

Quantifying the Impact of the COVID-19 Pandemic on Housing Prices in Los Angeles using Time Series Analysis

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Abstract. The real estate market is an indispensable part of both the national economy and the financial system. For households, housing is one of the most important consumer commodities, and a family's finances and expenses are bound to be significantly influenced. For a country, the housing market majorly affects the growth of the GDP, so even a small fluctuation in the real estate market can lead to a subsequent impact on the economy as a whole. Therefore, it is worthwhile to take housing price forecasts into consideration. In addition, with the outbreak of COVID-19, the impact this pandemic brings to the real estate market needs to be analyzed. As a result, this research focuses on making a forecast of housing prices in Los Angeles by applying the ARIMA model and then quantifying how the COVID-19 affects housing values using time series analysis. In that case, policymakers can make more informed regulations on the real estate market, making citizens' lives easier than before.

Keywords: Housing price, Los Angeles, ARIMA model, COVID-19.

1. Introduction

Real estate property is an inextricable part of both the country's economy and the financial module [1]. For households, housing is thought to be the most crucial consumer commodity in most cases, so it is unavoidable that real estate takes up the biggest share of the family's fixed asset [2]. Therefore, the family's savings and consumption can be influenced by housing to a large extent [3]. In that case, it requires that individuals understand how changes in housing prices affect their household wealth and how they affect their financial circumstances [4]. When it comes to a country, from a macro perspective, the property market primarily contributes to the growth of the GDP, so even a small fluctuation in the housing market can result in a huge impact on the economy as a whole [1, 5].

For the past 30 years, international financial markets have been increasingly merged together. In consideration of this financial globalization, many studies suggest that a global financial cycle, which is referred to as the GFC hereafter, is responsible for the co-movement of worldwide financial variables [6]. Theoretically, by altering the time-varying discount rates, the hypothesis that GFC produced boom-and-bust cycles in property values is backed by Martínez-García and Grossman's (2020) [6].

Take Los Angeles as an example; it ranks second in the U.S. in terms of size. In addition, it is situated in the southwest of California. Known as one of the major centers for commerce, worldwide trade, science, education, entertainment, and sports in the United States, housing prices in Los Angeles have been steadily rising over a long period of time.

Since the year 2020, the COVID-19 epidemic has had a catastrophic and long-lasting impact on people's lives and economies. To be specific, the COVID-19 was announced as a pandemic by the World Health Organization (WHO) on March 11, 2020 [7]. The virus spread to the whole world in a very short time; by November 2023, there had been approximately 771,000,000 confirmed cases of COVID-19, with about 7,000,000 deaths recorded globally [7]. Up until now, abundant studies have documented various negative impacts of this pandemic, ranging from housing prices to household consumption [8, 9]. For example, in order to mitigate the disease's spread, governments all over the world have implemented many strategies, such as movement control orders (MCO), which entail travel prohibitions, lockdowns at the district, state, and federal levels, and work-from-home policies

[10]. In that case, the energy system was unavoidably impacted because people were forced to stay at home at that time, and the share of residential energy consumption absolutely has a tendency to increase [10]. Subsequently, this shift in life and work had an impact on electricity consumption, which is involved in household consumption [10]. Similarly, the COVID-19 epidemic influences real estate prices as well.

Research regarding analyzing housing bombs is totally enough. Given that, this study aims to predict housing prices in Los Angeles after a full understanding of the entire real estate market, which will be useful for governments to make policies for the subsequent stabilization of the economic markets. In addition, previous research has focused on how the COVID-19 affects the cost of financial assets, including stocks, sovereign Eurobonds, corporate bonds, and US Treasury bonds [11]. Nevertheless, research on quantifying how the COVID-19 has an impact on housing prices is still lacking. In other words, how the COVID-19 epidemic affects the housing market is still ambiguous. Thus, analyzing how the COVID-19 influences housing values in Los Angeles can help policymakers make more informed regulations as well.

2. Methods

2.1. Data Source

The data set for the literature is collected from Zillow, and then the housing prices in Los Angeles from January 2000 to September 2023 are selected with 285 observations.

2.2. Data Visualization

The complete statistics are there for research for time series, so figuring out how housing prices change over the period of 285 months is necessary. Fig. 1 demonstrates the time series plot of Los Angeles monthly housing values.



Figure 1. Housing prices in Los Angeles

Observations of the monthly time series plot of the housing prices in Los Angeles can reveal some simple conclusions. First of all, it is clear that there is an apparent increasing trend over the period of 258 months, although there was a significant decrease from 2007 to 2013. Furthermore, no apparent seasonality or cyclicity are demonstrated in this time series plot.

2.3. Model Selection

The ARIMA model is a versatile and widely used approach for evaluating time series and forecasting future values based on historical data. The ARIMA model involves three key factors: autoregressive (AR), integrated (I), and moving average (MA).

3. Results and Discussion

3.1. Data Processing

The ACF plot displays the autocorrelation of the time series with various lags. Autocorrelation measures the linear relationship between the time series at a given time point and its previous values.

As shown in Fig. 2, a slow decay in autocorrelation can be observed, indicating that values at distant time points are still strongly correlated. As a result, the time series is not stationary.

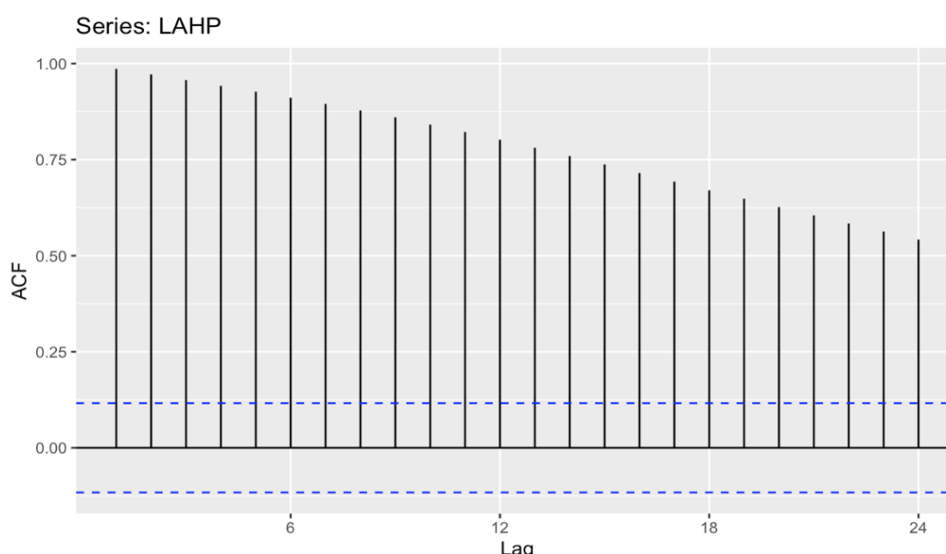


Figure 2. The ACF plot of LAHP

Subsequently, taking the log of the original data can help smooth the variance, making the time series more consistent over time.

After that, in order to stabilize the time series, differencing can be helpful. The ACF and PACF plots of second-order differenced LAHP are demonstrated below in Fig. 3 and Fig. 4. Besides, the time series plot of second-order differenced LAHP is plotted below in Fig. 5. Therefore, it is easy to draw the conclusion that after second-order differencing, time series can be stationary.

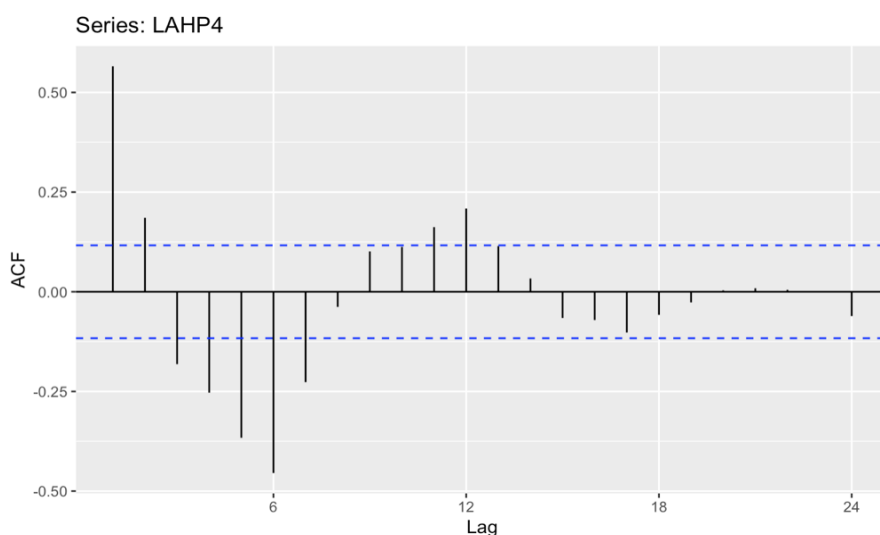


Figure 3. The ACF plot of the second difference LAHP

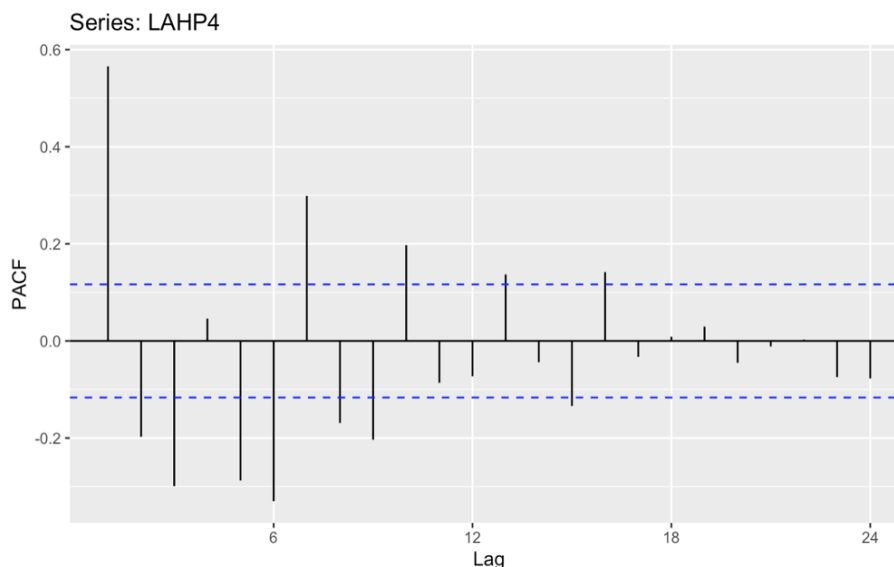


Figure 4. The PACF plot of the second difference LAHP

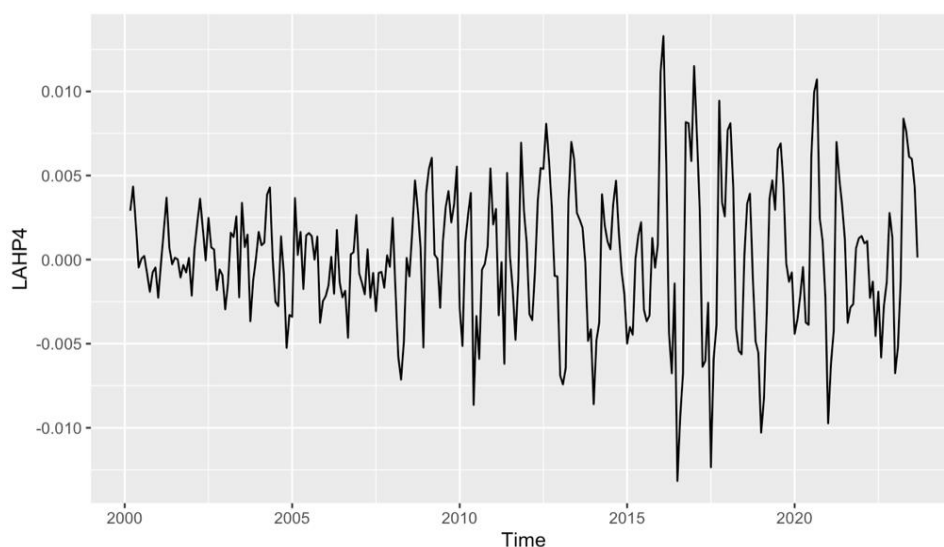


Figure 5. Time Series plot of second difference LAHP

3.2. Model Evaluation

In order to assess how well a model is, splitting the main data into two parts can be helpful: the training set and the test set, respectively. Defined January 2020 as the start of COVID-19, which was the date declared by the WHO. As a result, the training set contains the housing price data before January 2020, and the remaining data is contained in the test set.

Firstly, the optimal ARIMA model can be automatically selected by using the “auto. Arima” function based on the training set. The result shows that ARIMA (4, 2, 4) might be optimal. However, the p-value of the Ljung-Box test is equal to 0.02266, which is lower than 0.05, indicating that there are significant correlations between the residuals at different lags. This suggests that this model might not fully capture the temporal patterns in the data.

After that, the model needs further refinement by adjusting the model parameters. Determine which fits pre-pandemic data best by comparing four important indicators. Results are shown below in Table 1.

Table 1. Model Evaluation

ARIMA	ME	RMSE	MAE	MAPE
(5,2,4)	-3.811e-05	0.002748	0.001898	0.01461
(4,2,5)	-4.054e-05	0.002808	0.001941	0.01494
(5,2,5)	-4.240e-05	0.002731	0.001887	0.01453
(6,2,5)	-3.970e-05	0.002694	0.001863	0.01434
(5,2,6)	-4.074e-05	0.002720	0.001881	0.01449
(6,2,6)	-3.994e-05	0.002694	0.001863	0.01435

According to the results above, ARIMA (6, 2, 5) has the lowest ME and MAPE, so this model is the most applicable one. In that case, further predictions are based on this model as well.

3.3. Forecasting Results

Fig. 6 below illustrates a constant increasing trend in the next few years. And Table 2 shows the exact housing price predictions.

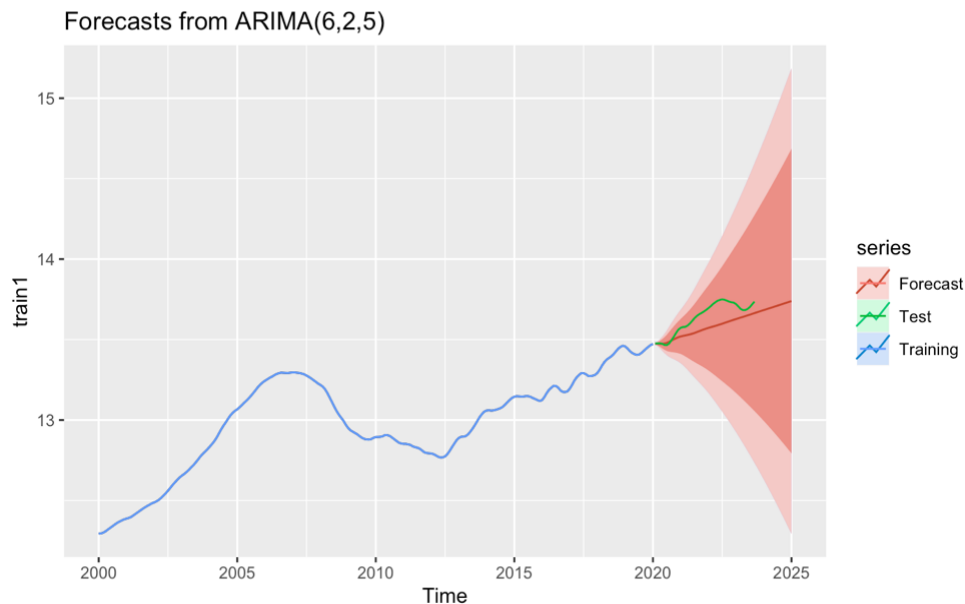


Figure 6. Forecasts of ARIMA (6, 2, 5)

Table 2. Housing price forecasts using ARIMA (6, 2, 5)

Date	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
2023.10	863863.458	460956.981	1618936.48	330565.466	2257548.39
2023.11	867941.851	454053.359	1659123.49	322216.835	2337961.61
2023.12	872004.619	447141.331	1700563.12	313969.146	2421868.72
2024.1	876051.361	440228.857	1743351.56	305825.513	2509489.74
2024.2	880099.282	433323.569	1787520.46	297791.841	2601061.01
2024.3	884165.906	426437.034	1833211.67	289876.428	2696809.59
2024.4	888260.203	419580.214	1880465.67	282089.592	2797005.67
2024.5	892400.231	412759.344	1929381.42	274432.333	2901881.85
2024.6	896577.486	405984.394	1979985.34	266910.854	3011654.04
2024.7	900783.303	399252.768	2032343.26	259525.437	3126547.75
2024.8	905026.949	392562.092	2086502.96	252276.251	3246766.06
2024.9	909290.587	385910.208	2142491.58	245160.898	3372551.04
2024.10	913565.176	379302.758	2200356.61	238174.767	3504155.12
2024.11	917850.681	372733.885	2260191.27	231322.935	3641877.85
2024.12	922137.847	366205.526	2322024.52	224600.826	3785997.69
2025.1	926435.773	359723.155	2385954.95	218010.826	3936883.58

Then, to determine whether the forecast is accurate enough, shift the focus to Fig. 7 and find that the residuals are consistent with white noise, which means that there are no systematic patterns left in the data that the model has not captured. Thus, the model's predictions align well with the observed values, making the forecasts reliable enough.

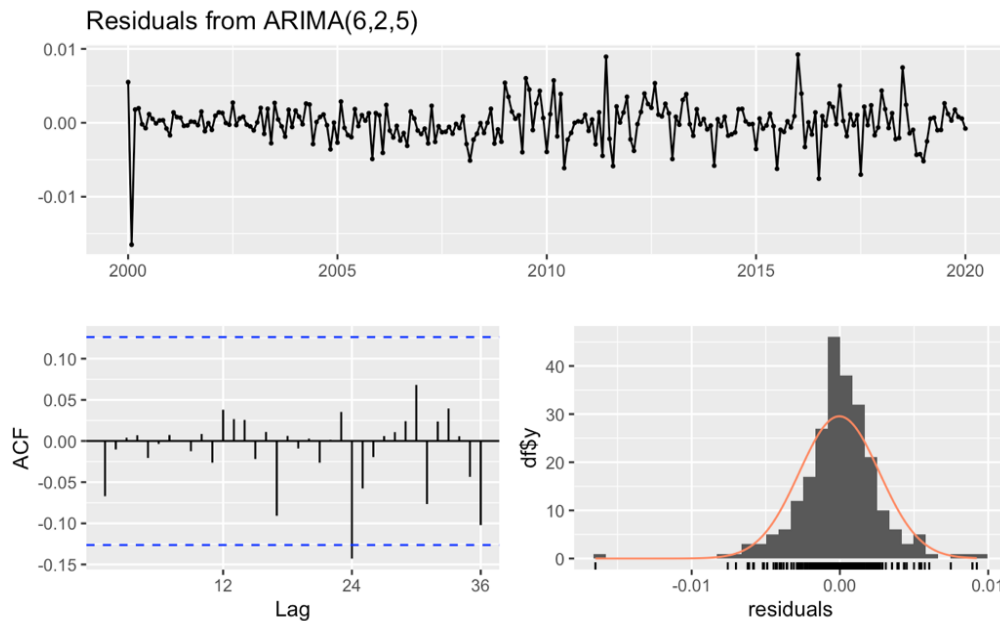


Figure 7. Check residuals

3.4. Discussion

Although the forecasts of housing prices in Los Angeles seem to be figured out, it remains to be studied whether housing prices change due to the COVID-19 pandemic. Consequently, in order to figure out this question, dividing the original main data into two parts, including the pre-pandemic set and the post-pandemic set, might be useful. And January 2020 should be set as the breakpoint, as reported by the World Health Organization (WHO). Besides, the correlated forecasts are defined as the forecast set. Then try to use the averages of the former three datasets to compare and then analyze the extent to which the COVID-19 epidemic has had an impact on housing values. To be specific, the average of the pre-pandemic set is equal to 455038.4 dollars, the average of the post-pandemic set is equal to 840296.8 dollars, and the average of the forecast set is equal to 779058.6 dollars.

As a result, despite the global pandemic, it is clear that there is an apparent increasing trend over this period, while with the intervention of COVID-19, housing prices in Los Angeles climb more than expected.

As for why this phenomenon occurs, presumably demand and supply can explain it. According to previous research, Greg Howard has concluded that, due to the requirement of remote work, the demand for housing has grown [12]. Therefore, increasing demand for housing leads to a rise in housing prices.

4. Conclusion

In summary, this research aims to help people acknowledge the future trend of housing prices straightforwardly, and the extent to which the COVID-19 epidemic influences property values in Los Angeles can be quantified by using time series analysis.

First of all, this article has applied the ARIMA model to make a forecast of housing prices in Los Angeles. And the results show an increasing tendency in the next few years; as of January 2025, the housing prices in Los Angeles are predicted to be 926435.77 dollars. In addition, with the huge shock that COVID-19 brought to the whole world, housing prices seem to have increased more than

expected. This phenomenon is probably explained by the demand-supply balance because telecommuting lasts for a long time. Consequently, the demand for housing increases.

But there is one thing that should not be ignored. The accuracy of the housing price forecast needs to be improved. As shown in Figure 6, the prediction interval expands significantly as time increases. In January 2025, the prediction interval of a 95% significant level ranges from 218010.83 dollars to even 3936883.58 dollars; this gap is too large, leading to the result not being accurate enough. As a result, in the following studies, more advanced forecasting models or more accurate and innovative methods need to be tried to make the forecast more reliable.

Given the significance of the property market to the country's economy, the results of this study also suggest that policymakers ought to put more effort into the effect of COVID-19 on real estate prices and actively enact more appropriate real estate regulations to make citizens' lives easier and happier.

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