Analysis of Influencing Factors on China's New Energy Vehicle Sales and Forecasting with ARIMA Model

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Abstract. This paper primarily focuses on the sales data of China's new energy vehicles (NEVs) and the associated influencing factors spanning from 2015 to 2024. It employs a dual-perspective approach: first, conducting a comprehensive visual analysis of total vehicle sales, regional ownership distribution, and model-specific sales performance; second, exploring the underlying drivers of NEV sales, such as government policy, technological innovation, and regional development disparities. Furthermore, the study develops and calibrates an ARIMA time series forecasting model by determining the optimal order and performing parameter optimization, in order to project NEV sales for the next three years. The forecasting results indicate that total NEV sales are expected to grow from 18.29 million units in 2025 to 27.38 million units in 2027, representing a compound annual growth rate (CAGR) of 14.4%. This steady upward trend suggests that the NEV market in China is entering a phase of maturity and stabilization. The research findings not only provide empirical evidence for evaluating market dynamics but also offer valuable data support for policymakers, automotive enterprises, and strategic planners aiming to navigate the rapidly evolving landscape of sustainable transportation in China.

1 Introduction

1.1 Research background

In the past few years, the rapid growth of China's economy has led to a sharp increase in energy consumption [1]. More than 57.8% of China's petroleum supply relies on imports [2]. With the sharp increase in the number of vehicles in ownership, the petroleum consumption of China's automobile industry will continue to rise, and this situation has exacerbated China's energy crisis. On the other hand, the exhaust emissions of fuel - powered vehicles are the main source of air pollutants, which poses a huge challenge to China's environmental protection efforts [3]. In this context, energy conservation and emission reduction have become particularly important, and the promotion of new energy vehicles is a key measure to address the above - mentioned problems.

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Starting from the "Ten Cities, One Thousand Vehicles" initiative, with the successive introduction of policies and the rise of the young consumer group, China's new energy vehicles have achieved significant breakthroughs in the past few years. In 2022, the sales of new energy vehicles in China witnessed an explosive growth, reaching 6.887 million units, a year - on - year increase of 93.4%, and ranking first in the world for eight consecutive years [4]. And whether it can continue to develop in this trend has become the primary consideration.

1.2 Research objectives and research questions

This study aims to analyze the growth trend, cycle, and development patterns of China's NEV market over the past decade using R language tools. It also explores the sales distribution across different regions and vehicle models, providing insights for automotive manufacturers and policymakers.

This study seeks to address the following research questions:

(1) What are the growth trends and development patterns of China's NEV market over the past decade? Specifically, how has the market evolved from the initial stage to the current scale?

(2) How do regional differences affect NEV sales in China? What are the key factors influencing regional ownership distribution, and which regions have the highest potential for future growth?

(3) What are the sales preferences for different NEV models? How can these insights inform future R&D directions and enhance market positioning strategies for automakers?

The findings of this study will offer valuable data support for the formulation of industrial policies and the strategic planning of enterprises. Additionally, the analysis of regional and model-specific sales will enhance the understanding of market dynamics and contribute to the development of targeted strategies.

2 Development history and current status of China's new energy vehicle industry

To better understand the current development trends and challenges of the NEV market, it is necessary to review the development history of China's NEV industry. This history not only reflects the impact of technological progress and policy support on the market but also reveals the characteristics and laws of market development in different stages. By analyzing the development history, it can more clearly see how the NEV market has gradually developed from the initial stage to the current scale, and on this basis, further explore future development directions and potential problems.

The development of China's NEVs has roughly gone through the following four stages:

(1) 1991-2005: Research and development layout stage

During this period, the key technologies of electric vehicles were listed as major national scientific and technological projects. This stage laid the foundation for future technological advancements and industrial development [5].

(2) 2006-2010: Industrialization preparation stage

China began small-scale demonstration applications of NEVs, exploring the feasibility of commercial deployment. This stage was characterized by pilot projects and the initial integration of NEVs into the transportation system [5].

(3) 2011-2015: Demonstration and promotion stage

The industrialization goals of China's NEVs were clarified, with significant policy support and increased investment in infrastructure. Large-scale pilot projects were launched in major cities, showcasing the potential of NEVs in real-world applications [5].

(4) 2016-present: Commercial application stage

NEVs entered mass production and widespread commercial use. Technological advancements, such as improved battery range and charging infrastructure, contributed to the rapid growth of the market [5].

3 Visual analysis of China's new energy vehicle sales

To comprehensively understand the development trend of China's NEV market, this part analyzes the sales data from the past 10 years across three dimensions: time trend, regional distribution, and vehicle model preferences. Through visual analysis, the main characteristics and development laws of the market can be better revealed.

3.1 Time trend analysis of total sales

This part uses R language to analyze the total sales data of China's NEVs from 2015 to 2024 to clarify their growth trend.

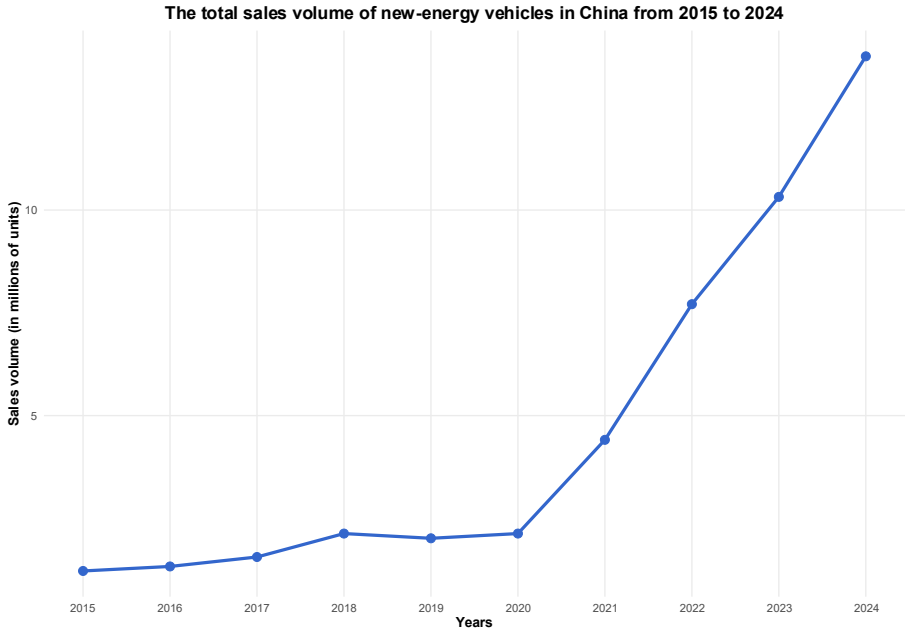

Fig. 1. Time trend analysis chart of total sales of China's new energy vehicles [6].

From Fig. 1, it can be seen that the sales of China's NEVs showed a clear upward trend in the past 10 years. The sales volume in 2015 was 1.22 million vehicles, and then it gradually increased year by year, rising to 1.33 million in 2016, 1.56 million in 2017, and further to 2.13 million in 2018. In 2019, it slightly declined to 2.01 million, but in the subsequent year, 2020, it stabilized at around 2.13 million.

Since 2021, the sales growth rate has significantly increased. The sales volume in that year reached 4.41 million, almost doubling compared with 2020. It surged to 7.71 million in 2022 and 10.32 million in 2023, breaking through the 10 million marks for the first time. In 2024, it reached a new high of 13.74 million in 2024.

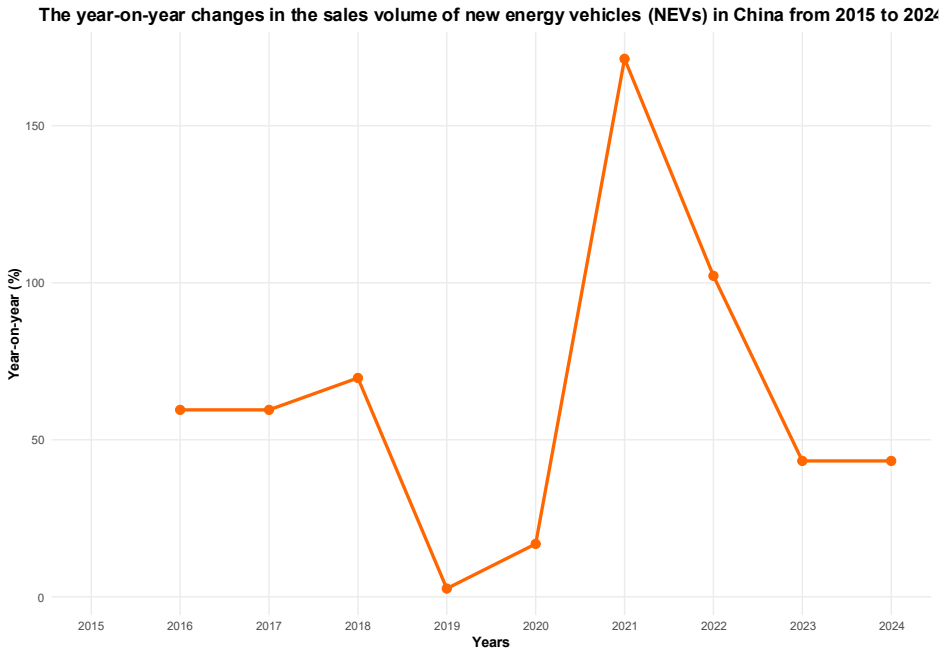

Fig. 2. Year-on-year change rate chart of China's new energy vehicle sales [6].

From Fig. 2, it can be seen that the year-on-year growth of new energy vehicle sales in China fluctuated significantly from 2015 to 2024. The period from 2015 to 2019 was the initial development stage of China's new energy vehicles, during which the entire market was in a state of exploration, leading to fluctuations in the year-on-year data. In 2021, there was an explosive year-on-year growth, which was mainly driven by the development of product technology and the improvement of market recognition. However, the year-on-year growth rate showed a downward trend after 2021, indicating that the market has gradually become saturated and the industry has entered a new stage of steady development.

3.2 Analysis of regional ownership distribution

This section uses R language to analyze the ownership of new energy vehicles in different provinces of China in 2022, so as to identify major markets and the reasons for the proportion of ownership.

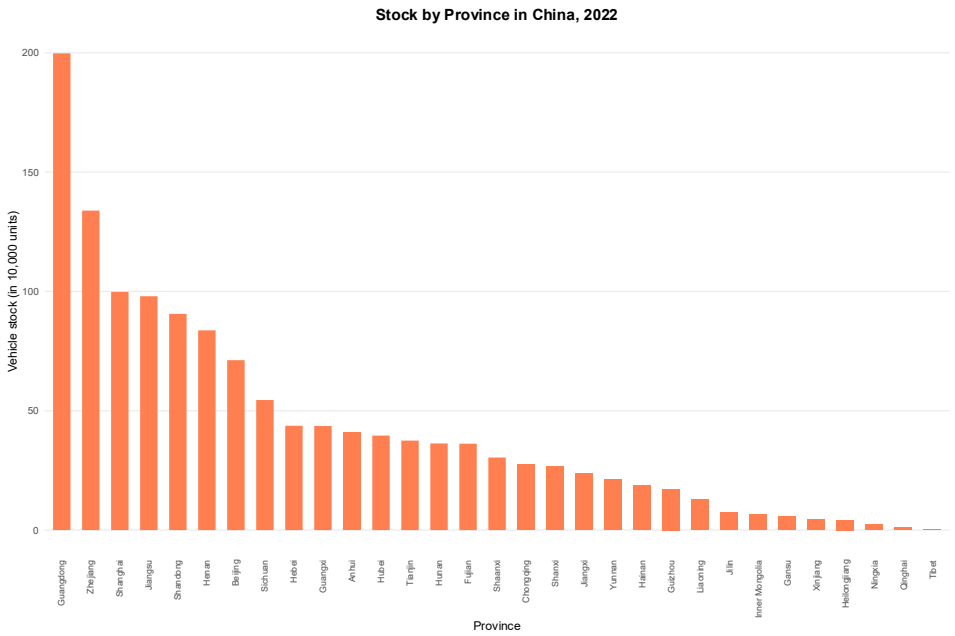

Fig. 3. Distribution map of new energy vehicle ownership in various provinces of China in 2022 [7].

From the data of NEV ownership in various provinces of China in 2022 (Fig. 3), the regional distribution characteristics are obvious, and the influencing factors include:

Economic factors: Guangdong (1.998 million vehicles), Zhejiang, Shanghai, Jiangsu and other regions are economically developed, with strong consumption capacity and high acceptance of NEVs by residents, forming the main market.

Climatic factors: Southern provinces (such as Guangdong, Zhejiang, etc.) have a mild climate (about 20℃ can effectively improve battery life and vehicle reliability), while northern provinces (such as Heilongjiang, Inner Mongolia, etc.) have winter temperatures as low as -20℃ all year round, resulting in low battery activity and relatively short service life, which makes consumers concerned about the driving range of NEVs, thus affecting the low ownership of NEVs in these regions [8].

Potential markets: Henan, Beijing, Sichuan and other populous and economically large provinces are at a medium level of ownership. These provinces have great market potential, and with the improvement of infrastructure such as the number of charging piles and the strengthening of promotion and publicity, it is expected to further expand the market.

In summary, if the market wants to continue expanding, the product side should focus on improving battery technology and enhancing the applicability of batteries under different temperature conditions [9]. At the same time, it is necessary to strengthen infrastructure construction and improve supporting facilities, such as building heating and cooling devices for charging piles [10]. In terms of preferential policies, in less economically developed regions, efforts should be made to increase car purchase subsidies, reduce consumers' purchase costs, and stimulate residents' willingness to buy.

3.3 Analysis of vehicle model sales preferences

This part uses R language to analyze the sales of different NEV models in February 2025, judge the mainstream models, and summarize the market demand preferences.

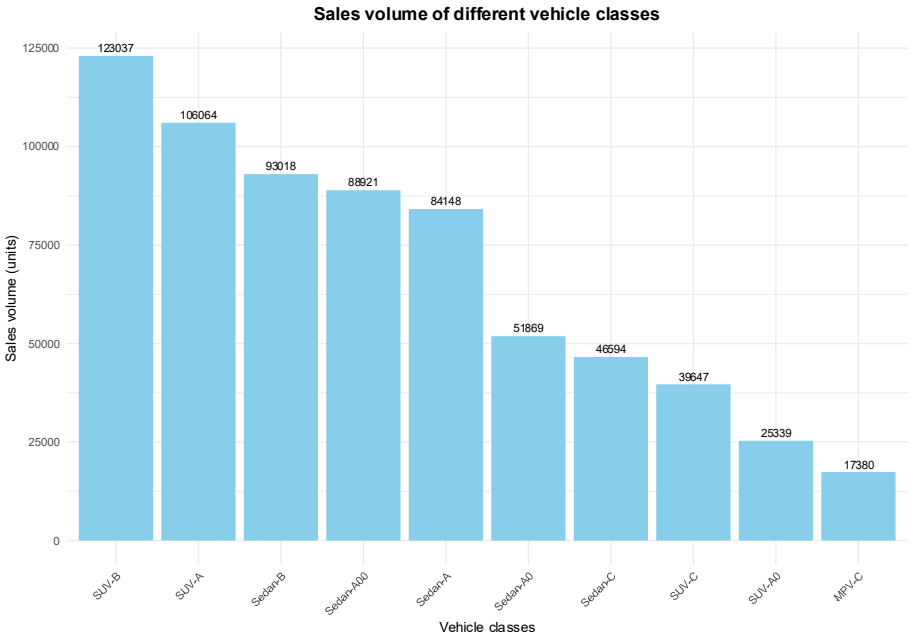

Fig. 4. Distribution map of sales preferences of different vehicle models of China's new energy vehicles in 2025 [11].

Fig. 4 shows that B-class SUVs ranked first with sales of 123,037 vehicles, followed by A-class SUVs and B-class sedans with sales of 106,064 and 93,018 vehicles respectively. This indicates that SUVs are the primary choice of consumers in the current NEV market. On the one hand, SUVs have spacious space and strong practicability, which is suitable for daily family travel. On the other hand, the technological update of fuel SUVs is relatively slow, and in the wave of intelligence, aspects such as intelligent assisted driving and vehicle-machine interconnection lag behind NEV SUVs.

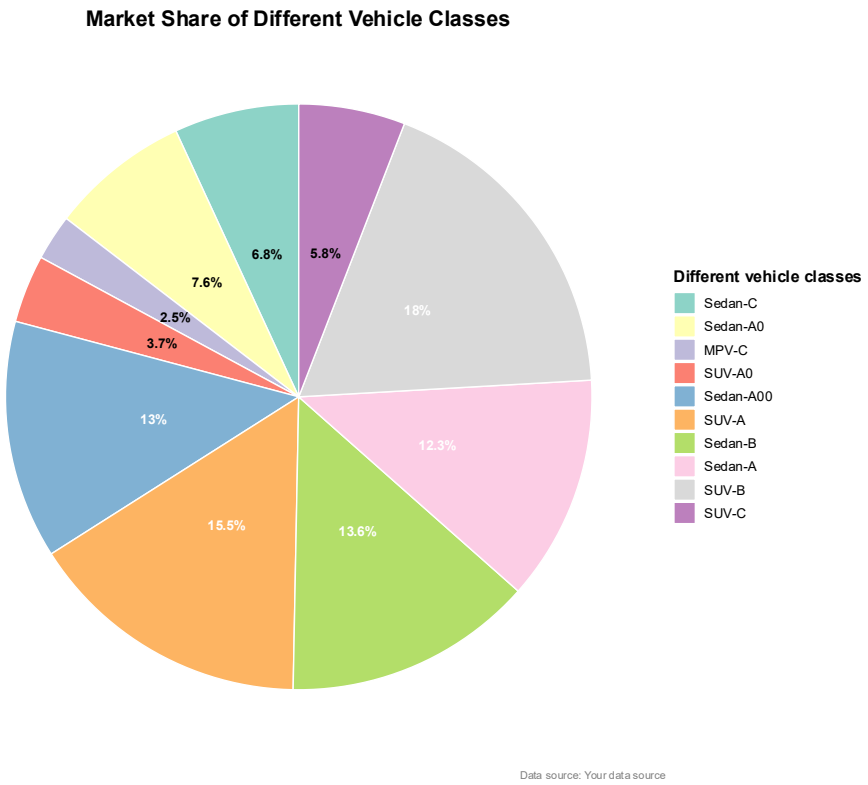

Fig. 5. Distribution map of sales shares of different class vehicle models of China's new energy vehicles in 2025 [11].

Fig. 5 illustrates that in the field of sedans, especially in the mid-to-high-end segment, it has long been dominated by traditional fuel vehicle brands. NEV brands still have a large gap in brand competitiveness compared with traditional fuel vehicle brands such as Mercedes-Benz and Audi. Traditional fuel vehicles have established strong brand recognition in the minds of consumers by virtue of long-term brand precipitation and mature product systems.

Combined with the above content, NEV SUVs should continue to maintain and consolidate the core advantages of product practicality and technology in the future and strengthen their leadership in the SUV field. At the same time, in the direction of NEV sedans, it is necessary to gradually narrow the gap with traditional fuel vehicles and enhance the market share by strengthening brand building, increasing technological R&D, and optimizing vehicle handling.

4 Analysis of influencing factors on China's new energy vehicle sales

To comprehensively understand the key factors influencing the sales of new energy vehicles in China, this section will analyze multiple dimensions such as policies, technology, and regions. By comprehensively considering these factors, it is possible to better predict the future development trends of the market and provide a basis for relevant policy formulation and corporate decision-making.

4.1 Analysis of policy factors

Policy regulation is the core factor for ensuring NEV sales at this stage [12]. Comparing the policy practices of small and medium-sized cities with first-tier cities can more clearly illustrate the direct impact of relevant policies on NEV sales.

Take Wuzhong as an example. In 2024, China promoted large-scale equipment updates and equipment trade-ins. Among them, NEV consumption had full competitive advantages. Take BYD Song， price at 149,800 yuan as an example, the vehicle can enjoy a total discount of 37,000 yuan. The decline in price reduced the purchase cost of local consumers, and the enthusiasm for purchase increased. In 2024, a total of 4,314 taxpayers in Wuzhong enjoyed the preferential policy of NEV purchase tax reduction and exemption, an increase of 1.48 times over the previous year, and sales increased rapidly [13]. It can be seen that the subsidy policy stimulated the consumption market in Wuzhong by reducing the purchase threshold, and became the key driving force to promote the growth of local NEV sales.

At the first-tier city level, the Beijing Small Passenger Car Index Office had issued relevant policies before 2024, clearly stipulating that fuel indicators can be used to purchase NEV models unlimitedly. And after the index is converted, it can be converted back to the fuel index again. In addition, Beijing also implemented the fuel-electricity interchange policy to encourage citizens to gradually replace fuel vehicles with NEVs. At the same time, the Beijing Municipal Government also issued relevant policies on trade-in in 2024. After the policy was implemented, the market responded strongly. In the first four months of 2025, Beijing's automobile sales reached 160,000 vehicles, of which NEV sales accounted for 47.8%, far exceeding the national average level in the same period. Combining the above cases, by optimizing the way to obtain purchase indicators and the preferential policies for purchasing NEVs, the enthusiasm of consumers to purchase has been mobilized, effectively promoting the development process of NEVs in Beijing.

In summary, whether it is the subsidy reduction and exemption in Wuzhong or the policy adjustment in terms of indicators in Beijing, both confirm from different perspectives that policy factors play a key role in the new energy vehicle market and are the absolute driving force behind the development of China's new energy vehicle industry.

4.2 Analysis of technological factors

Technological innovation also plays an important role in the sales growth of NEVs, and its technology is mainly reflected in batteries, autonomous driving and other related technologies [14].

Battery technology is the core of NEVs. Take the domestic NEV BYD Han EV as an example, some versions of it have a driving range of more than 700 kilometers. Long-range models are more favored by the market by virtue of their range advantages. As of May 2025, the monthly sales of BYD Han were 10,248 vehicles, ranking second among medium and large vehicles [15]. In addition, charging speed is also crucial. The fast-charging technology of enterprises such as CATL can greatly shorten the charging time. Charging for ten minutes can bring 400 kilometers of driving range to the vehicle [16]. This technological breakthrough has effectively improved the product experience of consumers and promoted the growth of NEV sales.

Autonomous driving technology also plays a pivotal role and has become a primary consideration for consumers when purchasing vehicles. With technological advancements, an increasing number of vehicle models are equipped with autonomous driving functions at different levels. Take the AITO M5 as an example; it is equipped with Huawei's high-level intelligent driving assistance system, which achieves reliable intelligent assisted driving through precise perception capabilities and excellent decision-making algorithms [17].

Currently, although significant progress has been made in intelligent driving technology, it is still insufficient to fully handle autonomous driving independently, and further technological development is required. On the evening of March 29, 2025, a Xiaomi SU7 Standard Edition in intelligent assisted driving mode identified an obstacle ahead, but due to loopholes in the "human-machine handover" process, the driver had insufficient reaction time, resulting in the tragic death of three people in the vehicle. As shown by the above case, autonomous driving technology is of great significance to new energy vehicles, as it can fully meet consumer needs. However, increased R&D investment is still necessary to promote the high-quality development of the new energy vehicle industry.

To sum up, technological progress such as battery range and autonomous driving has strongly promoted the sales growth of NEVs [18]. Technological innovation is the only way for the development of NEVs. Vehicle enterprises and scientific research institutions should increase investment and cooperate to break through technical bottlenecks and help the steady development of China's NEV industry.

4.3 Analysis of regional factors

The impact of regional differences on new energy vehicle (NEV) sales is mainly reflected in aspects such as economic level, climate conditions, and infrastructure, which echoes the results of the regional ownership analysis in Chapter 3.

From the perspective of NEV ownership in various provinces in 2022, Guangdong ranked first with 1.998 million vehicles, followed by Zhejiang, Shanghai, Jiangsu and other regions. These areas are economically developed, have strong consumption capacity, high public acceptance of NEVs, and possess a solid market foundation [19-21].

Climate factors also play a key role. Major provinces in southern China, such as Guangdong and Zhejiang, have relatively mild climates. According to a study by M.A. Bamdezh, temperatures around 20°C can effectively extend battery life and improve vehicle reliability [8]. In contrast, some northern provinces like Heilongjiang and Inner Mongolia have winter temperatures as low as -20°C for long periods, resulting in low battery activity and relatively shorter service life. This causes consumers to worry about the driving range of NEVs, thereby affecting NEV ownership in these regions.

In addition, provinces such as Henan, Beijing, and Sichuan have a medium level of ownership. These are populous and economically large provinces with great market potential. With the improvement of infrastructure such as the number of charging piles and the strengthening of promotion and publicity, their markets are expected to expand further.

In summary, regional factors influence the market performance of NEVs through economy, climate, and infrastructure. Enterprises need to formulate differentiated strategies according to the characteristics of different regions during market expansion.

5 Forecasting China's NEV sales based on the ARIMA model

5.1 Introduction to the ARIMA Model

The Autoregressive Integrated Moving Average (ARIMA) model is a classic time-series forecasting method proposed by Box and Jenkins in the 1970s [22]. This model transforms non-stationary sequences into stationary sequences through differencing and uses a combination of autoregressive (AR) and moving average (MA) to capture dynamic characteristics in data. The ARIMA model is typically expressed as ARIMA(p,d,q), where: "p" represents the autoregressive order, reflecting the dependency of the current value on historical values; "d" represents the differencing order, used to eliminate the non-stationarity

of the sequence; "q" represents the moving average order, describing the lag effect of the error term [23].

This paper takes NEV sales forecasting as an example to establish an ARIMA model for future sales prediction, providing a reference for market decision-making.

5.2 Application process of the ARIMA model

5.2.1 Data processing

This study focuses on China's NEV sales data over the past decade, using sales data from 2015 to 2024 (in millions of vehicles) [6]. First, the data was organized into a standardized format and converted into a time-series object, with the starting year set as 2015 and a frequency of 1. This step ensures the data meets time-series requirements for subsequent forecasting.

Second, to evaluate the prediction accuracy of the subsequent model, the data was divided proportionally: 80% as the training set and 20% as the test set [24]. This division allows the model to fully learn data characteristics from the training set while effectively testing the accuracy of parameters [25].

5.2.2 Model Selection and Establishment

First, the auto.arima() function in the forecast package was used to initially construct the model [26]. This function automatically screens relatively optimal models based on different (p,d,q) parameter combinations. After running, an initial model (0,2,0) was obtained, indicating that the original data required second-order differencing to achieve stationarity.

Table 1. ARIMA Model selection table.

	Model	AIC	AICc	BIC	RMSE	MAPE
1	ARIMA(0,2,1)	18.9296	22.9296	18.5131	0.4055	3.3910
2	ARIMA(0,2,0)	19.3955	20.3955	19.1872	0.6329	5.4173
3	ARIMA(1,2,0)	20.5031	24.5031	20.0867	1.2823	10.5076
4	ARIMA(0,2,2)	20.8397	32.8397	20.2150	0.3991	3.3217
5	ARIMA(1,2,1)	20.8793	32.8793	20.2546	0.4346	3.6797
6	ARIMA(2,2,1)	21.7333	61.7333	20.9004	1.6606	10.3537
7	ARIMA(0,2,3)	21.7743	61.7743	20.9413	1.1773	6.7035
8	ARIMA(2,2,2)	22.5695	Inf	21.5283	1.8207	11.9260
9	ARIMA(3,2,0)	22.5809	62.5809	21.7480	0.7783	4.3577
10	ARIMA(1,2,2)	22.7247	62.7247	21.8917	0.3389	2.8947
11	ARIMA(3,2,1)	22.9796	Inf	21.9384	1.0026	6.4007
12	ARIMA(0,2,4)	23.5738	Inf	22.5326	2.0738	12.9864
13	ARIMA(1,2,3)	23.7548	Inf	22.7136	1.4507	8.5765
14	ARIMA(2,2,3)	23.8041	-60.1959	22.5546	1.8546	12.3239
15	ARIMA(3,2,2)	24.1346	-59.8655	22.8851	1.4820	9.8023
16	ARIMA(2,2,4)	25.6930	-30.3070	24.2353	1.9008	12.6696
17	ARIMA(1,2,4)	25.7712	-58.2288	24.5217	1.0697	5.9816
18	ARIMA(3,2,3)	26.5224	-29.4776	25.0647	2.0997	13.7692
19	ARIMA(3,2,4)	27.6165	-20.3835	25.9506	2.4217	16.0750

Second, to seek a better solution, fixed d=2 (consistent with auto.arima's result), set the value range of p and q to 0-4, and used the Arima() function with a for loop to test 19 parameter combinations in Table 1, calculating error metrics such as RMSE (Root Mean Squared Error), MAPE (Mean Absolute Percentage Error), AIC, and BIC. These metrics comprehensively evaluate the model's fitting degree—the smaller the values, the better the model performance. By comparing the metrics of the 25 models, with a focus on AIC values and reference to other metrics, it was ultimately found that the ARIMA(0,2,1) model performed excellently in fitting, capable of more accurately capturing data characteristics. Therefore, ARIMA(0,2,1) was selected as the final model [27].

5.3 Model prediction results and accuracy evaluation

5.3.1 Model accuracy evaluation

When using the ARIMA(0,2,1) model to analyze and predict China's NEV sales, the training-test set division method was adopted to ensure the model's accuracy and reliability [6].
In terms of data division, the sales data of China's NEVs from 2015 to 2024 were divided at an 8:2 ratio: The first 80% constituted the training set, used for the ARIMA(0,2,1) model's learning and adjustment; The last 20% served as the test set, used to verify the model's prediction accuracy.

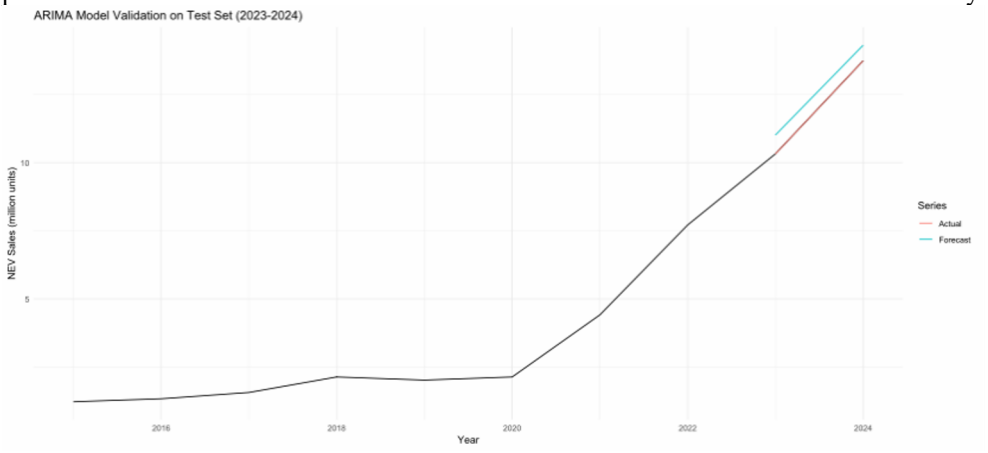

Fig. 6. Auto ARIMA model validation.

After training, comparing the model's predicted values with actual values in the test set showed that the trend of predicted values closely matched the actual values, successfully capturing the growth trend of NEV sales. This indicates the model effectively learned the sales patterns from the training set. Although the predicted values in the 2023-2024 test period were slightly higher than the actual values, the deviation remained within a reasonable range. Considering the complexity of the NEV market—affected by uncertain and dynamic factors such as policy guidance, technological innovation, and changes in market competition—such deviations are acceptable. For example, sudden policy adjustments may cause short-term fluctuations in market demand, and technological breakthroughs may lead to unexpected sales growth or decline, both of which can cause deviations between model predictions and actual values (Fig. 6).

5.3.2 Prediction results

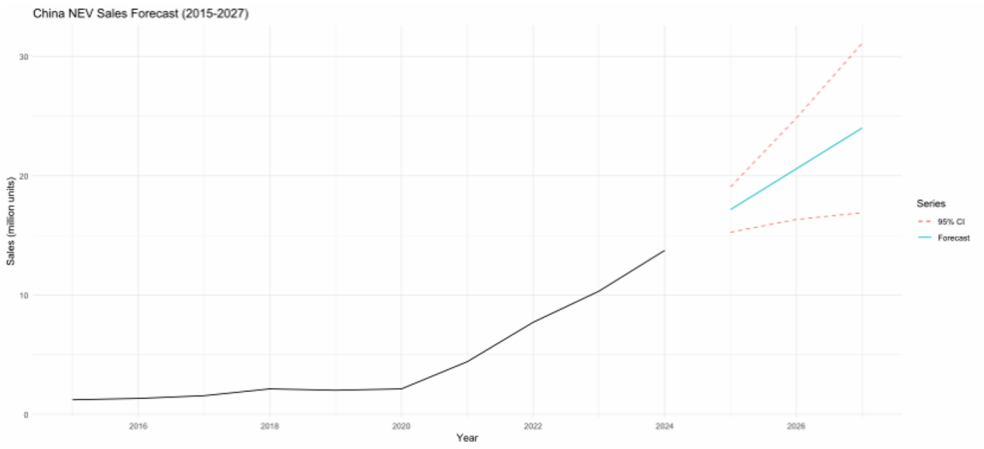

Fig. 7. China NEV sales forecast with ARIMA(0,2,1).

The ARIMA(0,2,1) model was used to predict China's NEV sales for the next three years. Fig. 7 shows the historical sales data (black curve), predicted values (blue curve), and a 95% confidence interval (red dashed lines). It can be clearly seen that historical sales grew slowly at first and then rose rapidly. In the prediction phase, the model expects this growth trend to continue, with sales further increasing by 2026.

Based on the model's predictions, China's NEV sales will maintain an optimistic development trend. With continuous technological progress (e.g., improved battery range) and the gradual improvement of charging infrastructure, market demand will be further stimulated. Meanwhile, sustained policy support (e.g., purchase subsidies, tax incentives) will also drive steady sales growth of NEVs.

6 Conclusion

This paper conducted a visual analysis of China's NEV sales data from 2015 to 2024, explored the underlying drivers of sales changes from multi-dimensional factors such as policy, technology, and regional differences, and predicted future sales using the ARIMA(0,2,1) model. The research findings show:

(1) In recent years, driven by policy support and technological progress, China's NEV market has achieved rapid expansion. Especially since 2021, sales have grown significantly, but the growth rate has gradually stabilized, indicating the market is transitioning from the introduction phase to the maturity phase.

(2) Sales are influenced by multiple interwoven factors: policy incentives (e.g., purchase subsidies, quota relaxation), technological advancements (e.g., improved range, application of intelligent driving functions), and regional differences (economic level, climate conditions, infrastructure), all of which jointly affect market performance.

(3) The ARIMA model predicts that NEV sales will grow from 16.8 million vehicles in 2025 to 26.2 million vehicles in 2029, with an average annual compound growth rate of approximately 12.3%, indicating a broad market prospect.

(4) Although the model's predictions are reasonable, due to the significant impact of uncertain factors such as policy adjustments and technological breakthroughs on the NEV industry, future sales may still fluctuate. Therefore, model predictions should be continuously optimized by incorporating the latest industry dynamics.

In summary, this study not only provides a quantitative basis for changes in NEV sales but also offers reference value for government decision-making and corporate strategic planning. Future research could consider introducing more macroeconomic variables or adopting multi-model comparison methods to further improve the accuracy and stability of sales forecasting.

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