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SARIMA Model for Sales Forecast: Evidence from New Energy Vehicles

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Abstract. With the development of environmental protection concepts, the new energy vehicle market has become one of the hot topics of academic attention, and predicting the sales volume of new energy vehicles has become a necessary content. In this context, this article analyzes the current development status of the new energy vehicle market and considers the cyclical development of the industry. Based on sales volume statistics from 2015 to 2025, the seasonal Autoregressive Integrated Moving Average Model (SARIMA) model is selected to predict future market sales volume. The research results show that the prediction effect of the SARIMA (0,1,1) (0,1,1)[12] model has certain reference value. At the same time, this article also provides the predicted values from May to December 2025. This study not only tested the application effect of SARIMA model in the field of new energy vehicles, but also provided empirical evidence for the future development of the automotive industry.

Keywords: New energy vehicles, ARIMA model, SARIMA model, Sales forecasting, Time series.

1. Introduction

The new energy vehicle (NEV) market in China has grown quickly, making it one of the biggest in the world. Significant improvements in legislation, technology, infrastructure, industrial chain, and market development have resulted from the Chinese government's crucial support and promotion of the NEV sector. Against the backdrop of a transforming global energy structure and a digital green economy, the demand for new energy vehicles has grown compared to traditional fuel vehicles, clearly indicating a trend toward replacing them [1]. Therefore, accurately predicting new energy vehicle sales is crucial for future trends in the automotive industry. It provides strong data support for industrial planning, policy formulation, and adjustment. This information is important for promoting high-quality development in the industry [2].

International Energy Agency (IEA) data indicates that over 14 million new energy vehicles were sold worldwide in 2023. Over 60% of global sales of NEVs came from China, the largest market in the world, indicating strong industrial vitality. As per the data provided by the China Association of Automobile Manufacturers, China sold just 17,000 new energy vehicles annually in 2013. The yearly sales reached 1.256 million units by 2018. The number of new energy cars sold in China increased from 9.495 million units in 2023 to 12.866 million units in 2024. Experts predict that this

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figure could exceed 16 million units by the end of 2025, setting a new record high. In just over a decade, the sales of new energy vehicles have increased nearly a thousandfold and continue to grow rapidly [3]. 2025 marks a critical turning point for new energy vehicles, shifting from policy-driven growth to market competition. Chinese automotive companies must consolidate their supply chain advantages, enhance technological breakthroughs, and reduce manufacturing costs; China will collaborate with other countries worldwide to tackle key technological challenges, jointly developing new technologies, business models, and industry ecosystems; the global market must address the challenges of charging standardization and power decarbonization. Therefore, in this highly competitive market, accurately predicting new energy vehicle sales is of great significance for enterprises to plan their production and other strategies in the face of future market uncertainties.

2. ARIMA and SARIMA models

Time series models with seasonal characteristics are handled by the Seasonal ARIMA model, often known as SARIMA, which is an extension of the ARIMA model. The symbol for it is ARIMA (p,d,q) (P, D, Q) [m]. One popular time series forecasting model is the ARIMA model. Autoregression (AR), differencing (I), and moving average (MA) comprise its three components. The AR component takes into account how previous observations have affected the time series' current value. The model is constructed using historical error terms using the moving average (MA) component. The differencing (I) component makes non-stationary time series stationary. Overall, the ARIMA model integrates these three components to address non-stationary time series data, using the operator of I to address non-stationarity, AR to capture long-term dependencies, and MA to handle short-term fluctuations. This makes the ARIMA model a powerful tool for describing linear relationships in time series data and for making forecasts [4-6]. This paper uses the characteristics of the ARIMA model to analyze and forecast time series data (monthly sales of NEV).

3. Establishment of the SARIMA model

3.1. Sources of data and preparation

Well-known automotive websites and the China Association of Automobile Manufacturers are the sources of the data. NEV sales data from January 2015 to April 2025 was used for cleaning and modeling.

3.2. Data processing and stationarity testing

According to the ARIMA model, time series data is assumed to be stationary, meaning that neither the variance nor the mean fluctuate over time. It is necessary to make nonstationary data stationary before modeling.

3.2.1. Data trend analysis

Figure 1 shows the time series chart of monthly NEV sales. From January 2015 to April 2025, the chart shows an overall significant upward trend. This trend became more pronounced after 2020. While data fluctuations were relatively small in the early period, they became larger in the later period with non-constant variance, indicating the possibility of variance.

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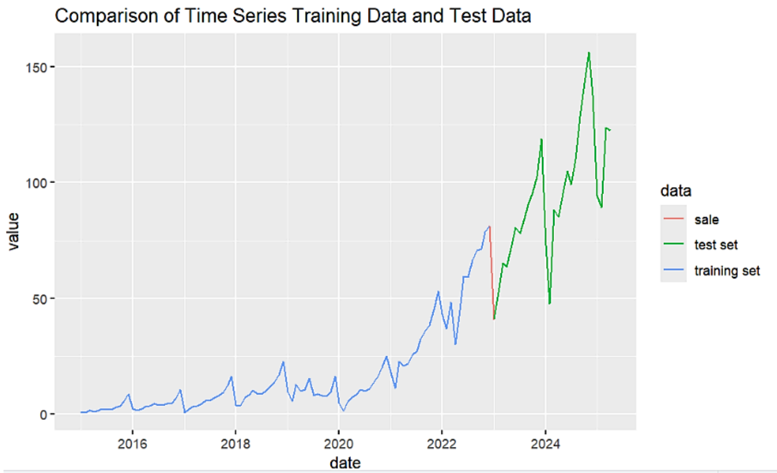

Figure 1. Time series chart of monthly sales of new energy vehicles in China

3.2.2. Stationarity test

Stationery can be tested using a variety of techniques. The null hypothesis is that there is a unit root and that the time series is non-stationary. This paper utilizes the Augmented Dickey-Fuller test to find out if a time series has a unit root.

Table 1. The results of ADF test

Original sequence	Dickey-Fuller=0.0422	p-value=0.99
First-order differential sequence	Dickey-Fuller=-6.302	p-value=0.01

The test findings in Table 1 show that the p-value is 0.99. The null hypothesis cannot be disproved when the p-value exceeds 0.05. The original time series is therefore non-stationary.

3.2.3. Data stationarity treatment

(1) Logarithmic Transformation

Log transformation is a commonly used method for variance stabilization. For data in which the variance increases with the mean, taking the log of the variable reduces the difference between large values and amplifies the difference between small values to some extent, thereby stabilizing the variance.

(2) Differencing Transformation

Differencing eliminates trends in the data and aids in variance stabilization. Based on the results of the data trend analysis and the ADF test, the original time series should undergo a logarithmic transformation first. Then, the transformed data should be processed using first-order differencing and seasonal differencing. Test the processed data for stationary. If the data does not meet the modeling requirements, then perform second-order differencing [7]. As shown in Table 1, the stationary test results indicate that the transformed data is stationary.

3.3. Building the ARIMA model

After smoothing the data, as shown in Figure 2, the model may contain seasonal and non-seasonal MA (1) components. Since the data underwent one difference and one seasonal difference, an initial

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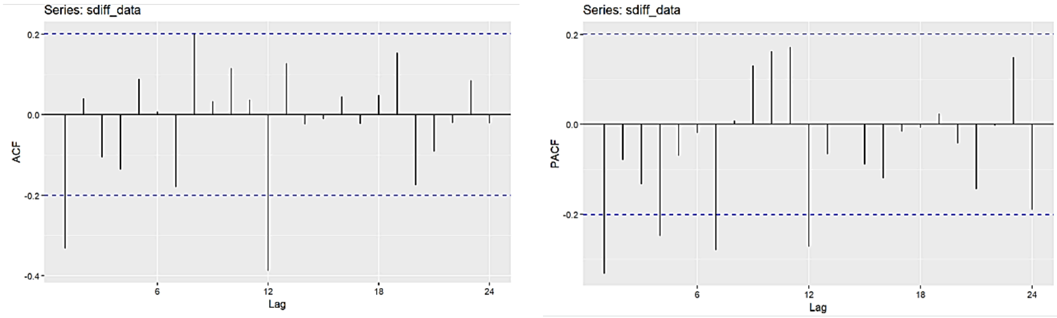
ARIMA (0,1,1) (0,1,1) [12] model was established.



(1) ACF (2) PACF

Figure 2: ACF and PACF

Multiple fittings were performed through this model and its derivative models, and the corresponding AICc values were calculated, as shown in Table 2. Based on the characteristics of the AICc values, the final optimal model was determined to be the ARIMA (0,1,1) (0,1,1) [12]. As can be seen from the residual plot of the fitted model in Figure 3, all residuals are within the significant threshold, indicating white noise characteristics. The Ljung-Box test also shows that there is no autocorrelation among the residuals [8-10].

Table 2. The values of AICc

Model	AICc
ARIMA (0,1,1) (0,1,1) [12]	62.80
ARIMA (0,1,2) (0,1,1) [12]	64.61.
ARIMA (1,1,1) (0,1,1) [12]	64.74
ARIMA (0,1,3) (0,1,1) [12]	65.10
ARIMA (0,1,1) (1,1,0) [12]	73.62
ARIMA (0,1,2) (1,1,0) [12]	75.62

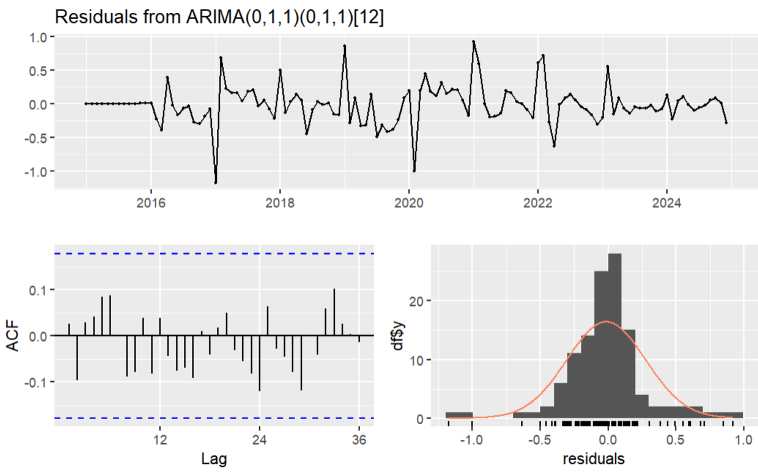


Figure 3. Residuals of the ARIMA(0,1,1)(0,1,1) [12] model

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3.4. Forecasting sales data and model testing

Data from January 2015–December 2022 as the training set and January 2023–April 2025 as the test set were used to compare the outcomes predicted by the ARIMA (0,1,1) (0,1,1) [12] model with the test set. The validity of the model is confirmed by the RMSE of 58.90723, as shown in Table 3. The sales of NEV from May to December of 2025 were then forecasted using the same data for fitting. Figure 4 graphs the trend of the anticipated data, whereas Table 4 displays the monthly sales prediction findings.

Table 3. Residuals of the ARIMA(0,1,1)(0,1,1) [12] model

	ME	RMSE	MAE	MPE	MAPE	MASE
Training set	-2.2197	9.5565	6.2101	-5.9948	14.3057	0.2736
Test set	2.7157	15.0273	11.5581	1.1934	12.3020	0.5093
Test set	0.4434					
RMSE	58.9072					

Table 4. The forecast values of sales

	Point forecast	Low 80	High 80	Low 95	High 95
May 2025	140.9297	95.2488	208.5188	77.4090	256.5745
June 2025	163.3137	105.0968	253.7790	83.2245	320.4750
July 2025	155.1126	95.5137	251.9004	73.8908	325.6147
August 2025	172.4794	102.0020	291.6526	77.2405	385.1498
September 2025	193.7725	110.3756	340.1818	81.9381	458.2460
October 2025	208.7873	114.8192	379.6589	83.6649	521.0326
November 2025	233.2649	124.0906	438.4902	88.8451	612.4425
December 2025	242.9705	125.2401	471.3718	88.1833	669.4544

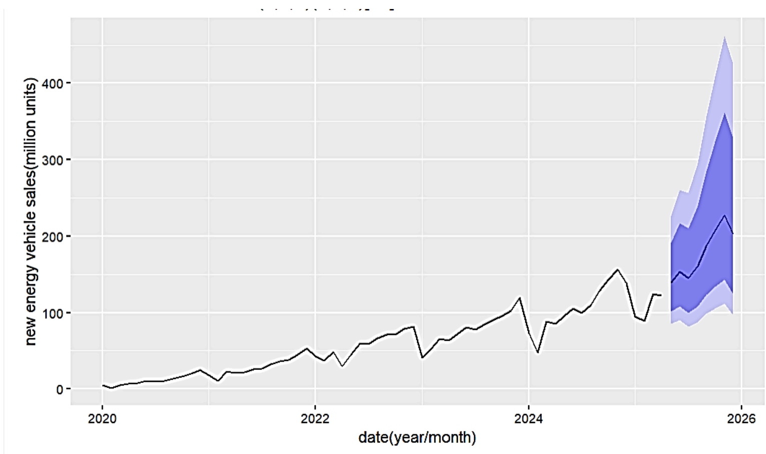

Figure 4. Monthly sales forecast for new energy vehicles

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4. Conclusion

The seasonal ARIMA (SARIMA) model was chosen in light of the noteworthy correlation between China's car sales and seasonality, as well as monthly nationwide sales statistics for new energy cars from January 2015 to April 2025. The SARIMA model was fitted and established after the model's structure and order were constructed in accordance with pertinent concepts and criteria. It is necessary to discover that the model performed well in terms of prediction after testing it on the test set. For the next eight months, the author projected the monthly sales of new energy cars using this methodology. In addition to providing crucial theoretical and practical assistance for the high-quality growth of the automobile industry, this paper anticipates that these forecasts will yield data to enable future manufacturing of new energy vehicles.

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