APPLICATION FOR 2010 RUSSELL ACKOFF DOCTORAL STUDENT FELLOWSHIPS

Wharton Risk Management and Decision Processes Center of the University of Pennsylvania

The Impact of Customer Behavior on the Automobile Supply Chain
A Study of Consumer and Manufacturer Reactions to Gas Prices

Student: Antonio Moreno-Garcia, 3rd year PhD student at OPIM

Advisor: Christian Terwiesch

TITLE

The Impact of Customer Behavior on the Automobile Supply Chain: A Study of Consumer and Manufacturer Reactions to Gas Prices

DESCRIPTIVE SUMMARY

Introduction and Hypotheses

The objective of this research project is to understand how gas prices affect the demand and supply of new cars.

On the consumer side, we would like to understand how consumers react to changing gas prices. In particular, we want to study what combination of three alternative behavioral models best explains the observed consumer choice when purchasing vehicles. In Model 1 consumers consider only current gas prices when evaluating the utility of different alternatives in terms of fuel economy. For example, when gas prices are high, consumers have a higher preference for fuel efficient vehicles. In Model 2 consumers consider both current gas prices and historical gas prices when evaluating the utility of different alternatives in terms of fuel economy (a high gasoline price after a steady increase of gas prices will be treated differently). In Model 3, we assume that consumers use information of future of oil prices. We want to find what proportion of type 1, 2 and 3 consumers best explains the choice data.

High fuel prices increase the relative utility for vehicles with higher fuel economy and reduce the relative utility of vehicles with lower fuel economy. The supply side reaction implies some assumption regarding the consumer behavior when gas prices are changing. We want to analyze whether companies are pricing *as if* customers behave as type 1, 2 or 3 customers. Also, on the supply side, firms can respond to the changes in demand caused by changes in gas prices by adjusting a set of marketing variables. For example, if gas prices go up, it is expected that manufacturers and dealerships will reduce the price of their less fuel efficient cars by offering incentives, rebates, and promotions, or by using some other marketing instruments.

However, such marketing driven approaches to demand changes are costly. Most firms would prefer to address these problems further upstream in the supply chain, especially in the areas of manufacturing and inventory management. Adjusting the model mix produced towards more fuel efficient vehicles simply provides a better response to higher gas prices than offering a price promotion on less fuel efficient vehicles.

Thus, our hypothesis is that the extent to which firms have to engage in marketing-related responses is largely influenced by their assumptions regarding customer behavior and by their operational capabilities. For example, we expect that manufacturers/dealerships who run with a higher number of days of supply (i.e. higher inventories) will have to engage in markdowns more often, because they will more often see themselves with the wrong inventory mix. Similarly, we expect that firms that have more flexible production capabilities and carry less inventory will be able to adjust to changing demand conditions without reducing their prices.

Another aspect of interest is how dealers' and manufacturers' margins change (in relative terms) when the demand for a vehicle is reduced due to an exogenous change, such as a sudden increase / decrease in gas prices. In other words, we want to analyze how manufacturers and dealerships split the burden from changes in demand due to changes in gas prices. Here there are several behavioral aspects that can be worth addressing. For example, preliminary analysis with our available data suggests that transaction prices of cars are lower in the last two days of the month, suggesting that car salespeople charge their negotiating behavior to meet their targets.

Finally, the cash for clunkers program also gives an opportunity to evaluate how the impact of the program in terms of fuel efficiency gains and firm pricing was moderated by the operational capabilities of the car makers and by their supply chain interactions with the corresponding dealerships, and by behavioral reactions to the program in both the supply and demand side.

Methodology

This is an empirical project. We use economic theory and behavioral and operations management models to motivate the hypotheses and to inform our work, but the main conclusions will be derived using statistical and econometric techniques.

We are also considering running a lab experiment to support our conclusions in terms of customer behavior with relation to gas prices.

Data

We are assembling a dataset from various sources. Part of the Ackoff scholarship will be used to purchase additional data. We have the following data:

- Sales: We have monthly sales data for the vehicles marketed in the U.S. in 2000-2009. This data is available at a higher level of aggregation (for example, we can observed the number of "Toyota Corolla" units that were sold in March 2009, but not the number of "Toyota Corolla CE", "Toyota Corolla S", etc). This implies that matching sales with vehicle specification requires using an aggregation function (e.g. mean, median) of the specifications of the different models of a model line. This data comes from Ward's Autoworld.

- Vehicle specifications: We have vehicle specifications (e.g. horsepower, weight, size) for the vehicles marketed in the U.S. in the period 2000-2009. This data comes from Ward's Autoworld and is at the model year level (e.g "Toyota Corolla CE 2009"). This data includes the annual manufacturer suggested retail price.

- Inventory: We have end-of-month inventory data for the vehicles marketed in the U.S. in 2000-2009. This data is available at the same level of aggregation as sales (e.g. "Toyota Corolla" in inventory in the end of March 2009). This data comes from Ward's Autoworld.

- Plant data: We have some data of North American plants, including their capacity, utilization. We only have some data for 2000-2005. The data comes from the Harbour Productivity Reports.

- Gas prices: We have weekly gas prices in different regions of the U.S. The data comes from the Energy Information Administration of the U.S. Department of Energy.

- Customer habits: We obtain data of income, number of vehicles and number of miles driven per vehicle from the U.S. National Household Travel Survey (2008).

I am considering to buy additional data from the Harbour Reports for the period 2006-2009. I am also considering buying a transaction dataset (Polk)

Relevance for Ackoff Scholarship

I think this project fits with the objectives of the call for proposals of the Ackoff scholarship. We are addressing two of the central areas of work described in the call for proposals. On one hand, our project has a strong component of behavioral economics and decision processes, as we are trying to understand how consumers respond to changing fuel prices. On the other hand, the fact that we are analyzing the impact in terms of fuel economy addresses some of the environmental aspects that are considered in the call for proposals.

Finally, I think that our work is policy relevant. A number of policies have been proposed to act on fuel economy. Two examples are the CAFE regulations and the Cash-for-Clunker programs. Our work can provide some insights into that type of policy actions.

FACULTY ADVISOR

Christian Terwiesch, Professor of Operations and Information Management, The Wharton School, University of Pennsylvania.