

The Impact of Raw Material Price Fluctuations and Technological Investment on the Profitability of Enterprises —Taking Electric Vehicle Company as an Example

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Abstract. Against the backdrop of evolving global supply chains and shifting market supply-demand structures, core battery raw materials such as lithium carbonate, cobalt and nickel have undergone drastic periodic price fluctuations, creating lasting cost pressure for new energy vehicle manufacturers, where R&D and technological investment serve as a vital internal strategy to mitigate external cost risks. Centered on exploring the interactive effects of raw material price volatility and corporate technological investment on enterprises' profitability, this paper takes cost transmission theory, technological innovation theory and sustainable profitability theory as theoretical foundations and adopts literature analysis together with comparative case study methods. Selecting BYD, Tesla and Volkswagen New Energy as research samples, the research analyzes quarterly raw material price data published by SMM from 2023 to 2026 and annual financial R&D indicators of the three automakers. The results indicate that raw material price fluctuations compress profit margins via industrial cost transmission channels, while persistent high-intensity technological investment achieves technical cost reduction and product premium to hedge cost shocks; enterprises with inadequate R&D layout cannot offset negative impacts from upstream price changes and suffer weak profitability accordingly. This paper proposes that new energy vehicle enterprises ought to expand long-term technological layout and balance short-term operating expenses and long-term innovative accumulation so as to strengthen profit resilience under volatile raw material markets.

Keywords: new energy vehicle, raw material price fluctuation, technological investment, cost Transmission, corporate Profitability

1. Introduction

Against the backdrop of global supply chain evolution and changing market supply-demand structures, the global new energy vehicle (NEV) industry is facing prominent operational uncertainties [1]. Core battery raw materials, including lithium and cobalt, are unevenly distributed globally, making battery-grade lithium carbonate prices experience drastic and frequent fluctuations from 2022 to 2025. As an uncontrollable external industrial factor, raw material price volatility

directly raises vehicle manufacturing costs, exerts continuous cost pressure on NEV enterprises worldwide, and becomes a key constraint on corporate profitability [2].

Facing persistent external cost shocks brought by raw material market changes, technological R&D investment has become a core controllable internal strategy for NEV enterprises to hedge market risks. Continuous technological innovation can optimize battery structures and production processes, effectively offsetting the profit squeeze caused by raw material price hikes. Meanwhile, technological advantages help enterprises build differentiated product competitiveness and brand premium, supporting long-term profit growth. Nevertheless, high R&D expenditures increase short-term operating expenses, restraining immediate profit performance. Accordingly, corporate profitability is jointly affected by external raw material market volatility and internal technological investment.

Most existing studies only discuss the single impact of raw material price fluctuations or R&D investment on corporate performance, lacking comprehensive analysis combining external industrial market changes and internal corporate strategies under the latest global industrial competition, as well as cross-country comparative research [3]. On this basis, this paper adopts literature analysis and comparative case study methods, selecting three representative NEV enterprises such as BYD (China), Tesla (the United States), and Volkswagen New Energy (Germany) [4].

This paper explores the differentiated profitability performance of enterprises under dual influences of raw material price volatility and technological investment, and clarifies the interactive mechanism of external cost pressure and internal R&D strategies. As a review-based case study without econometric models, all analyses and conclusions in this paper are supported by public industry data and corporate financial reports. The research findings provide practical references for global NEV enterprises to balance short-term profits and long-term technological layout, and improve profit resilience amid evolving global industrial and supply chain markets.

2. Theoretical basis

Raw material price fluctuation means that in this paper raw material price fluctuation mainly refers to the unstable and periodic price changes of core power battery materials, including lithium carbonate, cobalt and nickel. Driven by global supply and demand adjustments, supply chain operational changes and industrial capacity iteration, raw material prices present frequent volatility. As a common external market factor in the new energy vehicle industry, such fluctuations directly affect vehicle manufacturing costs and constitute a major exogenous operational variable for NEV enterprises.

Enterprise technological investment shows technological investment is a controllable internal strategic expenditure for enterprises to enhance core competitiveness through independent innovation. It is mainly reflected in R&D expenses, technological iteration investment and production process optimization investment. For new energy vehicle enterprises, technological investment focuses on battery upgrading, manufacturing process improvement and intelligent system research. It assists enterprises in achieving technical cost reduction and product differentiation, and serves as a crucial approach to hedge market volatility and improve long-term profitability quality [1].

Enterprise profitability is a core indicator that reflects an enterprise's ability to gain profits through operational resources. This paper evaluates the profit level and profit resilience of NEV enterprises based on typical financial indicators, including gross profit margin, net profit margin and operating profit. These indicators intuitively reflect the operational changes brought by external raw material volatility and internal R&D strategies.

Cost transmission theory refers to the cost transmission theory indicates that price changes of upstream raw materials will transmit downward along the industrial chain and directly affect the production cost and profit margin of downstream manufacturers. In the new energy vehicle industry, battery materials account for a high proportion of total vehicle costs [5]. Therefore, raw material price fluctuations can be rapidly transmitted to terminal vehicle manufacturing, resulting in obvious profit squeezing or cost recovery effects, which explains the general profit volatility of NEV enterprises [2].

Technological innovation theory means the technological innovation theory proposes that continuous R&D investment and technological iteration can break the limitations of traditional production modes. Through technological and process optimization, enterprises can realize cost reduction and efficiency improvement, and build differentiated product advantages and market premium capabilities. Although intensive R&D expenditure increases short-term operating costs, long-term technological accumulation effectively strengthens enterprises' risk resistance and sustainable profitability [6].

The last one is the sustainable profitability theory. This theory emphasizes that corporate profitability depends not only on short-term market conditions, but also on internal strategic layout and resource accumulation. Under the dynamic environment of changing supply chains and market supply-demand structures, enterprises can effectively hedge external market uncertainties and maintain stable and sustainable profitability by rationally allocating R&D resources and balancing short-term costs and long-term innovative investment.

The three theories are interrelated and mutually influence each other as can be seen in Figure 1.

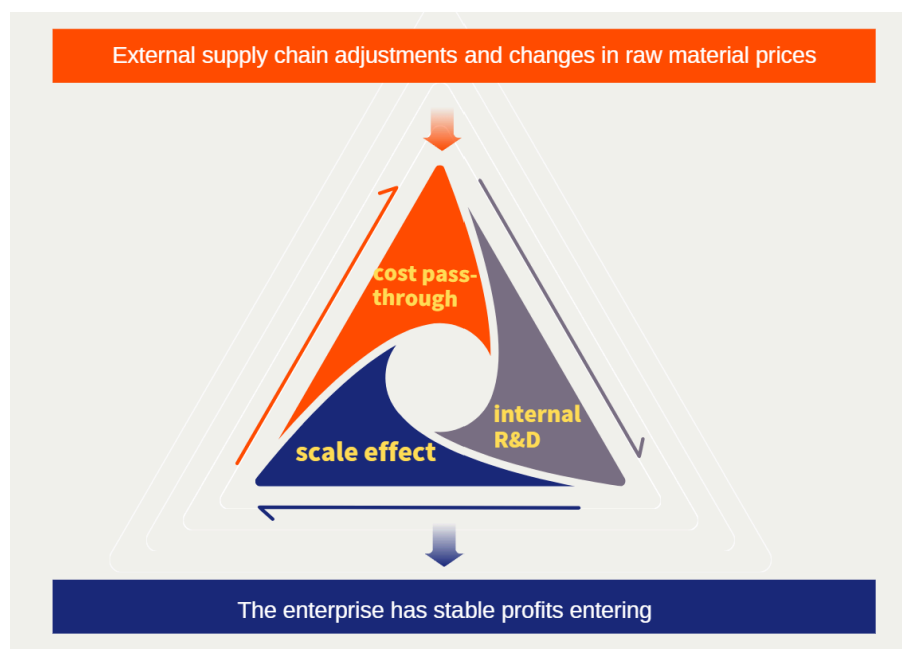


Figure 1. Three theoretical model transmission relationship diagrams

3. Date analysis

3.1. Price fluctuation analysis of core power battery raw materials

The price changes of power battery raw materials are the core external factors affecting the production cost of new energy vehicles [4]. This section selects three typical raw materials, namely

nickel, electrolytic cobalt and battery-grade lithium carbonate, and adopts quarterly average transaction data released by SMM from 2022 to 2025 to analyze the overall fluctuation characteristics and industrial cost impact. All data objectively reflect the changes of global market supply and demand and industrial capacity iteration, without involving sensitive geopolitical factors [7].

3.1.1. Price trend of nickel

Nickel prices operated at a high level in 2023, with the quarterly average price reaching 170,735 yuan per ton in the second quarter. Affected by the continuous release of global nickel industrial capacity and loose market supply, the price gradually declined in the second half of 2023, with the fourth-quarter average price falling to 139,443 yuan per ton. Throughout 2024, nickel maintained a low and volatile trend, with the annual quarterly average price decreasing quarter by quarter. In 2025, the market continued to bottom out, hitting a five-year low quarterly average price of 122,273 yuan per ton in the third quarter, and rebounded slightly at the end of the year. Overall, restricted by the long-term loose supply pattern of global nickel resources, nickel price has a moderate fluctuation range and limited rebound strength, forming a stable low-cost supply trend for downstream vehicle enterprises.

3.1.2. Price trend of electrolytic cobalt

Electrolytic cobalt prices showed obvious staged fluctuations from 2022 to 2025. In 2023, the price fluctuated between 213,500 yuan and 307,500 yuan per ton, reaching the annual peak in the third quarter. In 2024, driven by sufficient market supply and weak downstream demand, cobalt prices continued to decline, with the annual low price breaking 170,000 yuan per ton. In 2025, the market supply and demand structure reversed significantly. With the contraction of global commercial supply and the growth of demand for new energy and high-end manufacturing fields, electrolytic cobalt prices rose sharply, with the fourth-quarter average price surging by more than 150% compared with the 2024 low. The sharp reversal of cobalt price brings periodic cost pressure to new energy vehicle manufacturers.

3.1.3. Price trend of battery-grade lithium carbonate

Lithium carbonate, as the most core raw material of power batteries, has the most drastic price fluctuation and the strongest impact on the new energy vehicle industry. In the first half of 2023, the price remained at an ultra-high level, with the second-quarter average price as high as 308,130 yuan per ton, forming huge cost pressure on vehicle enterprises. Benefiting from the concentrated release of domestic and global lithium salt capacity, the price plunged cliff-like in the second half of 2023, dropping to 96,900 yuan per ton at the end of the fourth quarter. Throughout 2024, the price remained at a historically low level, with a narrow fluctuation range. In the second quarter of 2025, the price hit a five-year bottom of 59,900 yuan per ton, and then rebounded continuously with the recovery of downstream new energy vehicle market demand. The violent fluctuation of lithium carbonate price in the past four years directly leads to the obvious instability of manufacturing cost and profit space of global new energy vehicle enterprises.

3.1.4. Comprehensive summary of raw material price fluctuation

From 2022 to 2025, the three core battery raw materials have experienced a complete market cycle of high-price operation, capacity release and price bottoming, and staged recovery. The fluctuation range and driving factors of different raw materials are differentiated: lithium carbonate has the largest volatility and the strongest correlation with downstream vehicle manufacturing demand; electrolytic cobalt has a strong staged reversal driven by supply and demand restructuring; nickel has the most stable operation with small fluctuation amplitude. The overall fluctuating market of upstream raw materials forms a universal exogenous cost shock for the new energy vehicle industry, which is an uncontrollable external factor affecting the profitability of global vehicle enterprises [6].

3.2. Technological investment data analysis of representative NEV enterprises

Technological investment is a core controllable internal strategic variable for enterprises to hedge external cost risks. This section selects three typical multinational new energy vehicle enterprises, BYD (China), Tesla (United States), and Volkswagen New Energy (Germany), and adopts official annual financial report data from 2022 to 2025 to compare their R&D investment scale, investment intensity and operational characteristics. The core measurement indicators include annual R&D expenditure and R&D investment intensity (the proportion of R&D expenditure in operating revenue), which can intuitively reflect the technological innovation layout capability of different enterprises.

3.2.1. BYD's technological investment status

BYD has always maintained a high-intensity continuous R&D investment, with steadily growing R&D expenditure and increasing investment intensity year by year. According to BYD's official annual financial reports, the company's R&D expenditure reached 18.654 billion yuan in 2022, increased to 39.575 billion yuan in 2023, further rose to 53.195 billion yuan in 2024, and peaked at 57.978 billion yuan in 2025. Correspondingly, its R&D investment intensity continued to rise from 3.8% in 2022 to 7.89% in 2025. BYD focuses its R&D layout on blade battery technology, hybrid power system and intelligent manufacturing process optimization. Sustained high R&D investment helps the company realize independent control of core battery technologies and continuous technical cost reduction, forming a strong ability to hedge raw material price fluctuations.

3.2.2. Tesla's technological investment status

As a global leading intelligent new energy vehicle enterprise, Tesla maintains a stable high-level R&D investment scale. Converted by the annual average exchange rate, Tesla's annual R&D expenditure was about 21.8 billion yuan in 2022, 28.2 billion yuan in 2023, 32.2 billion yuan in 2024, and 45.4 billion yuan in 2025. Its R&D investment intensity remained stable at 4.5% to 5.2% during the study period. Tesla's R&D focus is on intelligent driving algorithms, 4680 battery technology and integrated die-casting production technology. Different from BYD's comprehensive industrial chain layout, Tesla's technological investment is more inclined to intelligent and manufacturing process innovation, which optimizes production efficiency and indirectly offsets raw material cost fluctuations.

3.2.3. Volkswagen new energy's technological investment status

Volkswagen New Energy, as a typical traditional fuel vehicle enterprise transforming to new energy, has a relatively low R&D investment level and slow technical iteration speed. From 2022 to 2025, its annual R&D expenditure increased moderately from 16.2 billion yuan to 24.8 billion yuan, with the R&D investment intensity always maintained at 2.9% to 3.2%. The overall investment scale and intensity are significantly lower than those of BYD and Tesla. Volkswagen's R&D layout is limited to the optimization of traditional vehicle electronic control systems, lacking independent core battery technology and innovative manufacturing processes [8, 9]. Insufficient technological investment leads to weak ability to respond to upstream raw material cost changes, resulting in long-term low profitability of its new energy vehicle business.

3.2.4. Comparative analysis of three enterprises' investment characteristics

By comparing the technological investment data of the three multinational enterprises, significant differentiated characteristics can be summarized. BYD has the largest R&D growth rate and the highest investment intensity, focusing on full-industry-chain technological breakthroughs with strong risk hedging ability [5]. Tesla has stable and high-quality R&D investment, focusing on intelligent manufacturing and algorithm iteration with balanced profit and innovation layout. Volkswagen New Energy has insufficient R&D investment and single technical direction, lacking core independent innovation capabilities [10, 11]. The differences in internal technological investment strategies directly lead to the differentiated profit performance of enterprises when facing the same external raw material price fluctuation, which verifies the regulatory effect of technological investment on corporate profitability [12].

4. Conclusion

4.1. Main findings

This paper takes global new energy vehicle manufacturers as research objects, and systematically analyzes the dual impacts of raw material price volatility and enterprise technological investment on corporate profitability based on cost transmission theory, technological innovation theory and sustainable profitability theory. Three core conclusions are drawn as follows.

First, the prices of lithium carbonate, electrolytic cobalt and nickel experienced dramatic periodic fluctuations from 2023 to 2026. Under the cost transmission mechanism, unstable upstream raw material costs continuously raise vehicle manufacturing expenses and form universal external cost pressure, which restricts the profit space of all new energy vehicle enterprises to varying degrees. Among the three raw materials, lithium carbonate presents the largest fluctuation range and exerts the most prominent cost impact on the industry.

Second, technological R&D investment is a controllable internal strategy to hedge raw material cost risks. By comparing the financial data of BYD, Tesla and Volkswagen New Energy, this paper finds that enterprises with sustained high-intensity R&D expenditure own stronger capacity of technical cost reduction and product differentiation. BYD and Tesla maintain higher R&D investment intensity and build independent core battery and manufacturing technologies, which effectively offset the negative impact of raw material price swings on profits. In contrast, Volkswagen New Energy has insufficient technological layout, lacking effective means to cope with upstream cost volatility, resulting in weak long-term profitability of its electric vehicle business.

Third, stable corporate profitability relies on the balanced coordination of external market changes and internal innovative layout. Raw material price fluctuation is an uncontrollable industrial factor, while reasonable long-term technological investment can weaken the profit suppression effect brought by cost shocks and help enterprises form sustainable profit resilience.

4.2. Management suggestions

In view of the above findings, targeted suggestions are proposed for new energy vehicle enterprises. For one thing, manufacturers should attach importance to long-term R&D layout, appropriately increase investment in battery material innovation and intelligent production technology, and rely on technological iteration to reduce the sensitivity of operating costs to raw material price changes. For another, enterprises need to formulate flexible R&D resource allocation plans, balance short-term operating expenditure and long-term technical accumulation, so as to maintain stable profit performance amid frequent upstream price fluctuations.

4.3. Limitations and future study

This paper only selects three typical transnational vehicle enterprises for comparative case analysis, without large-sample quantitative empirical test. It merely discusses lithium, cobalt and nickel and ignores other auxiliary battery raw materials, and adopts static annual data that cannot reflect the multi-year lag impact of R&D investment on profits. For future study, researchers can expand cross-border enterprise samples to build econometric models and quantify the hedging effect of technological investment. Scholars can also incorporate graphite and electrolyte into analysis to compare differentiated cost transmission intensity. Besides, continuous quarterly panel data can be used to measure the lag cycle of R&D risk buffer effects, and subdivide various R&D types to compare their abilities to resist raw material price shocks.

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