MODELING SUPPLY AND DEMAND IN THE CHINESE AUTOMOBILE INDUSTRY

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Overview

China is experiencing rapid economic growth and, along with it, rapid growth in vehicle ownership. Evidence from Chinese cities suggests average annual growth rates in per capita vehicle ownership of 10% to 25%. According to data from the China Statistical Yearbook, vehicle ownership increased by nearly 56 times between 1990 and 2011. The rapid growth in vehicle ownership and vehicle usage is linked to increasing global warming, emissions, air pollution, and other problems.

In this paper, we are developing and estimating a structural econometric model to estimate demand and cost parameters for all vehicles in China. We are applying our model to annual data we have collected on sales, prices, and characteristics of the majority of vehicle makes and models in China, including electric vehicles, hybrid vehicles, and alternative-fuelled vehicles, over the period 2004 to 2013. In addition to price, we have collected data on vehicle characteristics, such as power, fuel efficiency, vehicle type (e.g., sedans, SUVs, pick-ups, etc.), and displacement for the majority of vehicle makes and models in China. Our model will enable us to estimate demand- and cost-side parameters, own- and cross-price elasticities, markups, and variable profits for alternative vehicles.

The parameters we are estimating will enable us to better understand what factors affect the demand and cost of vehicles in China, and how consumers in China trade off various vehicle characteristics (such as fuel efficiency, whether the vehicle is an electric vehicle, etc.) with each other and with price. We will use the model to simulate the demand and cost for new vehicles, and also the effects of various government policies on demand and cost.

Methods

In this paper, we are developing and estimating a structural econometric model to estimate demand and cost parameters for all vehicles in China.

Our structural econometric model has several advantages over a survey approach. First, econometric models are estimated using actual data on actual vehicle purchase decisions, and therefore may be more accurate a depiction of consumer preferences, since these preferences are revealed by the actual decisions they make. In contrast, surveys are based on self-reported responses to questions and may be subject to many errors and biases that cause these responses to be inaccurate representations of the truth.

A second advantage of our econometric approach over a survey approach is that we will estimate our econometric models using a comprehensive data set we have collected and constructed on sales, prices, and characteristics of the majority of vehicle makes and models in China, and will therefore base our models and analysis on the vehicle purchase decisions of all vehicle owners in China, not just those of the consumers that are surveyed. Our comprehensive data set not only provides more information, but also is not subject to sample selection issues that would plague a survey of a sample of the population.

A third advantage of our econometric approach over a survey approach is that our econometric model will enable us to statistically control for multiple factors that may affect vehicle purchase decisions, including price; vehicle characteristics such as fuel economy, horsepower, and size; and consumer characteristics in a quantitative and rigorous manner.

A fourth advantage of the structural model is that the parameters we are estimating enable us to calculate consumer utility, firm profits, and welfare.

A fifth advantage of our structural econometric approach is that it enables us to estimate standard errors and confidence intervals for our parameters, and therefore to ascertain whether our parameters are statistically significant.

A sixth advantage of our structural econometric approach is that we can use the estimated parameters to simulate demand, supply, and welfare under counterfactual policy scenarios. These counterfactual policy simulations will enable us to analyze the effects of vehicle-related policies in China, including those regarding alternative vehicles.

A traditional logit model of vehicle demand assumes the independence of irrelevant alternatives, and can therefore generate unrealistic substitution patterns. In a logit model, if you take away a car model from the choice set, then consumers of that car will buy other cars according to their market shares. However, in reality, if you remove, say, a luxury car, the consumers of that luxury car are probably more likely to buy another luxury car than a random consumer would, even if luxury cars have low market share. In contrast, a Berry, Levinsohn and Pakes (1995) random coefficients demand model of vehicle demand addresses this problem by allowing for interactions between unobserved consumer characteristics and observed product characteristics, thus allowing different consumers to vary in how much they like different car characteristics.

Our research builds on the work of Berry, Levinsohn and Pakes (1995), who develop a model for empirically analyzing demand and supply in differentiated products markets and then apply these techniques to analyze the equilibrium in the U.S. automobile industry. Their framework enables one to obtain estimates of demand and cost parameters for a class of oligopolistic differentiated products markets. Unlike traditional logit demand models, their random coefficients model allows for interactions between consumer and product characteristics, thus generating reasonable substitution patterns. Estimates from their framework can be obtained using only widely available product-level and aggregate consumer-level data, and they are consistent with a structural model of equilibrium in an oligopolistic industry. They apply their techniques to the U.S. automobile market, and obtain cost and demand parameters for (essentially) all models marketed over a twenty year period. On the cost side, they estimate cost as a function of product characteristics. On the demand side, they estimate own- and cross-price elasticities as well as elasticities of demand with respect to vehicle attributes (such as weight or fuel efficiency).

Our research innovates upon the Berry et al. (1995) work by developing a model of the Chinese automobile market; by including alternative vehicles so that in addition to cost and demand parameters relating to gasoline-fuelled vehicles, cost and demand parameters relating to alternative vehicles can be estimated; and by modeling the behavior of not only private automobile companies but also the state-owned automobile companies in China.

Results

According to our preliminary results, The means of the marginal utility of the car attributes we model, including the alternative vehicle dummy, fuel efficiency, length, weight, capacity and horsepower are all positive and significant. Except for the coefficient on the length and passenger capacity (number of seats), all the other demand coefficients are larger in magnitude when we include the state-owned dummy variable in the supply-side pricing equation.

After adding the state-owned dummy variable in the supply-side pricing equation, the standard deviations of the marginal utility of fuel efficiency, length, weight, capacity, and horsepower are positive and statistically significant, which indicates that there is a distribution of tastes for these characteristics, with some people preferring a higher level, while some others preferring a lower level. However, the mean of the marginal utility of capacity is negative and significant, which indicates that on average people prefer cars with fewer seats.

On the cost side, all the coefficients corresponding to the attributes are positive and statistically significant. Moreover, the coefficient on the ownership dummy is positively significant.

Our research is significant for industry, government, society, academia, and NGOs. Our model of the demand and cost in the Chinese automobile market will be significant for industry, particularly car manufacturers interested in better targeting cars, including alternative vehicles, for the Chinese market. Our estimates of the factors that affect demand and supply in the Chinese automobile market is significant for policy-makers interested in developing incentive policies to increase market penetration of alternative vehicles with potential environmental and climate benefits.

Conclusions

The results presented in this paper are of interest to academics, policy-makers, and business practitioners, including automobile companies, alike.

References

Berry, S., J. Levinsohn, and A. Pakes. (1995). Automobile prices in market equilibrium. Econometrica, 63 (4), 841-890.