Sales Competition Among Automakers: A Comparative Study

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This study investigates the intensity of competition among North American automakers to resolve a longstanding debate in the literature regarding rivalry within the industry. Using seasonally adjusted monthly sales data, we applied Vector Autoregressive (VAR) Regression, Seemingly Unrelated Regression (SUR), Impulse Response Functions (IRF), and Granger Causality tests to examine sales interdependencies. Contrary to traditional theory, which assumes fierce intra-group rivalry, our findings reveal moderate competition, unevenly distributed across firms, aligning more closely with multimarket competition or resource partitioning theories. Our study offers a practical understanding of the competition in the auto industry, enabling managers to make informed strategic decisions.

Keywords: Autoregressive Models, Time Series Regression, Multimarket Competition, Resource Partitioning.

1. Introduction

Competition in the automotive industry is a key driver of technological advancement, market expansion, and consumer choice. While rivalry is often perceived as a source of pressure, it can also stimulate innovation, improve organizational efficiency, and enhance customer value by motivating firms to continuously improve the quality of their products and services in order to maintain a competitive advantage (Porter, 1985; Aghion et al., 2005). Furthermore, Liu et al., (2026) demonstrates that in the short term, market competition can positively impact product diversity. Similarly, Baker, J. B. (2007) discusses how antitrust fosters innovation and how competition encourages firms to lower costs, improve quality, and develop better products. Understanding and leveraging competition can provide strategic advantages for businesses. For example, Fortsch, Choi, and Khapalova (2021) highlighted the potential benefits of leveraging competitors' sales data to enhance sales predictions, which helped mitigate challenges such as overstocking or under stocking expensive inventories.

Literature on rivalry dynamics within industries has traditionally focused on studying strategic groups. The concept of strategic groups was introduced by Hunt (1972) and later developed by Porter (1979; 1980). Conventional wisdom suggests

that the fiercest competition occurs within strategic groups, where firms are thought to resemble one another on key strategic dimensions (Cool & Dierickx, 1993; McNamara, Deephouse, & Luce, 2003; McGee & Thomas, 1986; 1992; Nair & Filer, 2003). This intense competition fosters innovation and encourages companies to enhance their effectiveness and efficiency to remain competitive (Dranove, Peteraf, & Shanley, 1998). Similarly, Choi, Choi, and Suresh (2024) emphasized that businesses in the same strategic group utilize similar tactics and face comparable external economic challenges, such as raw materials, production capacities, and customer bases. Consequently, these firms must closely monitor their competitors' actions, particularly sales performance, to make informed strategic inventory and supply management decisions.

Contrary to the intense view of rivalry, other perspectives explain moderate competition. For example, the multimarket competition theory suggests that when firms face the same competitors across multiple markets, they engage in mutual forbearance, recognizing that excessive competition in one area could provoke retaliatory actions elsewhere (Bernheim & Whinston, 1990; Karnani & Wernerfelt, 1985). From a different perspective, the resource partitioning theory indicates that firms tend to differentiate into distinct market segments as industries mature, thereby reducing direct rivalry by targeting specific consumer preferences (Carroll, 1985; Carroll & Swaminathan, 2000). Both theories suggest that automakers may specialize in distinct vehicles (e.g., mass-market sedans, luxury cars, electric vehicles) rather than competing solely on price and sales volume, which could lead to competitive coexistence rather than head-to-head rivalry. Based on these views, companies intentionally focus on specific customer niches, product segments, or geographic territories, resulting in moderate competition (Dranove, Peteraf, and Shanley, 1998). Viewing the firms' competitive behaviors as resulting from multimarket interactions (mutual forbearance) or market segmentation (resource partitioning) challenges the assumption of intense rivalry within a strategic group.

Contradictions in theories about how companies compete within the same market prompt this study to explore the intensity of competition among North American automakers, building upon the work of Shoesmith and Pinder (2001) and Aviv (2003), who evaluated how firms interact in a competitive landscape.

The objective of this study is to assess rivalry with empirical evidence rather than theoretical assumptions. Rather than simply determining whether rivalry exists, this study contributes by challenging the conventional assumption of uniformly intense competition within strategic groups and by uncovering asymmetrical competitive influence among major automakers. To examine the intensity of rivalry, we obtained seasonally adjusted domestic (North America and Canada) monthly sales data from the U.S. Automotive News database, covering the period from January 2009 to December 2019. We constructed Vector Autoregressive (VAR) regression, Seemingly Unrelated Regression (SUR) models, Impulse Response Functions (IRF), and Granger causality tests to understand the interdependencies in sales. Our study period is carefully selected to ensure a true understanding of competition without the variability introduced by the global COVID-19 pandemic.

The dataset includes five major automakers in the North American auto industry: General Motors (GM), Ford, Honda, Toyota, and Nissan. We excluded companies for which continuous data was not accessible during our study window or where

there were numerous missing observations. For instance, databases from some automakers like BMW and Volkswagen had significant gaps in coverage, while others contained too many missing entries to be considered for the period. To ensure the reliability of our findings, we decided to exclude these companies from our study. Time series data for GM, Ford, Honda, Toyota, and Nissan were consistently reliable throughout this study.

The remainder of this research is organized as follows: Section 2 offers a comprehensive review of the relevant literature; Section 3 outlines the research design and methodologies; Section 4 presents the results; Section 5 discusses the managerial implications; and Section 6 concludes the research while addressing the limitations.

2. Literature Review

For ease of reference and accessibility of this section, Table 1 summarizes the key studies and findings from the literature on competition and the automobile industry.

Table 1 *Summary of Literature on Competition and the Automobile Industry*

Theme	Key Findings	Representative Studies
Competition and Competitive Intensity	Competition drives firms to become more efficient by compelling them to reduce operational costs and improve product quality to sustain profitability. Competitive intensity increases when firms face more rivals and fewer growth opportunities. Competition is strongest among structurally equivalent firms and organizations occupying similar niches. Business ecosystems and network rivalry influence innovation outcomes.	Auh and Menguc (2005); Barnett (1997); Hannan and Freeman (1989); Galvin et al. (2020)
Pricing, Market Dynamics, and Competition in the Automobile Industry	Research has examined pricing promotion strategies, supply chain optimization, advertising effectiveness, product recalls, negative externalities, environmental policy competition, and market power within the automobile industry.	Busse, Simester, and Zettlmeyer (2010); Zeng, Dasgupta, and Weinberg (2016); Karabakal, Günal, and Ritchie (2000); Hu, Xiao, and Zhou (2014); Borah and Tellis (2016); Nagler (2014); Meckling and Nahm (2019); Grieco, Murry, and Yurukoglu (2021)
Multimarket Competition Theory and Mutual Forbearance	Firms competing across multiple markets may choose moderate rivalry to avoid destructive outcomes. The mutual forbearance hypothesis suggests that firms recognize their interdependence and refrain from aggressive competition. In the automobile industry, this may explain why automakers differentiate products rather than compete solely on price and sales volume.	Konduck (2018); Bernheim and Whinston (1990); Karnani and Wernerfelt (1985); Jayachandran, Gimeo, and Varadarajan (1999); Baum and Korn (1996); Evans and Kessides (1994); Parker and Roller (1997)
Resource Partitioning Theory	As industries mature, firms segregate into distinct market segments, reducing direct rivalry. Companies may intentionally target specific customer niches, product segments, or geographic markets to avoid head-to-head competition. Evidence supporting this theory has been found in wine, craft beer, and software industries.	Carroll and Swaminathan (2000); Fosfuri, Giarratana, and Sebrek (2020); Swaminathan (2001); Mezias and Mezias (2000); Swaminathan (1995)

Auto Industry Research and Pricing Strategy	Previous automobile industry studies have examined pricing strategies, market power, advertising effectiveness, and product innovation.	Busse, Simester, and Zettlmeyer (2010); Grieco, Murry, and Yurukoglu (2021); Hu, Xiao, and Zhou (2014); Pichler et al. (2021)
Research Gap	Is there empirical evidence that competition among the five major North American automakers is characterized by intense rivalry or moderated competition, as reflected in the interdependencies of their sales performance?	Current study

3. Research Design and Methodologies

3.1 Research Hypothesis

Studying the company's sales data is essential for determining the intensity of competition. This research investigates whether all firms in the auto industry compete with similar intensity. However, analyzing one company's sales performance does not provide vital information about its rivalry or the intensity of competition. The interconnections among companies' sales offer a more sophisticated approach to measuring competition intensity. Consider a scenario where GM misestimates its sales due to its competitors over- or underperforming. This situation could significantly impact GM's available on-hand inventory, not based on the company's own sales predictions, but as a result of its competitors' performance. In such cases, it is advisable to use models that incorporate competitors' sales information. Thus, we used time series data to measure the degree of sales interdependence among five major automakers: General Motors (GM), Ford, Honda, Toyota, and Nissan. If significant connections in sales exist among automakers, it would indicate intense rivalry, supporting the traditional strategic group competition model. Conversely, if weaker sales interdependencies are identified, it suggests that firms either follow the mutual forbearance or resource partitioning theories. Furthermore, utilizing the sales data, we examine the duration of a competitive move and the speed of competitors' responses. Based on the above theoretical frameworks, we propose the following hypothesis:

H1: Competition among major North American automakers is moderate rather than intense, as measured by sales interdependencies.

While both multimarket competition and resource partitioning provide theoretical explanations for moderated rivalry, this study does not attempt to isolate these mechanisms directly. Instead, we use these theories as alternative interpretive frameworks for explaining observed sales interdependencies.

3.2 Data

Data for this study were obtained from U.S. Automotive News and cover the period from January 2009 through December 2019 for General Motors (GM), Ford, Honda, Toyota, and Nissan. This timeframe was intentionally selected to represent the pre-pandemic period and to avoid the disruptions and abnormal market conditions associated with the COVID-19 pandemic. Because the primary objective of this study is to examine the intensity of rivalry within a strategic group based on sales performance, excluding the pandemic period helps reduce noise arising from government shutdowns, supply chain disruptions, and other extraordinary events that could distort competitive relationships among automakers.

In addition, we chose not to include post-pandemic observations because the available data did not provide a sufficiently long time series to support robust panel data analysis. Including a shorter post-pandemic period could reduce the reliability of the statistical tests and increase the likelihood of estimation errors. Therefore, the 2009–2019 period was selected to provide a consistent and adequately sized dataset for examining competitive rivalry among the five major North American automakers.

The Automotive News Data Center is a subscription-based database that provides historical and current automobile sales statistics for automakers and dealers. Researchers can obtain the data by visiting the website (https://www.autonews.com/data-center/). The data is filtered by manufacturer's reporting period. Because access to the Automotive News Data Center requires a paid subscription, the data are not publicly downloadable without authorization from Automotive News.

The Automotive News Data Center contains a wide range of industry variables, including sales, inventory, and production data. However, data availability and completeness vary across automakers, which can limit their suitability for panel data and time-series analyses. During the data collection process, we found that some manufacturers, such as BMW and Mercedes-Benz, had several missing observations in their North American sales records. Other automakers also lacked the continuous series of observations required for reliable time-series analysis. In addition, the availability of certain data may lag by several years depending on the company. Hence, to ensure a balanced panel dataset with sufficient observations throughout the study period, we selected above mentioned five major automakers. These firms are widely recognized as key competitors within the North American automobile market and provided the most complete and consistent sales data for the period examined in this study.

Another important consideration is that the database includes variables measured at different geographic scopes, such as domestic sales, worldwide inventory, and domestic production. While these additional variables provide valuable opportunities for future research, researchers should exercise caution when combining them because they do not always correspond to the same market coverage. For example, Figure 1 illustrates the data available through the database, where the term "domestic sales" refers to North American automobile sales. As shown in the figure, some variables are available only at the worldwide level (e.g., worldwide inventory), while others are reported only at the domestic level (e.g., domestic sales). Therefore, comparable measures are not always available across all categories. For instance, worldwide inventory data are available, but corresponding worldwide sales and worldwide production data are not consistently reported. As a result, researchers may encounter difficulties when attempting to integrate sales, inventory, and production variables into a unified analytical framework.

Despite these limitations, the Automotive News Data Center remains a valuable source of automobile industry data. The database provides extensive historical information on major automakers and auto dealers and offers researchers access to data that can be obtained through a relatively modest subscription fee.

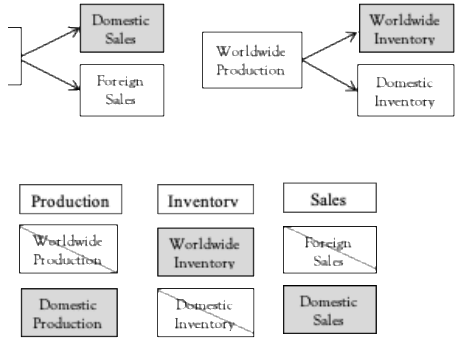


Figure 1 *The Automotive News Website Database's available Data Includes the units of sales, inventory, and production for the shaded boxes but not for the clear ones. This study utilizes domestic sales. The term 'domestic sales' in this database refers to auto sales in the United States and Canada.*

3.3 Methodologies

The most common methodologies for analyzing interconnected variables in econometrics are Vector Autoregressive Regression (VAR) and Seemingly Unrelated Regression (SUR) models. In the context of competition, VAR and SUR can model how one firm's sales performance influences others over time, enhancing our understanding of competitive dynamics in greater detail. VAR is ideal for grasping dynamic interdependencies and the impact of time-lagged variable effects among competing firms, while SUR offers more efficient estimation in the presence of cross-sectional correlations, making it helpful for examining simultaneous strategic interactions among firms. Together, these models provide valuable insights into the intensity of competition.

The structural form of VAR regression is $Y_{kt} = \beta_{k0} + \beta_{k,t-1}S_{t-1} + \beta_{k,t-1}S_{t-2} + u_k$, where Y_{kt} is the estimate of sales units for company k at time t. We used companies' initials for k (i.e., F, G, H, N, T for Ford, GM, Honda, Nissan, and Toyota, respectively). The term u_k refers to the errors in the sales estimates for company k. The reduced form of the VAR equations is displayed in equations 1.1 through 1.5 for all companies. We included two lagged sales, t-1 and t-2, using the company's previous month's sales and the month before that, because the preliminary results showed that any previous sales data beyond t-2 was insignificant.

$$GM: Y_{Gt} = \beta_{G,0} + \beta_{G,t}S_{t-1} + \beta_{G,t-1}S_{G,t-2} + u_G \quad \text{Eq. 1.1}$$

$$Ford: Y_{Ft} = \beta_{F,0} + \beta_{F,t}S_{t-1} + \beta_{F,t-1}S_{F,t-2} + u_F \quad \text{Eq. 1.2}$$

$$Honda: Y_{Ht} = \beta_{H,0} + \beta_{H,t}S_{t-1} + \beta_{H,t-1}S_{H,t-2} + u_H \quad \text{Eq. 1.3}$$

$$Toyota: Y_{Tt} = \beta_{T,0} + \beta_{T,t}S_{t-1} + \beta_{T,t-1}S_{T,t-2} + u_T \quad \text{Eq. 1.4}$$

$$Nissan: Y_{Nt} = \beta_{N,0} + \beta_{N,t}S_{t-1} + \beta_{N,t-1}S_{N,t-2} + u_N \quad \text{Eq. 1.5}$$

SUR equation systems differ from VAR in the way that the right-hand side includes exogenous variables; thus, we can better identify the key causal factors impacting the company's sales. In this system of regression equations, a company's sales is the dependent variable on the left side, while the competitors' sales are represented as independent variables on the right. A general form of SUR regression is $Y_{kt} = \beta_0 + \beta_{k,t}S_{k,t} + \beta_{k,t-1}S_{k,t-1} + u_k$. Due to the complexity of the SUR equation, we only use the time t and t-1 (skipping t-2). The reduced form of the SUR model is as follows.

$$GM: Y_{kt} = \beta_{G,0} + \beta_{F,t}S_{F,t} + \beta_{H,t}S_{H,t} + \beta_{T,t}S_{T,t} + \beta_{N,t}S_{N,t} + \beta_{G,t-1}S_{G,t-1} + \beta_{F,t-1}S_{F,t-1} + \beta_{H,t-1}S_{H,t-1} + \beta_{T,t-1}S_{T,t-1} + \beta_{Nt-1}S_{N,t-1} + u_G \quad \text{Eq. 2.1}$$

$$Ford: Y_{kt} = \beta_{F,0} + \beta_{G,t}S_{G,t} + \beta_{H,t}S_{H,t} + \beta_{T,t}S_{T,t} + \beta_{N,t}S_{N,t} + \beta_{G,t-1}S_{G,t-1} + \beta_{F,t-1}S_{F,t-1} + \beta_{H,t-1}S_{H,t-1} + \beta_{T,t-1}S_{T,t-1} + \beta_{N,t-1}S_{N,t-1} + u_F \quad \text{Eq. 2.2}$$

$$Honda: Y_{kt} = \beta_{H,0} + \beta_{G,t}S_{G,t} + \beta_{F,t}S_{F,t} + \beta_{T,t}S_{T,t} + \beta_{N,t}S_{N,t} + \beta_{G,t-1}S_{G,t-1} + \beta_{F,t-1}S_{F,t-1} + \beta_{H,t-1}S_{H,t-1} + \beta_{T,t-1}S_{T,t-1} + \beta_{N,t-1}S_{N,t-1} + u_H \quad \text{Eq. 2.3}$$

$$Toyota: Y_{kt} = \beta_{T,0} + \beta_{G,t}S_{G,t} + \beta_{F,t}S_{F,t} + \beta_{H,t}S_{H,t} + \beta_{N,t}S_{N,t} + \beta_{G,t-1}S_{G,t-1} + \beta_{F,t-1}S_{F,t-1} + \beta_{H,t-1}S_{H,t-1} + \beta_{T,t-1}S_{T,t-1} + \beta_{N,t-1}S_{N,t-1} + u_T \quad \text{Eq. 2.4}$$

$$Nissan: Y_{kt} = \beta_{N,0} + \beta_{G,t}S_{G,t} + \beta_{F,t}S_{F,t} + \beta_{H,t}S_{H,t} + \beta_{T,t}S_{T,t} + \beta_{G,t-1}S_{G,t-1} + \beta_{F,t-1}S_{F,t-1} + \beta_{H,t-1}S_{H,t-1} + \beta_{T,t-1}S_{T,t-1} + \beta_{N,t-1}S_{N,t-1} + u_N \quad \text{Eq. 2.5}$$

In the above equations, both VAR and SUR, the OLS matrices are used to compute the regression coefficients, where the procedures are related to variables and their beta coefficients.

$$\begin{bmatrix} Y_{Gt} \\ Y_{Ft} \\ \vdots \\ Y_{Nt} \end{bmatrix} = \begin{bmatrix} S_{G,t_i} \\ S_{F,t_i} \\ \vdots \\ S_{N,t_i} \end{bmatrix} \begin{bmatrix} \beta_{G,t_i} \\ \beta_{F,t_i} \\ \vdots \\ \beta_{N,t_i} \end{bmatrix} + \begin{bmatrix} u_G \\ u_F \\ \vdots \\ u_N \end{bmatrix} = (S)\ B + U$$

3.4 Econometric Tests to Validate Results

Since our dataset is a time series, various econometric tests must be performed to ensure the accuracy of the results, for which we utilized STATA software. First, we examined the normality of the data distribution using the Jarque-Bera test (the JB test). The JB test is a valuable tool for assessing the normality of data by examining its skewness and kurtosis and comparing these to what would be expected in a normal distribution, using the maximum likelihood function (Hamilton, 1994). The null hypothesis signifies that the data is normally distributed, while the alternative hypothesis rejects its normality. Similarly, it is reasonable to conduct the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (Dickey & Fuller, 1979; Phillips & Perron, 1988) to find evidence of autocorrelation and unit root problems (Hamilton, 2014).

Table 1a indicates that *a unit root is present* before taking the first difference of the obtained data, *as the values of the test statistics are smaller than the critical values*. Hence, it is inadvisable to trust the regression output because a 'random walk' exists. Consequently, we took the first difference in the data to address the unit root problem. Table 1b shows that *after taking the first difference, the unit root issue disappears, showing the values of the test statistics now greater than the critical values*. Furthermore, we confirmed this with the ADF and PP tests, both of which produced the same outcome.

Table 1a. *Results of the ADF (Augmented Dickey-Fuller) Test before Taking the First Differenced of the Sales Data.*

Company Sales	Test Statistics	Critical Value 5%
GMS	1.077	7.919
FS	0.652	7.920
TS	0.487	7.900
HS	0.629	7.199
NS	0.243	7.812

The next test is to validate the accuracy of our results by conducting stability tests on the VAR and SUR outcomes after performing the regression. Figures 2a and 2b show that all eigenvalues fall within the unit circle, indicating that our regression output is reliable.

Table 1b *Results of the ADF (Augmented Dickey-Fuller) Test after Taking the First Differenced of the Sales Data.*

Company Differenced Sales	Test Statistics	Critical Value 5%
GMSd	60.644	7.918
FSd	24.742	7.919
TSd	48.203	7.188
HSd	46.821	7.998
NSd	28.499	7.918

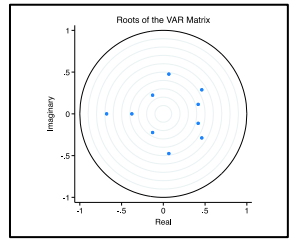


Figure 2a *VAR Stability Graph: The Eigenvalues are inside the Unit Circle, Indicating that the Results can be Trusted.*

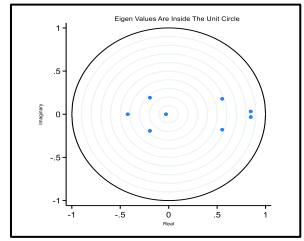


Figure 2b *SUR Stability Graph: The Eigenvalues are inside the Unit Circle, Indicating that the Results can be Trusted.*

4. Results and Discussions

The primary objective of this study is to measure the intensity of rivalry within the North American automobile industry. Although firms' strategic decisions are often not directly observable, their outcomes are frequently reflected in market performance indicators such as sales. Sales capture the market's response to a firm's product offerings, pricing strategies, promotional activities, and distribution efforts, making them a useful proxy for evaluating competitive performance. Changes in sales can signal shifts in competitive advantage, consumer preferences, or the effectiveness of strategic initiatives. Likewise, comparing sales performance across firms within the same industry can provide insight into competitive dynamics and market positioning.

While sales data alone cannot fully reveal the strategic decisions made by firms, they offer valuable evidence of how those strategies perform in the marketplace. Accordingly, this study focuses on the monthly sales of five major automakers—GM, Ford, Honda, Toyota, and Nissan—which provided continuous time-series data for the North American market (United States and Canada). The findings are presented in two sections: VAR results & discussions and SUR results & discussions.

4.1 VAR Results

By utilizing the VAR model, we examined the interrelationships among the sales of five competing automakers (Equations 1.1 through 1.5). The results, summarized in Table 2, indicate that the Root Mean Square Errors (RMSEs) for all companies improved by combining the sales into a VAR system of equations rather than using a single equation for each company (AR, autoregressive models). The RMSE for GM using AR regression was 45,024, but it decreased to 41,817 when we employed VAR regression, representing an improvement of 7 percent. Ford's RMSE improved from 32,076 to 28,340, Honda's from 19,670 to 18,685, Toyota's from 29,872 to 27,915, and Nissan's from 17,819 to 15,895 units. With low regression errors, we can infer that VAR regressions produce more successful outcomes than AR regressions. The improvement in regression error implies that competitors' monthly sales are indeed interrelated and that these companies might be competing for sales. However, the slight improvement in RMSEs (ranging from 5% to 12% across the companies) suggests that intense competition is not evident, at least when analyzing the companies' sales using VAR models. On the other hand, the improvements in R^2 values were more significant, ranging from 12% to 40% (Table 2). For example, we

observed that GM's R^2 value increased from 0.63 to 0.70, reflecting a 12% improvement. The R^2 for Ford rose from 0.51 to 0.64, Honda from 0.29 to 0.49, Toyota from 0.37 to 0.49, and Nissan from 0.30 to 0.49. Across the board, the R^2 values increased from 12% to 40%. Therefore, the results in Table 2 suggest that including the competitor's sales could enhance the coefficient of determination, with a minimum improvement for GM and a maximum for Honda.

Table 2 *Ar (Individual Firms) Versus Var (Combined Firms) Regressions Outcome.*

Automaker	GM	FORD	HONDA	TOYOTA	NISSAN
RMSE (AR)	45,024	32,076	19,670	29,872	17,819
RMSE (VAR)	41,817	28,340	18,685	27,915	15,895
Improvement	7%	12%	5%	7%	11%
R^2 (Single Firm)	0.6333	0.5119	0.2930	0.3734	0.3058
R^2 (VAR)	0.7077	0.6451	0.4904	0.4953	0.4907
Improvement	12%	20%	40%	24%	37%

Nevertheless, R^2 indicates the proportion of variance explained by the model; thus, the regression error, RMSE, may be a better indicator of whether these companies' sales influence one another. However, the slight improvement in RMSE implies that the sales of one company may not affect the sales of another, even when they are in the same industry. These results contradict conventional wisdom regarding fierce competition in the auto industry, indicating a weak or moderate rivalry among the firms, thus supporting our hypothesis.

Table 3 *Var Regression Outcome: The Beta Coefficients and P-Values.*

Sales	GM	FORD	HONDA	TOYOTA	NISSAN
GM	**0.5769 (0.000)***	0.6662 (0.004)*	-0.8522 (0.049)*	0.4409 (0.190)	-0.2811 (0.403)
FORD	0.1929 (0.026)*	**0.4972 (0.003)***	-0.5828 (0.047)*	-0.9277 (0.678)	0.1206 (0.586)
HONDA	-0.5422 (0.334)	-0.1951 (0.058)	**0.3300 (0.007)***	0.3896 (0.792)	0.01746 (0.907)
TOYOTA	0.3145 (0.713)	0.1155 (0.045)*	-0.6315 (0.028)*	**0.5832 (0.008)***	-0.3211 (0.883)
NISSAN	-0.9312 (0.051)*	0.2004 ((0.022)*	-0.4322 (0.008)*	0.2758 (0.031)*	**0.6117 (0.000)***

VAR Model's Beta Coefficients are Bolded for the Company's Own Previous Sales.
* The Variable is Significant at the 5% level.

After examining the regression errors and R^2 values, we then analyzed the beta coefficients. Table 3 presents the variations in beta coefficients and their p-values among automakers. Table 3 highlights that while VAR analysis is essential for capturing rivalry among members of a strategic group, it is evident that not all companies compete equally in sales. First, many variables were insignificant at the 95% level (p-value greater than 0.05). Second, we observed some irregularities;

while Nissan's sales, for example, did not impact the sales of other companies (Table 3, far right column), the company's sales were significantly influenced by others (Table 3, bottom row). On the other spectrum, Honda's sales were not affected by competitors (third row), but they impacted competitors' sales (third column). One might conclude that Honda is a major player, influencing all sales, while Nissan is the opposite. Further analysis of the impulse response function in the next section suggests no evidence of intense rivalry among the strategic group.

The impulse response function (IRF) traces the effect of a one-time shock (any unexpected change, i.e., price change, innovation, etc.) from one variable on other variables (current and future). The primary goal of an IRF is to quantify a shock and its duration over time. It illustrates the time path of the impact—how long the effect lasts and whether it strengthens, diminishes, or reverses over time. The IRF can be particularly useful for examining rivalry among competitors within the same strategic group. If we believe that the members of a strategic group compete fiercely, we must anticipate that the IRF will show a significant impact that lasts for a while.

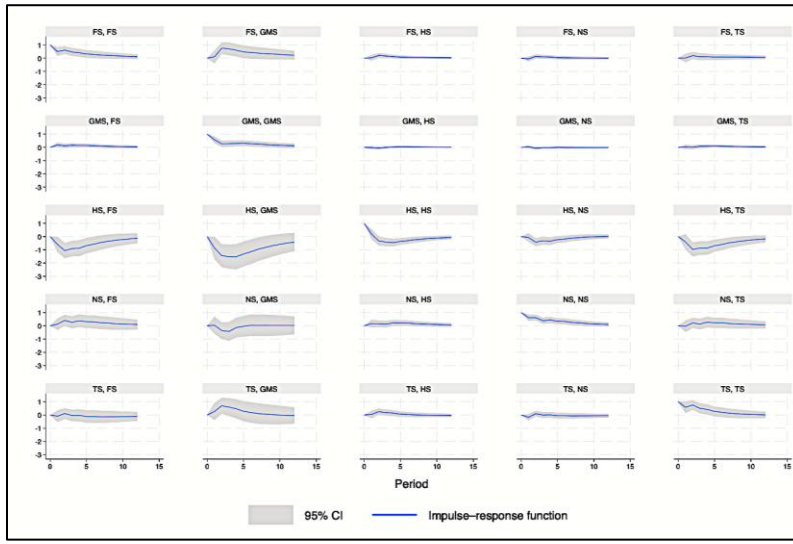


Figure 3 *The Impulse Response Function for Five Automakers.*

The impulse response function might be surprising if we assume fierce competition exists within the auto industry, but it becomes less surprising given our VAR regression, which indicated moderate competition. Figure 3 displays the IFR graphically. The first row represents Ford, the second GM, with the remainder being Honda, Nissan, and Toyota, respectively. To interpret the graph, the first row and first column indicate the impact of unexpected changes in Ford's sales on its own sales predictions. The gray area illustrates the disturbance in prediction (increase in the error of the sales forecast). We begin with the first row and read from left to right. The second, third, fourth, and fifth columns of the first row indicate the impact on GM, Honda, Nissan, and Toyota, respectively. For instance, if an unexpected shock occurs in Ford's sales (first row), GM's sales prediction would be affected,

while the sales predictions for the other automakers would remain unchanged because only GM (the second column) shows an increase in the gray area.

By monitoring the columns in Figure 3, we discover that changes in any automaker's sales predictions impact GM's sales predictions (second column). Hence, we can conclude that GM's sales predictions are sensitive to competitors' sales, but the company's sales do not affect competitors' sales predictions. This is evidenced by the gray area (errors in predictions) increasing in the second column, which illustrates the influence of competitors' sales on GM's sales, while it remains unchanged in the second row, indicating the impact of GM's sales on others. Additionally, it's important to note that the IRF shows prediction/estimation errors. Therefore, we cannot say whether the sales quantities are ever impacted, but we can affirm that the sales predictions become inaccurate. We also cannot determine the direction of the prediction errors.

So, what's the conclusion after studying VAR regression and IRF output? We believe that Table 3 and Figure 3 raise doubts about a fierce rivalry among members of the same strategic group. However, some competition must exist, as Table 2 suggested, signifying that VAR methodology outperformed the AR regression. Ultimately, we can conclude that there is evidence to support our hypothesis, stating the existence of moderate competition.

4.1.1 VAR Discussion

The VAR and IRF results provide several important insights into the nature of competition among major North American automakers. First, the improvement in model performance when moving from individual AR models to the VAR framework indicates that competitors' sales are not entirely independent. The inclusion of rival firms' sales improved both RMSE and R^2 values across all automakers, suggesting that sales performance contains information about competitors' behavior. This finding supports the notion that firms within the studied strategic group monitor and respond to one another. However, the relatively modest reduction in RMSEs, ranging from 5% to 12%, suggests that these interdependencies are limited in magnitude. While competitors' sales contribute to explaining variation in sales performance, the influence does not appear strong enough to indicate intense rivalry.

These findings are consistent with the multimarket competition literature and the mutual forbearance hypothesis. Rather than engaging in direct and aggressive competition, automakers may recognize their interdependence and avoid actions that could trigger retaliatory responses from rivals. Such behavior would be expected to reduce the degree to which one firm's sales directly affect another's sales, resulting in the moderate interdependencies observed in the VAR model. The results therefore suggest that rivalry exists, but it is more restrained than traditional views of fierce automobile competition would imply.

The beta coefficients further support this interpretation by demonstrating that competitive influence is not evenly distributed among firms. Honda appears to occupy a unique position within the studied strategic group, as its sales affect competitors while remaining relatively unaffected by them. In contrast, Nissan appears to be more susceptible to competitors' actions while exerting limited influence on rival firms. These asymmetries suggest that firms within the same

strategic group do not necessarily possess equal competitive power. Instead, differences in brand strength, market positioning, customer loyalty, and product portfolios may allow some firms to shape market outcomes more effectively than others.

The impulse response analysis provides additional evidence against the existence of intense rivalry. If competition were highly aggressive, unexpected shocks to one automaker's sales would be expected to generate substantial and persistent effects on competitors. However, the IRF results reveal relatively limited spillover effects across firms. Although certain automakers, particularly GM, appear sensitive to changes in competitors' sales predictions, these effects are neither widespread nor persistent. The absence of strong and long-lasting responses suggests that unexpected market changes affecting one firm do not substantially alter the sales trajectories of other firms within the strategic group.

Taken together, the VAR and IRF findings challenge the common assumption that automakers compete in a highly aggressive, zero-sum environment. Although competition clearly exists, the evidence suggests that firms are able to maintain a degree of strategic independence. This observation is also consistent with the resource partitioning perspective, which argues that firms reduce direct rivalry by differentiating products and targeting distinct market segments. The wide variety of vehicles offered by major automakers—including compact cars, trucks, SUVs, luxury vehicles, and electric vehicles—may reduce direct head-to-head competition and help explain why sales interdependencies remain relatively modest.

Overall, the evidence indicates that competition among the five major North American automakers is best characterized as moderate rather than intense during the studied period. The VAR model demonstrates that sales are interconnected, but the magnitude of these relationships is limited. The beta coefficients reveal uneven competitive influence among firms, while the impulse response analysis shows little evidence of strong or persistent competitive shocks. Collectively, these findings support the study's hypothesis and suggest that competition within this strategic group is shaped by product differentiation, market segmentation, and strategic coexistence rather than by direct and aggressive rivalry.

4.2 SUR Results

The SUR equations were listed from equations 2.1 through 2.5. The difference between the VAR regression and SUR lies in the inclusion of exogenous variables. Again, we begin by analyzing the RMSE and R^2. Table 4 displays the outcomes of the SUR. We observed that the RMSE for Ford, GM, Honda, Toyota, and Nissan were 15,210, 29,163, 8,338, 11,167, and 11,181, respectively. Although all R^2 values are high, the highest R^2 belonged to Toyota at 0.9, while the lowest was for Nissan at 0.72. A comparison of VAR and SUR is presented in Table 5. The SUR methodology significantly improved the regression errors. Table 5 confirms that utilizing SUR can reduce the regression errors for GM, Ford, Honda, Toyota, and Nissan by 30, 46, 55, 60, and 30 percent, respectively. The R^2 values also improved; the highest change was observed for Toyota, with a 60 percent increase, while the lowest increase was tied between GM and Nissan, with a 30 percent increase for each.

Table 4 *The SUR Results.*

Equation	RMSE	R^2	Chi^2	$P(Chi^2)$
GM	29,163	0.8437	8ac9	0.000
Ford	15,210	0.8885	1,323	0.000
Honda	8,338	0.8710	1,081	0.000
Toyota	11,167	0.9110	1,676	0.000
Nissan	11,181	0.7223	406	0.000

Table 5 *Var and Sur Comparison.*

Automaker	GM	FORD	HONDA	TOYOTA	NISSAN
RMSE (VAR)	41,817	28,340	18,685	27,915	15,895
RMSE (SUR)	29,163	15,210	8,338	11,167	11,181
Improvement	30%	46%	55%	60%	30%
R^2 (VAR)	0.7077	0.6451	0.4904	0.4953	0.4907
R^2 (SUR)	0.8437	0.8885	0.8710	0.9110	0.7223
Improvement	19%	27%	43%	84%	47%

Another noticeable change was the improvement in variable significance in the SUR. We discovered that some variables that were not significant in VAR regression became significant in the SUR, implying 'simultaneous' rivalry. Therefore, the SUR could capture a more intense rivalry among competitors in the same strategic group than VAR regression could detect. On the other hand, the comparison of Tables 2, 3, and 5 and Figure 3 indicate that we must conclude that moderate rivalry exists, in support of our hypothesis.

4.2.1 Sur Discussion

The SUR results provide an important complement to the VAR findings by demonstrating that competitive relationships among automakers become more apparent when exogenous factors are incorporated into the analysis. Compared with the VAR model, the SUR framework produced substantially lower regression errors and higher explanatory power across all firms. These improvements suggest that a portion of the variation in automobile sales is influenced by factors external to the company's own sales. By accounting for these influences, the SUR model is able to capture competitive dynamics that may remain obscured in a VAR framework alone. The substantial reduction in RMSE and the corresponding increase in R^2 values indicate that competitive interactions among automakers' sales are more complex than simple sales interdependencies. The results suggest that rivalry may operate simultaneously through multiple channels, including market conditions, consumer preferences, economic factors, and firm-specific strategic decisions. Consequently, models that incorporate exogenous influences appear better suited for explaining sales performance within the automobile industry than models that rely exclusively on endogenous relationships.

Another important finding is the increase in variable significance within the SUR framework. Several variables that were insignificant in the VAR analysis became significant once exogenous factors were included. This result suggests that

competitive interactions among automakers may occur simultaneously rather than sequentially. In other words, firms may respond to similar market conditions at the same time, creating relationships that are not fully captured by lagged sales data alone. The SUR methodology therefore provides additional evidence that rivalry exists among members of the studied strategic group and may reveal dimensions of competition that are overlooked when using VAR models exclusively.

Despite the stronger relationships identified by the SUR model, the overall conclusions remain consistent with the findings from the VAR and impulse response analyses. While the SUR results reveal greater interconnectedness among competitors, the evidence does not support the existence of *intense* rivalry. If competition were highly aggressive, one would expect strong and pervasive interdependencies across all models and measures. Instead, the findings suggest that competitive influences are present but limited in magnitude. The improvements in model performance demonstrate that firms are affected by one another, yet these effects are not sufficiently strong to characterize the industry as one of fierce competition.

The consistency of the SUR findings with the earlier VAR and IRF results strengthens the robustness of the study's conclusions. Although different methodologies capture different dimensions of competitive behavior, they converge on the same general interpretation: rivalry exists among the five major North American automakers, but it is best described as *moderate* rather than intense. This convergence across multiple analytical approaches increases confidence that the observed pattern reflects the true nature of competition within the strategic group rather than a methodological artifact.

Overall, the SUR analysis reinforces the central argument of this study. The inclusion of exogenous variables reveals stronger competitive relationships than those detected by the VAR model alone, suggesting that rivalry among automakers is influenced by broader market forces. Nevertheless, when considered alongside the VAR and IRF evidence, the results continue to support the hypothesis that competition among the five major North American automakers is characterized by moderate rivalry and strategic coexistence rather than aggressive head-to-head competition.

4.3 Correlation Matrix and Granger Causality Results

To further examine the existence of rivalry among the members, we can rely on the correlation matrix and Granger causality. Table 6 displays the results of the correlation matrix for the automakers' monthly sales. A correlation coefficient greater than 0.7 is considered strong, while a coefficient between 0.4 and 0.7 is moderate, one between 0.2 and 0.4 is weak, and values below 0.2 indicate no correlation. Table 6 presents the strongest correlation between the sales of Honda and Toyota at 0.79. The sales of Ford show moderate correlations with Honda and Toyota at 0.55 and 0.58, respectively. There are weak correlations between the sales of Ford and GM at 0.41, and between Toyota and Nissan at 0.48. All other correlations are insignificant.

However, correlation refers to a statistical relationship between two variables, in which changes in one variable are associated with changes in another (positively or negatively). If two variables are correlated, they move together (in the same direction

or the opposite). Correlation does not imply that one variable causes the change in the other. On the other hand, causality implies a cause-and-effect relationship between two variables, where a change in one variable directly causes a change in another. Therefore, while some moderate correlation exists, analyzing causal relationships (VAR, SUR, or Granger causality) is more important to uncover the intensity of the rivalry among the competitors.

Table 6 *Correlation Matrix for Sales.*

	GM	**Ford**	**Honda**	**Toyota**	**Nissan**
GM	1.000				
Ford	0.418	1.000			
Honda	0.327	0.556	1.000		
Toyota	0.246	0.585	0.790	1.000	
Nissan	0.037	0.355	0.352	0.480	1.000
Note: Correlations above 0.7 is strong, between 0.5 and 0.7 is moderate, and below 0.5 is weak.					

There are two types of causal relationships. The first is true causality, a direct cause-and-effect relationship between two variables, where changes in one variable can directly lead to changes in another. Establishing such causality requires understanding the underlying mechanisms, conducting controlled experiments, or presenting alternative explanations. This information is not readily available to current scholars. The second type is Granger causality, a statistical concept used to determine whether one-time series can predict another. Although Granger causality is not true causality, this temporal causal relationship is based on predictability. If the Granger test is positive, we can conclude that the rivalry among the members of the same strategic group is significant because their sales impact each other; otherwise, we cannot assert the existence of fierce competition.

Table 7 *The Granger Causality Test Results for Sales. The Beta Coefficients are Omitted due to Clutter.*

Company	**Impacted by**	**P-value**	**Company**	**Impacted by**	**P-value**
GM	Ford	0.223	Honda	GM	0.042**
GM	Honda	0.063*	Honda	Ford	0.591
GM	Toyota	0.341	Honda	Toyota	0.192
GM	Nissan	0.335	Honda	Nissan	0.310
Ford	GM	0.055*	Toyota	GM	0.338
Ford	Honda	0.263	Toyota	Ford	0.774
Ford	Toyota	0.419	Toyota	Honda	0.130
Ford	Nissan	0.107	Toyota	Nissan	0.216
			Nissan	GM	0.100
** Significant at 95%			Nissan	Ford	0.130
* Significant at 90%			Nissan	Honda	0.888
			Nissan	Toyota	0.784

Table 7 presents the results of the Granger causality analysis among the sales of five automakers, with the p-values indicating significance. According to the Granger test, Honda's sales can influence GM's (p-value, 0.063) and can also be affected by GM's sales (0.042). While Ford does not influence GM's sales, the company's sales can be affected by GM's (0.055). However, the other variables show no significant impact on one another at the 90 and 95 percent confidence intervals. Therefore, we conclude that we did not find a strong causal relationship among the sales of these companies within the same groups, but rather a moderate competition. Considering the results from the VAR, SUR, IRF, and Granger causality tests, we conclude that our hypothesis is supported.

4.3.1 Correlation Matrix and Granger Causality Discussion

The correlation matrix and Granger causality analyses provide additional insight into the nature of rivalry among the five automakers and reinforce the conclusions drawn from the VAR, SUR, and impulse response analyses. The correlation results indicate that some firms exhibit similar sales patterns over time, particularly Honda and Toyota, which displayed the strongest association among the automakers. Moderate correlations were also observed between Ford and both Honda and Toyota. These relationships suggest that certain firms may be responding to similar market conditions, consumer preferences, or industry-wide trends. However, the relatively small number of moderate-to-strong correlations and the absence of widespread high correlations indicate that sales movements among automakers are not highly synchronized.

Importantly, unlike causality, correlation alone cannot establish the existence of competitive rivalry. Firms may exhibit correlated sales because they are exposed to the same economic conditions, seasonal demand patterns, fuel prices, interest rates, or other external influences. Therefore, while the correlation matrix provides evidence of shared market dynamics, it does not necessarily imply that the actions of one automaker directly influence the sales performance of another. This distinction highlights the importance of examining causal relationships (such as VAR, SUR and Granger) rather than relying solely on measures of association.

The Granger causality analysis offers a more rigorous examination of competitive interactions by evaluating whether past sales of one automaker improve the prediction of another automaker's future sales. The results reveal only limited evidence of predictive relationships among the selected firms during the studied period. While a small number of statistically significant relationships were identified, most automakers did not exhibit meaningful causal connections with one another. This finding is particularly important because if rivalry within the strategic group were intense, one would expect sales changes at one firm to systematically influence the sales performance of competitors. Instead, the Granger results indicate that such predictive relationships are relatively rare.

The limited evidence of Granger causality suggests that the sales performance of these automakers is driven more by firm-specific factors and broader market conditions than by direct competitive reactions among rivals. This interpretation is consistent with both the multimarket competition and resource partitioning perspectives discussed earlier. Automakers may compete within the same industry while simultaneously serving different customer segments, emphasizing different

product categories, and pursuing distinct strategic objectives. As a result, sales fluctuations experienced by one firm do not necessarily trigger corresponding responses from competitors.

The consistency of the Granger causality findings with the VAR, SUR, and impulse response results further strengthens the overall conclusions of this study. Each methodology approaches rivalry from a different perspective—correlation through association, Granger causality through predictability, VAR through dynamic interdependence, and SUR through simultaneous relationships. Despite these methodological differences, all approaches converge on a similar conclusion: competition among the five major North American automakers exists, but it is not sufficiently strong to be characterized as fierce rivalry.

Overall, the correlation matrix and Granger causality analyses provide additional support for the study's hypothesis. While some degree of interconnectedness is evident among automakers, the absence of widespread causal relationships suggests that competition within this strategic group is moderate rather than intense. These findings imply that automakers are able to maintain strategic independence despite operating within the same industry, further supporting the view that product differentiation, market segmentation, and strategic coexistence play important roles in shaping competitive behavior.

5. Managerial Implications

This study discovered that while sales can indicate rivalry among members of the North American auto industry, analyzing eleven years of sales data for GM, Ford, Honda, Toyota, and Nissan did not reveal the anticipated intense rivalry. However, the comparison of Tables 2, 3, and 5 indicated that some rivalry was present at a weaker intensity, and the improvement in R^2 values and the regression errors further suggest that some competition exists among the strategic group. Therefore, in compliance with Fortsch, Choi, and Khapalova (2021), our analysis showed that it is beneficial for companies to utilize SUR regression because it outperformed VAR and simple regressions. Moreover, compared to AR, we found that VAR and SUR models significantly enhanced all the regressions' R^2 values by allowing the models to include data from competitors' sales. The highest R^2 value improvement was for Honda at 40 percent after using VAR and 84 percent for Toyota after using SUR. Similarly, all the regression errors (RMSEs) significantly decreased after using VAR and SUR. While Tables 4 and 5 presented a summary of SUR outputs for all automakers, the Appendix includes Tables 8, 9, 10, 11, and 12, which present the outcome of SUR for GM, Ford, Honda, Toyota, and Nissan, respectively.

The insignificance of many beta coefficients and the IRF further suggested that moderate competition is more likely than fierce competition. As shown in Figure 3, competitive shocks dissipate quickly, reinforcing the idea that firms are not engaged in aggressive head-to-head competition. In Table 7, the lack of strong Granger causality further supports the notion that firms do not reactively compete but instead engage in moderate competition. For example, Toyota, Honda, and Nissan exhibit low interdependencies, suggesting that they have differentiated into distinct consumer markets.

The findings have significant strategic implications for automotive industry managers and policymakers. First, since intense rivalry is not observed, automakers

can maximize profits by targeting distinct market niches rather than engaging in costly price wars. Thus, these firms should prioritize market segmentation over direct price competition. Second, competitive intelligence should focus on long-term strategic differentiation. As sales reactions are limited, automakers should invest in branding, product differentiation, and technological innovation instead of reactive pricing strategies.

5.1 Theoretical Implications

This study contributes to the literature on strategic groups and competitive rivalry by providing empirical evidence that competition among firms operating within the same industry is not necessarily characterized by intense rivalry. Traditional views of competition often assume that firms within the same strategic group compete aggressively for market share and sales. However, the findings from the VAR, SUR, impulse response, correlation, and Granger causality analyses consistently indicate that rivalry among the five major North American automakers is *moderate* rather than intense during the studied period. This finding contributes to the strategic management literature by demonstrating that firms within a strategic group may exhibit limited sales interdependencies despite competing in the same market.

The results also provide empirical support for the multimarket competition theory and the mutual forbearance hypothesis. While rivalry exists among the five studied automakers, the relatively weak interdependencies observed in sales performance suggest that firms may recognize their mutual dependence and avoid highly aggressive competitive actions that could trigger retaliation. Rather than competing solely through price reductions or direct sales competition, firms appear to rely on differentiation strategies and long-term positioning. This finding extends prior research by showing how moderated rivalry can be observed through sales-based measures rather than inferred solely from market structure or firm behavior.

In addition, the findings contribute to the resource partitioning literature. The limited causal relationships and moderate sales interdependencies suggest that five studied automakers may reduce direct competition by targeting different customer segments, product categories, and market niches. The coexistence of compact vehicles, trucks, SUVs, luxury vehicles, and electric vehicles within the same industry provides a plausible explanation for why firms can operate within the same market while maintaining relatively independent sales performance.

Finally, this study contributes methodologically to the rivalry literature by demonstrating the value of combining correlation analysis, Granger causality, VAR, SUR, and impulse response functions to evaluate competitive intensity among the selected automakers. Each method captures a different dimension of rivalry—association, predictability, dynamic interdependence, simultaneous relationships, and competitive shocks. The consistency of the findings across these methodologies strengthens confidence in the conclusion that rivalry among the five automakers is moderate. More broadly, the study illustrates how sales-based time-series methods can be used to empirically measure competitive intensity and strategic interactions among firms.

6. Conclusion, Limitations, and Future Research

In this study, we focused on domestic sales data to understand the competition among North American automakers. Contrary to conventional wisdom, our findings

suggested moderate rivalry among the five automakers. However, we believe that the unavailability of specific data may have limited our understanding, as we could not include all automakers. Similarly, we obtained our data from an automotive website, and our conclusions depend on the accuracy of that data. Nonetheless, we emphasize that rivalry is present, even if it may not be as strong as anticipated. Some other limitations are as follows. First, we have adopted a straightforward approach to linear relationships. Specifically, we employed vector autoregressive regression and seemingly unrelated regression. Due to the complex nature of the auto industry, our results might have differed if a nonlinear modeling approach had been utilized. We suggest that further research should explore alternative methods to uncover the competition among North American automakers. Second, our findings indicate that analyzing time series data for sales may not be sufficient for assessing competition within the same strategic group. Other factors could signify intense competition. For example, pricing, frequent price changes, promotional activities, product innovation, differentiation, capital investment, marketing, advertising, customer loyalty, mergers and acquisitions, and customer switching costs could provide a more comprehensive understanding of the competitive dynamics, along with other key indicators that enhance the understanding of competition.

Another promising avenue for future research is to examine how competitive intensity evolves over time, particularly during periods of major industry disruption. The automotive industry has experienced significant changes in recent years, including the COVID-19 pandemic, semiconductor shortages, supply chain disruptions, electrification, and the emergence of new competitors in the electric vehicle market. Future studies could investigate whether rivalry intensifies or weakens during such periods and whether competitive dynamics differ between stable and turbulent market environments. A longitudinal comparison of pre-pandemic, pandemic, and post-pandemic periods could provide valuable insights into how external shocks influence strategic interactions among automakers.

Future research may also expand the scope of analysis beyond the five automakers examined in this study. While our analysis focused on firms with sufficiently complete and continuous sales data, researchers may consider including additional manufacturers, luxury brands, electric vehicle producers, or international competitors as more comprehensive data become available. Furthermore, future studies could compare rivalry across different strategic groups within the automotive industry, such as traditional automakers versus electric vehicle manufacturers, mass-market versus luxury brands, or domestic versus foreign producers. Such comparisons could improve our understanding of how competitive intensity varies across market segments and industry structures.

Finally, future research could explore the relationship between rivalry and firm performance outcomes. While this study focused on measuring competitive intensity through sales interdependencies, future studies may investigate how varying levels of rivalry affect profitability, market share growth, innovation, operational efficiency, and long-term firm performance. Understanding the consequences of moderate versus intense rivalry would provide valuable theoretical and managerial insights into the strategic implications of competition within the automotive industry.

7. References

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Appendix

Table 8 *Sur Results for GM.*

GM	Coefficient	Error	P(value)
FS(t)	1.582	0.125	0.000
HS(t)	0.192	0.296	0.517
TS(t)	-0.063	0.223	0.775
NS(t)	-0.855	0.219	0.000
GMS(t-1)	0.385	0.075	0.000
FS(t-1)	-0.696	0.148	0.000
HS(t-1)	-0.124	0.293	0.671
TS(t-1)	0.532	0.229	0.020
NS(t-1)	-0.093	0.228	0.683
Constant	26,680	15,100	0.077

Table 9 *Sur Results for Ford.*

Ford	Coefficient	Error	P(value)
GMS(t)	0.423	0.033	0.000
HS(t)	-0.030	0.149	0.840
TS(t)	0.189	0.107	0.076
NS(t)	0.584	0.106	0.000
GMS(t-1)	-0.120	0.043	0.005
FS(t-1)	0.506	0.066	0.000
HS(t-1)	-0.059	0.150	0.604
TS(t-1)	-0.365	0.111	0.001
NS(t-1)	-0.046	0.116	0.691
Constant	14,497	7,697	0.060

Table 10 *Sur Results For Honda.*

Honda	**Coefficient**	**Error**	**P(value)**
GMS(t)	0.016	0.025	0.517
FS(t)	-0.009	0.048	0.840
TS(t)	0.655	0.038	0.000
NS(t)	-0.081	0.063	0.203
GMS(t-1)	-0.047	0.025	0.057
FS(t-1)	0.049	0.461	0.279
HS(t-1)	0.477	0.077	0.000
TS(t-1)	-0.362	0.061	0.000
NS(t-1)	0.155	0/066	0.019
Constant	1,515	4,511	0.737

Table 11 *Sur Results for Toyota.*

Toyota	**Coefficient**	**Error**	**P(value)**
GMS(t)	-0.009	0.033	0.775
FS(t)	0.107	0.060	0.076
HS(t)	1.134	0.066	0.000
NS(t)	0.404	0.076	0.000
GMS(t-1)	0.039	0.033	0.230
FS(t-1)	-0.112	0.058	0.056
HS(t-1)	-0.576	0.105	0.000
TS(t-1)	0.638	0.070	0.000
NS(t-1)	-0.405	0.083	0.000
Constant	6,701	5,923	0.258

Table 12 *Sur Results of Nissan.*

Nissan	Coefficient	Error	P(value)
GMS(t)	-0.132	0.033	0.000
FS(t)	0.338	0.061	0.000
HS(t)	-0.143	0.112	0.203
TS(t)	0.413	0.077	0.000
GMS(t-1)	0.220	0.033	0.516
FS(t-1)	-0.185	0.059	0.002
HS(t-1)	0.227	0.114	0.048
TS(t-1)	-0.294	0.085	0.001
NS(t-1)	0.577	0.072	0.000
Constant	4,802	5,938	0.419

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