

Short-Term Forecasting of Pork Price Based on The ARIMA Model

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Abstract. China's large population requires a large and diverse amount of food, of which pork is one of the important agricultural products related to the national economy and people's livelihood. Based on the pork price data from 2010 to July 2023, this paper adopts the ARIMA time series model to forecast the pork price in the short term from August 2023 to February 2024 in order to provide a powerful reference for the macroeconomic management of the country. After testing, the ARIMA model has a certain guiding and reference value for predicting the high and low pork prices in the short term, which can provide a decision-making basis for the macroeconomic management of the country.

Keywords: ARIMA Time Series Analysis; Pork Price Forecast; Macroeconomic Management.

1. Introduction

As people's quality of life continues to improve, there is a growing concern for health and a growing awareness of the centrality of diet in maintaining good health. Given our large population base and diverse food needs, pork has become one of the key agricultural products affecting the country's economy and people's lives. The price of pork has fluctuated significantly [1] in recent years due to the double blow of African Swine Fever [2] and New Crown Epidemic [3]; at the same time, the increase in the price of agricultural products has also had a significant impact on the daily consumption of the population and macroeconomic strategies. The fluctuation of pork price is not only affected by the price of poultry and aquatic products but also by the price fluctuations of other agricultural products and changes in labor costs [4]. The price fluctuation of pork has a direct impact on people's daily expenses and consumption standards. Therefore, paying close attention to the fluctuation of pork prices helps us to understand our purchasing power and quality of life more accurately. This article focuses on the predictive analysis of the price of pork (i.e., boneless uniform meat).

By collating and analyzing the relevant studies on pork prices by scholars at home and abroad, it is found that most scholars at home and abroad mainly analyze the fluctuation pattern of the price of hogs [5], Liao Park [6] and his team use the spiderweb theory with the ARMA model to predict the price cycle of hogs. The prediction results reveal that the fluctuation of the price of hogs exhibits a convergent spiderweb pattern. Liu Based on the VAR model, Liu Mingyue et al. [7] empirically studied the fluctuation of China's hog price, that corn and new crown epidemics have an impact on the fluctuation of pork prices and proposed to stabilize the market price of hog feed, increase the intensity of prevention and control of epidemics and improve the early warning mechanism of hog price to prevent excessive fluctuation in the price of pork recommendations. However, only some scholars have made specific forecasts and analyses of pork prices.

Therefore, this paper takes pork price as an entry point by using the ARIMA model to generate time variables on the perfected data, perform first-order differencing, and get the related time series graph; by observing the time series graph, ACF PACF graphs determine the values of p and q and initially determine to construct ARIMA (1,1,1) model [8]; after that, we use SPSS expert simulator to determine the degree of fit optimization of this model fit optimization degree, to determine the establishment of the model is established; Finally, according to the historical data and the construction of the best model to predict the short-term future price of pork, in order to be able to give the government decision-making departments to provide certain reference advice.

2. ARIMA model algorithm principle

ARIMA model [9], also known as the differential integration moving average autoregressive model, can be subdivided into Autoregressive model AR, Moving Average model MA and Autoregressive Moving Average model ARIMA. Average model ARIMA).

The linear combination of observations characterizes the ARIMA model X_t with their lagged p-order observations and the inclusion of a random error factor

$$X_t = \varphi_1 X_{t-1} + \varphi_2 X_{t-2} + \dots + \varphi_p X_{t-p} + \alpha_t \quad (1)$$

In Equation (1), X_t represents the zero-mean stable series, α_t represents the random error, and φ is the regression coefficient of the model. The AR model is generally abbreviated as AR(p).

The MA model is characterized by the fact that the observation X_t is the same as the previous $t - 1, t - 2, \dots, t - q$ random error terms entering the system at moments $t - q; \alpha_t, \alpha_{t-1}, \dots, \alpha_{t-q}$ is a linear union between the

$$X_t = \alpha_t - \theta_1 \alpha_{t-1} - \dots - \theta_q \alpha_{t-q} \quad (2)$$

In this Equation, θ represents the regression coefficient of the model. The abbreviation of the MA model is MA (q). the observation X_t of the ARIMA model is not only related to its observations at p time points in the past but also has a certain dependence on the q random errors that it enters into the system at previous moments; that is:

$$X_t = \varphi_1 X_{t-1} + \varphi_2 X_{t-2} + \dots + \varphi_p X_{t-p} + \alpha_t - \theta_1 \alpha_{t-1} - \dots - \theta_q \alpha_{t-q} \quad (3)$$

As can be seen from equation (3), the ARIMA (p q) model is actually a combination of the ARIMA (p) model and the MA (q) model.

The stability of time series is a key factor in performing time series analysis and forecasting. Therefore, before starting ARIMA modeling, the time series to be analyzed must satisfy the stability condition. For non-stationary time series, the difference method can be used to smooth them and verify their smoothness. After smoothing the time series with a d-order difference, we constructed an ARIMA model for in-depth analysis. After the estimation of the model parameters was completed, we used the reversibility of the data transformation to ensure that the estimation of the model parameters matched the data before smoothing. The model constructed through this process is named the integrated ARIMA model, also known as the ARIMA (p d q) model.

3. Empirical analysis of pork price forecasting based on ARIMA time series model

3.1. Data sources

The experimental data of the thesis mainly comes from the National Bureau of Statistics, WIBS and other websites, and the price data of pork (boneless price) from January 2010 to July 2023 is selected (unit: yuan/kg).

3.2. Model Establishment

In this paper, the difference time series obtained by first-order differencing of the original data is shown in Figure 1.

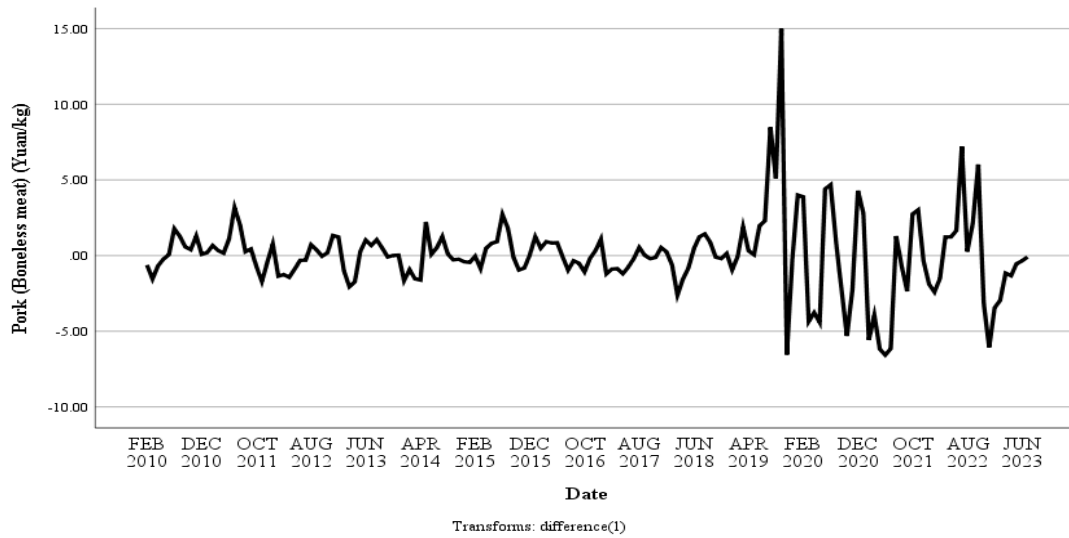


Figure 1. First difference time series diagram

Afterwards, the ACF and PACF plot test is carried out, and the results are shown in Figure 2 and Figure 3.

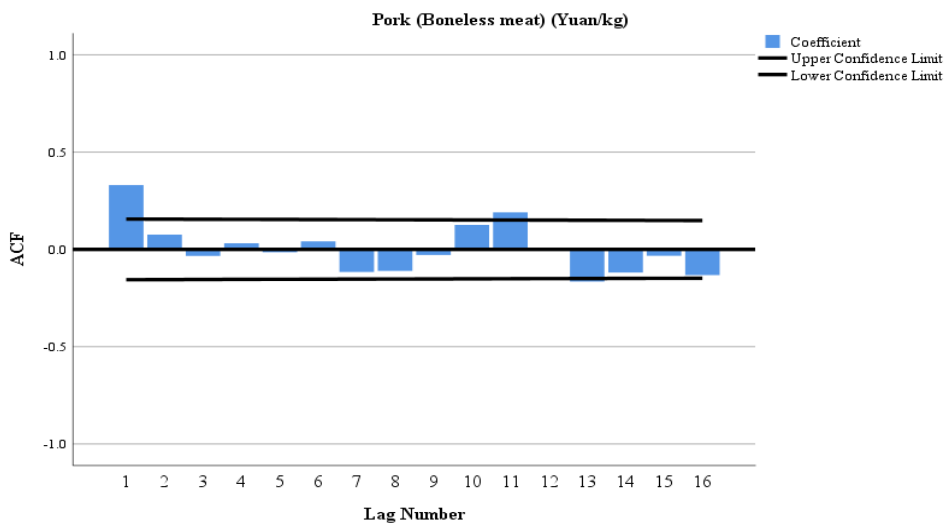


Figure 2. First-order difference ACF diagram

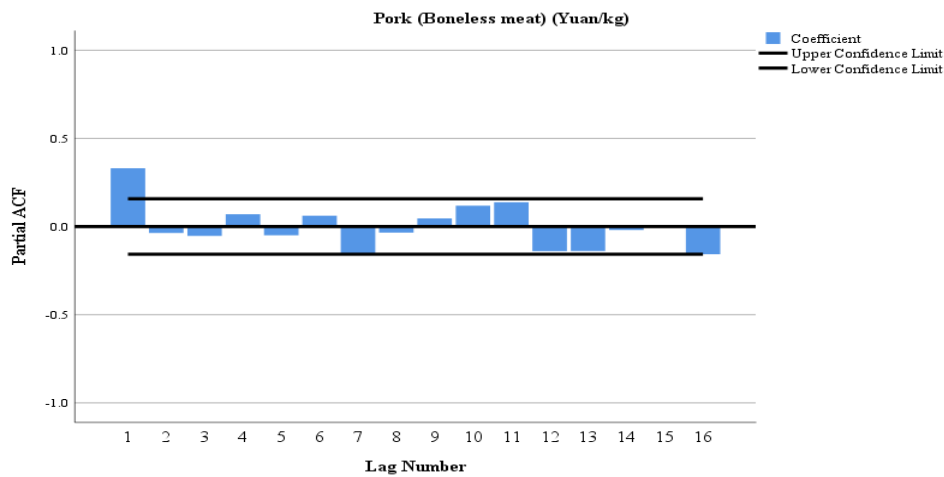


Figure 3. First-order difference Partial ACF diagram

According to the sequence Figure 1, it can be seen that the data are not stable in some intervals, with an upward trend, in which the upward trend in 2020 is obvious and anomalous, combined with the context of the times, during 2019 and 2020, the domestic pig stocking rate was extremely low due to the swine fever epidemic at that time. Coupled with the impact of other factors, making China's pork serious oversupply, the price of pork in that year all the way up; from Figure 2 and Figure 3, we can see that the original sequence after the first-order differencing ACF, PACF plot are first-order drag-tailed, so that the sequence after the first-order differencing is smooth, and p and q are equal to 1. Excluding the abnormal background and the price of pork's seasonality is not prominent, considering the time series, this paper chooses to ARIMA(1,1,1) model.

3.3. Model Setting

In order to ensure the accuracy of time series modeling, this paper uses the expert modeler function of SPSS software to test the ARIMA(1,1,1) model constructed above and selects the option of "automatic detection of outliers," and the fitting results are shown in Table 1:

Table.1. Expert modeler statistics

Model	Number of Predictors	Model Fit statistics			Ljung-Box Q(18)		Number of Outliers
		Stationary R-squared	R-squared	Statistics	DF	Sig.	
ARIMA(1,1,1)	0	0.674	0.977	24.803	16	0.073	8

From the chart, we know that the model given by the expert modeler is also the ARIMA (1,1,1) model, the smooth R-squared value is 0.674, and the significance is greater than 0.05 that is, there is no autocorrelation in the residual series, so the fitting effect is relatively perfect, in line with the expected, so the model test is passed [10].

3.4. Residual white noise test

After the ARIMA(1,1,1) model is selected, its residual part needs to be tested for white noise. If the residuals are found to have autocorrelation, autoregressive or sliding average should be introduced to explain, reconstruct the model and evaluate it, and then the residuals of the new model should be tested for white noise and keep repeating the operation until the residuals are determined to be white noise. For white noise detection, it is still possible to use autocorrelation plots, the results of which are shown in Figure 4:

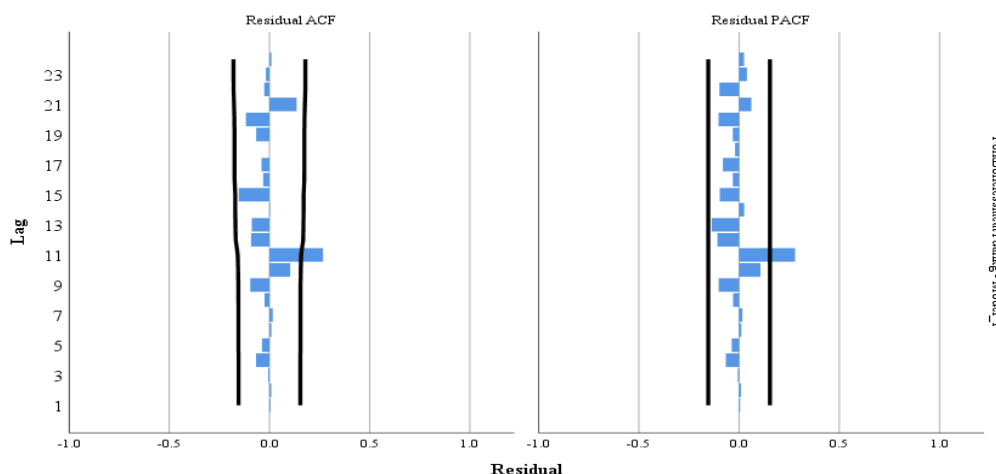


Figure 4. Residual ACF,PACF plot

From the figure, we can observe that after the first order differencing, except for the data of 11 periods (for the data in the anomalous background), all the autocorrelation coefficients fall within the confidence range, the autocorrelation coefficients in the random distribution at the same time also tends to be gradually close to 0; similarly, the residuals of the PACF coefficients are also roughly 0; therefore, the residuals data are white noise data.

3.5. Data Prediction

According to the best model constructed, the forecast value of pork prices from August 2023 to February 2024 ends, as shown in Table 2.

Table.2. Pork price forecast for August 2023 - February 2024

Year	Month	Pork price forecast
2023	8	22.98
2023	9	23.1
2023	10	23.22
2023	11	23.34
2023	12	23.46
2024	1	23.59
2024	2	23.71

4. Conclusion

In this paper, based on the monthly variation data of pork prices in China from 2010 to July 2023, a short-term forecast of pork prices from August 2023 to February 2024 is made using the ARIMA model. Through the study, we found that using the ARIMA model[11] can accurately predict short-term fluctuations in pork prices, and therefore, this pork price research project is of significant importance and extensive practical value in future application scenarios. Firstly, for consumers, predicting the price of pork helps them to plan their consumption more accurately, and at the same time, the prediction of the price trend also assists them to plan their purchases rationally in order to reduce the financial burden that the price fluctuations may cause; secondly, for farmers, predicting the price of pork helps them to formulate a more informed production strategy. Finally, pork price prediction helps the government understand and grasp the latest trend in the pork market but also provides more policy support and decision-making basis for the government to formulate more effective macroeconomic policies, thus promoting the development of China's hog farming industry.

Although ARIMA models are relatively simple and adaptable to construct, they have high data stability requirements, requiring the input time series data to be stable or stable through differencing. Therefore, if we find a specific pattern or trend in the data, we can consider using other types of ARIMA models for fitting, such as the seasonal ARIMA model and the non-stationary time series ARIMA model. By using a model that fits the characteristics of the data, the fitting effect and predictive ability of the model can be improved. Therefore, when using ARIMA models, the most appropriate model must be selected by considering the specific data and background.

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