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ECONOMIC FACTORS AND RETAIL SALES OF NEW VEHICLES IN THE UNITED STATES

MICHAEL SIVAK
BRANDON SCHOETTLE

SUSTAINABLE WORLDWIDE TRANSPORTATION
UNIVERSITY OF MICHIGAN

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Michael Sivak
Brandon Schoettle

The University of Michigan
Sustainable Worldwide Transportation
Ann Arbor, Michigan 48109-2150
U.S.A.

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16. Abstract

Typical analyses of vehicle sales do not differentiate between retail sales of individual vehicles and fleet sales of multiple vehicles to commercial, rental, and governmental entities. In contrast, this study examined the relationship between several economic factors and seasonally adjusted retail sales of new light-duty vehicles (cars, SUVs, pickup trucks, and vans). The size of the U.S. population was also included in the analysis. Multiple linear regression was used to model the relationship in the United States for monthly data over a 10-year period from January 2007 through December 2016.

The results indicate that the unemployment rate, the price of gasoline, and population size were significant predictors of retail sales; both higher population and higher gas prices were associated with higher retail sales, and higher unemployment rates were associated with lower retail sales. Because the best-fitting regression model provided a reasonably good fit to the data (accounting for 84% of the variance in retail sales), this model was then used to predict future retail sales for 36 scenarios defined by the combinations of three levels of population size, three levels of gasoline price, and four levels of unemployment. For each population level, the highest retail sales were predicted for a combination involving the lowest unemployment rate and the highest price of gasoline. Conversely, the lowest retail sales were predicted for a combination involving the highest unemployment rate and the lowest price of gasoline.

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Introduction

Typical analyses of vehicle sales do not differentiate between retail sales of individual vehicles and fleet sales of multiple vehicles to commercial, rental, and governmental entities. While some factors likely affect both retail and fleet sales in similar ways, other factors likely have differential effects. Consequently, separate analyses of these two groups of sales are more likely to provide better guidance concerning future sales for each group than when these two groups are combined.

The present study was designed to examine the relationship between several economic factors and retail sales of new vehicles in the United States. Multiple linear regression was used to analyze the relationship between retail sales of light-duty vehicles (cars, SUVs, pickup trucks, and vans) and disposable income, the price of gasoline, and the unemployment rate. (An additional variable in the regression was the population size.) The analysis used monthly data for a 10-year period. If any of these factors prove to be significantly associated with retail sales, then the best-fitting regression model could be used to make "what if" inferences about possible future retail sales under a variety of hypothetical economic scenarios.

Method

Approach

A multiple linear regression was used to analyze possible relationships using monthly data from January 2007 through December 2016.

Dependent variable

The dependent variable was the seasonally adjusted retail sales (i.e., excluding fleet sales) of all new light-duty vehicles for each month. During the 120-month period examined, unadjusted monthly retail sales ranged from 538,161 to 1,464,009, with the percentage of retail sales out of all sales ranging from 75% to 90%. The unadjusted retail sales data were provided by Cox Automotive (M. Krebs, personal communication, July 11, 2017), and they were based on an analysis by Cox Automotive of sales data reported by the Bureau of Economic Analysis and Auto Rental News/Bobit Business Media. The seasonal adjustment factors were computed from the seasonally adjusted and unadjusted total sales in Bureau of Economic Analysis (2017), and they were then applied to the unadjusted retail sales data from Cox Automotive.

Independent (predictor) variables

The following four independent variables were used:

- Real disposable income per capita in chained 2009 dollars, seasonally adjusted annual rate (Federal Reserve Bank of St. Louis, 2017b)
- Price of regular gasoline (Energy Information Administration, 2017), adjusted for inflation relative to the December 2016 price (Federal Reserve Bank of St. Louis, 2017a)
- Unemployment rate, seasonally adjusted (Bureau of Labor Statistics, 2017)
- Resident population as of the 15th day of each month, estimated by compound interpolation between 300,624,000 (the population on January 15, 2007) and 324,218,000 (the population on December 15, 2016)[1]

[1] The population on January 15, 2007 was derived by compound interpolation using the values for July 1, 2006 and July 1, 2007 (U.S. Census Bureau, 2010). The population on December 15, 2016 was obtained from U.S. Census Bureau (2017).

Results

Model fit to the data from 2007 through 2016

The overall regression was statistically significant, $F(4,115) = 154.0$, $p < .001$). Three of the four independent variables were significant predictors: population ($t = +13.9$), the unemployment rate ($t = -17.6$), and the price of gasoline ($t = +5.7$). A positive t value indicates a positive relationship between the predictor and the dependent variable, and vice versa. Consequently, both higher population and higher gas prices were associated with higher retail sales, while higher unemployment rates were associated with lower retail sales.

The model accounted for 84% of the variance in retail sales ($r^2 = 0.84$). The best-fitting equation was as follows:

Retail sales = -3,414,078 + (0.015 × population) - (68,874 × unemployment rate) + (64,511 × price of gasoline)

Figure 1 plots the actual, seasonally adjusted retail vehicle sales versus the predictions based on the equation obtained from the regression analysis.

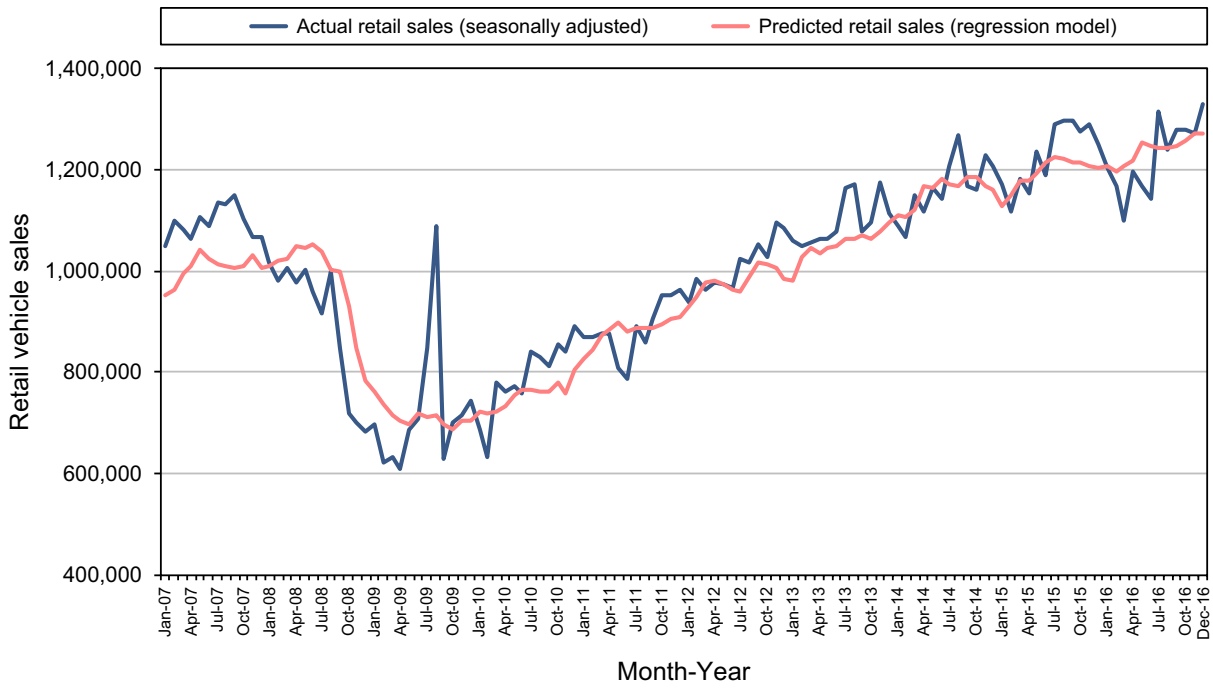

Figure 1. Actual, seasonally adjusted retail vehicle sales versus predictions based on the regression model.

Overall, the model accounts well for the long-term trends in retail sales. (The single largest discrepancy is for August 2009, when the actual sales were 34% greater than the predicted sales. This large discrepancy is likely the consequence of the federal Car Allowance Rebate System—informally referred to as the "Cash for Clunkers" program—in which buyers received a rebate when they traded in an older vehicle for the purchase or lease of a new one with substantially better fuel economy. This program was in effect from July 27 through August 24, 2009.)

Using the regression model to calculate percentages of car sales for "what if" scenarios

Given the reasonably good fit of the regression model to the data from 2007 through 2016, the model was used to calculate monthly retail sales for 36 possible future scenarios. These scenarios were defined by all combinations of the following levels of population, price of gasoline, and unemployment rate:

- Resident population: 330 million, 335 million, and 340 million (for comparison, the population on December 31, 2016 was 324,304,000)
- Price of gasoline per gallon: $2, $3, and $4 (the December 2016 value was $2.25)
- Unemployment rate: 3%, 5%, 7%, and 9% (the December 2016 value was 4.7%)

The predicted seasonally adjusted retail sales for the 36 selected scenarios are listed in Table 1, ranging from 1,045,100 to 1,737,300. As is evident from Table 1, for each population level, the highest retail sales were predicted for a combination involving the lowest unemployment rate (3%) and the highest price of gasoline ($4). Conversely, for each population level, the lowest retail sales were predicted for a combination involving the highest unemployment rate (9%) and the lowest price of gasoline ($2).

Table 1
Predicted monthly retail vehicle sales for 36 scenarios. (For each population level, the entry in red represents the lowest retail sales and the entry in blue the highest retail sales.)

Population	Price of gasoline per gallon	Unemployment rate	Predicted monthly seasonally adjusted retail sales
330 million	$2	3%	1,458,300
		5%	1,320,600
		7%	1,182,800
		9%	1,045,100
	$3	3%	1,522,800
		5%	1,385,100
		7%	1,247,300
		9%	1,109,600
	$4	3%	1,587,300
		5%	1,449,600
		7%	1,311,800
		9%	1,174,100
335 million	$2	3%	1,533,300
		5%	1,395,600
		7%	1,257,800
		9%	1,120,100
	$3	3%	1,597,800
		5%	1,460,100
		7%	1,322,300
		9%	1,184,600
	$4	3%	1,662,300
		5%	1,524,600
		7%	1,386,800
		9%	1,249,100
340 million	$2	3%	1,608,300
		5%	1,470,600
		7%	1,332,800
		9%	1,195,100
	$3	3%	1,672,800
		5%	1,535,100
		7%	1,397,300
		9%	1,259,600
	$4	3%	1,737,300
		5%	1,599,600
		7%	1,461,800
		9%	1,324,100

Discussion

Limitation of regressions

An important caveat to keep in mind is that, while a regression can identify associations between factors, it cannot identify causal relationships. Therefore, the relationships obtained in this study are not necessarily causal.

Limited number of variables considered

This analysis considered possible associations between retail sales of light-duty vehicles and three key economic variables. However, the retail sales are likely related to other factors as well, both economic and non-economic. Nevertheless, the regression model provided a reasonably good fit, accounting for 84% of variance in retail sales.

Price of gasoline and retail sales

The results of this analysis indicate a *positive* association between the price of gasoline and retail sales. One possible explanation for the direction of this effect is that higher gasoline prices contribute to additional sales by people who are upgrading their vehicles in terms of improved fuel economy.

Seasonal adjustment

The seasonal adjustment factors that were applied to retail sales in this study were originally derived to apply to total sales. Therefore, having adjustment factors specific to retail sales only would have likely resulted in an even better fit for the regression model.

Conditions associated with high and low retail sales

As population increases, so do the expected retail vehicle sales. For a given population level, the highest retail sales are expected for a combination involving the lowest unemployment rate and the highest price of gasoline. Conversely, the lowest retail sales are expected for a combination involving the highest unemployment rate and the lowest price of gasoline.

Summary

Typical analyses of vehicle sales do not differentiate between retail sales of individual vehicles and fleet sales of multiple vehicles to commercial, rental, and governmental entities. In contrast, this study examined the relationship between several economic factors and seasonally adjusted retail sales of new light-duty vehicles (cars, SUVs, pickup trucks, and vans). The size of the U.S. population was also included in the analysis. Multiple linear regression was used to model the relationship in the United States for monthly data over a 10-year period from January 2007 through December 2016.

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