Gas Prices and Automobile Advertising Expenditures in U.S. Markets

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Abstract

I examine how automobile manufacturers change their advertising strategies when gasoline prices rise. In particular, I use a robust OLS regression to estimate how gasoline prices affect advertising expenditures on vehicles with different levels of MPG. I use detailed data from the ACCRA Cost of Living Index, Adspender, and Polk's NVPP. My results show that automakers shift their advertising expenditures toward vehicles with higher MPG in response to higher gas prices. Fuel-efficient vehicles in large and luxury segments are more likely to be advertised in response to rising gas prices than those in the midsize segment.

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INTRODUCTION

Gasoline prices have increased dramatically in the past few years, rising from a national average $1.5 a gallon in December 2003 to $4 per gallon in July 2008, when they reached their highest level ever in real terms (Energy Information Administration data). As gas prices have soared and environmental concerns have risen in recent years, the federal government has tried to reduce dependence on imported oil and cut tailpipe emissions. Policy makers have tried to implement policies that lower gas consumption: Carmakers have been encouraged to develop and supply more fuel-efficient vehicles, while consumers receive tax breaks for purchasing these fuel-efficient vehicles. Congress has enacted Corporate Average Fuel Economy (CAFE) standards[1] to reduce energy consumption by increasing the fuel economy of cars and light trucks. The federal government has provided aids for automakers to develop cars and technologies that improve fuel efficiency. Other policy instruments have also been introduced, such as increasing the federal gasoline tax,

[1] The Corporate Average Fuel Economy (CAFE) sets limits on the sales weighted average fuel economy, expressed in miles per gallon (mpg), of a manufacturer's fleet of passenger cars or light trucks with a gross vehicle weight rating (GVWR) of 8,500 lbs. or less, manufactured for sale in the United States, for any given model year. Fuel economy is defined as the average mileage traveled by an automobile per gallon of gasoline (or equivalent amount of other fuel) consumed as measured in accordance with the testing and evaluation protocol set forth by the Environmental Protection Agency (EPA).

subsidizing the purchase of fuel efficient vehicles such as hybrids, and taxing fuel-inefficient vehicles.

Previous studies suggest that rising gasoline prices have had a large effect on the demand for automobile attributes and fuel efficiency. (Atkinson and Halvorsen 1984; Ohta and Grilliches 1986; Li, Von Haefen, and Timmins 2008) However, automakers' response to hikes in gas prices has not been investigated. There are at least two possible answers: (1) Since fuel-efficiency is an attribute that is valued when gas prices rise, automobile manufacturers may respond by increasing their marketing budget for fuel-efficient cars. (2) Alternatively, when gas prices rise, consumers will alter their demand toward more fuel efficient vehicles, meaning that, automakers will face large low-MPG car inventories. If it is costly to change production platforms or adjust company strategies, they may increase marketing activities for low-MPG cars to speed up their inventory turnover rate as they predict increased future demand of fuel-efficient cars.

This paper examines how an increase in gas prices affects the business strategies and focus of automobile producers. I seek to answer two questions: (1) How do gasoline prices affect automobile manufacturers' business focus (in terms of advertising) with respect to models with different MPG levels? (2) How do gasoline

prices affect advertising expenditures on vehicles with different levels of MPG across segments? I use detailed data from ACCRA Cost of Living Index, Adspender and Polk's NVPP. I view advertising expenditures as a good indicator of automakers' business focus and strategies. This paper sheds light on how gasoline prices affect automakers' business focus, and the results can assist policy makers in examining how automakers have responded to policies encouraging them to introduce more fuel-efficient vehicles.

This paper is organized as follows. Section 2 reviews the literature. Section 3 describes the data. Section 4 establishes the model to investigate the effect of gasoline prices on automobile advertising expenditure allocation. Section 5 discusses my regression results and Section 6 discusses the relevance of the results to policies for the automobile industry. Section 7 concludes.

LITERATURE REVIEW

To begin my research, I review how advertising interacts with sales and consumer behavior, especially in the automobile industry. I then describe how gasoline prices affect consumer behavior toward automobiles and automobile sales performance. Lastly, I establish my assumptions and construct my model.

Auto manufacturers use marketing activities to introduce new or redesigned models, to promote older less-popular models, or to speed inventory turnover. In general, they use advertisements to achieve their sales goals. Marketing activities directly affect customers' knowledge, attitude and behavior toward the underlying products, which will result in financially measurable outcomes such as sales, profits and shareholder values in both the short and the long run. Customer impact and improvement in marketing assets, such as brand equity, influence the firm's market share and sales and enhance its competitive market position. (Ambler 2000) Brands which better differentiate themselves through marketing activities can enjoy lower price elasticity and acquire greater market shares (Boulding, Lee, and Saelin 1994) Cowling and Cubbin (1971) and Peles (1971) found significant effects of advertising on automobile firms' sales or market shares, although they differed as to whether the effect was long-lasting or short-lived.

Caves and Greene (1996) suggest that the use of advertising varies across industries depending on market structure, product characteristics, and consumer characteristics. For example, consumer purchasing behavior toward some basic economic goods can be easily driven by advertising while consumer adoption behavior for luxury goods may be motivated by other factors. Similarly, target audiences in different segments also have different responses to gas price and advertisements. Optimality conditions require that products with lower demand elasticities and/or higher profit margins will have higher advertising expenditures. Berry, Levinsohn, and Pakes (1995) have shown that crowded segments, such as small and compact automobiles, have greater price elasticities of demand. This suggests that small and compact vehicles will be advertised less than luxury vehicles, all else equal. To avoid any potential bias introduced by analyzing advertising expenditures for cars with different product characteristics and target markets, I control for differences in market segment (subcompact, compact, midsize, large, and luxury automobiles) in my analysis of advertising decisions.

However, there exist some confounding factors even within the same segment: consumer's knowledge and manufacturer-specific factors, such as the array of models produced and the market portfolio, may affect advertising expenditures. In my

analysis, I introduce dummy variables to control for industry and manufacturer attributes that may also affect advertising expenditures.

Previous studies have shown that market environment and competition are both important factors in marketing productivity. How the firm reacts to the environment and competition can improve its performance, especially when experiencing economic and geopolitical turbulence and uncertainty. Competition can drive marketing expenditures higher and thus fuel the escalation in advertising expenditures even when expenditures may not have the anticipated results. Montogmery and Wernerfelt (1991) show that escalating advertising destroys value rather than creating it. Thus, I control for environmental and competitive factors by using ADSPEND as a percentage of total advertising expenditures in the segment within the auto industry in my regression model.

Grilliches and Makoto (1986) conclude that the energy crises of 1973 and 1979 and the associated increasing in gasoline prices caused consumers to change their demand for automobiles and automakers to adjust their products and prices. As a result of rising gas prices, the market share and the prices of small cars increased relative to those of large cars while various automobile qualities changed, including a down-sizing of length, weight, and horsepower and an increase in gasoline efficiency.

Carlson (1978) applies seemingly unrelated regression to estimate the demand for automobiles of different sizes, suggesting that high gasoline prices decrease the demand for intermediate and full sized autos while increasing the demand for subcompact and compact cars. He concludes that fuel economy is a prime determinant of consumers' purchasing decisions in response to soaring gas prices or an energy crisis. The result of his study indicates that consumers considered that only subcompacts to be truly fuel-efficient cars.

Li, Von Haefen, and Timmins (2008) find that soaring gasoline prices induce a fuel-efficient vehicle to stay in service longer while a fuel-inefficient vehicle is more likely to be scrapped, *ceteris paribus*. They also conduct simulations and estimate that a 10% increase in gas prices will generate a 0.22% increase in the fuel economy of the entire vehicle fleet in the short run (one year) and a 2.04% increase in the long run (after the current vehicle stock is replaced). I can therefore expect that an increase in gas prices will generally increase the demand for fuel-efficient automobiles both in the short run and in the long run.

I will analyze available data in order to empirically understand automakers' decision making in response to rising gas prices. While advertising expenditures can be easily quantified among all the marketing activities, I am interested in the

relationship between gas prices and automakers' advertising expenditures for models with different MPG levels. I aim to clearly identify the effect of gas prices on the marketing strategies of automakers.

DATA

I employ data from the American Chamber of Commerce Research Association (ACCRA) Cost of Living Index, Adspender (from 2003 4Q to 2006 4Q) and Polk's National Vehicle Population Profile (NVPP) to analyze the relationship between gas prices and advertising expenditures on models with different levels of MPG.

Adspender provides data on the quantity of advertising expenditures for brands in various industries across 18 media, with breakdowns by company, brand and product, and markets (cities). I extract advertising expenditures in the automobile industry with the breakdown by 18 companies, 30 brands, 100+ models and 90+ markets from 2003 4Q to 2006 4Q. Table 1 shows the statistics of advertisement expenditures in different segments within automobile industry.

Table1: Statistics of Auto Advertisement Expenditures by Segment

Segment	Mean	Std. Dev	Min	Max	Obs.
1(subcompact)	63.86	186.16	0	3,971.30	1,846
2(compact)	103.43	251.01	0	3,853.90	2,758
3(midsize)	77.79	199.45	0	2,793.80	2,270
4(large)	44.68	74.06	0	587.90	579
5(luxury)	114.48	254.43	0	2,924.40	896

The ACCRA Cost of Living Index (COLI) provides a reliable quarterly source of city-to-city comparisons of key consumer costs including regular unleaded gasoline

prices, available from 1990 to 2008 3Q. Table 2 summarizes the variations in gas prices across years and urban areas.

Table2: Statistics of the Gas Prices across Nation by Year

Year	Mean	Std. Dev	Min	Max	Obs.
2003	1.52	0.16	1.30	2.04	87
2004	1.80	0.22	1.38	2.54	351
2005	2.27	0.37	1.57	3.45	328
2006	2.51	0.32	1.92	3.30	313

Polk 's National Vehicle Population Profile is a census of all currently registered passenger cars and light-duty trucks in the U.S., Canada and Puerto Rico. Polk's New Registration Data provides detailed indicators for new vehicle registrations by make, year and segment; this provides me the volume of new vehicle sold (market share in terms of sales quantity) at the model level by year from 1999-2006.

The MPG data are from the fuel economy database complied by the Environmental Protection Agency (EPA). I combine city and highway MPGs following the weighted harmonic mean formula provided by the EPA to measure the fuel efficiency of a model: MPG=1/[(0.55/city MPG) + (0.45/highway MPG)]. Table 3 shows the combined statistics of MPG and other automobile features collected from Polk’s NVPP and EPA.

Table3: Statistics of Auto Attributes by Segment

Segment	Variable	Obs.	Mean	Std. Dev.	Min	Max
1(subcompt)	MPG	9,575	27.40	5.16	19.00	41.02
	Price	9,575	16,117.50	5,029.64	9,750.00	36,655.00
	hybrid	9,575	0.03	0.17	0.00	1.00
	Quantity	9,575	116,381.00	109,118.40	3,899.00	387,388.00
2(compact)	MPG	9,279	24.06	1.97	18.24	28.00
	Price	9,279	17,902.98	3,771.50	11,800.00	29,995.00
	hybrid	9,279	0	0	0	0
	Quantity	9,279	115,675.20	111,142.80	4,467.00	397,750.00
3(midsize)	MPG	12,144	20.77	2.10	13.00	25.00
	Price	12,144	24,599.12	6,332.81	16,000.00	53,100.00
	hybrid	12,144	0	0	0	0
	Quantity	12,144	116,430.00	128,777.50	1,491.00	426,970.00
4(large)	MPG	3,698	19.31	1.90	12.00	22.00
	Price	3,698	26,013.36	3,090.03	20,990.00	31,340.00
	hybrid	3,698	0	0	0	0
	Quantity	3,678	147,645.60	203,520.20	10,995.00	939,511.00
5(luxury)	MPG	4,089	19.25	1.61	15.35	25.00
	Price	4,089	33,016.68	3,927.21	18,300.00	56,490.00
	hybrid	4,089	0	0	0	0
	Quantity	4,089	35,967.91	26,401.76	1,972.00	77,895.00

Quarterly data will be sufficient for this analysis because marketing campaigns usually last a month and it takes more than a month for non-pricing advertising activities to have an impact on business performance. I use a multivariate statistical model to examine the effects of multiple variables on the dependent variable—advertising expenditures. I can then control for the effects of each variable and assess its independent relationship with the dependent variable with a multivariate regression.

THEORETICAL FRAMEWORK

For each of the five vehicle categories (1-subcompact, 2-compact, 3-midsize, 4-large, 5-luxury), we pool all the vehicles in the segment in each of the MSAs from 2003 4Q to 2007 4Q. Note that I examine the model advertising at the brand segment level rather than at the model level because automakers adjust their model portfolio within each segment from time to time. I assume that advertising expenditures that cross geographic or model lines are non-rivalrous; i.e. brand level advertisement will have equal effect on all divisions and models, and advertising expenditures at the national level serve as marketing effort equally for each market (city).

I extract the MPG, price, quantity (sales) and hybrid information for each model, and merge them with the gas price data from ACCRA COLI. I include segment dummies from the Polk data in order to control for segment-specific confounding factors. For each segment, I calculate the average MPG, price and hybrid dummy weighted by yearly sales quantity of each model belonging to the segment. For example, the price of Ford segment 1 in year 2005 is calculated as the average prices of all the models in that segment weighted by their sales quantity in 2005.[2] Thus, I

[2] I do not use vehicle model level data because vehicle models change over time, which makes panel

am able to examine how automobile producers adjust their advertising focus in terms of MPG level in each segment in response to the gas price.

I examine the relationship between advertising expenditure and gas price and other various determinants of advertising expenditures while controlling for confounding variables. In particular, I estimate the following equation:

$$\ln(ADSPEND_{ijts}) = B_0 + B_1\, GAS_{j(t-1)} * MPG_{it\,s} + B2\, GAS_{j(t-1)} + a\, PRICE_{its} + b\, HYBRID\ DUMMY_{its} + c\, X_k + error_{jit} \quad (1)$$

$ADSPEND_{ijts}$ represents advertising expenditures for segment *s* of brand *i* in MSA area *j* (city) at time *t* (time) divided by total advertising expenditure on segment *s* in area *j*. I use comparative advertising expenditures (the advertising expenditures of each brand segment divided by the total advertising expenditures in the segment across all firms) instead of absolute advertising expenditures. This controls for the fact that many companies may cut their budget in an economic downturn, and the absolute amount of ADSPEND may be misleading when we evaluate the marketing focus of a company on certain models. Thus, my model controls for general trends of the segment or the industry that may affect advertising expenditures.

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data analysis difficult. In particular, the entry or exit of models is not likely to be exogenous and my model is not able to explain those entry and exit decisions.

X_k represents external variables (segment, quarter, year, market) that affect advertising expenditures of brand *i*. I also include industry and manufacturer conditions that affect advertising expenditures: price and a hybrid dummy variable for brand *i* in segment *s* at time *t*. Because I am looking at brand level rather than model level observations, I weigh average price and hybrid entries for each brand segment against the quantities of each model.

I obtain $GAS_{j(t-1)}$ from the ACCRA Cost of Living Index data set and multiply it by MPG_{its}, obtained from the Polk data. Also, we include $GAS_{j(t-1)}$ to see its direct effect on ln(ADSPEND). Note that the $GAS_{j(t-1)}$ used here is the gas price from first-lagged quarter, because I assume advertisement budgets are determined 2-3 months in advance.

In Equation (1), the derivative of ln(ADSPEND) with respect to GAS is $B_1 MPG_{its} + B_2$. A positive B_1 would mean that the automobile manufacturer shifted its advertising focus toward its fuel-efficient models in response to the rise of gas price.

I test this model in different automobile segments and the results are compared across automobile industry.

RESULTS AND DISCUSSION

My regression results can provide valuable information on how changes in gas price affect advertising expenditures across segments. I control for confounding variables by including vehicle segment dummies, hybrid dummies, quarter dummies, year dummies, and market dummies. MSA demographic variables (market dummies) are used to control for cross-sectional heterogeneity. Quarter dummies and year dummies are used to capture seasonal business strategies, macro-economic factors, or new product launch routines that may affect advertising expenditures.

I present the regression results from equation (1) in Table 4 along with several alternative specifications. The effect of GAS * MPG on advertising expenditures is of particular interest because it is directly related to how gas prices affect automakers' advertisement strategies in terms of business focus on cars with different MPG levels. In specification [4], the coefficient estimate of GAS * MPG on the ln(ADSPEND) is 0.6306 with a robust standard error of 0.0106. That is, for example, a one cent increase in the gas price will drive automakers to increase 3.64% of the advertising expenditures for vehicles with 27.4MPG while decrease 1.46 % of the advertising expenditures for vehicles with a 19.24 MPG. It indicates that fuel-efficient cars are more heavily promoted than low-mpg cars.

Table4: How Gas Prices Affect ADSPEND for Cars with different MPG levels

Spec.	Depend. Variable	Regression	GAS	GAS*MPG	PRICE	Obs.	R-sq.
[1]	ADSPEND	Linear	-2.69E-01	1.19E-02	4.77E-06	38,785	0.2345
	(no lagged)	*(Robust S.E.)*	*6.45E-03*	*1.72E-04*	*1.99E-07*		
[2]	ADSPEND	Linear	-2.85E-01	1.62E-02	5.20E-06	38,785	0.2449
	(lagged)	*(Robust S.E.)*	*7.08E-03*	*2.25E-04*	*2.00E-07*		
[3]	ln(ADSPEND)	Semi-log	-8.70E+00	4.41E-01	1.23E-04	38,785	0.1344
	(no lagged)	*(Robust S.E.)*	*3.31E-01*	*8.12E-03*	*1.33E-05*		
[4]	ln(ADSPEND)	Semi-log	-1.36E+01	6.31E-01	1.45E-04	38,785	0.1404
	(lagged)	*(Robust S.E.)*	*3.74E-01*	*1.06E-02*	*1.33E-05*		

Note:

1. I include Segment(Seg), Hybrid, Quarter(Qtr), Year(Yr), and Market(Mkt) dummies in the regressions.
2. All the coefficient estimates are statistically significant at the 5% level.
3. Gas prices in specification [2] and [4] are prices from first-lagged quarter
4. The dependent variable in specifiacation [3] and [4], ln(adspend), is logarithm of the advertisement expenditure of a brand in a given segment.
5. GAS*MPG is calculated by multiplying gas prices and average mpg of a segment of a brand.
6. ADSPEND is in thousands
7. Robust standard errors are in italic;

I use robust standard errors because regression error is likely to be heteroskedastic. In specifications [3] and [4], I use ln(ADSPEND) as the dependant variable to account for non-linearity and thus improve the fit of the estimates. I assume automakers decide their advertising budget 2-3 months in advance. Thus, I include specifications [2] and [4] and confirm that the gas prices for the first-lagged quarter have a more significant effect on ADSPEND and improve the accuracy of our model. As a result of the comparison, I use ln(ADSPEND) as the dependent variable and the first-lagged quarter gas prices as one of my independent variables

(specification [4]) to further examine my model across different segments in the automobile industry. The comparison of regression results is later presented in Tables 5, which helps me to understand the strength of a unit change of independent variables on the % change of ADSPEND across different segments.

Table5: How Gas Prices Affect ln(ADSPEND) for Cars w/ Different MPG Levels across Seg.

Segment	Estimation Technique	GAS(t-1)	MPG*GAS(t-1)	PRICE	Dummies
Industry	OLS	-2.69E-01	1.19E-02	4.77E-06	Seg,Hybrid,Qtr,Yr,Mkt
(Total)	(Robust S.E.)	*-6.45E-03*	*1.72E-04*	*1.99E-07*	
Subcompact	SURE	-3.55E+01	1.27E+00	1.58E-03	Qtr,Hybrid,Yr,Mkt
(Seg1)	(Robust S.E.)	*1.92E+00*	*4.53E-02*	*4.89E-05*	
Compact	SURE	-2.48E+00	-8.78E-02	-4.27E-04	Qtr, Yr, Mkt
(Seg2)	(Robust S.E.)	*1.60E+00*	*4.39E-02*	*4.38E-05*	
Midsize	SURE	3.17E+01	-1.44E+00	-1.15E-03	Qtr, Yr, Mkt
(Seg3)	(Robust S.E.)	*1.06E+01*	*-1.39E+01*	*-2.32E+01*	
Large	SURE	-8.71E+00	6.22E-01	1.87E-03	Qtr, Yr, Mkt
(Seg4)	(Robust S.E.)	*2.20E+00*	*8.56E-02*	*9.23E-05*	
Luxury	SURE	-3.91E+01	1.95E+00	1.93E-04	Qtr, Yr, Mkt
(Seg5)	(Robust S.E.)	*1.49E+00*	*6.83E-02*	*4.43E-05*	

Note: All coefficients are significant at 5% level; robust standard errors are in italic; hybrid feature only applies to cars in Seg1

To capture heterogeneity in demand for vehicles in different segments that may arise from differences in dealer availability and consumer attitudes toward different types of vehicles (i.e., cars, SUV, or pickup truck), I run trial regressions with interaction terms between market dummies and segment dummies in equation (1). The trial regressions give very similar estimates which confirm that the interaction

between market and segment dummies will not affect my model.

In equation (1), the derivative of ln(ADSPEND) with respect to GAS is B_1 MPG + B_2. The positive and significant coefficient on $GAS_{j(t-1)}$ * MPG_{its}, B_1, implies that an increase in the gas price will drive automakers to increase the advertising expenditures for vehicles with higher MPG cars and reduce the advertising expenditures on less fuel-efficient models. The identification of this coefficient is based on the cross-market advertising expenditure variation in response to differences in gas prices across markets. In my research, auto advertising expenditures serve as an indicator of automakers' business focus; the regression results are consistent with my assumption that fuel-efficiency is a promoted characteristic of cars when gas prices rise. From the automakers' point of view, they choose to advertise more heavily their high MPG cars in order to stimulate customers' demand for vehicles with high fuel efficiency. This is in line with policy makers' expectations. They can also reach out to customers who are not fully informed about fuel-efficiency features or convert their perceptions toward certain types of cars. Given that fuel-efficiency features can signal a strong research and development base for an auto company, automakers may want to advertise for their high-MPG vehicles in order to build a positive brand image and demonstrate their leading industry trends in fuel

efficiency to their investors or business partners.

Presented in Table 5, regressions are run independently for each segment and show consistent results across all the segments in the automobile industry (1-subcompact, 2-compact, 3-midsize, 4-large, 5-luxury). Since these five regressions may have cross-segment parameter restrictions and correlated error terms, I run them jointly as a seemingly unrelated regression system and present the results in the same table. The mixed results show interesting advertisement strategies for models in different segments. For midsize car segment, the negative estimate for the coefficient on GAS * MPG indicates that automakers try to promote more low-MPG car purchases in order to speed their inventory turnover rate as they predict increased future demand of fuel-efficient cars as gas prices soar. For large and luxury car segments, the positive and significant coefficients of GAS * MPG, $B_{1,}$ suggest that fuel-efficient vehicles are more likely to be advertised in response to rising gas prices. While consumers perceive large and luxury vehicles as fuel inefficient, automakers need to advertise more heavily on high MPG vehicles in these segments in order to change consumers' old perceptions and achieve their sales goals. The positive B1 may also indicate that automakers introduce more new entries in large and luxury car segments in order to retool their production portfolio and meet governmental

regulation, which requires more advertisement expenditures.

POLICY DISCUSSION

In 2008, U.S. automobile manufacturers experienced the worst auto sales in decades and faced unprecedented challenges under the financial crisis. Owing billions in debt as the credit market tightened, major automakers requested federal loans to survive the economic downturn. The automobile industry crisis in 2008 and 2009 also allowed the government to use a bailout plan as a tool to prod the industry to change its business model. Congress passed a law in December 2007 requiring automakers to achieve an average fuel efficiency of 35 MPG across all their vehicles by 2020. In March 2009, the federal government imposed new fuel-efficiency standards requiring compacts, sedans and other passenger cars to meet 30.2 MPG and pickup trucks, sport utility vehicles and minivans to reach 24.1MPG beginning with the 2011 model year, aiming to achieve energy independence and bring more fuel efficient vehicles to American families. Automobile manufacturers will have to retool to begin producing cars and trucks with higher MPG on an accelerated schedule in response to the economic and political environment and to the higher oil prices. I expect the automakers to increase their advertising expenditures on their new fuel-efficient cars in an attempt to stimulate consumers' demand of high MPG cars when gas prices increase, which is consistent with the goals of the policy.

When the government examines the effectiveness of its policies in fuel-economy, is helped by the fact that B_1 is positive, indicating that the automobile manufacturer will focus more on its fuel-efficient models in response to the rise of gas price and the related public policies. The model in my research could assist policy makers to examine how automakers respond to the policies and how to assist automakers to achieve fuel efficiency by enforcing regulations.

CONCLUSION

This paper examines how automobile manufacturers adjust their business focus on models with different MPG levels in the face of gasoline price fluctuations. This is done by constructing an empirical model in which I recover the elasticity of advertising expenditure with respect to gas price as a function of MPG. I then analyze the effect of gas prices on automakers' advertising expenditures on models with various MPG across different segments in the automobile industry between 2003 4Q to 2006 4Q. The model yields a positive coefficient in the interaction between gas price and MPG, implying that automakers shift their relative advertising expenditures toward vehicles with higher MPG cars in response to higher gas prices. Assuming auto advertising expenditures serve as an indicator of automakers' business focuses, I conclude that fleet fuel-efficiency is promoted by automakers in response to rising gas prices.

This study can be enhanced by including more observations. While I use data only from 2003 4Q to 2006 4Q because of limited accessibility, it is data from 2008 and later that show significant gas price fluctuations. With gasoline prices falling again in the second half of 2008 and 2009, more data should be collected to observe whether consumer demand will shift to small cars and how automakers adjust their

advertising plan.

In 2008, the federal government imposed new CAFE requiring cars to improve their fuel-efficiency. When Adspend data from 2008 and after are available, the model in this paper can assist policy makers to examine how automakers respond to policies encouraging them to introduce more fuel-efficient vehicles. Furthermore, I can continue my research by mapping automobile advertisement expenditures to corresponding sales performances and investigate how to adjust automakers' marketing strategies in response to changes in gas prices and sales performances. Further extension of this research can assist the government in understanding which automakers are likely to achieve the new fuel-efficiency regulations and who are less likely to perform well with their existing business strategies. Thus, the government can prioritize their bailout budget and assist automakers in danger before auto company bankruptcies take place.

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