

Green Transition and Financial Performance: Evidence from Traditional Automobile Manufacturers in the European Union

Ruoyu Zhao

*Faculty of Business and Economic, Monash University, Melbourne, Australia
rzha0188@student.monash.edu*

Abstract. For major listed traditional automobile manufacturers in the European Union, green transition has moved from an emerging strategic choice to a necessary business transformation. This shift is mainly driven by increasingly strict carbon emission requirements and growing consumer acceptance of electrified mobility, which have pushed established carmakers to adjust their product structures, investment priorities, and long-term strategies. This study examines the association between electrification and financial performance among five major manufacturers from 2019 to 2024. Data are drawn from annual reports, vehicle delivery reports, and consolidated financial statements. Descriptive statistics, trend comparisons, and scatterplots are used to compare electrified vehicle sales share with operating profit margin, return on assets, and return on equity. Results show that higher electrification is generally associated with stronger operating margins and asset returns, while the relationship with shareholder returns is weaker. Firm-level patterns remain uneven, and continued growth in electrified sales does not always coincide with continuous financial improvement. Electrification may therefore support financial performance, but its value depends on how effectively the transition is integrated into wider business operations.

Keywords: Green Transition, Electrification, Automobile, Profitability

1. Introduction

For major listed traditional automobile manufacturers in the European Union, green transition is no longer merely an environmental commitment. It has become a transformation that affects industrial structure and financial decision-making. Environmental regulation and market transformation have increased pressure on incumbent carmakers to reduce emissions and adapt their business strategies toward electrification, while the expansion of electric vehicle demand has further changed market expectations for mobility [1, 2]. For incumbent manufacturers, the transition is more complex than launching new electric models. It requires adjustments in product portfolios, powertrain technology, production systems, supply chains, and capital allocation, while businesses based on internal combustion engine vehicles must still be maintained. Previous research has connected green innovation with firm performance and has discussed automobile electrification from perspectives

such as technology upgrading, policy pressure, employment effects, and market diffusion [3, 4]. However, much of this discussion focuses on environmental outcomes, industrial change, or innovation strategy rather than the direct financial consequences for listed traditional automobile groups [5, 6]. Whether electrification improves profitability and asset efficiency, or creates short-term pressure through research and development spending, capital expenditure, and restructuring costs, remains insufficiently clear. In this context, Volkswagen Group, BMW Group, Mercedes-Benz Group, Renault Group, and Stellantis are selected as five representative firms from 2019 to 2024. The analysis compares each firm's electrified vehicle sales share with return on assets (ROA), operating profit margin, and return on equity (ROE), using data analysis as the main method and comparative analysis as a supplementary method. This design offers firm-level evidence on how green transition may affect the financial performance of incumbent automobile manufacturers.

2. Literature review

2.1. Green transition and corporate financial performance

Green transition does not affect corporate financial performance through a single channel. The natural-resource-based view suggests that environmental capability may become a competitive resource when firms integrate environmental strategies into business operations [7]. Porter and van der Linde further argue that stricter environmental regulation can encourage innovation, improve resource efficiency, and promote product or process redesign [3].

However, this positive effect is not guaranteed. Ambec and Lanoie show that environmental improvement may influence firms through both revenue-related and cost-related channels [8]. Liao and Liu further find that the effect of environmental innovation varies across countries, industries, and data types [4]. Therefore, the relationship between green transition and financial performance should be understood as conditional rather than fixed.

2.2. Green transition in traditional automobile manufacturing

In automobile manufacturing, green transition is mainly reflected in electrification, which changes both vehicle products and production systems. For traditional European carmakers, the shift from internal combustion engine vehicles to electrified models requires adjustments in key areas such as product portfolios, powertrain technologies, and battery-related supply chains. Unlike new electric vehicle firms, incumbents must pursue electrification while maintaining fuel-vehicle businesses, commercial networks, and established brands. Electric vehicle demand has also become a central force in automobile transformation [2].

This complexity explains why existing studies often focus on the industrial consequences of electrification. Cotterman et al. show that the transition from conventional to battery electric vehicle powertrains changes automotive labor demand [5]. Pavlínek further examines how electric vehicle production reshapes European production networks and regional industrial positions [9]. These studies provide useful evidence on the production and industrial dimensions of automobile electrification.

2.3. Research gap and analytical focus

Taken together, previous studies have explained both the performance logic of green transition and the industrial consequences of automobile electrification. However, they provide less direct evidence

on whether electrification is associated with financial performance among listed traditional automobile manufacturers. This gap is important because incumbent carmakers face opportunities from electric vehicle demand while also bearing costs from technology investment and business restructuring. Therefore, this study focuses on whether electrified vehicle sales share is associated with return on assets, operating profit margin, and return on equity among major European traditional automobile groups.

3. Research design

3.1. Sample selection

This study selected five majors publicly listed traditional automakers headquartered in the European Union: Volkswagen Group, BMW Group, Mercedes-Benz Group, Renault Group, and Stellantis. These companies constitute the main sample for financial trend analysis; they are representative of the industry, and their official disclosures are traceable. Each company has a mature internal combustion engine business while continuously expanding its electric vehicle portfolio, allowing this study to observe financial changes under a dual business structure. The observation period covers 2019 to 2024, capturing the accelerated electrification process, external macroeconomic disruptions, and subsequent supply-chain and market fluctuations affecting the automotive industry. Due to differences in corporate disclosure practices, reporting availability, and operational conditions across companies and years, the dataset exhibits imbalance.

3.2. Data sources

Data are collected exclusively from annual reports, consolidated financial statements, vehicle sales or delivery reports, and official corporate websites [10-14]. Revenue, operating profit or earnings before interest and taxes, consolidated net income, total assets, and total equity are obtained from official financial disclosures. Electrified vehicle sales, total vehicle sales, and reported sales shares are drawn from official sales and delivery information. No third-party commercial database or external estimate is used.

Differences in vehicle classifications, geographic coverage, and reporting periods create missing or non-comparable observations. Such observations are retained as missing rather than supplemented or estimated. These source-selection and comparability rules determine how the study variables are defined and measured.

3.3. Variable measurement

Company-reported electrified vehicle sales share is used as a proxy for green transition. Because firms apply different definitions, the study follows each company's official disclosure rather than reconstructing a uniform measure from incomplete unit data. BMW Group and Volkswagen Group include battery electric and plug-in hybrid vehicles. Mercedes-Benz Group includes both categories for passenger cars but battery electric vehicles only for vans. Renault Group and Stellantis lack comparable group-level shares and are excluded from the main electrification-share analysis, although they remain in the financial trend analysis. The final electrification variable contains 14 firm-year observations from BMW Group, Mercedes-Benz Group, and Volkswagen Group.

Financial performance is measured by operating profit margin, return on assets, and return on equity. The calculation methods for these indicators are presented in Equations (1)-(3).

$$\text{Operating Profit Margin (\%)} = \frac{\text{Operating Profit or EBIT}}{\text{Revenue}} \times 100 \quad (1)$$

$$\text{Return on Assets (\%)} = \frac{\text{Consolidated Net Income}}{\text{Year-end Total Assets}} \times 100 \quad (2)$$

$$\text{Return on Equity (\%)} = \frac{\text{Consolidated Net Income}}{\text{Year-end Total Equity}} \times 100 \quad (3)$$

Operating profit margin reflects profitability from core business operations, return on assets measures the efficiency with which firms use their assets to generate earnings, and return on equity reflects the returns generated for shareholders. Together, the three indicators provide a broader assessment of operating profitability, asset efficiency, and shareholder returns.

3.4. Analytical methods

This study uses descriptive statistics, trend comparisons, and scatterplot analysis. Descriptive statistics are first used to summarise the sample size and distribution of the main variables. Financial performance trends are then compared across the five sampled firms, while electrified vehicle sales trends are examined using the available comparable data. Finally, matched observations are used to examine the relationships between electrified vehicle sales share and the three financial indicators. Given the small sample and differences in reporting scope, the results identify trends and preliminary associations rather than causal effects.

4. Results

4.1. Descriptive overview

The financial variables contain 27 to 28 firm-year observations, whereas electrified vehicle sales share contains 14 observations. The mean operating profit margin is 7.70%, ranging from -0.78% to 13.64%. Return on assets averages 3.18%, with values between -6.92% and 9.21%. Return on equity has a mean of 9.22% and shows the greatest variation, ranging from -31.60% to 25.23%. Electrified vehicle sales share averages 13.18%, with a minimum of 4.60% and a maximum of 24.20%. These results indicate substantial variation in financial performance across firms and years, particularly in shareholder returns.

4.2. Financial performance trends

Figures 1-3 jointly illustrate changes in operating profitability, asset efficiency, and shareholder returns among the five sampled automobile manufacturers from 2019 to 2024. Rather than showing three independent financial outcomes, the indicators reveal a common pattern in firms' financial resilience. Performance generally weakened around 2020, improved during 2021-2023, and declined again in 2024. However, the extent to which operating recovery translated into efficient asset use and shareholder returns differed substantially across firms.

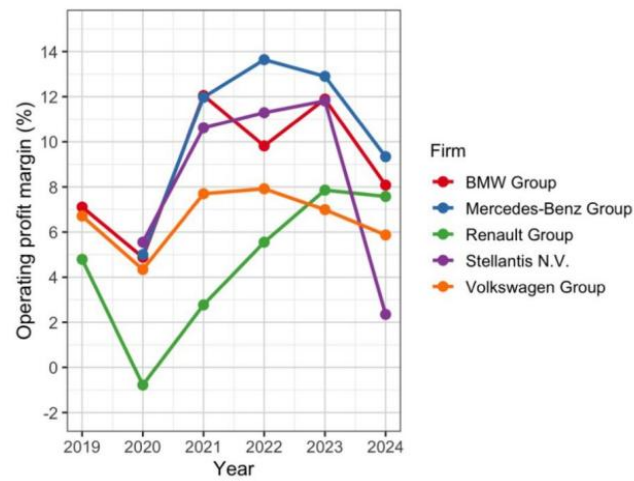


Figure 1. Operating profit margin trends of the sampled automobile manufacturers, 2019-2024

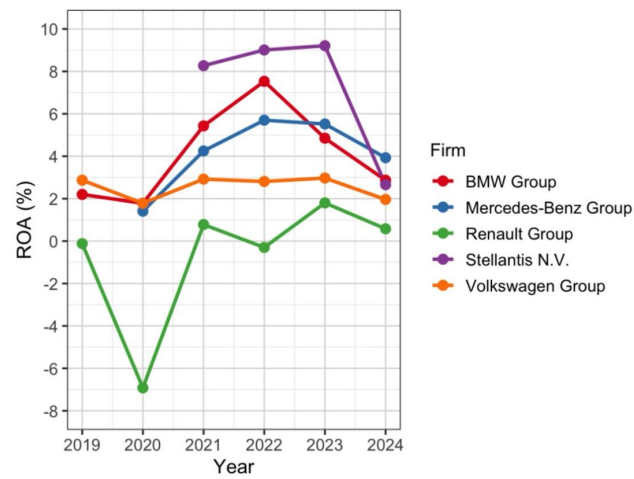


Figure 2. Return on assets trends of the sampled automobile manufacturers, 2019-2024

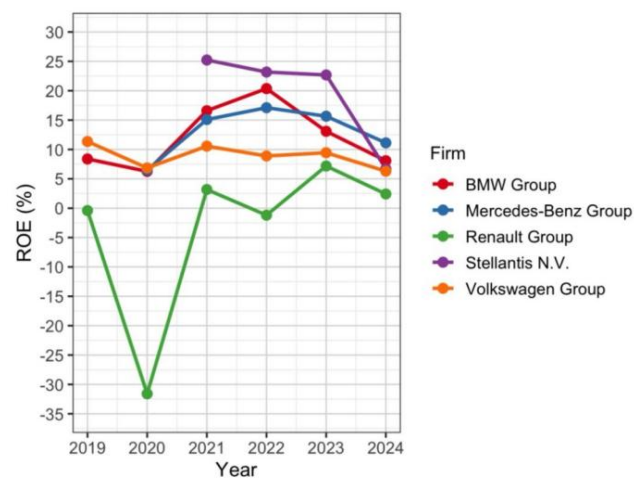


Figure 3. Return on equity trends of the sampled automobile manufacturers, 2019-2024

BMW Group and Mercedes-Benz Group showed relatively balanced post-2020 recoveries. Their operating margins increased strongly after 2020, while ROA and ROE also improved during the same period. This alignment suggests that improvements in core operating profitability were accompanied by stronger asset utilisation and shareholder returns. Nevertheless, the decline in all three indicators by 2024 shows that the earlier recovery did not produce continuously improving financial performance. These firms maintained stronger results than several other sampled manufacturers, but their financial positions were still exposed to changing operating conditions.

Stellantis displayed the strongest financial performance during 2021–2023. Its operating margin remained above 10%, while its ROA and ROE were also the highest or among the highest in the sample. The simultaneous strength of the three indicators indicates that the firm generated high operating profits while using its asset and equity bases efficiently. However, the sharp decline in operating margin, ROA, and ROE in 2024 reveals that this performance was not stable throughout the observation period. The result highlights an important distinction between achieving high profitability and maintaining financial resilience over time.

Renault Group followed a markedly different path. Its negative operating margin, ROA, and ROE in 2020 indicate that weak operating performance was accompanied by inefficient asset use and substantial losses to shareholders. Although its operating margin recovered steadily afterward, ROA and ROE remained relatively weak and volatile. This divergence suggests that improvements in operating activities did not immediately translate into equally strong overall returns. It also indicates that financial recovery may occur at different speeds across profitability, asset efficiency, and shareholder return measures.

Volkswagen Group showed less extreme variation than Renault or Stellantis. Its operating margin, ROA, and ROE generally remained within moderate ranges, indicating comparatively stable but less pronounced financial performance. This pattern suggests greater consistency, although it also shows that stability did not necessarily correspond to the strongest profitability or returns.

Taken together, the three figures identify three different financial patterns: balanced recovery for BMW and Mercedes-Benz, high but less stable performance for Stellantis, and weaker or more gradual recovery for Renault, while Volkswagen remained comparatively stable. ROE varied more widely than operating margin and ROA, indicating that shareholder returns were especially sensitive to changes in earnings and equity. Overall, the findings show that financial strength should not be assessed through profitability alone. A firm may achieve a high operating margin without maintaining equally stable asset efficiency or shareholder returns, making the combined evaluation of all three indicators necessary for understanding its financial capacity during green transition.

4.3. Electrified vehicle sales share trends

Figure 4 presents the company-reported electrified vehicle sales shares of BMW Group, Mercedes-Benz Group, and Volkswagen Group. Because the firms apply different vehicle classifications, the figure is used to identify broad transition patterns rather than provide a strictly uniform ranking. BMW and Volkswagen include battery electric and plug-in hybrid vehicles, while Mercedes-Benz applies a partly different reporting scope.

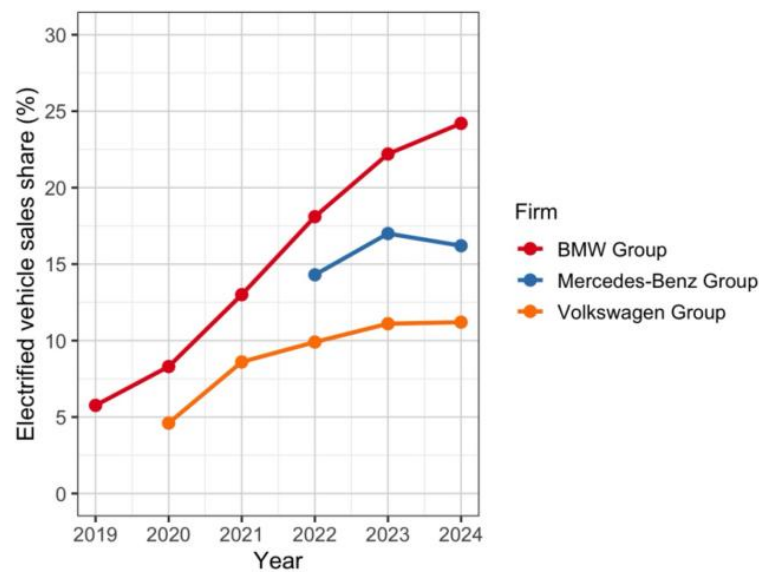


Figure 4. Electrified vehicle sales share trends of BMW Group, Mercedes-Benz Group, and Volkswagen Group, 2019-2024

Overall, electrified vehicles became an increasingly important part of the three manufacturers' sales structures, although the speed and continuity of transition differed. BMW showed the clearest and most sustained expansion, with its electrified vehicle sales share increasing from 5.76% in 2019 to 24.20% in 2024. This continuous rise indicates that electrification was progressively integrated into its wider product portfolio.

Volkswagen also achieved substantial growth, increasing from 4.60% in 2020 to 11.20% in 2024. However, growth became relatively limited toward the end of the period, suggesting a slower expansion after the initial increase. Mercedes-Benz reported a relatively high electrified share of 14.30% in 2022, rising to 17.00% in 2023 before declining slightly to 16.20% in 2024.

Taken together, the results show that electrification was advancing across the sampled manufacturers, but not through a uniform path. BMW demonstrated continuous acceleration, Volkswagen showed more moderate later-stage growth, and Mercedes-Benz maintained a comparatively high but slightly fluctuating share. These differences provide the basis for examining whether stronger electrification progress was accompanied by stronger financial performance.

4.4. Electrification and financial performance

Figures 5-7 show broadly positive relationships between electrified vehicle sales share and the three financial indicators. The association is clearer for operating profit margin and return on assets, while return on equity is more dispersed.

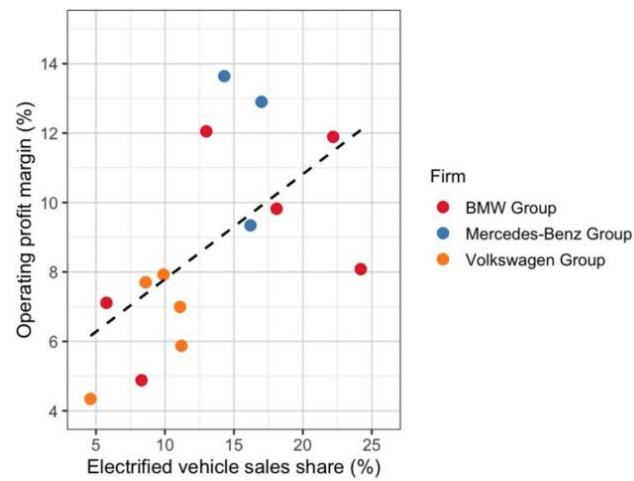


Figure 5. Relationship between electrified vehicle sales share and operating profit margin

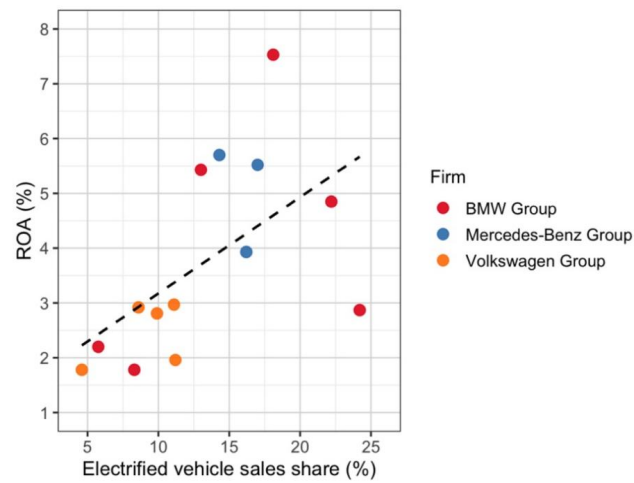


Figure 6. Relationship between electrified vehicle sales share and return on assets

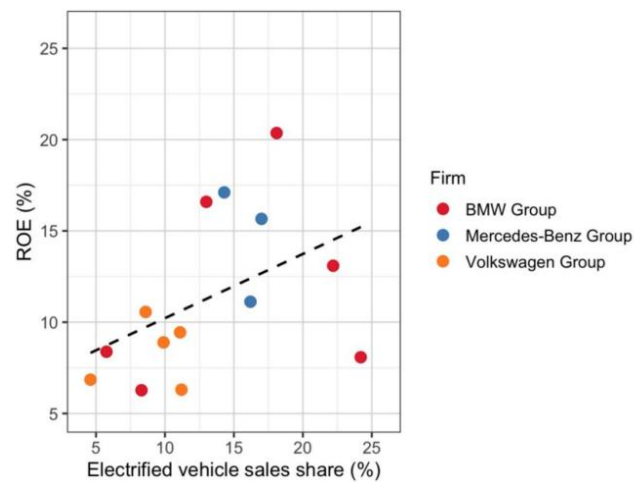


Figure 7. Relationship between electrified vehicle sales share and return on equity

BMW provides the clearest example of both the potential and limits of this relationship. Its electrified vehicle sales share increased continuously from 5.76% in 2019 to 24.20% in 2024, while its financial performance strengthened substantially after 2020. However, all three financial indicators declined in 2024 despite the continued increase in electrification. This indicates that rapid electrification can coexist with strong financial performance but does not by itself ensure continuous improvement.

Mercedes-Benz also combined a relatively high electrified share with strong operating margin, ROA, and ROE in 2022 and 2023. In 2024, both its electrified share and financial results weakened, suggesting that the financial outcome of the transition remained sensitive to broader business conditions. Volkswagen followed a more gradual electrification path and maintained comparatively moderate financial performance, showing greater consistency but lower returns than BMW and Mercedes-Benz in several observations.

Overall, Figures 5-7 show broadly positive associations between electrified vehicle sales share and financial performance, although the strength of the relationships differs across the three indicators. Operating profit margin and return on assets show clearer patterns, while return on equity is more dispersed. Firm-level outcomes also remain uneven across companies and years.

5. Discussion

5.1. Interpretation of the findings

The uneven firm-level patterns suggest that electrification is not a standalone source of financial advantage. Its financial outcome depends on whether manufacturers can convert electrified vehicle sales into sustainable margins while managing product development, production restructuring, battery sourcing, and distribution costs. This conditional pattern is consistent with previous empirical evidence suggesting that environmental capabilities contribute to competitive advantage and financial performance only when they are effectively integrated into firms' strategic operations [15].

Electrification may improve market positioning and provide access to expanding vehicle segments. At the same time, it may increase capital requirements and create short-term cost pressure. This dual-channel mechanism is consistent with previous evidence suggesting that environmental initiatives may create long-term competitive benefits while simultaneously imposing short-term implementation and operational costs [16]. The weaker relationship with return on equity further indicates that shareholder returns also depend on financing structures, equity levels, and other firm-specific conditions

5.2. Managerial implications

Managers should not assess green transition solely through the growth rate of electrified vehicle sales. A rising electrification share may demonstrate product transformation, but it does not automatically indicate stronger financial performance. The key issue is whether electrification is supported by efficient production, disciplined investment, appropriate pricing, and effective portfolio management.

Firms with stronger financial capacity may be able to accelerate electrification while absorbing high initial costs. Firms with weaker profitability may need to sequence investment more carefully and avoid expanding faster than their operating systems can support. The different patterns across BMW, Mercedes-Benz, and Volkswagen also imply that there is no single optimal transition speed.

A successful strategy should match the pace of electrification with the firm's technological capability, cost structure, market position, and capacity to generate stable cash flows.

Managers should therefore assess electrification together with financial outcomes rather than treat sales-share growth as a standalone target. A combined assessment can reveal whether stronger market adoption is being translated into sustainable profitability, efficient asset use, and shareholder value.

5.3. Research limitations

This study is limited by its small sample and uneven data coverage. The financial analysis includes five manufacturers, but the electrification analysis is restricted to BMW, Mercedes-Benz, and Volkswagen because comparable group-level data are unavailable for Renault and Stellantis. Company definitions of electrified vehicles also differ, reducing strict cross-firm comparability.

The observed relationships may also reflect market demand, production costs, supply-chain conditions, pricing strategies, and other firm-specific factors. Future research could extend the period, include more manufacturers, construct a more consistent electrification measure, and apply panel methods to separate within-firm changes from cross-firm differences.

6. Conclusion

Across the sampled manufacturers, electrification generally advanced during the observation period, while financial outcomes varied across firms and years. Higher electrified vehicle sales shares were often linked to stronger operating margins and better asset efficiency among firms with comparable data. Their relationship with shareholder returns was less stable. Firm-level patterns also differed. BMW and Mercedes-Benz combined relatively high electrification with stronger financial results in several years. Volkswagen followed a more gradual transition path and recorded more moderate outcomes. Even so, rising electrification did not lead to continuous financial improvement. BMW's electrified sales share continued to increase in 2024, while all three financial indicators declined. These results show that electrification can support financial performance, but sales growth alone is not enough. Firms also need effective cost control, disciplined investment, efficient asset use, and stable operations. Successful transition therefore depends on how well electrification is integrated into the wider business. Caution is still required when interpreting the findings. A small and unbalanced sample limits generalisation, and company reporting methods are not fully comparable. Future research should extend the study period, apply more consistent electrification measures, and use panel-data methods to separate changes within firms from structural differences across manufacturers.

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