Can Pro-Active Fuel Economy Strategies Help Automakers Mitigate Fuel-Price Risks?

EXECUTIVE SUMMARY

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Executive Summary

The high oil and gasoline prices we have experienced over the past two years have dramatically increased the attention paid to vehicle fuel economy by drivers, new car buyers, and the government. Detroit automakers, who have long depended on the least fuel-efficient vehicles to provide most of their profits (and some of who have argued that fuel economy did not matter very much to their customers) are seeing their sales and profits evaporate, as new vehicle buyers switch to more fuel-efficient vehicles. Management apparently assumed that (1) fuel prices would stay low forever, and/or that (2) their customers would not change their vehicle choices because of high fuel prices.

Events of the past two years have demolished both assumptions. The price of gasoline soared in 2005 and again in 2006, but more importantly the real price of gasoline has been rising at a 10% annual pace since 1999, and at a faster 16% annual rate since 2002. The price of gasoline ($2.70/gallon average so far in 2006) is 98% above what it was in 1999 and 83% above what it was in 2002. By lowering vehicle purchase prices (in cash, zero or low interest-rate loans, employee pricing for all), Detroit managed to maintain the sales of their profitable SUVs and pickups in units, if not revenue or profit. By the last quarter of 2005, the automakers' ability (or willingness) to cut prices again and again simply to sell the same number of units collapsed. Since then, consumers have migrated to more fuel-efficient options, primarily at the expense of Detroit automakers' share and profits.

In this study, we examine the economic viability of improving fuel economy as a strategy to mitigate the risk of high fuel prices and to gain a competitive advantage.

By adopting a "game theory" approach to representing the competitive interactions among the automakers and using different scenarios to represent the risks automakers face with respect to fuel prices and consumer demand, we are able to identify which strategies maximize profits for the automakers and support U.S. auto industry employment.

Rising fuel prices are a primary contributing factor to rapid erosion of Detroit automaker market share, profits and jobs.

- While GM, Ford, and DaimlerChrysler have significant cost disadvantages compared to their Japan-based competitors, some of which can be attributed to issues beyond the control of current management (exchange rates, health care and pension costs), poor fuel economy decisions by management have contributed significantly to their situation.

- Automakers that are highly leveraged in truck-based products (truck-based SUVs and pickups) are especially vulnerable to higher fuel prices since these products are less fuel-efficient.

- Detroit automakers have earned a high portion of their profits from truck-based products. In 2004, Ford earned 62% (GM 61%, DaimlerChrysler 44%) of variable profits from trucks and SUVs, versus 36% for Nissan and 28% for

Toyota (Honda 0%). Consequently, when higher fuel prices restricted truck-based product prices and profits, Detroit automaker profits were disproportionately affected.

- Since January 1999, fuel prices have been rising, and the ability of automakers to maintain prices and profits of trucks has steadily declined. However, since Detroit automakers were heavily committed to trucks, and switching production from trucks to cars is costly, they accepted lower profits rather than lower unit sales of trucks.

- In 2005, the price of gasoline rose 19% above its 2004 level, and the share of variable profits from pickups and SUVs fell 4.0 percentage points for both Ford and GM. This profit erosion continued in the first half of 2006—GM's share of variable profits from pickups and SUVs fell an additional 5.0 percentage points (Ford's fell 1.0 percentage point). The cash cows are rapidly dying off.

- New-vehicle dealers, because they are closer to the retail market than the automakers are, have more accurately read the market's shift away from gas-guzzlers than have the automakers. Dealers have only indirect influence on the new products they get from the automakers, but they directly control the mix of used vehicles that they sell alongside the new vehicles. They obtain used vehicles to sell from wholesale auctions. Prices at wholesale auctions reflect dealers' collective judgment about what consumers are willing to pay (before adding a competitive mark up). Since January 2000, the auction price of used full-size SUVs has fallen from 185% of the average auction price of all vehicles to 133% (June 2006)—a 52-percentage point drop—while the real price of gasoline rose 88% from $1.55/gallon to $2.92/gallon. The implied relationship is strong: a 1.0% increase in the real price of gasoline is associated with a 7 percentage-point reduction in the wholesale auction price of full-size SUVs versus the average auction price of all vehicles.

- GM and Ford's dependence on truck-based products is eroding their market share. Larger Japan-based automakers (Toyota, Honda, and Nissan) are seeing share and profit growth, and are increasing their North American capacity because they have a larger selection of fuel-efficient vehicles that are attractive to Americans. However, because both GM and Ford committed to rolling out new large SUVs more than four years ago, they are not significantly cutting their capacity to produce these gas-guzzlers. Instead as their operations contract due to declining sales, they are cutting capacity to produce mid-size and smaller vehicles.

Technological Options

What options do automakers have to improve fuel economy by 2010? In this study, we assume that the basic product portfolio of any manufacturer is mostly fixed. However, within the fixed product portfolio, a manufacturer has the option of improving the fuel

economy of its vehicle models by adopting improved engine, transmission, and other fuel saving technologies.

For simplicity, we analyze two distinct fuel economy strategies, "Business as Usual" (BAU) and "Proactive" (PROA). An automaker following the BAU strategy is assumed to make only those improvements in fuel economy that would be necessary for future CAFE standards. An automaker following the PROA strategy is assumed to make those fuel economy improvements beyond CAFE that consumers would value (and pay for). Developing these scenarios requires an engineering assessment of what fuel economy technologies are available and a detailed forecast of each manufacturer's future product plans including when individual models would have an opportunity to integrate new technology.[1]

Our data include 1,145 separate make, model, engine, transmission, and body style configurations in 2010. Of these, 154 configurations (13%) are expected to have new engines by 2010 that are potentially eligible for the advanced or moderate fuel-saving packages and 931 configurations with carry-over engines are eligible for foregoing projected improvements in horsepower downsizing. [2] Since the automakers understandably protect information about the future products and powertrains, our base assumptions for 2010 come from a forecast by The Planning Edge. It is possible that some automakers have already decided to implement some of the improvements we apply in the PROA strategy. However, since our base average fuel economy for Detroit automakers in 2010 is equal to what CAFE will require of them, and since the fuel economy of the Detroit automakers has historically not exceeded the requirement, Detroit automakers are not likely to have decided to implement our complete PROA packages.

Based on this assessment, we determined that if all automakers were to follow a PROA fuel economy improvement strategy and implement the fuel-saving packages we identified:

- Overall fuel economy would increase 6.0% above baseline 2010 fuel economy or 7.4% above model year 2005 estimated fuel economy of 24.5 mpg (EPA 2005). The 7.4% increase over today's level is consistent with the 4.0%-8.2% range we derived from a review of other studies and amounts to a modest 1.5% annual increase between 2006 and 2010

- Ford has the greatest opportunity to apply advanced technologies (34% of its base 2010 sales). DaimlerChrysler can apply advanced technologies to entries accounting for 30% of its sales and GM can apply advanced technologies to entries accounting for 19% of its sales. The Detroit automakers have more

[1] We derive these strategies by combining a detailed baseline 2010 sales forecast by manufacturer, model, engine, transmission, and body style from The Planning Edge) with an engineering analysis by Dr. Feng An (an expert in fuel economy technologies).
[2] We excluded as ineligible for improvement hybrids, diesels, and a few gasoline engines (60 configurations in all).

opportunity to improve the fuel economy of their vehicles than do Nissan (16%), Toyota (8%), and Honda (6%).

Methodology & Scenario Analysis

The impact of alternative fuel economy strategies and fuel prices on total sales by the industry is estimated using a simplified model of the total market demand for vehicles. To assess the change in market share for individual vehicle models under different fuel economy strategies and fuel price scenarios, we use an econometric model of discrete choice along with estimates of consumers' willingness-to-pay for attributes of vehicles. Discrete choice models match the intuitive notion that a vehicle is a bundle of attributes and that the vehicle's value to a consumer is derived from the value the consumer places on the attributes. The demand for vehicles is seen as a derived demand arising from the demand for vehicle attributes.

In this study we enhanced the model we used previously (McManus et al. [2005]), by incorporating measures of the key vehicle attributes of performance and size, along with the attributes examined in that study, fuel economy and retail purchase price. We updated our estimates of the model's parameters with 2005 data, using econometric techniques that exploit the correlation between vehicle price and vehicle attributes to derive data-based estimates of consumers' willingness to pay for fuel economy, performance, and size.

We used scenario analysis to compare automaker profits in four market-demand scenarios defined by fuel prices ($2.00/gallon and $3.10/gallon) and consumer discount rates (0% and 7%). The consumer discount rate measures the rate at which consumers discount future operating savings and costs to make them comparable to today's purchase price. Technically, the discount rate equals the prevailing market rate of interest minus the rate of expected inflation in fuel prices, and can be positive or negative (if consumers expected 14% annual percent inflation in fuel prices and the market interest rate were 7%, then the discount rate should be -7%). The lower the discount rate, the more value future savings of fuel are worth. We limited the lower bound on the discount rates in our simulations to 0% to be conservative.

We assume that automakers aim to maximize profits and decide whether to pursue PROA increases in fuel economy with that aim in focus as well as in light of uncertainties regarding future fuel economy standards, fuel price, and other automakers' fuel economy strategies. CAFE standards put a lower limit on each automaker's average fuel economy, but do not prevent any automaker from exceeding the standard.

To identify each automaker's optimal strategy under these uncertainties, we adopt a "game theory" approach. We model five automaker-competitors (individual Detroit, Japanese Big Three, and other), and we assume that each must choose either an aggressive or a BAU fuel economy strategy. An outcome in the simulation, of which there are 128, is defined by the fuel price, the consumer discount rate, and the choices of each of the five competitors. Letting this process run until it results in a stable outcome in which no automaker could gain by switching strategies given what the other automakers choose (Nash equilibrium),

we find that the optimal strategy for each automaker is to pursue PROA improvements in fuel economy. This conclusion is quite robust; it holds when neither fuel price nor consumer discount rates are known; and it also holds when fuel price and consumer discount rates are known (among the four demand scenarios).

Another way to find the solution of the simulation is to apply the maximin principle of game theory (choose the strategy that maximizes the worst case one can expect). Four market demand scenarios, five competitors, and two strategies yield 128 possible outcomes, 32 outcomes in each of the four market demand scenarios. The maximin principle reaches the same solution; all automakers should choose PROA.

Results: Increasing Fuel Economy Performance Increases Expected Profits

The surprising conclusion of our analysis is:

Each automaker should pursue proactive improvements in fuel economy that exceed what CAFE requires, regardless of the fuel economy strategies of other automakers, for fuel prices between $2.00/gallon and $3.10/gallon consumer discount rates between 0% and 7%.

Detroit Automakers' Profits are Highly Sensitive to Fuel Prices under Business-As-Usual Fuel Economy Scenarios

- Detroit automakers' profits are much more sensitive to fuel prices than the Japanese automakers. These results are consistent with the findings in McManus et al. [2005]. Detroit automakers lose $3.1-$3.6 billion in variable profits when fuel costs $3.10/gallon compared to $2.30/gallon, accounting for 72-77% of the total industry losses. In contrast, the three biggest Japanese manufacturers (Toyota, Honda, and Nissan) also see a reduction in variable profits, but at a much lower level, $0.8 billion.

- Conversely, if fuel prices drop to $2.00/gallon, Detroit automakers do better than the Japanese automakers. Detroit's variable profits increase by $1.2 to $1.4 billion when fuel costs $2.00/gallon compared to $2.30/gallon. In contrast, the three biggest Japanese manufacturers only gain a total of $0.3 billion.

- The differences in Detroit's profits between high and low consumer discount rates are small compared to the differences generated by fuel prices. The variable profits of the three largest Japan-based automakers (Toyota, Honda, and Nissan) are much less sensitive to both fuel prices and consumer discount rates than Detroit's are.

- These results are driven by two critical factors. First, if fuel prices increase to $3.10/gallon, overall sales decline by 3.5%. At $2.00/gallon, overall sales increase by 1.3%. Second, higher fuel prices decrease consumer demand for fuel-inefficient products, especially truck-based SUVs, and increase demand for more fuel-efficient options, including crossovers, minivans, and cars. At lower fuel prices, the reverse is true. Consequently, since Detroit automakers sell a much larger fraction of less efficient truck-based vehicle products, they are much more vulnerable to variable fuel prices than the Japan-based automakers are.

Proactively Increasing Fuel Economy would Benefit Detroit Automakers

The results of our simulations were surprising, even to us. In all four market-demand situations we evaluated (defined by fuel price and consumer rate of time discount), proactively increasing fuel economy would be the optimal strategy for all automakers, in that it would result in the highest variable profit that each automaker could be assured of earning, no matter what price of fuel (between $2.00-$3.10/gallon), consumer rate of time discount (between 0%-7%), or actions by its competitors were realized.

What was especially surprising was that the Detroit automakers (GM, Ford, and DaimlerChrysler) have more to gain from pursuing the aggressive fuel economy improvement strategy than do the three largest Japan-based automakers (Toyota, Honda, and Nissan). This is because the Detroit automakers face more risk (are more vulnerable) if they pursue BAU than the Japan automakers do. The Detroit automakers also have more opportunities for improvement, since Detroit automakers currently have lower average fuel economy than the Japan automakers do.

- Detroit automakers would benefit from raising the fuel economy of their vehicles regardless of fuel prices and consumer discount rates. Our results show that a PROA, industry-wide program to increase fuel economy performance would increase the profits of Detroit automakers by $0.8-$2.0 billion per year (depending on the market-demand situation).

- While the gains are greatest in the case of high fuel prices with low consumer discount rate and smallest in the case with low fuel prices and high consumer discount rate, the gains are nevertheless positive in all four potential market-demand situations we evaluated.

- Ford stands to gain the most in annual profits, more than twice as much as GM or DCX, by proactively pursuing fuel economy performance. Ford's gains are from $0.5-$1.4 billion, depending on the market-demand situation. GM's gains are from $0.2-$0.5 billion, depending on the market-demand situation. DCX's gains are $0.1 billion (There are differences in DCX's gains between market-demand situations, but not sufficient to register at this level).

- On the other hand, the three largest Japan-based automakers show very different results from those of Detroit. The Japan-based manufacturers actually see a reduction in their profits of $0.1-$0.6 billion. In large part this is due to the fact that the Japan-based automakers have more fuel-efficient fleets than the Detroit automakers have, and therefore have less room for improvement. Under a PROA fuel economy strategy, Detroit-based manufacturers narrow the gap in fuel economy performance between their fleets and the fleets of the three largest Japan-based automakers.

These surprising results are driven by the following factors:

- The higher fuel economy level of the fleet helps to insulate total industry sales from declining under the high fuel price scenarios. That is, the entire industry makes more profit under high fuel prices if fuel economy levels are higher, ($1.2-$1.4 billion). More surprising is our prediction that under low fuel prices, total industry profits are higher by $0.8-$0.9 billion if all automakers following PROA. This is because at $2.00/gallon, some of the fuel economy technologies are still cost-effective. This assessment is consistent with recent National Research Council findings on fuel economy (NRC [2002]).

- The key factor that explains the advantages to Detroit-based automakers of adoption of a PROA fuel economy strategy is opportunity—the Detroit-based automakers have lower fuel economy than the three largest Japan-based automakers and thus have more room for improvement. In the technological options section of this report we identified a larger set of improvement opportunities (for both new and carry-over powertrains) for the Detroit-based than for the three largest Japan-based automakers. (We excluded improvements that were not valued by consumers, and such technically possible but not valued improvements were more likely to be excluded for the Japan-based than for the Detroit-based automakers.)

- The three largest Japan-based automakers could, in principle, maintain their fuel economy advantage by applying more technologies to more vehicles, but they would do so at the cost of profits. It is important to note that, while the Detroit automakers could narrow their fuel economy disadvantage relative to the Japan 3 automakers through a proactive fuel economy strategy, the Japan 3 automakers would still have an advantage.

- Our study concludes that the Detroit automakers would benefit from pursuing PROA fuel economy improvements above what CAFE requires. This does not imply that raising CAFE requirements would benefit the Detroit automakers. That question was not directly addressed in the study, and it is important to understand that when we speak of an industry-wide or market-wide proactive fuel economy improvement strategy, we do not mean a higher CAFE standard, we mean the situation in which all automakers have chosen the PROA fuel economy strategy.

Proactively Increasing Fuel Economy would Protect American Jobs

We estimated the impact of strategic choices by automakers on U.S. employment using the well-known model developed and maintained by Regional Economic Models, Inc. (REMI). The REMI model takes the latest national input-output coefficients, which show how much each industry buys from every other industry, and tunes them to particular geographies using trade-flow data generated from the US Census of Transportation.

- Under high fuel prices, a market-wide PROA fuel economy improvement strategy would create 15,000-35,000 new jobs (throughout the whole economy) due to increased production by Detroit automakers. Decreased production by foreign-owned transplants would offset 10,000-19,000 jobs, for a net increase of 5,000-16,000 new jobs.

- Under low fuel prices, but with low consumer discount rates as well, the net gain in new jobs is smaller (168 net new jobs), as 11,000 new jobs due to increased production by Detroit automakers are nearly fully offset by reduced production by foreign-owned transplants.

- Only in the case with low fuel prices and high consumer discount rate would the market-wide proactive fuel economy increases result in job losses.

Public Policy Implications

In light of our conclusion that the optimal strategy for all automakers is aggressive fuel economy improvement, even with $2.00/gallon fuel, why has it taken a steadily rising fuel price for five years, billions in lost profit, and tens of thousands of job losses to stimulate action by the Detroit automakers? What are the barriers to implementing the optimal strategy?

Deploying new technologies takes time and money to accomplish, and time and money are in short supply in Detroit. The cumulative effects of declining market share, rising fuel prices, and uncompetitive product development are forcing drastic and costly changes at Ford, GM, and DaimlerChrysler. For the first time in more than 20 years, their survival is in doubt. GM and Ford may have just enough cash for one cycle of product development to bring new versions of their full product lines to market. Items seen as important but secondary to new vehicle designs are not getting funded.

Public policy actions that will be accepted by Detroit automakers in the current situation will be actions that enhance their ability to respond to changing market conditions. Our research shows that increased fuel economy has the potential to enhance their flexibility, but pressing concern about what are seen as bigger issues make achieving progress challenging.

To adequately address public policy concerns about fuel economy in the current economic environment requires the active, direct involvement of industry, labor, government, and

other organizations in the search for policies that are generally acceptable to all interested parties and, more importantly, that work. New policies are inevitable. If industry leaders do not become engaged with other stakeholders, it is very likely that the new policies will be more onerous.

Improving the fuel economy of America's light vehicle fleet would help reduce our dependence on oil (much of which is in the hands of unstable or hostile regimes) and contribute significantly to reducing emissions of pollutants and greenhouse gases. Our research indicates that improving the fuel economy of Detroit automakers' fleets would also reduce the risks to profits and American jobs of volatility in fuel prices. Reducing fuel consumption has become a national priority for leaders from both political parties. An emerging consensus sees reducing fuel consumption as a means to enhance national security, increase the market flexibility of American workers and communities, and help address climate change.

There are four areas that a formal coalition of stakeholders with a federal mandate to develop policies should address: improving fuel economy, enhancing regulatory rationality and certainty, supporting the development of advanced technologies, and building a domestic supply chain for advanced technology fuel-efficient vehicles. These need to be considered in conjunction with the key policy leverage points at which interventions can have significant effects: the decision by consumers to purchase a vehicle, the decision by automakers of the range of vehicles with different attributes to produce, and the decision by suppliers of which technologies to develop and provide to the automakers.

No one would question the importance of purchase price (capital cost) in consumers' vehicle choices. Tax incentives to encourage consumers to purchase fuel-efficient vehicles are already part of our policy environment, as are tax incentives to purchase inefficient SUVs and trucks. Most observers believe that an increase in the federal excise tax on motor fuels would not find sufficient support in Congress, yet the recent experience with higher fuel prices has demonstrated the power of raising operating costs to influence consumers' vehicle choices and thereby improve aggregate fuel economy.

However it is difficult for consumer-focused instruments alone (incentives and/or fuel taxes) to achieve dramatic improvements in fuel economy. Automakers cannot radically alter their product mix very rapidly, nor do all consumers switch from one type of vehicle to another overnight. We have seen significant evidence of the beginning of a move from SUVs to cars by consumers, and some automakers have acknowledged it, but the present composition of the fleet is not going to change radically in the near term. Encouraging the development of technologies that improve the fuel economy all vehicle segments across the entire market, are needed to produce significant improvements in fuel economy.

Encouraging advanced technologies across the entire fleet of vehicles calls for instruments that increase the portfolio of fuel-saving technologies available, make the technologies now or soon to be in the portfolio more attractive to automakers, and/or enhance the ability of suppliers to develop and commercialize new technologies.