Dean&Francis
ISSN 2959-6157

Multiple Regression Analysis of the Factors Influencing the Sales of New Energy Vehicles in China

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Abstract:

In recent years, the global climate crisis and energy crisis have become increasingly serious, prompting countries to strongly support the development of clean energy technology. New energy vehicles represent a significant avenue for transforming and upgrading the automobile industry worldwide, offering environmental protection and energy-saving advantages. This thesis addresses the vital factors influencing the volume of new energy vehicle sales in China. Within an empirical research framework, multiple regression analysis is used. This study begins with the background of the new energy vehicle market, recognizing factors such as policy incentives, technological progress, and charging infrastructure improvements, and then proposes research hypotheses. By collecting relevant data, the study uses multiple linear regression models to evaluate the influence of various factors on both the demand and supply sides of sales. The results show that the amount of subsidy in vehicle purchases and charging time significantly affects sales, while factors like price and technological progress do not hold as much weight. Based on these findings, the thesis suggests policy recommendations such as increasing and improving vehicle purchase subsidies and enhancing charging facilities for the healthy development of the new energy vehicle industry. Finally, the limitations of this study, such as the limited data scope, the problem of multicollinearity, and the failure to consider the effects of external macroeconomic factors, are summarized. The paper concludes with a discussion of potential avenues for future research.

Keywords: New Energy Vehicle, Factors, Multiple Regression Analysis.

ISSN 2959-6157

1. Introduction

Recently, two major global challenges, climate change and the energy crisis, continued to intensify during the last years. Against this background, new energy vehicles (NEVs) now have become key directions owing to their advantages in terms of energy and the environment, in the reorganization and modernization of the global automotive sector. For this, new clean energy technology research and development are much more supportive to all countries in the world. In the past decade, China has been acting as the world's largest automotive market and among the largest in terms of carbon emissions, due to the introduction of a package of policies and subsidy programs for the support and promotion of the NEV sector. Huge numbers of NEVs are sold in China, based on the Data from the China Association of Automobile Manufacturers, last year the sales reached 6.887 million units, increasing by 93.4% compared to the previous year, with the penetration in the market surging to 25.6%. Over the first seven months of 2023, production and sales of NEVs reached 4.591 and 4.526 million units, respectively, growing both over 40% compared to the same time last year, among which domestic sales stood at 3.89 million units, up 32.5% year on year [1]. Total NEV sales are predicted to exceed 9 million units at the end of 2023, making China the largest market for NEVs in the world.

As policy-driven growth gradually transitions into market-driven competition, a wide array of factors—including consumer acceptance of NEVs, advances in technological innovation, the improvement of charging infrastructure, and broader macroeconomic conditions—have emerged as critical determinants of China's NEV market performance. Among the primary factors influencing NEV sales are supply, demand, and energy price differentials, with demand currently exerting the most significant influence under existing market conditions, followed by supply [2]. The research conducted by Liang, which employs the SSA-SVR model for forecasting domestic NEV sales, offers valuable recommendations for fostering the sustainable development of the NEV sector [3]. Comprehensive understanding and scientific analysis of the multifaceted factors influencing NEV sales are crucial for formulating more effective industrial policies, shaping market expectations, and driving the sustainable growth of the NEV industry.

Factors affecting China's new energy vehicle sales are multiple and complex. Although numerous scholars have proposed various theoretical frameworks identifying the key factors influencing NEV sales, empirical studies providing precise evaluations of these factors in the Chinese context are still lacking. Current academic and industry research on NEV sales drivers remains relatively fragmented. To gain a comprehensive understanding of the factors influencing the sales of new energy vehicles in China, it is essential to examine relevant theoretical frameworks in conjunction with empirical research, taking into account the unique context of China.

Therefore, the current study will try to use a multiple regression analysis methodology to determine the key drivers of NEV sales from the China market perspective on both the demand and supply sides. On the demand side, such factors as purchase costs and policy incentives, among other relevant elements, will be examined to determine how they influence consumer purchase intentions. On the supply side, it will explore the importance of variables such as charging infrastructure, technological advancement, and pricing strategy regarding increasing NEV sales. This study clarifies the relative importance of various demand- and supply-side factors for their effects on NEV sales using empirical analysis. Eventually, the research will offer targeted policy recommendations and marketing strategies to governments and businesses to promote the sustainable and healthy development of the NEV industry.

2. Sources of Data

The Catalogue of Recommended Vehicle Types for the Promotion and Application of New Energy Vehicles and the Notice of the Ministry of Finance, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, and the Ministry of Development and Reform Commission on the Financial Subsidy Policy for the Promotion and Application of New Energy Vehicles in 2022 were the two primary sources of the data used in this study. The latter is a very trustworthy source for official statistics data, including details on the vehicle's mileage, energy usage, and subsidy amount. In addition, information about electric heaps has been compiled from the China Electric Vehicle Charging Infrastructure Promotion Alliance. The "2024-2025 Energy Conservation and Carbon Reduction Action Program," released by the State Council, includes a plan to progressively lift global purchase bans on new energy vehicles and put in place supportive measures to help them go through the regulatory process. Furthermore, comprehensive details about the particular specifications of the vehicle in issue can be found on the official websites of each car manufacturer.

2.1 Model Design

In this study, based on the 30 sample data collected, the results of descriptive statistical analysis are shown below: the descriptive statistics are in Table 1.

Table 1. Statistical processing of the data

	Mean	Std. Dev.	Min	0.2500	Median	0.7500	Max
Y: July Sales	2308.06	2014.11	-1284.68	1179.95	2289.65	3331.60	6971.46
X_1: Price (RMB)	245162.84	123338.38	50745.91	140175.51	252520.86	313434.73	540700.14
X_2: Energy Consumption (kWh/100km)	14.82	2.3	11.00	12.99	14.98	16.38	19.00
X_3: Range (km)	579.70	156.19	297.90	486.44	584.33	664.06	934.17
X_4: Purchase Subsidy (RMB)	15850.00	8254.73	3000.00	9250.00	15000.00	20000.00	35000.00
X_5: Charging Time (hours)	0.93	0.32	0.40	0.65	0.98	1.17	1.48
X_6: Policy Support Index	0.95	0.31	0.52	0.69	0.95	1.22	1.50
X_7: Technology Progress Index	1.96	0.53	1.15	1.53	1.94	2.31	2.99

2.2 Model Structures

A multiple linear regression model is utilized in this study to investigate the impact of supply-side and demand-side factors on new energy vehicle sales. The regression equation has the following form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \epsilon \quad (1)$$

Where β_k is the regression coefficient, ϵ is the random error term, and Y is the dependent variable, representing the July sales volume of new energy vehicles (NEVs) in 2024, which is the key outcome we aim to predict and understand. This is influenced by various independent variables from both demand and supply sides. β_0 is the constant term (intercept), indicating the baseline sales when all independent variables are zero. Independent variables X_1, X_2, ..., X_k represent factors on both the demand and supply sides. Demand-side factors include price (X_1, RMB), this reflects the retail price of new energy vehicles. Lower prices are generally expected to increase demand, while higher prices might deter buyers. Energy consumption per 100 km (X_2, kWh/100 km), this measures the energy efficiency of the vehicles, with lower values indicating more efficient models. Consumers may prefer more energy-efficient vehicles, impacting sales. Driving range (X_3, km), this indicates how far the vehicle can travel on a single charge. A longer driving range is typically viewed favorably by consumers, potentially boosting sales. Subsidy amount (X_4, RMB), this represents the monetary incentives provided by the government to encourage NEV purchases. Higher subsidies can increase affordability and drive up sales. Charging time (X_5, hours), this reflects the time required to fully charge the vehicle. A shorter charging time may make the vehicle more attractive to consumers, potentially increasing demand. Supply-side factors include the index of policy support (X_6), which is an aggregate measure of the strength and comprehensiveness of governmental policies supporting NEV production and adoption, such as tax incentives, regulations, and infrastructural developments. Stronger policy support could drive higher production and sales. And technological progress (X_7), this variable captures advancements in NEV technology, such as improvements in battery life, performance, and vehicle features. Technological progress can enhance both the appeal of the vehicles and the efficiency of production, potentially boosting supply and sales.

The use of multiple linear regression analysis allows for the simultaneous assessment of the impact of multiple independent variables on a dependent variable, as well as the quantification of the independent effects of these variables. Furthermore, it can assist in identifying significant influences and enhance the precision of the model by controlling for confounding variables. Furthermore, regression modeling demonstrates robust predictive capacity, is readily comprehensible, and is adaptable to diverse domains. Whether employed to elucidate the interrelationships between variables or to forecast future trends, multiple linear regression represents an exceptionally efficacious analytical instrument.

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2.3 Model Estimation

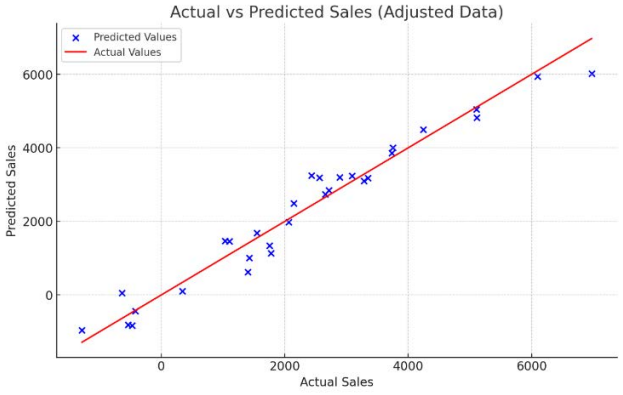

Fig. 1 Actual vs Predicted Sales: The plot below illustrates the relationship between the model's predicted sales and actual sales (Photo/Picture credit: Original).

In Figure 1, the red line shows the actual values, while the blue dots reflect the anticipated values. The closer the dots are to the red line, the more accurate the model's prediction. The horizontal coordinates indicate the actual sales, while the vertical coordinates indicate the predicted sales, both expressed in units.

2.4 Model Fitting Results

In this study, a multiple linear regression model was used to assess the factors impacting the sales of new energy cars. According to Figure 1, the coefficient of determination (R^2) of the model is 0.87, indicating that the selected independent variables can explain approximately 87% of the variability in new energy vehicle sales. This explanatory power suggests that there is a robust linear relationship between the independent variables in the model and sales volume, which better reflects the volatility of the market data. The adjusted R-squared value is 0.85, indicating that while the explanatory power of the model is somewhat diminished when the number of independent variables is considered, it nevertheless retains a considerable degree of explanatory strength. This indicates that the model is robust and exhibits minimal multicollinearity. The F-test of the model demonstrates that it is statistically significant, indicating that the overall effect of the independent variables on the sales of new energy vehicles is significant.

2.5 Interpretation of Regression Coefficients

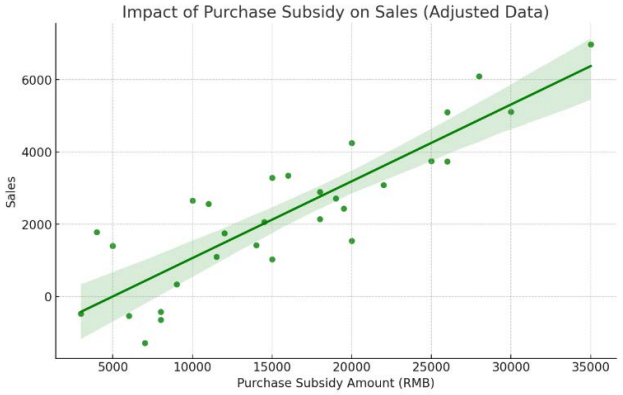

Fig. 2 Purchase Subsidy (RMB). The graph demonstrates the correlation between the provision of subsidies for the purchase of vehicles and the resulting sales volume (Photo/Picture credit: Original).

According to Figure 2, the horizontal axis represents the amount of subsidy for car purchases in dollars, while the vertical axis depicts sales in units. And, the regression coefficient is approximately 0.18, indicating that the purchase subsidy has a positive effect on sales volume, albeit a relatively mild one. The p-value is close to 0.05, suggesting that the effect of the purchase subsidy on sales volume is close to statistically significant. Specifically, if other variables remain unchanged, the sales volume of new energy vehicles will increase by approximately 0.18 units for every $1 increase in vehicle purchase subsidy. This result suggests that the government's vehicle purchase subsidy policy has a certain effect on the sales of new energy vehicles, although the statistical significance is slightly lower than the traditional 5% level.

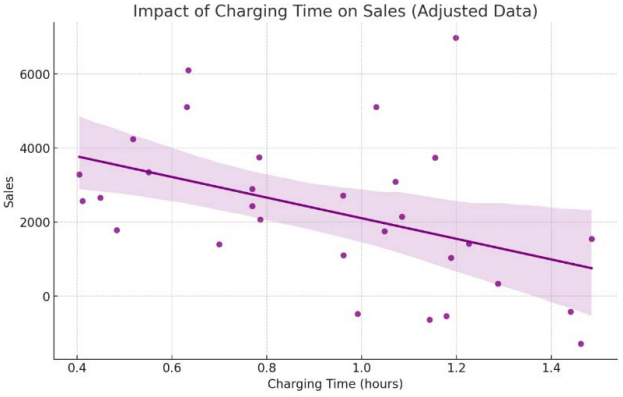

Fig. 3 Charging time (hours). The chart above shows the reverse relationship between charging time and sales (Photo/Picture credit: Original).

According to Figure 3, the regression line indicates that

longer charging times result in lower sales. The horizontal coordinate denotes the time at which the vehicle was charged, while the vertical coordinate represents the sales volume in units. And, the regression coefficient is approximately -1500, indicating that the duration of the charging process has a slight negative impact on sales. The p-value is close to 0.05, suggesting that the influence of charging time on sales is approaching the threshold of statistical significance. Specifically, assuming that all other variables remain unchanged, for every one-hour increase in charging time, the sales of new energy cars are expected to drop by roughly 1,500 units. This result suggests that although the increase in charging time has a certain inhibitory effect on sales, its effect is relatively mild, and the sensitivity of consumers to charging time is not as strong as expected.

2.6 Price (RMB)

The results indicated that, although there was a negative correlation between price and sales volume, this effect did not reach statistical significance ($p > 0.05$) in the model. This indicates that, based on the available data, fluctuations in price do not exert a considerable influence on sales volume. This may be attributed to the potential for other factors to exert a more significant impact, or to consumers demonstrating reduced sensitivity to the cost of automobiles using new energy.

The analysis revealed that other variables, including the index of the strength of policy support and the index of the level of technological progress, did not demonstrate statistical significance. This may indicate that the impact of these factors is less pronounced than anticipated within the current data range. The p-value of 0.576 for the strength of policy support indicates that, although the impact of the strength of policy support on sales is negative, this result is not statistically significant ($p > 0.05$). This suggests that alterations in the degree of policy support do not exert a considerable influence on sales within the context of the present model and data set. The level of technological progress has a p-value of 0.997, indicating that the level of technological progress exerts a negligible effect on sales. This result is highly statistically insignificant ($p > 0.05$). This suggests that the level of technological advancement does not accurately reflect its impact on sales, given the limitations of the current data set.

2.7 Model Robustness Check

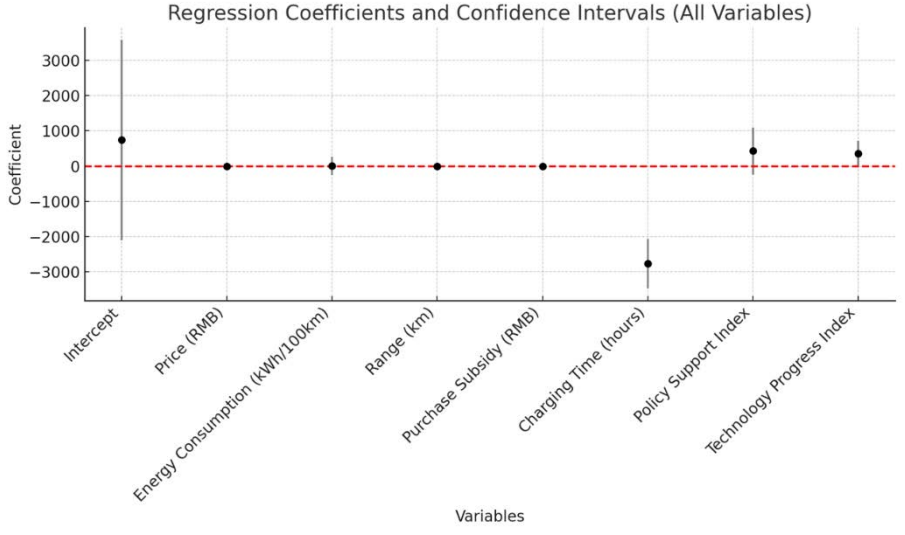

Fig. 4 Regression coefficients and confidence intervals: the figure illustrates the regression coefficients of the variables in question, along with their respective confidence intervals (Photo/ Picture credit: Original).

According to Figure 4, the red line represents the point at which the regression coefficients are equal to zero, and variables whose confidence intervals do not contain zero are deemed to be statistically significant. And, the horizontal coordinate denotes the independent variables, encompassing both supply side and demand side elements. On the other hand, the regression coefficient of every independent variable in the given regression model is represented by the vertical coordinate. Each independent variable's impact on the dependent variable is shown by the coefficients. A rise in the independent variable is correlated with an increase in the dependent variable, according to a positive regression coefficient. A negative regression coefficient, on the other hand, indicates that a

ISSN 2959-6157

rise in the independent variable is connected to a fall in the dependent variable.

3. Discussion

3.1 Research Findings

From the analysis above, two demand-side factors—Purchase Subsidy (RMB) and Charging Time (hours)—stand out as having the most significant impact on EV sales. Government subsidies directly reduce the cost of purchasing; while charging time affects how convenient the vehicle is for daily use. These factors play a key role in consumer buying decisions. On the supply side, the Policy Support Index and Technology Advancement Index show more complex and less clear effects, suggesting that the current policies and technological improvements have a limited direct impact on sales, and their influence might become clearer over a longer period.

Overall, demand-side factors, particularly purchase subsidies and charging time, have a more immediate and stronger impact on EV sales than supply-side factors. This highlights the current importance of consumer behavior and market demand in driving the EV market.

3.2 Recommendations

First, maintaining and enhancing purchase subsidies is key to boosting EV sales. The government should continue its current subsidy programs and possibly increase the support. The research shows that subsidies help reduce the cost of EVs, directly encouraging more people to buy them. Expanding subsidy coverage can stimulate demand even further, giving EVs a stronger position in the market. Based on the new energy vehicle policy incentive effect and media richness perspective, Zhou Yuping also pointed out that we should consider the policy incentives for the whole life cycle of new energy vehicles, and the corresponding policy incentives need to satisfy the consumer's purchasing demand and the current growth of the new energy vehicle industry [4].

Second, improving charging infrastructure is crucial for a better user experience. The study shows that longer charging times negatively affect sales, meaning that reducing charging times could greatly improve the appeal of EVs. Chen Long's study on the factors influencing the sales of new energy vehicles based on multiple linear regression also pointed out that the factor with the greatest influence on car sales is the charging time of the car [5, 6]. The government should invest more in building charging stations and improving related technology to offer faster and more efficient charging. This can significantly increase consumer confidence in EVs and support market growth. As indicated by Xu, the anticipated sales and developmental trajectory of China's new energy vehicles, as elucidated by research findings, suggest that raising the bar for technical innovation, the ascendance in carbon trading prices, and the augmentation of the amount of charging piles will facilitate the attainment of the projected sales target for new energy vehicles more expeditiously and cost-effectively [7]. Enhancing the infrastructure, can markedly enhance consumer awareness of new energy vehicles and facilitate market expansion. Moreover, as evidenced by Zhou et al.'s study of China's new energy vehicle industry's policy evolution, during the strategy deepening stage, the new energy vehicle industry, spearheaded by the pure electric drive strategy, assumes a pivotal role, with the power battery garnering heightened attention [5].

Lastly, balancing policy support with technological advancement is important for long-term success. While short-term policies like subsidies are helpful, over-reliance on them should be avoided.

Wu Jiang and Wang Meng's study on the market effect of policy adjustment on the promotion of new energy vehicles in China also pointed out that the key factor to promote the promotion of new energy vehicles and the development of the market is technological progress [5]. Future policies should focus more on supporting charging infrastructure and technological development. Zhou made the argument that there is a need to improve the coordination between upstream and downstream policy [5]. On the other hand, upstream raw materials and components are given less consideration in the current industrial policy, which promotes downstream cars. The gap between upstream and downstream technologies readily impedes China's new energy automotive industry's progress toward raising its overall technological standard. Therefore, to secure the synergistic growth of upstream and downstream common technologies, future policy design should center on China's new energy vehicle industry chain. [5]. Additionally, businesses need to ensure that technology improvements match market needs, avoiding either excessive updates or falling behind consumer expectations. This balance is key to ensuring that EV technology continues to meet consumer needs and supports the sustainable growth of the industry.

4. Conclusion

This paper makes a modest contribution in systematically analyzing the factors influencing the sales volume of China's new energy vehicle market, revealing the relative importance of demand-side and supply-side factors through multiple regression. In addition, this study adds

to the current empirical research on the new energy vehicle market, especially in terms of the trade-off between demand-side and supply-side factors. The findings show that demand-side factors, such as purchase subsidies and charging time, have some especially significant effects on sales. The influence of supply-side factors is relatively complex and insignificant. Based on this, this paper offers policy recommendations for bolstering the purchase subsidy and enhancing the infrastructure for charging, giving the government and businesses a scientific foundation on which to build pertinent policies. The policy of not restricting the purchase of new energy vehicles has not been able to promote the promotion of new energy vehicles significantly is not sustainable, and is not the key to the promotion of new energy vehicles in the future. It is suggested that the relevant departments should tilt the promotion policy to the end-user, increase the investment in the research and development of new energy vehicle technology, accelerate the elimination of backward production capacity through policies and regulations, and adjust the new energy vehicle license plate support policy in due course.

Further research could enhance the precision and breadth of the analysis by expanding the data set, employing nonlinear models, and integrating external macroeconomic variables. Furthermore, cross-country comparative studies and consumer behavior analysis will provide substantial support for understanding the development patterns of the global new energy vehicle market and developing more precise marketing strategies. With these improvements, future research will be able to reveal the dynamics of the new energy vehicle market in greater depth and provide more comprehensive empirical support for policy and management decisions.

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