Price Prediction of Second-hand Houses in Beijing in the Post-epidemic Era Based on ARIMA Model

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Abstract. As one of China's pillar industries, the growth of the national economy is significantly influenced by the real estate sector. Affected by the epidemic, the real estate capital chain is broken, and the real estate market faced crisis. At the beginning of 2023, the national policy was liberalized, and the real estate market gradually recovered. This paper takes the listing price of second-hand residential buildings in Beijing during the epidemic period as the research object, establishes an ARIMA model, analyzes the monthly data during the epidemic period from 2019 to 2023, and uses R software to predict the trend of real estate prices in Beijing in the next two years. The findings indicate that by the start of 2024, Beijing's second-hand house prices would continue to expand steadily and healthily. The significance of this paper is to use the past and current values of the time series of secondary residential prices to accurately predict real estate prices in the post-epidemic era. These results provide a basis for the national macroeconomic regulation of the real estate market.

Keywords: Real estate, ARIMA model, Price forecasting.

1   Introduction

As a pillar industry in China, the real estate industry has been one of the locomotives of economic growth in the past 20 years, accounting for 7.34% of GDP, which has an important impact on China's society and economy. In the face of the impact of the epidemic, real estate supply and demand have both declined, From the standpoint of supply, the epidemic's decrease in consumption and income may indirectly diminish families' and individuals' capacity to pay for housing, leading to a drop in demand for housing. From the supply side, real estate companies' sales offices are momentarily shuttered, which has an impact on how quickly projects are delivered from the supply side [1]. The confidence in the real estate market has been weak. To rebuild trust in the real estate market, the Ministry of Housing and Urban-Rural Development has gradually liberalized epidemic prevention and control methods since 2023 and has sequentially launched new real estate rules. People's demand for real estate information is increasing as the real estate market improves, and real estate prices have become a common concern. Doing a good job in real estate price prediction research,

is conducive to investors mastering real estate price information, allowing investors to make a reference for decision-making, and reducing information asymmetry [2].

Beijing is China's political capital, and the epidemic has affected the city's real estate market. As a political center, Beijing's accurate understanding of the development of Beijing's real estate market is of certain significance to stabilizing the national real estate market. Since the current research on the prediction of real estate prices in Beijing in the post-epidemic era is still blank, this paper selects the average listing price of second-hand residential buildings in Beijing as the research object, and uses data on real estate prices during the outbreak to estimate real estate prices in the post-epidemic age, in order to support the macro-control of the country's economy. This study investigates the period from 2019 to 2022, employs R software for time series analysis, and develops an ARIMA model to forecast the trajectory of real estate values in Beijing over the following two years [3].

China attaches great importance to the study of real estate price trends, and in the past, scholars used different methods to predict real estate prices, which are summarized as follows. Hu studied the real estate price trends in six districts of Hefei City by establishing an ARIMA model, and achieved good results [3]. Liu et al. conducted a prediction study on real estate prices by establishing the VAR-GM(1,1)-SVR model [4]. Zhang performed a grey correlation study based on the GM(1,N) model from the perspectives of real estate demand, supply, and macroeconomics. The findings revealed that the land supply area and loan interest rate had little bearing on real estate prices [5]. Lin et al. studied real estate prices in different regions of Wuhan based on GIS technology [6]. Based on BP neural network, Hu conducted research and analysis on the influencing factors and prices of real estate prices in Changsha [7]. Zhang predicts the price of second-hand houses based on NGBoost algorithm, and applies the traditional random forest model as a comparison model, and the results show that the NGBoost model performs well in prediction [8]. In recent years, machine learning has emerged and there have been advances in real estate price prediction research. Chen et al. studied the influence of travel convenience and housing area heat factors on housing prices, and made real estate price prediction based on DBSCAN clustering algorithm and DNN neural network [9]. In summary, the quantitative forecasting methods for real estate price forecasting usually include regression analysis forecasting method, time series analysis method, BP neural network model method, gray prediction analysis method, machine learning analysis method, etc. This paper adopts the ARIMA model, which is commonly used in the time series analysis method, which is widely used and relatively simple, and only requires endogenous variables without the help of other exogenous variables.

2   Data & Method

This article selects the relevant data on the average listing price of second-hand residential properties in Beijing found on Wind. Based on the monthly data of 2019~2023, a total of 39 average listing prices of second-hand residential buildings in

Beijing were used as input data to analyze and predict the prices of second-hand residential buildings in the next two years.

Summation autoregressive moving average model is the full name of the ARIMA (p,d,q) model, in which p is the autoregressive term, q is the moving average term, and d is the quantity of differences that occur when the time series is stationary. The ARIMA model is a commonly used modeling method in econometrics, which is a combination of difference operation and ARMA model [10]. It is based on the idea that a time series is a set of random variables that depend on time t (except for observations caused by individual accidental factors). The ARIMA method divides the predictive model into 5 phases: stationarity test, white noise test, determination of parameters, model test, and prediction application.
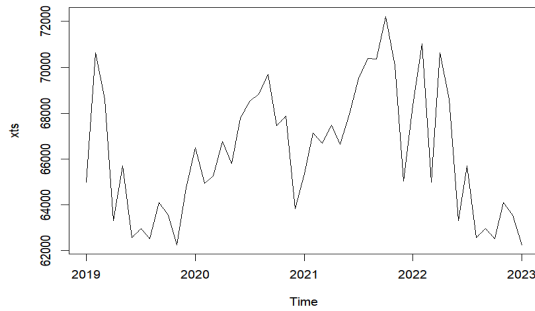

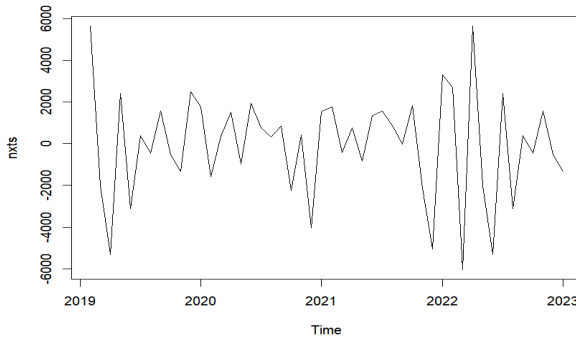**Fig. 1.** Average listing price of second-hand residential properties in Beijing.

Fig. 2. First-order differential graph

3   Results & Discussion

3.1   Stationary Inspection

The time series of the average listing price of second-hand residential buildings in Beijing shows that the price of real estate fluctuates significantly between December 2019 and February 2023 (seen from Fig. 1), and the original time series graph's unit root test shows that the P value is equal to 0.635 higher than 0.05, indicates that a unit

root exists and the time series is not stable. After the original time series is differenti-
ated, the unit root test is carried out to test its stability, and the p-value is equal to 0.03
and less than 0.05 and the time series is stable after first-order differentiation, and
second-order differentiation is not required. Plot the timing diagram after first-order
difference with R (shown in Fig. 2).

3.2   White Noise Test & Parameter Determination

After the difference, the white noise test continues, and the P value is equal to
0.01278 and less than 0.05, indicating that it is not white noise, and the parameters in
the ARIMA model can be determined in the next step. By observing the autocorrela-
tion plot and the partial autocorrelation plot p and q tailing (as illustrated in Fig. 3 and
Fig. 4). It is automatically determined by the software algorithm, and the output of the
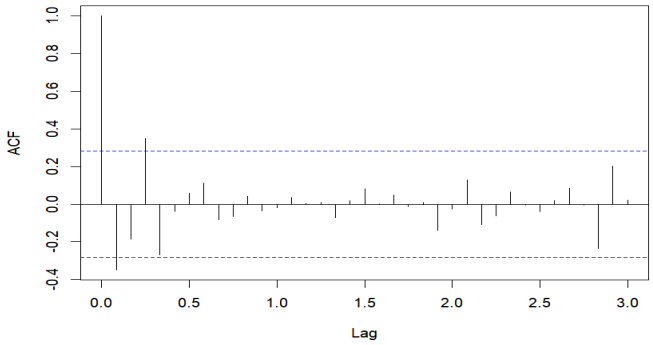resulting optimal model is ARIMA(1,0,1).

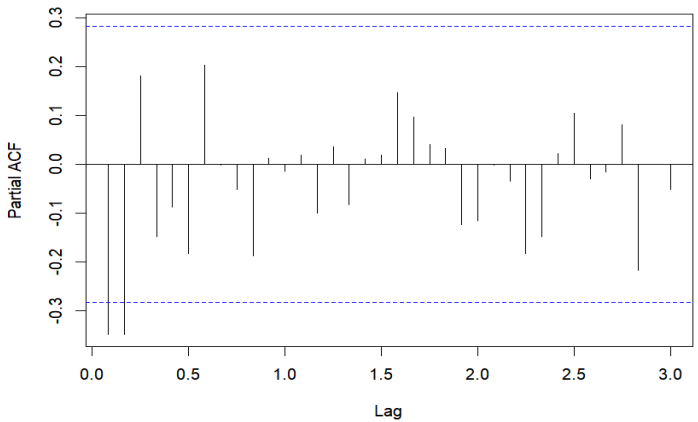**Fig. 3.** First-order differential sequence ACF plot.

Fig. 4. First-order differential sequence PACF plot.

3.3   Model Testing & Prediction

The model fitting effect is tested, and only if the output result is white noise can indicate that the model is successfully established. By drawing the fit of the QQ plot with its added line, determine whether the residuals follow a normal distribution, and then perform a white noise test on the residuals (as given in Fig. 5). From the QQ plot, the scatter points are distributed around a straight line, indicating that the residuals follow the normal distribution feature. From the output result, the p-value equal to 0.98 greater than 0.05 proves that the residuals are not correlated. In summary, the model passed the white noise test, and the model was successfully established. The model is used to make short-term predictions on the average listing price of second-hand residential buildings in Beijing, and according to the forecast chart (as depicted in Fig. 6), in the short term, the average listing price of second-hand residential buildings in Beijing will maintain a steady increase on the basis of price maintenance.
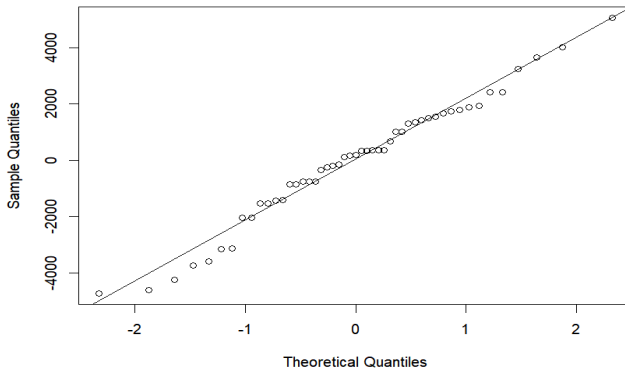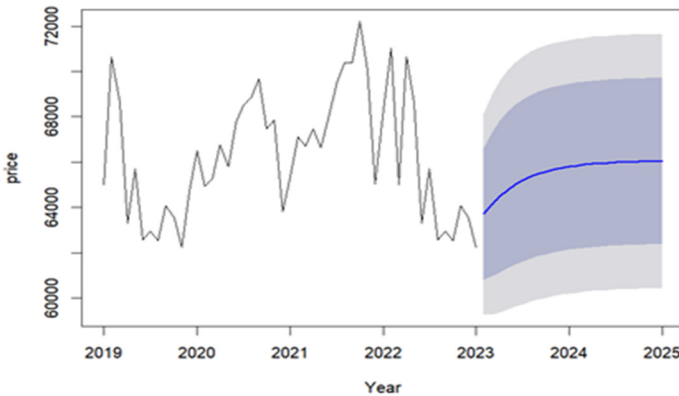

Fig. 5. The Q-Q plot.

Fig. 6. Forecasting results.

4   Conclusion

In summary, this study finds that in the post-epidemic era, Beijing's real estate prices will enter a stage of healthy and stable growth. In the short term, based on price maintenance, Beijing's average listing price for used residential structures will continue to rise steadily, which may be due to the following reasons. Due to the gradual optimization of the epidemic policy, the backlog of demand in the early stage has been released, the real estate market has recovered, additionally, the price of used homes has been gradually rising; economic expectations, post-pandemic era, consumption and employment environment gradually recover, buyers have expectations for the future. Regarding to seasonal factors, after the Spring Festival every year, Beijing ushered in the "small Yang Spring", many families have the need to buy houses and exchange houses, which will lead to the growth of house prices in a short period of time. From the end of 2023 to the beginning of 2025, real estate prices are forecast to be relatively stable. The reason may be that the country has been paying attention to house price fluctuations. At the end of 2016, the Central Economic Work Conference proposed that "housing is not speculation", and since then it has been continuously mentioned in various documents. In December 2018, the Ministry of Housing and Urban-Rural Development emphasized "stable land prices, stable housing prices, and stable expectations". Adhering to the long-term mechanism of real estate regulation and control, the primary goal of present and future regulatory regulations is to sustain the real estate market's steady growth, and in 2021, the Beijing Municipal Housing and Urban-Rural Development Commission publicly solicited opinions from the public, and "housing is not speculation" is planned to be written into legislation. The significance of this paper lies in the fact that, on the one hand, it gives the Beijing real estate market and the Beijing government a foundation for macro-control. For real estate investors, on the other hand, it offers a basis and point of reference for making decisions.

It should be noted that the data selected in this paper is the monthly data of the average listing price of second-hand residential buildings in Beijing during the epidemic period, and the lack of data may lead to inaccurate model accuracy. Secondly, there are many factors that affect real estate prices, such as season, per capita income, geographical location, etc., which will have a certain impact on the price trend of real estate in the future period. The ARIMA model in this paper is relatively simple, and new actual values can be added in the future to modify the ARIMA model and further refine the operation, so that the model has better predictability to facilitate in-depth research on this topic. Overall, these results offer a basic guideline for real estate price prediction.

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