

# Analysis of Policy Impact on New Energy Vehicle Sales in China

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**Abstract:** This study quantitatively assesses the impact of the 2020 purchase tax exemption policy on New Energy Vehicle (NEV) sales in China and forecasts future market trajectories. Utilizing monthly data from 2014 to 2024, the research employs a hybrid framework combining Difference-in-Differences (DID) for causal inference and a Seasonal Autoregressive Integrated Moving Average (SARIMA) model for forecasting. Exploratory analysis reveals high market volatility and a substitution effect ( $r = -0.35$ ) against fuel vehicles. The DID results demonstrate that the policy renewal significantly boosted NEV sales, generating an average monthly increase of approximately 285,300 units relative to the counterfactual. Robustness is confirmed via parallel trend and placebo tests. Furthermore, the SARIMA model predicts continued growth throughout 2025, reaching an estimated 1.57 million monthly units by year-end, despite distinct seasonal fluctuations. The study concludes that fiscal incentives are highly effective but recommends a gradual phase-out strategy to avoid market volatility. These findings assist policymakers in optimizing exit mechanisms and manufacturers in adjusting inventory for seasonal cycles.

**Keywords:** NEVs, Purchase Tax Exemption, DID, SARIMA, Policy Evaluation

## 1. Introduction

In recent years, as global concerns over energy shortages have intensified and the international community's consensus on environmental protection has grown stronger, the environmental damage caused by fossil fuel vehicles has drawn significant attention. Consequently, New Energy Vehicles (NEVs), powered mainly by electricity, are attracting increasing investment from major automobile-producing countries. In China, the rapid expansion of the NEV industry has been largely driven by proactive government intervention. Since the beginning of the 21st century, the Chinese government has introduced a comprehensive set of policy tools, including fiscal subsidies and tax incentives, to promote the adoption and industrialization of NEVs.

Existing literature confirms that reasonable policy incentives significantly boost the automotive and manufacturing industries, particularly for New Energy Vehicles (NEVs). Barahona, Gallego and Montero (2020)[1] demonstrated that targeted regulations and differentiated tools, such as restricting high-emission vehicles, can effectively guide market demand toward cleaner options. He, Ozturk, Gu and Silva-Risso (2021)[2] highlighted the sensitivity of demand to non-monetary incentives, finding that eliminating HOV lane privileges reduced hybrid sales by approximately 14%, thereby removing critical functional value. Similarly, Diamond (2009)[3] identified upfront rebates as the most effective incentive for Hybrid Electric Vehicles (HEV) adoption, emphasizing that policy timing and visibility are crucial. In the context of China, Shen, Shi, and Fu (2024)[4] found that a balanced combination of moderate environmental regulation and tax incentives optimizes the innovation efficiency of NEV enterprises.

Regarding empirical methodology, the Difference-in-Differences (DID) model is widely employed to identify causal relationships in policy analysis. Yao et al. (2024)[5] utilized the DID framework to reveal that the withdrawal of fiscal subsidies in China disrupted the industrial chain and suppressed NEV sales. However, to address the limitations of DID in capturing time dependence and seasonality, time series models are often introduced. Yu, Wang, Xu and Zhang (2024)[6] demonstrated that a hybrid framework incorporating the Seasonal Autoregressive Integrated Moving Average (SARIMA) model effectively captures seasonal trends and provides accurate forecasts for the electric vehicle market.

However, these policy measures have brought unexpected consequences, such as over-reliance on

direct financial subsidies, which can lead to improper resource allocation and inefficiency. Therefore, assessing the true effectiveness of specific fiscal policies is crucial for the industry's sustainable development. While existing literature has extensively studied the impact of direct subsidies or general industrial policies, research specifically isolating the causal effect of the vehicle purchase tax exemption—a policy directly reducing consumer costs—remains relatively limited, especially regarding the Chinese market. Furthermore, few studies have integrated causal evaluation with time-series forecasting to provide a unified framework for both retrospective policy assessment and prospective market trajectory analysis.

This paper fills these gaps by quantitatively assessing the impact of China's 2020 purchase tax exemption policy renewal on NEV sales and forecasting future market trends. Utilizing monthly data from 2014 to 2024, we employ a hybrid empirical framework combining Difference-in-Differences (DID) for causal inference and a Seasonal Autoregressive Integrated Moving Average (SARIMA) model for forecasting. Our study makes three main contributions. First, we provide transparent, data-driven evidence of the causal effect of the tax exemption policy, distinguishing it from synchronous fluctuations in the traditional fuel vehicle market. Second, by identifying a substitution effect between NEVs and fuel vehicles, we offer insights into the competitive reallocation within the automotive industry. Third, we link policy evaluation with predictive analysis, offering policymakers and manufacturers a scientifically grounded reference for optimizing exit mechanisms and inventory management.

The remainder of this paper is organized as follows. Section I introduces the institutional background of China's NEV industry and describes the data. Section II outlines the empirical strategy, including the DID framework and the SARIMA model specifications. Section III presents the empirical results, including the parallel trend tests, baseline regression estimates, robustness checks, and sales forecasts. Finally, Section IV concludes with policy recommendations.

## 2. Institutional Background and Data

### 2.1. Institutional Background

According to the definition by the State Council of China, New Energy Vehicles (NEVs) refer to automobiles that adopt new power systems, primarily including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs). To promote the adoption of these vehicles, the Chinese government has implemented a series of fiscal incentives. The most significant measure among these is the purchase tax exemption policy.

Under the standard tax regime, vehicle purchasers in China are required to pay a purchase tax amounting to 10% of the taxable price of the vehicle. The exemption policy, first introduced in 2014, relieves consumers of this burden when purchasing qualified NEVs. This study focuses specifically on the policy renewal announced in April 2020 by the Ministry of Finance, the State Taxation Administration, and the Ministry of Industry and Information Technology. This extension maintained the 10% exemption rate, directly reducing the effective price for consumers and serving as an exogenous shock to the market demand, which provides a quasi-experimental setting for our empirical analysis.

### 2.2. Data Source and Variables

We constructed a monthly dataset covering the period from January 2014 to December 2024, yielding a total of 132 observations. The sales data are sourced from the China Association of Automobile Manufacturers (CAAM) and the China Passenger Car Association (CPCA), representing the authoritative figures for the Chinese automotive market. Tax indicators and policy release dates were collected from the National Bureau of Statistics and the Ministry of Finance.

The key dependent variable is the monthly sales volume of vehicles (in 10,000 units). To implement the Difference-in-Differences (DID) strategy, we define two groups: the Treatment Group consisting of NEVs, and the Control Group consisting of traditional fuel vehicles. The policy intervention variable, *Post*, takes a value of 1 for all months on or after April 2020, and 0 otherwise.

Table 1 presents the descriptive statistics for the main variables. The data reveals a significant structural divergence between the two market segments. The average monthly sales volume of NEVs is approximately 22.69 (10,000 units) with a high standard deviation of 30.68, indicating a rapid expansion phase and significant volatility (Coefficient of Variation > 1). In contrast, fuel vehicle sales exhibit characteristics of a mature market, with a higher mean of 169.36 but a relatively stable demand pattern.

Table 1: Descriptive Statistics of Key Variables.

Variable	Mean	SD	Min	Median	Max
Sales Data (10,000 units)					
NEV Sales	22.69	30.68	0.09	6.71	129.30
Fuel Vehicle Sales	169.36	35.70	64.30	166.27	263.60
Passenger Vehicle Sales	192.05	37.95	96.50	191.75	311.84
Fiscal Indicators (100 Mn CNY)					
Vehicle Purchase Tax	247.78	45.50	144.00	242.17	355.00
Value-added Tax (VAT)	4277.90	1238.59	1090.00	4494.00	7689.07
Consumption Tax	961.98	304.88	168.00	1006.80	1624.00

### 3. Empirical Strategy

#### 3.1. The Difference-in-Differences Model

To isolate the causal effect of the policy renewal in April 2020, we employ a Two-Way Fixed Effects (TWFE) Difference-in-Differences (DID) model. Sales of NEVs serve as the treatment group, while sales of fuel vehicles act as the control group, as they are subject to the same macroeconomic conditions but were not affected by the specific tax exemption renewal. The baseline specification is

$$Sales_{it} = \beta_1(Treat_i \times Post_t) + \beta_2(Treat_i \times t) + \gamma_i + \delta_t + \theta_{i,m(t)} + \epsilon_{it} \quad (1)$$

Where  $Sales_{it}$  denotes the monthly sales volume of vehicle type  $i$  at time  $t$ .  $Treat_i$  is a dummy variable equal to 1 for NEVs and 0 for fuel vehicles, and  $Post_t$  takes a value of 1 for periods on or after April 2020.

The coefficient of interest is  $\beta_1$  which captures the policy effect (ATT). Crucially, we include the interaction term  $(Treat_i \times t)$ , where  $t$  is a linear time trend. The coefficient  $\beta_2$  controls for the pre-existing long-term trend differences between the rapidly growing NEV market and the mature fuel vehicle market. Furthermore,  $\theta_{i,m(t)}$  represents group-specific seasonal fixed effects, absorbing recurrent seasonal shocks specific to each vehicle type.  $\gamma_i$  and  $\delta_t$  denote vehicle-type and time fixed effects, respectively.

#### 3.2. The SARIMA Model

To forecast the future trajectory of NEV sales, we adopt a Seasonal Autoregressive Integrated Moving Average (SARIMA) model. This framework is well-suited for our data as it accommodates both the non-stationary growth trend and the recurring seasonal patterns (e.g., February troughs and December peaks) observed in the Chinese automotive market. The general form of the model is denoted as  $SARIMA(p, d, q) (P, D, Q)_{12}$ , where  $s = 12$  accounts for the monthly seasonality.

The model specification is determined based on the Akaike Information Criterion (AIC) and residual diagnostics. We perform a logarithmic transformation on the sales data ( $y_t = \log(Y_t)$ ) prior to modeling to stabilize the variance. The forecasting performance is evaluated using out-of-sample metrics, including Root Mean Square Error (RMSE), on the last 24 months of data.

### 4. Empirical Results

#### 4.1. Policy Impact Analysis

The validity of our DID strategy hinges on the parallel trend assumption. Figure 1 plots the estimated coefficients from a dynamic event study. The results show that prior to the policy renewal in April 2020 (periods  $t < 0$ ), the interaction coefficients are statistically indistinguishable from zero ( $p = 0.864$ ), supporting the parallel trend assumption. Following the policy intervention, we observe a sustained and increasing positive effect on NEV sales.

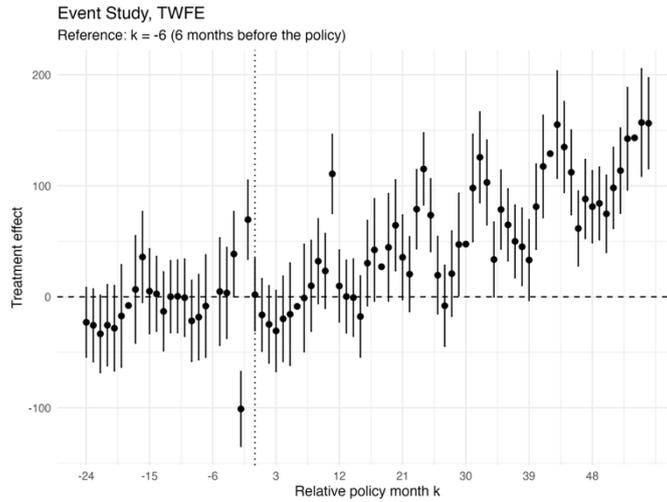


Figure 1: Dynamic Impact of Policy Renewal on NEV Sales.

Table 2 reports the baseline regression estimates. Column (1) presents the results from our preferred specification (Equation 1). The coefficient on the interaction term ( $Treat_t \times Post_t$ ) is 28.53 and statistically significant at the 5% level. This estimate suggests that the policy renewal is associated with an average monthly increase of approximately 285,300 NEV units relative to the counterfactual trend. The significant coefficient on the trend interaction term ( $Treat_t \times t$ ) confirms that NEVs were already on a steeper growth trajectory than fuel vehicles, which our model successfully controls for.

Table 2: Baseline DID Regression Results.

Term	Estimate	Std. Error	t-value	p-value
Treat × Post (ATT)	28.53	12.83	2.24	0.027
Treat × Time Trend	0.72	0.17	4.13	< 0.001
R-squared	0.94			
Observations	132			

#### 4.2. Forecasting NEV Sales

Having established the causal impact of the policy, we forecast the market trajectory for 2025 using the SARIMA framework. Figure 2 presents the STL decomposition of the log-transformed NEV sales. The "seasonal" panel clearly illustrates the recurring annual cycle, characterized by a distinct trough in February and a peak in December, justifying the inclusion of seasonal components in our model.

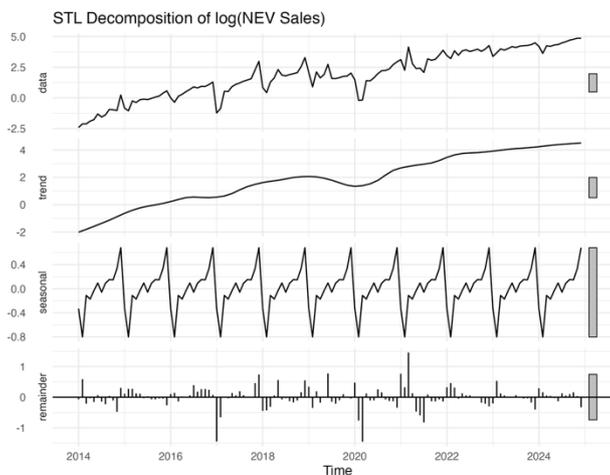


Figure 2: STL Decomposition.

Based on the AIC minimization and residual diagnostics, the optimal model specification is identified as SARIMA(1,1,2) (2,0,0)<sub>12</sub>. Figure 3 displays the 12-month-ahead forecast. The model predicts that

NEV sales will continue their upward trend throughout 2025, reaching approximately 1.57 million units by December. This projection implies that despite the gradual saturation of the early adopter market, the momentum driven by policy and organic demand growth remains robust.

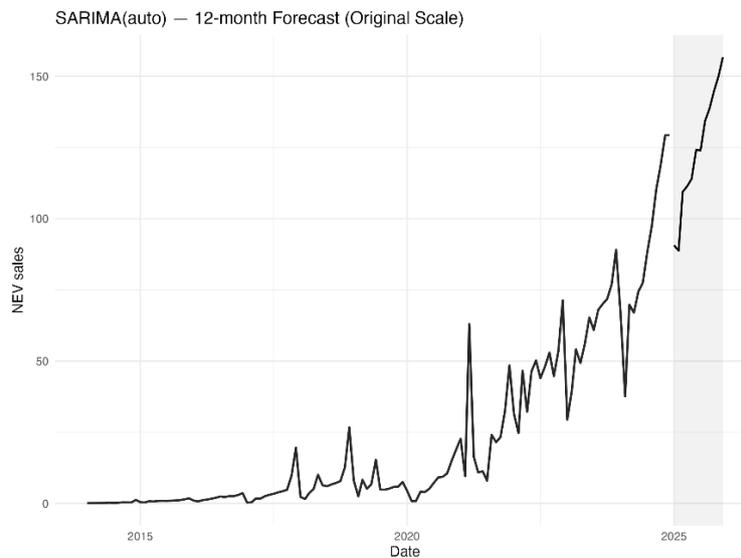


Figure 3: Forecast for 2025

## 5. Conclusion

This paper quantitatively assesses the impact of China's 2020 purchase tax exemption policy on the New Energy Vehicle (NEV) market. Utilizing a monthly dataset from 2014 to 2024, we employ a Difference-in-Differences framework to isolate the causal effect of the policy renewal. Our results indicate that the tax exemption significantly accelerated NEV adoption, generating an average monthly increase of approximately 285,300 units relative to the counterfactual trend of fuel vehicles. This finding highlights the high price sensitivity of Chinese consumers and the effectiveness of fiscal incentives in steering market demand.

Furthermore, our SARIMA forecasting analysis predicts that this growth momentum will persist throughout 2025, with sales expected to reach 1.57 million units per month by year-end. However, the market continues to exhibit strong seasonality and volatility.

Based on these findings, we recommend that policymakers avoid sudden policy terminations ("policy cliffs"). Instead, a gradual phase-out strategy, such as incrementally reducing the exemption rate is advisable to ensure a smooth transition from policy-driven growth to market-driven sustainability. For manufacturers, inventory strategies should be adjusted to align with the predictable seasonal cycles identified in our model. Which is arrange for maintenance or reduce production in the first quarter to avoid inventory accumulation. On the contrary, production plan should be increased in the third quarter to prepare for the sharp increase in demand at the end of the year. Lastly, the government should support traditional automakers in upgrading their production lines and provide re-skills training for workers in the traditional automotive supply chain to alleviate the social and economic frictions brought about by such industrial structure changes. Meanwhile, traditional car manufacturers should also enhance their technological level, increase investment in research and development, and produce better product.

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