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Source Decomposition and Structural Changes in the Growth of China's New Energy Vehicle Sales

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Abstract. Based on the monthly "Operation of the Automotive Industry" reports released by the Ministry of Industry and Information Technology, this study constructs a 56-month dataset on China's new energy vehicle (NEV) market from January 2022 to August 2026. It applies a two-factor symmetric decomposition of market size and penetration rate, together with an incremental decomposition of domestic sales and exports, to identify the sources and stage-specific changes in NEV sales growth from the perspectives of product structure and sales destination. The results show that from 2023 to 2025, increases in the penetration rate accounted for 64.6%, 85.3%, and 63.9% of the annual sales increments, respectively, making penetration the main accounting source of NEV growth. From January to August 2026, the contribution of total automotive market size was −38.5 × 10,000 vehicles, while the contribution of the penetration rate was 144.2 × 10,000 vehicles, indicating that NEV sales growth did not result from an expansion of the overall automotive market. Over the same period, NEV exports increased by 192.8 × 10,000 vehicles, while domestic sales decreased by 87.1 × 10,000 vehicles; the export increment offset the decline in domestic sales. Sensitivity tests using reported cumulative values and aggregated monthly decompositions do not alter the main conclusions. The findings indicate that analyses of NEV market growth should distinguish among total market expansion, changes in penetration, and domestic versus export sales flows, rather than using all-channel industry growth as a direct proxy for domestic market performance.

Keywords: new energy vehicles, sales growth, structural decomposition, market penetration, automobile exports

1. Introduction

The expansion of the new energy vehicle market is commonly described in terms of sales volume, growth rate, and penetration rate, but these three indicators answer different questions. An increase in sales may result from expansion of the overall automobile market or from a higher share of NEVs in total automobile sales; when total sales include exports, it may also result from changes in sales destination. Data from the China Association of Automobile Manufacturers (CAAM), published by the Ministry of Industry and Information Technology, show that NEV sales reached 1,649.0 × 10,000 vehicles in 2025, accounting for 47.9% of total automobile sales [1]; from January to August 2026, sales reached 1,065.0 × 10,000 vehicles, accounting for 52.4% [2]. These aggregate figures

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describe the scale of the industry, but by themselves they cannot show whether domestic sales increased in parallel, nor can they distinguish the increments associated with overall market expansion from those associated with changes in product structure.

Existing studies explain the diffusion of electric vehicles from perspectives such as policy, infrastructure, and consumer behavior. Zhang et al. [3] reviewed policy categories including fiscal support, infrastructure, and R&D investment; Liu et al. [4] used data from 61 Chinese cities from 2009 to 2018 to distinguish policy effects in the public and private sectors and addressed the endogeneity of charging infrastructure; Zhao et al. [5] analyzed policy mixes and their heterogeneity using data from 275 cities from 2016 to 2022. These studies provide a basis for understanding the mechanisms of market expansion and also caution against interpreting concurrent changes directly as causal effects. For recent industry monitoring, before identifying mechanisms, it is necessary to establish an incremental accounting framework with consistent statistical definitions that can be verified item by item. In addition, Li et al. [6] discussed the interaction between infrastructure and demand through the indirect network effects between charging facilities and electric-vehicle adoption; Springel [7] further showed that, in the presence of network externalities, different subsidy instruments may have different effects. The IEA's annual global electric-vehicle report [8] provides an international comparative context for sales, industry, and trade structures; Hu et al. [9], using data from 336 Chinese cities, found that the drivers of growth and their spatial differences vary across types of NEVs. These studies show that NEV sales growth is multi-factor and multi-level, further highlighting the need to structurally decompose aggregate growth.

This paper addresses two questions. First, how much of the increase in NEV sales is associated with changes in the total automobile market size and how much with changes in the NEV penetration rate? Second, how much of the increase is associated with domestic sales and how much with exports? The contribution of this paper is to use the same set of publicly available monthly data for accounting along two complementary dimensions, and to test whether the conclusions depend on the data version or temporal aggregation method by substituting cumulative reported values and by aggregating monthly decompositions. The study focuses on a verifiable description of recent market structure; it does not propose a new forecasting algorithm or estimate policy treatment effects.

2. Data sources and research methods

2.1. Sample construction and statistical definitions

The main data source is the monthly "Operation of the Automotive Industry" report published by the Ministry of Industry and Information Technology, with the underlying data provided by the China Association of Automobile Manufacturers. The sample covers 56 months from January 2022 to August 2026, with no missing values for the three core variables: total automobile sales, NEV sales, and NEV exports. Data retrieval was completed on September 22, 2026, and the title, publication date, and original link of each report were retained. Annual and same-period cumulative values were taken from the corresponding December or August reports [1, 2, 10-13] and used only for external verification and sensitivity analysis; the main analysis consistently uses the values reported for each individual month.

Let total automobile sales be A, NEV sales be N, and NEV exports be X, all measured in 10,000 vehicles. Both A and N include passenger and commercial vehicles, and sales include exports; therefore, they cannot be directly substituted with domestic passenger-vehicle retail data. Define the all-channel NEV sales penetration rate as $p=N/A$, the export share as $q=X/N$, and domestic sales on a consistent basis as $D=N-X$. D is a sales indicator obtained by subtracting association-reported

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exports from association-reported sales and is not equivalent to domestic end-market retail sales, which include imported vehicles; likewise, p is not the domestic market penetration rate. Because total automobile export data consistent with the full sample are unavailable, this paper does not calculate a domestic NEV penetration rate.

Data processing first standardizes reporting periods and units, then checks the three core reported values month by month, and finally calculates derived indicators. When the sum of monthly values differs from the cumulative value reported in the corresponding report, both sets of published values and their difference are retained; interpolation, proportional allocation of the discrepancy, or differencing adjacent cumulative values is not used to rewrite the original monthly data. For example, the sum of monthly NEV export values for 2023 is 115.3 × 10,000 vehicles, whereas the annual report gives 120.3 × 10,000 vehicles [11]. The public reports do not provide sufficient information to explain every discrepancy item by item; this paper therefore does not attribute all discrepancies uniformly to rounding and does not mix different data versions within the same decomposition.

Table 1. Market size and sales structure by period

Period	Automobile sales (10,000 vehicles)	NEV sales (10,000 vehicles)	NEV exports (10,000 vehicles)	Penetration rate (%)	Export share (%)
2022	2684.9	687.2	67.5	25.59	9.82
2023	3004.5	944.8	115.3	31.45	12.20
2024	3142.7	1285.9	127.5	40.92	9.92
2025	3434.6	1644.4	258.3	47.88	15.71
Jan–Aug 2025	2109.7	959.2	150.5	45.47	15.69
Jan–Aug 2026	2031.1	1064.9	343.3	52.43	32.24

Note: This table aggregates values reported for individual months rather than directly copying official cumulative values. Penetration rate is N/A, and export share is X/N. For 2026, the comparison is only with January–August 2025. Data source: monthly reports of the Ministry of Industry and Information Technology; author's calculations.

2.2. Symmetric decomposition of market size and penetration rate

Let b denote the base period and t the comparison period. The sales identity is:

$$N_t = A_t p_t \tag{1}$$

Structural decomposition may depend on the order of decomposition. Following the idea of averaging polar decompositions [14], equal weights are assigned to the two paths—"change market size first" and "change penetration first"—to obtain the following exact two-factor decomposition:

$$\Delta N = \frac{p_t + p_b}{2}\Delta A + \frac{A_t + A_b}{2}\Delta p = C_A + C_p \tag{2}$$

Here, Δ denotes the comparison period minus the base period, C_A is the contribution of market size, and C_p is the contribution of the penetration rate. Equation (2) is equivalent to assigning half of the interaction term ΔAΔp to each factor; under the two-factor multiplicative identity, the residual is zero. A positive contribution indicates that the change in the factor corresponds to an increase in

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sales, whereas a negative contribution indicates a decrease. The term "contribution" here refers to an accounting allocation of the increment; the penetration rate incorporates combined changes in domestic and export sales structure and should not be interpreted as the independent effect of consumer preferences or of any specific policy.

2.3. Incremental decomposition of domestic sales and exports

Under the same statistical definition, domestic sales and exports together constitute total NEV sales; therefore:

$$N_t = D_t + X_t; \quad \Delta N = \Delta D + \Delta X \tag{3}$$

When ΔN is nonzero, the contribution rate of any component C is defined as 100% × C/ΔN. A contribution rate above 100% means that positive growth in that component offsets negative growth in another component; it does not mean that the component's share of total sales exceeds 100%. To avoid ratio distortions when the total increment is close to zero, the monthly figures report only absolute increments and do not compare monthly contribution rates. Equations (2) and (3) describe the same total increment from the perspectives of product structure and sales destination, respectively; the two sets of contributions cannot be added together.

The monthly analysis compares each month with the same month of the previous year, yielding 44 year-on-year observations from January 2023 to August 2026. For annual analysis, A, N, and X are first summed across the months of each year, after which the within-period penetration rate is calculated and decomposed. For 2026, only January–August is compared with the same months of the adjacent year, avoiding comparison between an incomplete year and a full year. Year-on-year comparisons can reduce ordinary monthly seasonality, but they are not equivalent to seasonal adjustment; the timing of the Spring Festival and base effects may still influence monthly results.

3. Empirical results

3.1. Sales expansion and structural change

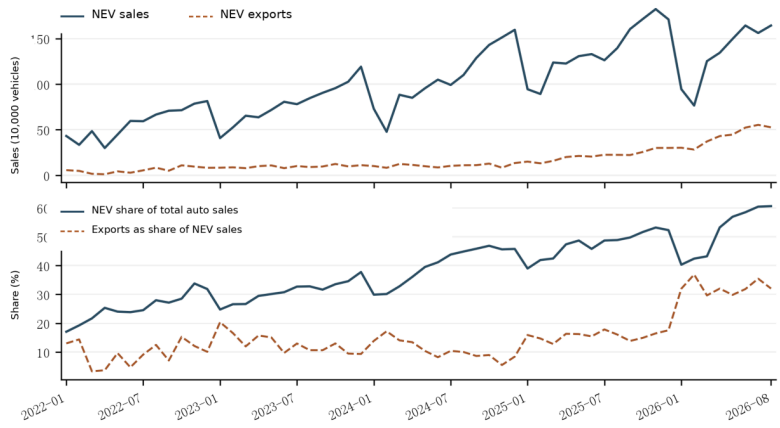


Figure 1. Monthly NEV sales and sales structure

Note: The upper panel shows sales levels and the lower panel shows sales shares; both use the original monthly reported values without seasonal adjustment. The denominator of the export share is total NEV sales.

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Table 1 shows that, based on the aggregation of individually reported monthly values, annual NEV sales rose from 687.2 × 10,000 vehicles in 2022 to 1,644.4 × 10,000 vehicles in 2025, an increase of 139.3%; over the same period, total automobile sales increased by 27.9%. The NEV sales penetration rate rose from 25.59% to 47.88%, an increase of 22.28 percentage points, indicating that NEV sales expanded faster than the overall automobile market. This comparison is based on complete calendar years and is interpreted separately from the same-period observations for 2026.

The relative importance of exports did not increase monotonically across stages. From 2022 to 2024, exports accounted for 9.82%, 12.20%, and 9.92% of NEV sales, respectively; the share rose to 15.71% in 2025. Therefore, no single long-run average export growth rate can summarize all stages. In January–August 2026, the export share rose to 32.24%, 16.55 percentage points higher than the 15.69% recorded in the same period of 2025, indicating a marked change in sales destination. Figure 1 also shows monthly fluctuations in both sales and shares, so stage-level judgments should be based on aggregated values for comparable periods.

3.2. Higher penetration as the main accounting source of annual sales increments

Table 2. Decomposition of NEV sales increments along two dimensions

YoY period	Total increment ΔN	Market-size contribution C_A	Penetration contribution C_p	Domestic contribution ΔD	Export contribution ΔX	Export contribution rate (%)
2023	257.6	91.2	166.4	209.8	47.8	18.6
2024	341.1	50.0	291.1	328.9	12.2	3.6
2025	358.5	129.6	228.9	227.7	130.8	36.5
Jan–Aug 2026	105.7	-38.5	144.2	-87.1	192.8	182.4

Note: Except for contribution rates, the unit is 10,000 vehicles. Each period is compared with the same-length period of the previous year. Each row satisfies ΔN=C_A+C_p=ΔD+ΔX; displayed values may not add exactly in the last digit because of rounding.

In 2023, NEV sales increased year on year by 257.6 × 10,000 vehicles, of which the market-size contribution was 91.2 × 10,000 vehicles and the penetration-rate contribution was 166.4 × 10,000 vehicles, accounting for 35.4% and 64.6% of the total increment, respectively. In 2024, the total increment expanded to 341.1 × 10,000 vehicles; the market-size contribution fell to 50.0 × 10,000 vehicles, while the penetration-rate contribution rose to 291.1 × 10,000 vehicles, accounting for 85.3%. In 2025, the market-size contribution rebounded to 129.6 × 10,000 vehicles, but the penetration-rate contribution remained 228.9 × 10,000 vehicles, accounting for 63.9%. Taken together, the results for the three years show that the shift in product sales structure toward NEVs was the main accounting source of annual growth.

January–August 2026 shows a different combination. Total automobile sales fell from 2,109.7 × 10,000 vehicles in the same period of the previous year to 2,031.1 × 10,000 vehicles, a decline of 3.7%, while NEV sales still increased by 105.7 × 10,000 vehicles, or 11.0%. The corresponding market-size contribution was −38.5 × 10,000 vehicles and the penetration-rate contribution was 144.2 × 10,000 vehicles, with contribution rates of −36.4% and 136.4%, respectively. Thus, growth in this period cannot be explained by expansion of the overall automobile market; the increment associated with the higher NEV share exceeded the decrement associated with contraction of the

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total market. The penetration rate rose from 45.47% to 52.43%, but it remains an all-channel indicator that includes exports.

3.3. Export increments offset the decline in domestic sales

From the perspective of sales destination, domestic sales contributed 209.8 × 10,000 and 328.9 × 10,000 vehicles in 2023 and 2024, respectively, accounting for 81.4% and 96.4% of the annual increments; domestic sales were therefore the main source of incremental growth. In 2025, domestic sales and exports increased by 227.7 × 10,000 and 130.8 × 10,000 vehicles, respectively, and the export contribution rate rose to 36.5%, although the contribution from domestic sales remained larger than the export contribution. In other words, growth in 2025 reflected simultaneous expansion of domestic sales and exports. The role of exports strengthened, but it had not yet exceeded the domestic increment.

From January to August 2026, exports increased from 150.5 × 10,000 to 343.3 × 10,000 vehicles, an increase of 192.8 × 10,000 vehicles; domestic sales fell from 808.7 × 10,000 to 721.6 × 10,000 vehicles, a decline of 87.1 × 10,000 vehicles or 10.8% year on year. After offsetting each other, the two components yielded an increase in total sales of 105.7 × 10,000 vehicles. The export contribution rate was 182.4%, while the domestic-sales contribution rate was −82.4%. This result shows that aggregate growth and a decline in domestic sales coexisted during the period. Therefore, growth in total sales or an all-channel penetration rate above 50% alone cannot justify the conclusion that domestic end-market demand expanded in parallel.

The monthly results provide supplementary directional evidence. In all eight months from January to August 2026, the year-on-year increment in domestic sales was negative and the year-on-year increment in exports was positive; except in February, the year-on-year increment in total sales was positive in every month. This pattern was therefore not caused by a single anomalous month. At the same time, the total increment in January was only 0.1 × 10,000 vehicles, so directly comparing contribution rates would produce extremely large values. Accordingly, this paper relies on the absolute-increment figure and same-period cumulative decomposition for interpretation and does not treat a single-month ratio as a test of structural break.



Figure 2. Decomposition of monthly year-on-year increments by market structure and sales destination

Note: The upper panel shows the decomposition into market size and penetration rate; the lower panel shows the decomposition into domestic sales and exports. Positive and negative components are stacked separately. The black line is the total increment, i.e., the algebraic sum of the components. The two panels describe the same increment and must not be added across panels.

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4. Sensitivity analysis and discussion

4.1. Alternative data versions and temporal aggregation methods

The first test replaces the aggregation of monthly reported values with the cumulative values published directly in the corresponding monthly reports, and applies the replacement to both the base and comparison periods to maintain internal consistency in each calculation. This tests whether the results depend on discrepancies between monthly and cumulative values. Table 3 shows that, using cumulative reported values, the penetration-rate contribution rates for 2023–2025 are 64.6%, 85.6%, and 63.7%, respectively, all above 60% and consistent with the main conclusion of the baseline analysis.

Table 3. Sensitivity results using cumulative reported values

YoY period	Penetration contribution rate (%) Monthly sum / cumulative reported	Export contribution rate (%) Monthly sum / cumulative reported	Domestic increment (10,000 vehicles) Monthly sum / cumulative reported
2023	64.6 / 64.6	18.6 / 20.1	209.8 / 208.4
2024	85.3 / 85.6	3.6 / 2.4	328.9 / 329.0
2025	63.9 / 63.7	36.5 / 36.7	227.7 / 229.3
Jan–Aug 2026	136.4 / 138.7	182.4 / 184.8	-87.1 / -87.3

Note: "Cumulative reported" refers to the cumulative values listed in the corresponding December or August reports, with the same type of data used for both the base and comparison periods. Both calculations use the same formulas.

Using cumulative reported values, the total increment for January–August 2026 is 103.0 × 10,000 vehicles, the domestic-sales increment is −87.3 × 10,000 vehicles, and the export increment is 190.3 × 10,000 vehicles; the penetration-rate and export contribution rates are 138.7% and 184.8%, respectively. Compared with the baseline results, the numerical values change somewhat, but the directions—"negative market-size contribution and positive penetration-rate contribution" and "declining domestic sales offset by exports"—remain unchanged. For 2024, the export contribution rate changes from 3.6% to 2.4%, indicating that smaller components are more sensitive to the data version and that differences in their decimal places should not be overemphasized.

The second test first applies Equation (2) to the year-on-year increment of each month and then aggregates the monthly components into annual components, in order to examine the difference between monthly weights and period-level aggregate weights. This method yields penetration-rate contribution rates of 60.3%, 86.2%, and 64.7% for 2023, 2024, and 2025, respectively, and 134.9% for January–August 2026, preserving the main conclusion. The total increment is identical under both methods, but the allocation between market size and penetration need not be identical because "aggregate first, then decompose" and "decompose first, then aggregate" use different weights. The sales-destination decomposition is linearly additive, so the domestic and export components are unaffected by this aggregation order.

4.2. Interpretation of results and scope of applicability

For industry monitoring, sales growth, sales penetration, and domestic sales should be reported jointly. An increase in all-channel penetration may accompany an expansion in domestic sales, but it

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may also be influenced by changes in export structure; therefore, domestic end-market consumption, manufacturers' domestic sales, and exports should be reported separately. For business analysis, a rising share of export increments suggests the need to track destination markets, model mix, delivery pace, and profitability; however, this paper does not contain those data and therefore cannot be used to assess the magnitude of profit improvement or overseas risk. For policy evaluation, the results can indicate mechanisms that warrant further testing but cannot substitute for identification of policy effects.

This study has three main limitations. First, the 56-month national aggregate sample cannot reveal differences across provinces and cities, firms, price segments, or powertrain types, and 2026 covers only eight months, so the results cannot be extrapolated to the full year. Second, discrepancies exist across different versions of the monthly reports. This paper improves transparency by retaining the original values and conducting substitution tests, but it cannot reconstruct the complete historical revision chain. Third, both decompositions are based on accounting identities; they do not control for variables such as policy, income, prices, charging infrastructure, trade conditions, or inventories, nor do they test for structural breaks. Therefore, the paper does not use causal expressions such as "significantly promoted" or "shifted from policy-driven to market-driven," and it does not treat descriptive decomposition results as evidence of statistical significance. Future research can test specific mechanisms after adding comparable regional panel data and end-market sales data.

5. Conclusion

Using monthly public data from January 2022 to August 2026, this paper conducts a verifiable structural decomposition of the growth in China's NEV sales. Unlike an analysis that only compares sales growth rates, this paper accounts for the same sales increment along two dimensions—"total automobile market size–NEV penetration rate" and "domestic sales–exports"—and tests the sensitivity of the results to data versions and temporal aggregation by substituting cumulative reported values and aggregating monthly decompositions.

The results show clear stage differences in the sources of NEV growth. From 2023 to 2025, increases in penetration accounted for more than 60% of the annual sales increment each year, reaching 85.3% in 2024. This indicates that the expansion of NEV sales mainly corresponded to a structural increase in their share of total automobile sales rather than a proportional expansion of the overall automobile market. From January to August 2026, this pattern became even more pronounced: the year-on-year decline in total automobile sales turned the market-size contribution negative at −38.5 × 10,000 vehicles, while higher penetration still corresponded to a positive contribution of 144.2 × 10,000 vehicles. At the same time, the sales destination changed markedly: NEV exports increased by 192.8 × 10,000 vehicles year on year, while domestic sales on a consistent basis decreased by 87.1 × 10,000 vehicles. The export increment exceeded the increase in total sales and offset the decline in domestic sales. Therefore, growth in all-channel sales, a penetration rate above 50%, and expansion of domestic demand are not interchangeable judgments.

The significance of these findings is that NEV market monitoring should distinguish among aggregate volume, structure, and sales destination. On the one hand, total automobile sales, NEV penetration, and domestic sales on a consistent basis should be reported together, so that domestic market conditions are not judged solely from total sales or all-channel penetration. On the other hand, when the role of exports in incremental growth rises rapidly, destination markets, model mix, prices, and firm profitability should also be examined to assess sustainability. It should be emphasized that this paper uses descriptive decompositions based on accounting identities and

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therefore cannot identify the causal effects of policy, prices, income, charging infrastructure, or other factors. Future research may incorporate more granular data on firms, regions, powertrain types, and end-market retail sales to study heterogeneity in the sources of NEV growth across markets and vehicle types and to test the relevant mechanisms.

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