can quickly understand the changes in the corresponding products. Relevant persons in charge of each region can conduct regular knowledge training for farmers, so that farmers can keep abreast of various information related to agricultural products, help farmers understand the market demand structure, and reasonably guide market expectations.

Adjust and improve the production mechanism and circulation policies of agricultural products. The government needs to devote more energy to maintain the stability of agricultural production prices by improving the market mechanism. The state should invest more funds in agricultural development and improve the subsidy system. Learn from the prices of foreign agricultural products to stabilize the domestic agricultural product market, adjust the prices of agricultural products within a reasonable range in the production process of agricultural products, and comprehensively use the reserves of agricultural products and the adjustment of import and export to keep the prices of agricultural products in the market relatively stable. In order to maintain the stable development of the production price index of agricultural products at a certain level, and promote the healthy operation of the economy and society.

Rational use of international agricultural resources and markets. In order to ensure the stability of agricultural product prices, it is necessary to make full and reasonable use of the international market to bring us benefits [3]. Leaders should learn all aspects of the flow of foreign agricultural product markets. All relevant government departments should provide timely planning guidance for the import and export trade of agricultural products. On the premise of stable prices, we will actively explore foreign markets, so that Chinese agricultural products have a more solid position in the international trade market.

4 In Conclusion

The fluctuation of the production price of agricultural products affects the income of farmers and affects the healthy operation of the economy and society. Through the research, it is found that the current agricultural production price index in Heilongjiang Province has fluctuated more obviously in recent years. This phenomenon is affected by the fluctuation of the production price index of four kinds of agricultural products. Among them, the fluctuation of the production price index of animal husbandry products has the greatest impact, and the production price index of planting products is the most affected. Producer price index fluctuations have less impact. Through python software, using the agricultural product price index data of Heilongjiang Province in each quarter from 2003 to 2021, the value of the agricultural product production price index in the four quarters of 2022 is predicted, and it is analysed that there will still be large fluctuations in the agricultural product production price index in Heilongjiang Province. Put forward

some suggestions for stabilizing the prices of agricultural products, such as the timely announcement of changes in the prices of agricultural products in domestic and foreign markets, and the adjustment and improvement of the production mechanism and circulation policies of agricultural products. Make rational use of international agricultural resources and markets.

Acknowledgement. The results of this research are funded by the "2020 Heilongjiang Provincial Undergraduate Universities Fundamental Research Funding Project of Heihe University Special Fund (No.: 2020-KYYWF-0882)".

References

1. Chen C (2016) Short-term forecast of China's agricultural product price index based on SARIMA model. J Hum Univ Bus 23(02):16–20
2. Lan C, Zhang M (2016) Prediction of weighted Markov chain in agricultural product producer price index. J Fuyang Norm Univ (Nat Sci Ed) 33(02):97–101
3. Wang F, Yang X (2012) The overall characteristics and trends of corn price fluctuations in Jilin Province. Contemp Ecol Agric 1:67–69
4. Nie G, Zhou Y (2017) Quantitative research on the synergistic relationship between China's economic growth, agricultural product price index and PPI. J Hebei Univ Geosci 40(03):44–48
5. Shi K (2015) Analysis of the impact of rising agricultural prices on inflation. Stat Decis 18:161–164
6. Zhang X (2018) Analysis of the influencing factors of price fluctuations of agricultural products in my country. Contemp Econ 08:26–27
7. Xian Z (2003) The calculation and release of the national agricultural product producer price index. China Stat 09:4–5