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FIXING DETROIT: HOW FAR, HOW FAST, HOW FUEL EFFICIENT

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The Automotive Industry Crisis of 2009 is the worst the industry has ever experienced. This paper helps resolve the debate on how much and fast it should change and how it should it respond to demands for increased fuel efficiency. Looking at the actions of successful corporate turnarounds, the lessons are very clear: implement broad, deep, fast change, replace the management team, and transform the culture. We modeled the impacts of different fuel economy standards on profitability and sales, using the most accepted estimates of all the key parameters, and conducted an extensive sensitivity analysis on the key parameters. The impact of higher fuel economy standards on industry profits is very clear: increasing fuel economy 30% to 50% (35 MPG to 40.5 MPG) would increase the Detroit 3's gross profits by roughly $3 billion per year, and increase sales by the equivalent of two large assembly plants. The sensitivity analysis showed our findings are very robust. The overall risk and reward profile is very positive, with only a small chance of losing and a very large probability of gain.</td></tr>
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Executive Summary

The domestic auto industry is in the worst financial crisis in its history. To date, Ford Motor Company has managed to avoid the conditions that forced Chrysler Group LLC and General Motors Corporation to accept government scrutiny in exchange for bailout loans. However, now that Chrysler has entered bankruptcy the impact on the supply base that supports all three companies is mounting and the probability of a negative impact on Ford is rising. Thus, the crisis affects the entire industry, with the Detroit 3 hit hardest.

If any doubters remained, the crisis has clearly revealed that the business model of the Detroit 3 automakers is broken. Analysts may disagree about how much and how quickly the model needs to change, but all are in agreement that it must change.

The forces responsible for this crisis did not appear suddenly to blindside the industry in 2008. They have been building for years. In research begun in 2005, we identified and examined a series of misalignments between the market and Detroit's product portfolio, especially with respect to fuel economy. There is broad consensus between both industry and non-industry stakeholders that improving the fuel economy of the product portfolio is necessary to achieve widely accepted public policy goals (reduced dependence on oil, energy independence, and greenhouse gas reductions). However, some in the industry and the government believe that in the current crisis the fuel economy target and/or the speed with which the industry makes progress toward it should be lessened.

The domestic auto industry is faced with a set of choices: how much should it change, how fast should it change, and how should it respond to demands for increased fuel efficiency? The purpose of this paper is to help resolve this debate.

Given recent government intervention, the impact of these decisions reach far beyond the industry. Every American taxpayer now holds a stake in the success of our domestic auto industry.

To provide objective information to help policy makers understand the issues involved, we conducted research on two themes that we report here. One theme looks at change in a crisis, and the other looks at the impacts of mandated fuel economy improvements on the industry. What links the themes is the product portfolio.

The long-term success of a turnaround depends on executing an excellent portfolio of products, and the impact of mandated fuel economy improvements depends on the alignment of the industry's product portfolio with consumer values. The questions concerning speed and scope of change and the impact of fuel economy on profitability address the core drivers of long-term viability of the Detroit 3.

Methodology

To address the questions of speed and scope of change, we looked at the actions of other large corporations that have managed successful turnarounds. There is extensive literature on this subject, both academic studies and interviews with corporate leaders. In order to address the question of fuel economy standards, we model the impacts of different fuel economy standard increases (30%-35 miles per gallon (MPG), 40%-37.7 MPG, 50%-40.4 MPG) on the profitability and sales of the industry and separately for the Detroit 3, the Japan 3, and all others. The model captures the cost of fuel economy improvement on

suppliers, its impact on pricing, and the resulting changes in demand. The inputs to the model are the most recent and accepted estimates of all the key parameters, but since there is debate on many of these values, we conduct an extensive sensitivity analysis on the results.

Findings

The lessons from successful turnarounds are very clear:

- **Implement Broad, Deep, Fast Change**: All successful efforts addressed the fundamental issues that drove them into crisis and they did it as quickly as possible.
- **Replace Management Team**: In addition to changes in strategy and structure, in all cases there were widespread changes in management.
- **Transform Culture:** All of the successful companies considered changing culture a critical requirement and made it a top priority for success.
- **Build a portfolio of excellent products:** The path to long-term financial health for any company rests on having a great product portfolio. Our domestic auto industry, in its modern incarnation, has never been able to execute an excellent portfolio, only isolated successes.

The impact of higher fuel economy standards on industry profits is also very clear:

- **An industry-wide mandated increase in fuel economy of 30% to 50% (35 MPG to 40.5 MPG) would increase the Detroit 3's gross profits by roughly $3 billion per year, and increase sales by the equivalent of two large assembly plants**.
- **The Detroit 3 gain profits over base in all scenarios, with the largest profits gained from pursuing more aggressive fuel economy.**
- **Japanese automakers profit gains are smaller than the Detroit 3**, with the smallest profits gained from pursuing 50% increase (40.4 MPG) in fuel economy.
- **At 50% increase, the Japanese industry loses sales while the domestics continue to gain in sales and profitability,** a result driven by the different starting points.

Profits				
	Base	30% (35 MPG)	40% (37.7 MPG)	50%(40.4 MPG)
Detroit 3	$39.5	$2.9	$3.2	$3.1
Japan 3	$27.1	$0.9	$0.7	$0.3
Others	$18.8	$0.9	$1.0	$1.2
Market Total	**$85.4**	**$4.7**	**$4.9**	**$4.6**

Vehicle Sales (000)				
Scenario O/(U) Base				
	Base	30% (35 MPG)	40% (37.7 MPG)	50% (40.4 MPG)

Detroit 3	7,276	527	521	446
Japan 3	5,282	72	(27)	(171)
Others	2,646	145	147	133
Market Total	**15,204**	**744**	**641**	**408**

The value given to fuel economy by automakers has critical impact moving forward:

- **There is compelling evidence that the Detroit 3 have systematically underestimated the value of fuel economy to customers.**
- **Because Detroit 3 automakers have long underestimated the consumer value of fuel economy, raising fuel economy standards will not cost more than consumers would be willing to pay.**
- **In every scenario, the average cost-per-vehicle (direct plus indirect) is less than what consumers would be willing to pay.**

Consumer Value of Fuel Economy			
Passenger Cars			
Industry-Wide Fuel Economy Improvement	Direct + Indirect Cost per Vehicle	Consumer Value of Fuel Saved	Value - Cost
30%	$1,679	$2,180	$501
40%	$2,296	$2,697	$400
50%	$2,935	$3,136	$201
Light Trucks			
Industry-Wide Fuel Economy Improvement	Direct + Indirect Cost per Vehicle	Consumer Value of Fuel Saved	Value - Cost
30%	$1,752	$2,994	$1,242
40%	$2,410	$3,701	$1,290
50%	$3,111	$4,319	$1,208
Total Light Vehicles			
Industry-Wide Fuel Economy Improvement	Direct + Indirect Cost per Vehicle	Consumer Value of Fuel Saved	Value - Cost
30%	$1,715	$2,578	$863
40%	$2,352	$3,187	$835
50%	$3,021	$3,714	$693

Testing Our Assumptions: Sensitivity Analysis

Recognizing that our findings challenge long-held domestic industry beliefs about fuel economy and will be met with great skepticism and scrutiny, we conducted a sensitivity analysis of our eleven assumptions, such as the price of fuel and consumer value of fuel economy.

Our finding that Detroit 3 automakers' profits would increase under higher fuel economy standards is very robust. We assessed the sensitivity of our prediction of Detroit 3 automakers' profits to extreme values of 11 uncertain factors we predict for our model, and found that just three of the factors had extreme values capable of generating a drop in Detroit 3 profits: an extremely low consumer response to fuel costs relative to vehicle prices (less than one-fourth Sawhill's (2008) statistically estimated median value), a gasoline price of $1.50 per gallon (an extremely low price not seen since 1999), or direct manufacturing costs (materials and labor) that are 2.2 times the estimates we used (Meszler) and 3 to 4 times the National Research Council (2002) estimates (adjusted for inflation). While the three factors could result in losses rather than gains in profits, the likelihood of lost profits is low. There is a 7% chance that profits would be less than zero if CAFE were increased 30% (35 MPG), a 15% chance of a

loss if it were 50% (40.4 MPG). As intuition would suggest, the larger mandate increases the downside risk. But it also offers greater upside opportunity, as the chance that increased profits could exceed $6 billion is 18% for a 50% increase in fuel economy, but only 6% for a 30% increase. The total uncertainty attached to the larger increase is greater, which means both more upside and more downside.

Overall, the risk and reward profile of these scenarios is very positive, with only a small chance of losing and a very large probability of gain.

Sensitivity Analysis				
		30% (35MPG)	40% (37.7MPG)	50% (40.4 MPG)
Probability Change Profit <$0		7%	10%	15%
Probability Change Profit >$6bn		18%	13%	6%

Conclusion

A broad consensus has emerged in the current crisis that the Detroit 3 automakers need to be transformed. The business model they have followed since the 1970's is clearly broken. While the need for transformation is widely accepted, there is still disagreement about the scope and pace of change, and some voices in the industry and in government are suggesting that fuel economy and greenhouse gas regulations should be lowered or delayed.

We studied two general themes in the research reported here: the nature of change in a crisis and its impact on the way transformations should be done, and the impact of higher fuel economy regulations on costs, consumer demand for vehicles, and automakers' profits. Our findings support rapid, wide-reaching change in business models. The key to a long-term recovery is executing an excellent portfolio of products, and we find evidence that increasing fuel economy standards encourages automakers to create a portfolio of products that is more likely to raise the profits of the Detroit 3 automakers than to lower them.

Chapter One: Change in Crisis

There are those who believe that because the domestic auto industry is in crisis, it is the wrong time to make anything other than the immediate changes necessary for today's survival. On the other hand, there have been widespread calls for broad changes that address the core issues that led to the current troubles and that these changes should be executed as quickly as possible.

This sections addresses four major questions:

- Should changes be broad or focused on immediate issues?
- Should change be as fast as possible or spread out?
- Should existing management be replaced?
- Is changing culture important in a turnaround?

These questions are broadly important to US policy because the taxpayer is funding the bailout, so it is of vital national interest that it succeeds. If the industry is compelled to move quickly and broadly when caution and focus is in order, then success is imperiled. But just as dangerous is a turnaround that fails to address the core issues and only defers the day of reckoning, making it ultimately more expensive.

ANALYSIS OF SUCCESSFUL TURNAROUND EFFORTS

In order to address these questions, we analyzed extensive literature on the successful turnaround of six international companies of comparable size, distress, and diversity to the domestic automobile industry. There is an abundance of academic research on these cases as well as multiple interviews with the people who led the efforts (sources are in the back). One of the world's most successful turnaround experts, David James, has also commented on many of these issues.

There is a surprising degree of agreement from all these sources on these questions and lessons learned about change, personnel, culture and product portfolio. The research revealed universal approaches critical to success.

SUCCESSFUL TURNAROUND: KEY LESSONS LEARNED

I. Implement Broad, Deep, Fast Change

There is overwhelming agreement that change should take place as fast as possible and be as comprehensive as possible. A crisis presents a unique opportunity to make changes that would not be possible in "better" times and urgency is a must for the successful renewal of a company on the brink.

Further, the root causes of the crisis lie in deeper issues of structure and strategy, so if they are not changed the company will do too little, too late and not deal with real problems.

"The rallying cry of our turnaround was do it **fast**, do it **right away**, do it **all at once**, do it **now**!" –**Continental**

"Make **mega changes**" and "Move **expeditiously**." **-Lockheed Martin**

"We had ...a '**kitchen sink'** quarter, when you clean up the mess."–**Novell**

"When you have that window of opportunity called a crisis, move as **quickly as you can**, get **as much done** as you can." **-Xerox**

"Fixing IBM required an enormous sense of **urgency**. " "We **changed almost everything** in this company, literally, in three months, eight months, a couple of years." **-IBM**

"Many executives misdirect their efforts...they put all their energy into managing the company's cash flow when they **should be addressing corporate structure and strategy**...because they find it hard to rethink the structures and strategies they themselves put in place. Whatever the reason, the consequences are usually the same. The rescue starts too late and accomplishes less than it should." –**David James**

"A **degenerative disease will not be cured by procrastination**. It requires decisive action." –**Peter Drucker**

II. Replace Existing Management Team

There is strong consensus that widespread changes in personnel are necessary in a turnaround. For most, the issue was changing the people at the top of the organization, while IBM had a big problem with middle management. But the dominant thinking is that the most serious problems are the result of poor management, not external bad luck, so asking the people who made the mess to genuinely admit it was their fault and reverse course will not happen. Instead, the existing management clings to the hope that some miracle will rescue them and avoid the difficult decisions.

When Sergio Marchionne took over Fiat, he made significant changes in its management team, going down several levels as did Carlos Gohn at Nissan and Renault. Just recently, Toyota, which has had its first loss in many years but is not imperiled, announced it would replace 40% of its management, including the top three executives.

"**Clean House**. The same team that leads a company into crisis is rarely able to get it back on track." –**Continental**

"We ...**replaced** most of the executive **management team**, reducing seven layers of management to four." –**Novell**

"If necessary, **sweep out the old leaders**...Unfortunately in many cases I have **had to fire them** because they...maintain their **hope for some miracle solution and resist the rescuers** in an effort to conceal their failure." – **David James**

"At the top of the organization was a leadership team that really wanted to speed things up. The customer facing parts of the organization felt that that the changes were the right thing to do. But **there was a group of people in the middle that didn't want to have anything to do with it**. They just wanted it to go away. They wanted it to be the way it used to always be." **-IBM**

III. Transform Culture

One of the consistent themes in the literature is the importance of culture to a successful turnaround. Everyone said that culture was a main contributor to the problem and needed to be addressed directly and quickly. Anne Mulcahy, Xerox CEO, made it clear she thought the culture was a problem but that rather than "kill it", she would change it. Recent correspondence with GM's CEO indicates he believes changing culture is critical to GM's long-term viability and has made it a priority in his turnaround plans.

"**Establish a results oriented culture**...Build a new corporate culture. A healthy culture is simply...honesty, trust, dignity, and respect" –**Continental**

"**Novell had a dysfunctional culture, a sick culture**...a culture of fear...and **it was a big problem**." – **Novell**

"In addition to cost cutting, innovation, and growth...**the fourth requirement for transformation is culture change**." – **Siemens**

"**It's all about culture**. You have to transform the culture, not just the strategy. Culture is what people do when no one is watching...**Culture** isn't just one aspect of the game; it **is the game**." –**IBM**

When the CEO of one of Mulcahy's biggest lenders said she would have to kill the culture to succeed, **Mulcahy shot back, "I am the culture. If I can't figure out how to bring the culture with me**, I'm the wrong person for the job." She **appealed to employees with missionary zeal**, in videos and in person--what Burns called a "laying on of hands." She implored them to "save each dollar as if it were your own. **-Xerox**

IV. Implement a Clear and Well-Communicated Strategy

It is important to have a clear and well-communicated strategy. All the CEOs talked about the need to work hard to communicate the plan to all levels of the organization in a clear and consistent way and, while listening to feedback, to be firm on what needed to be done. Successfully implementing the changes required aligning the organization at all levels. Since all turnaround plans required deep changes in the operations of the enterprise, the people on the front lines had to understand what they needed to do and why they needed to do it.

V. Institutionalize Accountability

Another theme was the importance of identifying failure quickly and eliminating it. There is a tendency to hold on to existing people, plans, and businesses even after repeated failures. This simply removes accountability and perpetuates problems.

VI. Focus on value, not costs

To execute a successful turnaround, management must understand how their actions change the total value of their products, not just the costs. This means having an understanding of how their customers view their products; what it is the customers want and are willing to pay for. A culture of cost cutting, unfortunately, leads to the development of products that people do not like, as product decisions are made on a basis that is always incomplete and usually disastrous.

"After 15 years of a low cost approach, **Continental** had created a ***doom loop***. By **focusing only on costs**, **the airline had created a product no one wanted to buy.**" **-Continental**

The culture of cost cutting at the Domestic 3, especially GM, has been well documented. While the forward capital plan has not been published, press reports have stated that capital and engineering resources for the next generation of products have been cut fairly drastically. If so, then there is reason to be concerned about their market success and the long-term health of the companies.

VII. Understand the balance sheet

Turning around a major enterprise requires understanding what the real assets and liabilities are. Simply trying to increase cash flow will be too slow and do too little to make a significant difference. The company is usually hemorrhaging cash so changing product or pricing will require too much time to save the enterprise. In the context of the auto companies, this means understanding which regions, brands, and products are generating real value and which are not and then removing the former ruthlessly.

Bottom line: Execute Excellent Portfolio of Products

The path to long-term financial health of any company is not a great mystery; it rests on having a great product portfolio. Our domestic auto industry, in its modern incarnation, has never been able to execute an excellent portfolio, only isolated successes. The fundamental cause has been insufficient capital and engineering, driven by a culture focused on cost cutting, myopic to value and tone deaf to customers. The management team is fundamental to the culture. They lead and sustain it. Their worldview, their values, and their plans have made these companies what they are today. One would hope that human beings are capable of radical change in values and vision but human experience proves otherwise. Instead, it is human nature, especially when joined by others, to defend one's position, in the hope that one day you will be proven right. The result: every decision will be challenged; every change watered down. The problem is they don't have time to waste.

As the Detroit 3 automakers are poised on the brink of turnaround or demise, they must make a choice of how far, how fast, and how fuel-efficient the transformation of their product portfolio will be. This is not their decision alone to make. Given the highly interdependent nature of the domestic automobile industry, the taxpayer has substantial vested interest in the choices made by not just GM but all domestic automakers.

At this moment in history, there is a widespread consensus in Detroit, both within the industry and the media, that the industry is being forced to build more fuel-efficient vehicles by a government that places more importance on ideology than the market. Story after story frames the issue of a struggling industry that will not survive tough fuel economy standards. However, there is substantial evidence that the domestic auto industry has ignored customers' demands for fuel economy, and has consistently undervalued the impact of fuel economy on their profit potential. For example, GM conducted internal research for decades that found customers value fuel economy far more than the company's financial calculations assumed. As publicly reported, the company systematically discounted these research results when calculating the benefits of improving fuel economy, often by as much as two-thirds. In other words, if the research said the sales gain would be 10%, the number used to do financial calculations was 3%. In fact, the belief that fuel economy was not "worth it" became so ingrained into the culture of the company, and so institutionalized in decision making that the senior people might not even be aware that

they have been ignoring their own research.

The previous section provided detailed documentation on the need for transformation to be far and fast if the Detroit 3 are to succeed. The question that remains is: How fuel-efficient? We now turn to this fundamental question.

Chapter Two: Profit impact of higher fuel economy standards

Regulatory standards exert substantial influence on product portfolios and the attributes of products, and both Federal and state standards for greenhouse gas emissions (GHG) and fuel economy were in the process of tightening before the current industry crisis. Congress established an industrywide 35 MPG Federal Corporate Average Fuel Economy standard (CAFE) to be attained by the year 2020, and California's Air Resources Board (CARB) set a GHG standard that by 2016 is roughly equivalent to 35MPG. The U.S. Environmental Protection Agency (EPA) is expected to issue Federal GHG rules in the near future. However, the current crisis has prompted some in the industry and others to argue for reducing or at least slowing the implementation of standards until the crisis is over.

The "just not in a crisis" argument for reducing or delaying future fuel economy and GHG emissions standards is based on the claim that the costs of improving vehicles exceed what consumers are willing to pay for the improvements. This claim is not different because of the crisis, and has always been a standard element of the industry's criticism of higher standards. Such investments are certain losers, asserts the industry, and we support the social goals of the investments and are committed to make them someday, just not in a crisis.

This argument depends on some unproven propositions. If the unproven propositions are not true, then the "just not in a crisis" argument fails. The unproven propositions are (1) that automakers know the value that consumers place on attributes of vehicles, (2) that automakers know the cost of changing attributes, and (3) that the vehicles that exist in the vehicle market are optimal in all attributes.

Our analysis of the impact of fuel economy standards on profitability raises doubts about all three propositions on which the "just not in a crisis" argument depends. The "just not in a crisis" conclusion is, "lowering or slowing the implementation of higher standards would give relief (higher profit) to the Detroit 3." Our analysis tests this conclusion and raises the stakes by addressing the question, "Would ***tightening*** the standards and/or ***speeding*** their implementation result in higher or lower profits for the Detroit 3?"

We estimated the impacts of higher fuel economy standards relative to a baseline forecast of sales, revenue, and costs for 2016. The baseline forecast used 2008 fuel economy levels (average MPG 26.9), and incorporated anticipated changes in products offered and sales by manufacturer and segment. We examined three scenarios for higher industrywide fuel economy standards defined by percentage increases in baseline fuel economy: 30% (35 MPG approximately CAFE 2020 or Pavley 2016); 40% (37.7 MPG); and 50% (40.4 MPG). Consumer demand and manufacturer cost models were used to estimate for each scenario the impacts on sales and profits relative to the baseline. We then conducted an extensive sensitivity analysis to the key parameters in our model.

Baseline: Middle Range Industry Forecast 2016

Middle Range Industry Forecast, 2016			
	Thousands of Units Sold		
Type of Vehicle	**Detroit 3**	**Japan 3**	**Industry**
Passenger Car	2,660	3,374	7,773
Crossover Utility	1,370	1,101	2,868
Minivan & Large Van	581	232	859
Pickup	1,772	368	2,140
Sport Utility	892	207	1,565
Industry	**7,276**	**5,282**	**15,204**
Source: The Planning Edge, April 2009			

See Citi Investment Research (2009), *CAFE Panel Conference Call & Briefing*, April.

Type of Vehicle	Chrysler	Ford	GM	Honda	Nissan	Toyota	Others	Industry
Passenger Car	418	828	1,415	1,065	664	1,645	1,738	7,773
Crossover Utility	174	574	622	345	235	520	396	2,868
Minivan & Large Van	307	140	135	127	0	106	45	859
Pickup	440	612	719	21	96	251	0	2,140
Sport Utility	253	185	454	0	94	113	466	1,565
Total	1,592	2,339	3,345	1,559	1,089	2,634	2,646	15,204
Source: The Planning Edge, April 2009								

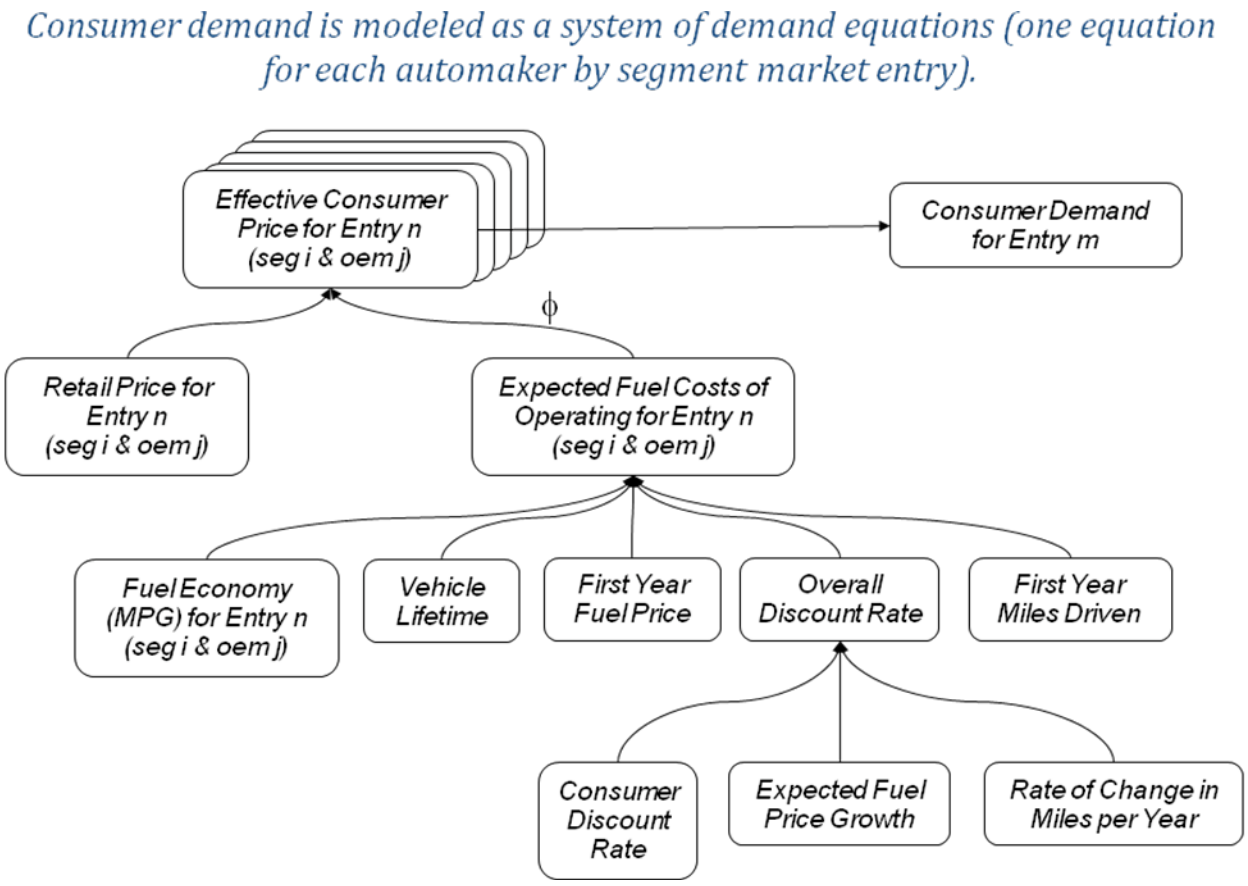
See Citi Investment Research (2009), *CAFE Panel Conference Call & Briefing*, April.

Sales by automaker and segment for our baseline scenario were provided by The Planning Edge. All the changes we consider in this report were with respect to this baseline. The scenario represents The Planning Edge's mid-range outlook for the U.S. market in the near future.

We defined cost and demand for the automaker by segment level. In the analysis, a market entry (the lowest level we modeled) is defined as an aggregate of an automaker's products in a segment. For example, GM has several Luxury Car products that we aggregated into a composite "GM Luxury Car" market entry. The attributes of the GM Luxury Car market entry are the sales-weighted averages of the products that comprise the market entry (fuel economy is the sales-weighted harmonic average).

The aggregation to automaker by segment market entries is consistent with our market demand and automaker cost information. We are using a price-elasticity demand model that is defined at the automaker by segment level. The own and cross-price elasticities were originally derived from a segment level elasticity model from General Motors. We estimated the automaker by segment elasticities using a method developed by the Congressional Budget Office. The costs of improving fuel economy, which were provided by Meszler Engineering Services (See CITI Investment Research (2009) for details), are defined at the segment level. We applied these segment-level costs to each automaker within the appropriate segment.

Consumer Demand



Consumer demand is modeled as a set of 75 demand equations -- one for each market entry. There are 7 automakers: the Detroit 3, the Japan 3, and an aggregate of all others. With the 15 segments in our model, there are 105 (=15X7) possible market entries, but since an automaker may not offer products in all segments there are 75 actual market entries.

The quantity of entry **m** demanded by consumers is a function of the "effective consumer prices" of all 75 market entries. (The elasticity matrix is 75 X 75.) The effective consumer price for an entry **n** is the retail price of that entry plus the adjusted expected future fuel costs for that entry. The adjustment in expected fuel costs consists is multiplied by **ϕ**, a measure of the relative consumer response to fuel cost (an operating cost) vs. retail price (a capital cost).

We estimate the expected fuel costs as the discounted present value over the life of the vehicle of the annual future expected fuel costs of operating the vehicle. Along with the fuel economy of entry **n**, several consumer preference factors determine expected fuel costs. Vehicle Lifetime is the consumer time horizon for the present value calculation. First Year Fuel Price and First Year Miles Driven establish the level of annual fuel costs.

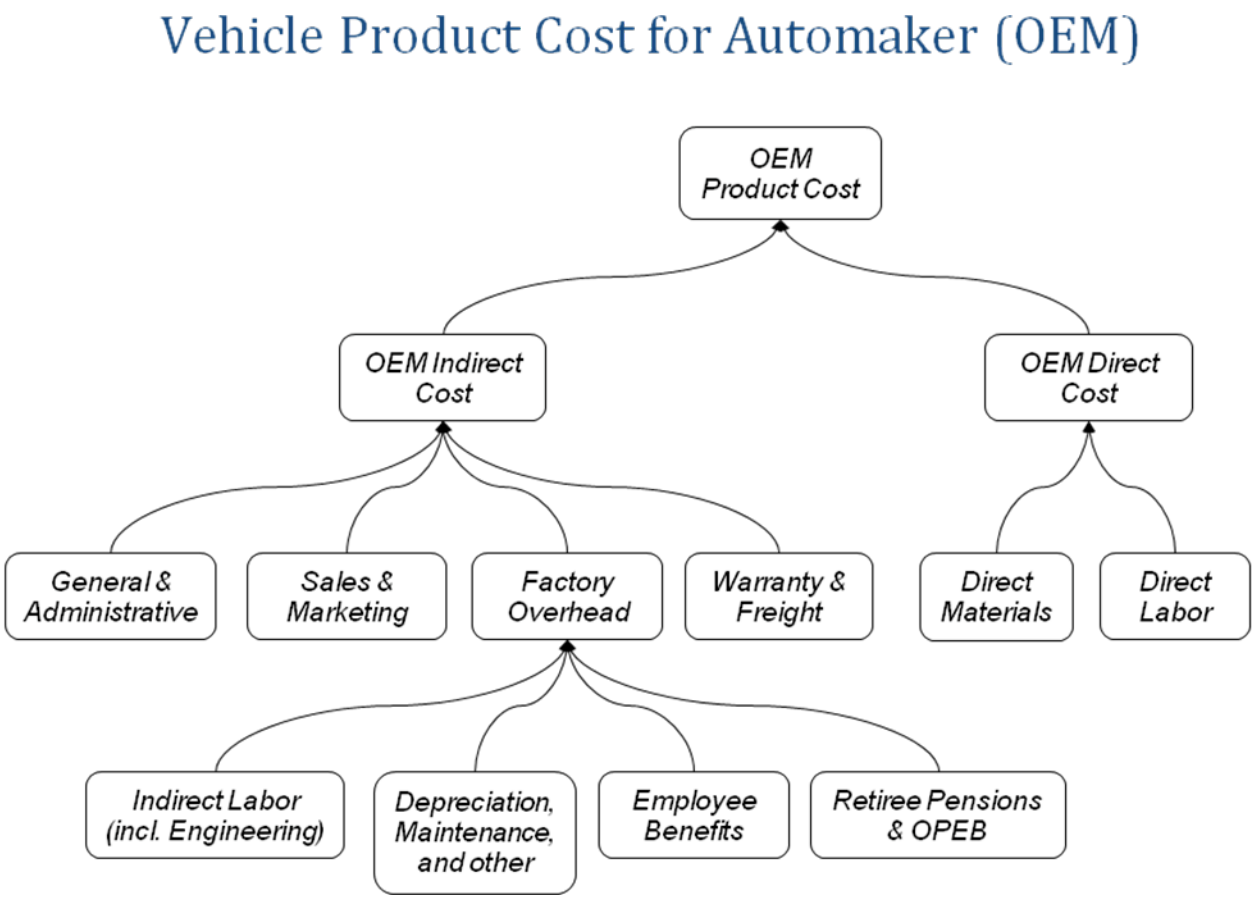
The future fuel costs are brought into present value by applying the Overall Discount Rate, which is defined by consumer behavior and expectations about the Expected Fuel Price Growth, the Rate of Change in Miles per Year, and the (real) Consumer Discount Rate. Expected annual vehicle miles

generally fall as a vehicle ages based on two considerations. Not all vehicles survive from one year to the next, and a declining fraction of vehicles of a given vintage remain in use as they age. There is also evidence from the National Household Travel Survey that older vehicles are driven fewer miles.

Direct and Indirect Costs of Improving Fuel Economy

We estimated the direct and indirect costs of improving fuel economy at the "enterprise" level—combining the change in costs at the automaker and its dealerships.

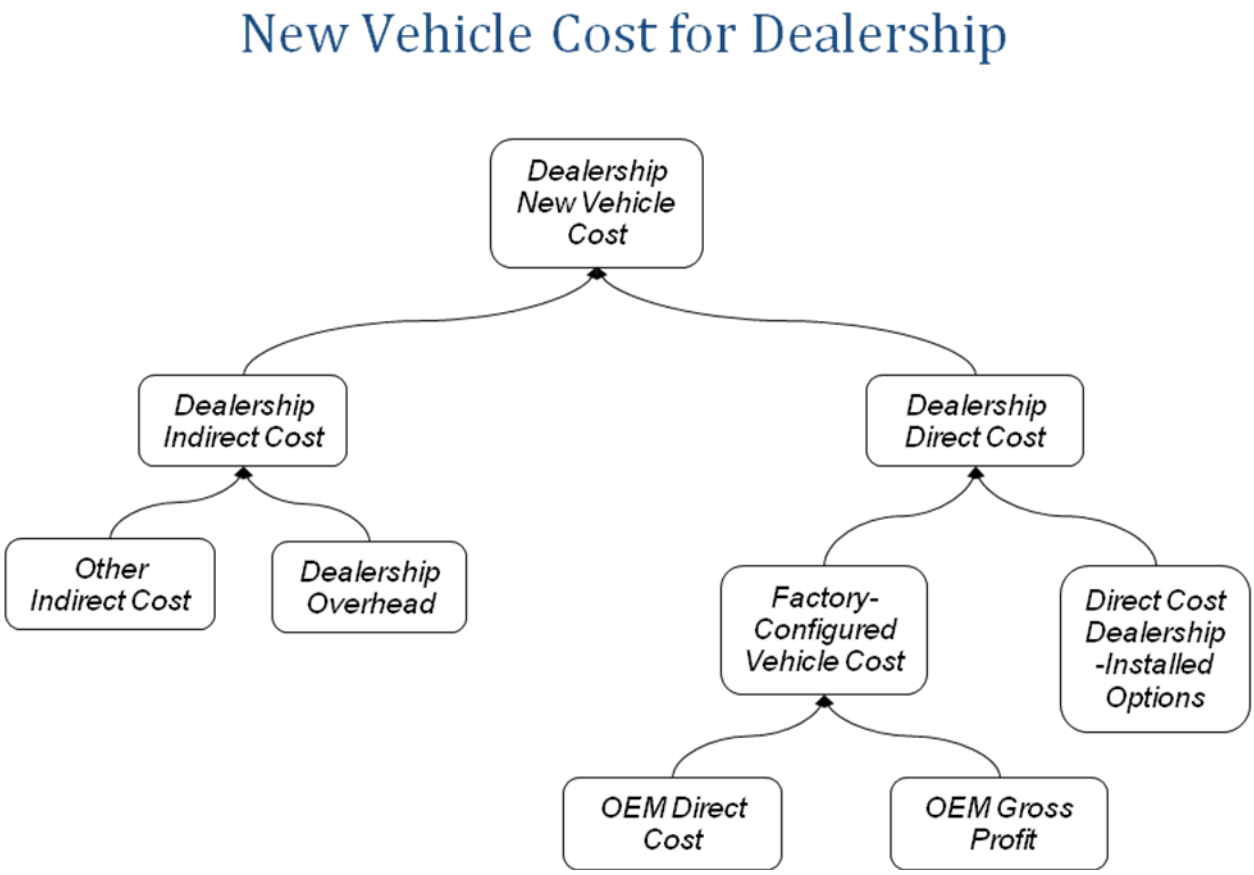
Automakers' Direct and Indirect Costs



We developed a model of product cost to estimate the impact of improving vehicle fuel economy on OEM and Dealership cost and retail price. Our estimates of the impact of a given industrywide percentage increase in fuel economy on product cost and profit assume that each market entry is improved by the same percentage. This significantly eases the model's computational burden, and does not materially influence our directional findings. Our analysis focuses on the impact of alternative scenarios on the (gross) profits of the Detroit 3. If they can meet an industrywide increase in fuel economy by applying different rates of improvement by segment, then they would be able to increase profits (reduce losses) above what results from the assumed uniform improvement rate. Thus, our (gross) profit impacts are understated.

The OEM Product Cost model distinguishes between Direct and Indirect Costs. The estimates of the Direct Cost of improving fuel economy were developed by Meszler Engineering Services and are contained in CITI Investment Research (2009). Direct cost = Direct Labor + Direct Materials. We assume that an improvement in fuel economy also increases some Indirect Cost items including, Warranty & Freight, and Factory Overhead (mainly Engineering in Indirect Labor and Depreciation, Maintenance, and Other). We measure the Indirect cost increase by multiplying Direct cost by an Indirect Cost Ratio (assumed to be identical for all automakers).

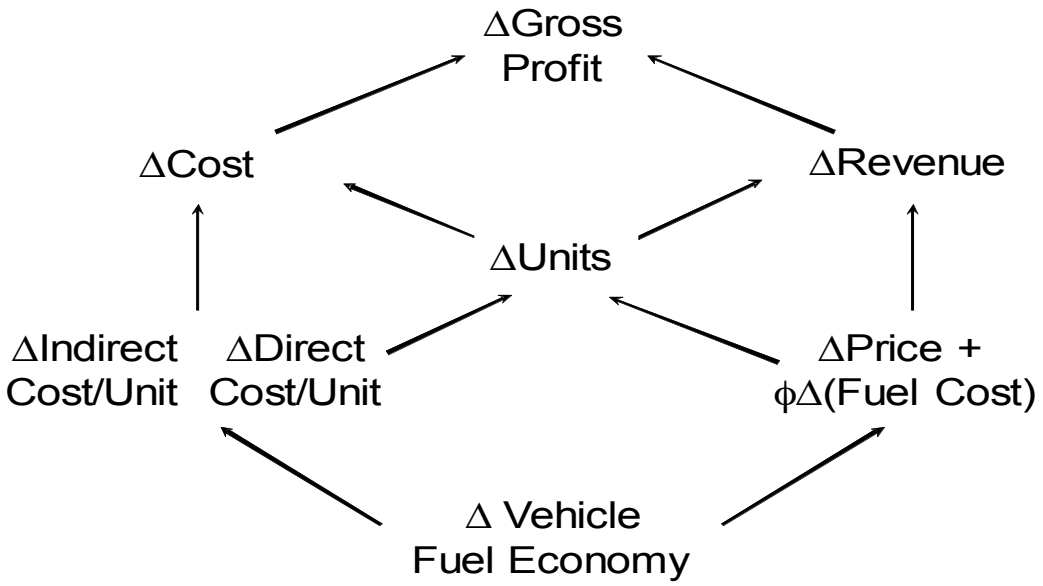
The Dealerships' Direct and Indirect Costs



The Dealership New Vehicle Cost model also distinguishes between Direct and Indirect Costs. From the vertical perspective of the enterprise (the OEM and its dealerships), dealership costs are all indirect. We incorporate dealership costs that change when technologies are used to improve fuel economy into our measure of Enterprise Indirect Cost. These may include Direct Cost Dealership-Installed Options, Dealership Overhead, and Other Indirect Cost.

Enterprise Cost Model

An industrywide increase in vehicle fuel economy has impacts on OEMs' and dealerships' product costs, on product prices, and on consumers' willingness to pay for vehicles —leading to changes in profits.



We combine each automaker and its dealerships for an enterprise view of costs, sales, revenue, and profits. An industrywide increase in fuel economy increases the cost per vehicle. Direct Costs changes include OEM direct labor and materials costs of new components that raise the cost of manufacturing. Indirect Cost changes include other changes in OEM costs that vary with output (warranty and freight, if affected by new technologies); and some OEM costs that do not vary with production, but cover the costs of changing the vehicle or the manufacturing process (OEM engineering expense and OEM factory overhead). Indirect costs also include dealership costs that are changed to deal with selling and servicing new technologies.

Vertical View of Enterprise (Automaker and Its Dealerships)

Change in Cost = (1 + Indirect Cost Multiplier) X (change in Direct Cost)

Change in Price = (1 + ICM + Gross Profit Rate) X (change in Direct Cost)

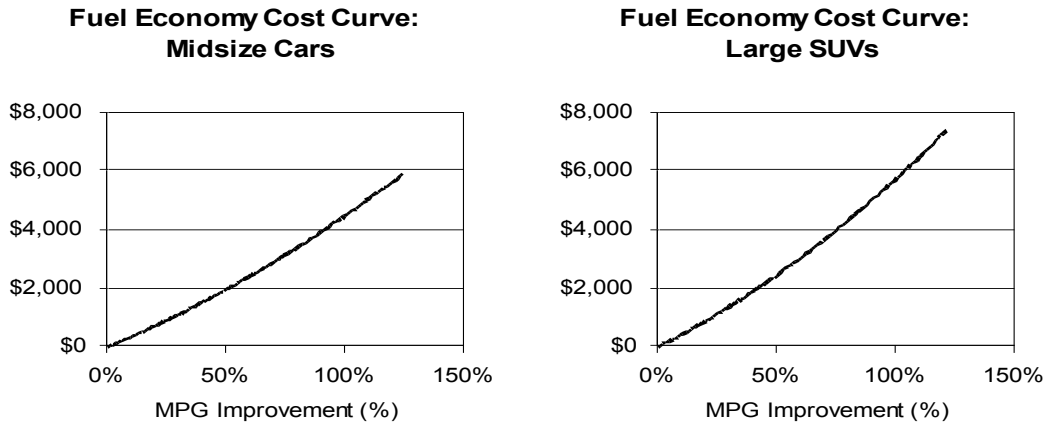
Consumers

Change in Full Price = Change in Price + ϕ(change in Fuel Cost)

The prices and full prices of all market entries are changed by the industry-wide improvement in fuel economy. The impact on sales on vehicles by automaker and segment is predicted by applying the elasticity matrix to the changes in full prices.

Change in Gross Profit = Change in Revenue - Change in Variable Cost

We estimated the increase in the per -vehicle Direct Costs resulting from raising fuel economy using cost curves. The curves differ by segment, as seen in the examples.



Source: Meszler Engineering Services, April, 2009

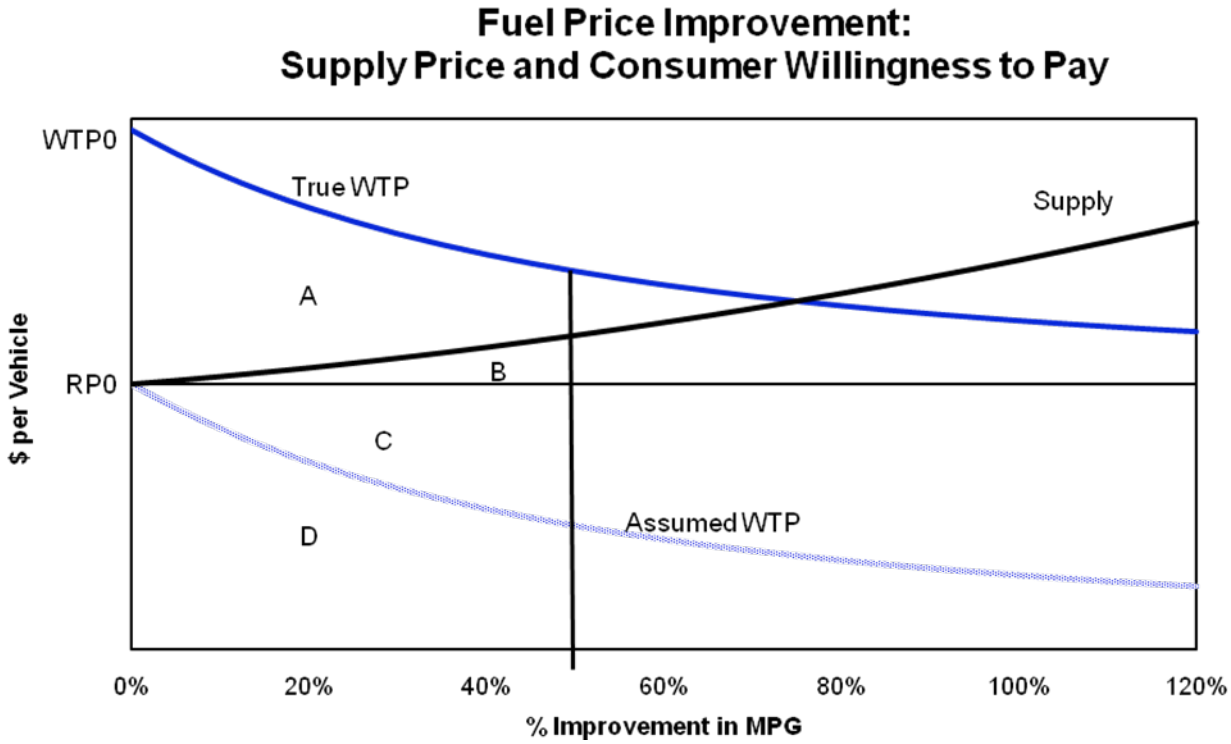
Our estimates of the impact on Direct Cost of a percentage increase in fuel economy were computed using information provided by Meszler Engineering Services (see CITI Investment Research (2009) for details). We defined cost curves for each segment that predict the change in Direct Cost as a quadratic function of the percentage change in fuel economy.

$\Delta DC = A(\Delta E/E) + B((\Delta E/E)^2)$

In the sensitivity analysis, we treat uncertainty in the change in cost through an uncertain multiplicative factor that scales the change in direct costs to be higher or lower than the prediction from the curves.

Automaker Knowledge of Consumer Willingness to Pay

Evidence that automakers underestimate the value of fuel economy to consumers leads us to reject the assumption that fuel economy is optimized in the baseline scenario.



A standard assumption of neoclassical economic theory is that automakers have complete knowledge of the market -- they know the preferences of their customers for all vehicle attributes, including fuel economy, and automakers make and sell vehicles that meet these consumer preferences exactly. It necessarily follows that any improvement in fuel economy would cost more to supply (areas B + C + D) than it would be valued by consumers (area D).

However, there is compelling evidence that automakers (especially the Detroit 3) systematically underestimate the value of fuel economy to consumers.

- References to poor selection ("I can't find the vehicle I want with the fuel economy I need.") by consumers who stated that it was a bad time to buy a new vehicle increased during the 1970s, peaked in 1980, and did not return to pre-oil shock levels until 2002. References started rising again in 2003 and exceeded the 1980 peak in 2008 (University of Michigan Survey of Consumers).

- In recent years, as the real price of gasoline increased the unit sales of fuel-inefficient SUVs and large cars, which ought to have fallen, did not seem to be affected. Why? Automakers substantially offset the increase in the resulting present value of fuel costs by dropping prices of vehicles and dropping prices of fuel-inefficient vehicles the most. Estimates of the responsiveness of vehicle sales to fuel prices that ignore these vehicle price offsets understate consumer preferences for fuel economy (McManus 2007; Miller & Langer 2008).

- "…they are not making cars and trucks that enough Americans want to buy. And this has been true to some degree since the first energy shock hit the U.S. in the early 1970s." (Crandell & Winston WSJ 11/27/08)

- Continuing loss of market by Detroit 3 to competitors with more fuel-efficient vehicles.

Using the True WTP (assuming consumers respond the same to fuel cost as to retail price) the net gain to consumers is the area A. Automakers can raise prices and increase Gross Profits.

Results: Profits and Sales Impacts

Industry average fuel economy is 26.9 MPGin the baseline mid-level future-market scenario. Gross profits are estimated for the automakers and their dealerships combined at $85.3 billion for the industry. Vehicle unit sales are 15.204 million, reflecting The Planning Edge's expectation of a recover from current sales that are running below 10 million on an annual basis Services (See Citi Investment Research (2009) for details).

We estimated detailed impacts for three scenarios for industry-wide fuel economy improvements:

30% improvement (35.0MPG)
40% improvement (37.7 MPG)
50% improvement (40.4 MPG)

We used the EPA's laboratory composite fuel economy values, unadjusted for CAFE flex-fuel credits, so a precise match to CAFE is not expected.

We estimated the detailed impacts on the industry of three levels of improvement in industrywide fuel economy: 30%, 40%, and 50%. Industry total gross profit increases relative to the base case in all three scenarios; Detroit 3 gross profits increase roughly $3 billion (8%) relative to the base case in all three scenarios.

Sales and Gross Profit Impacts				
	Base	30%	40%	50%
Market MPG	**26.9**	**35.0**	**37.7**	**40.4**
Gross Profits (billions)				
		Scenario O/(U) Base		
	Base	30%	40%	50%
Detroit 3	$39.5	$2.9	$3.2	$3.1
Japan 3	$27.1	$0.9	$0.7	$0.3
Others	$18.8	$0.9	$1.0	$1.2
Market Total	**$85.4**	**$4.7**	**$4.9**	**$4.6**
Vehicle Sales (000)				

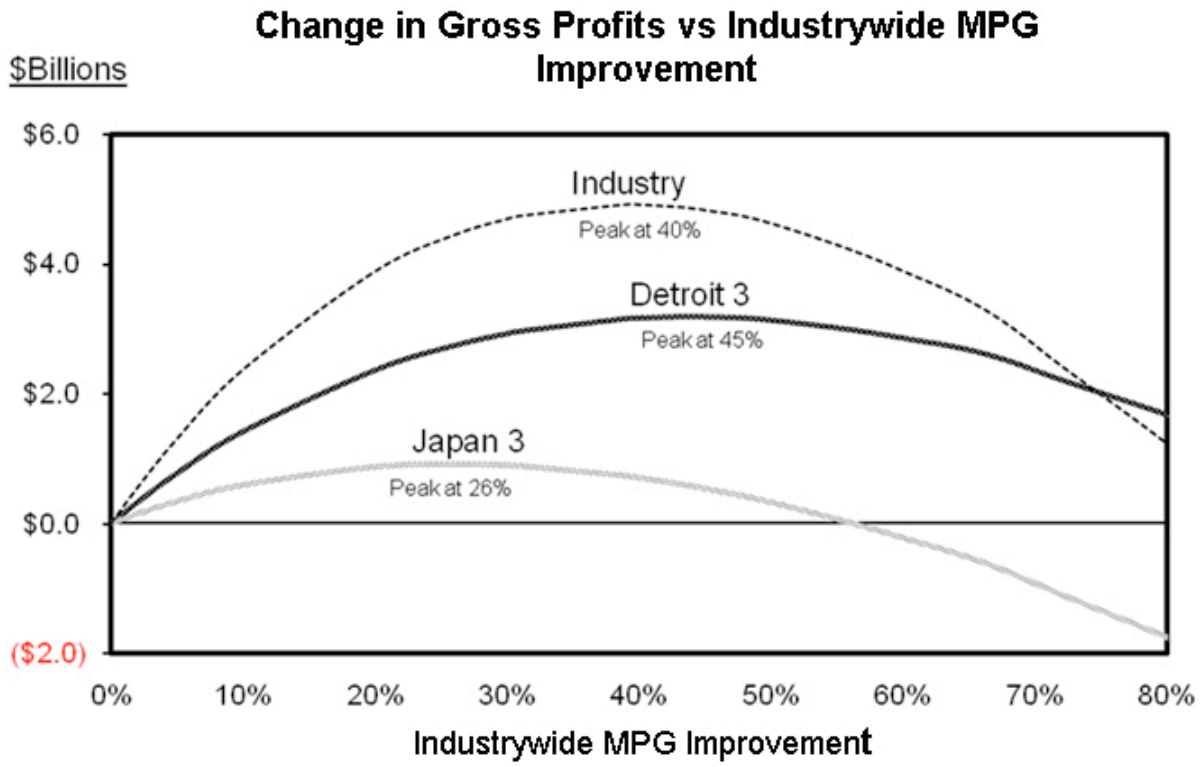
		Scenario O/(U) Base		
	Base	30%	40%	50%
Detroit 3	7,276	527	521	446
Japan 3	5,282	72	(27)	(171)
Others	2,646	145	147	133
Market Total	**15,204**	**744**	**641**	**408**

The results show that higher fuel economy standards are favorable to the Detroit 3 automakers. Gross profits of the Detroit 3 automakers increase relative to the baseline by roughly $3 billion (8%) in all three scenarios. Unit sales of the Detroit 3 automakers increase relative to base by 446,000 to 527,000 (about two assembly plants at 80% utilization).

The results are not as favorable for the Japan 3 automakers. Gross profits of the Japan 3 automakers increase relative to the base case in all scenarios, but the size of the increase appears to fall as fuel economy standards increase from 35 MPG to 40.4 MPG. Part of the explanation for the less favorable outcomes for the Japan 3 automakers can be traced to changes in unit sales. The Japan 3 automakers' unit sales increase if industrywide fuel economy improves 30% (to 35 MPG), but decrease by 27,000 units if industrywide fuel economy improves 40% (to 37.7 MPG), and then by 171,000 units if industrywide fuel economy improves 50%.

Profit and Industrywide Fuel Economy Improvments

The patterns we observed in comparing the three scenarios for fuel economy improvement (30%, 40%, 50%) motivated an in-depth analysis. The change in gross profits rises and then falls as fuel economy improvement goes from 0% to 80%.



As fuel economy improvement goes from 0% to 80% (and higher), Direct and Indirect Costs rise at an increasing rate. At the same time, from the consumer's perspective, vehicle purchase price rises while the projected fuel costs of operating the vehicle fall. The consumer's full price falls if the fuel cost savings exceed the price increase, and the full price rises if the fuel cost savings fall short of the price increase.

The rising and then falling of the change in gross profits are the result of the interaction between monotonically rising industry costs and falling and then rising consumer full prices. Full price falls at smaller increases in fuel economy since consumers are willing to pay more for these increases than it costs automakers to make them so unit sales increase. At some point, the price increases exceed the fuel savings and full prices begin to increase, and unit sales begin to fall. Eventually the automakers' gross profits also stop rising and start falling.

Japan 3 automakers start with a more fuel-efficient fleet and face the u-turn in gross profits before the Detroit 3 do. Customers of the Japan 3 already get more fuel economy than do customers of the Detroit 3, so Japan 3 customers value a given percentage increase less than do Detroit 3 customers.

The point at which the Detroit 3's profit gains from industrywide improvements peak could occur at lower or higher improvements, if some factors are different from our prediction. For example, if fuel prices were higher than the $3 per gallon we forecast, then the turning point would occur at higher industrywide fuel economy improvement.

Robustness of Results to Uncertainty

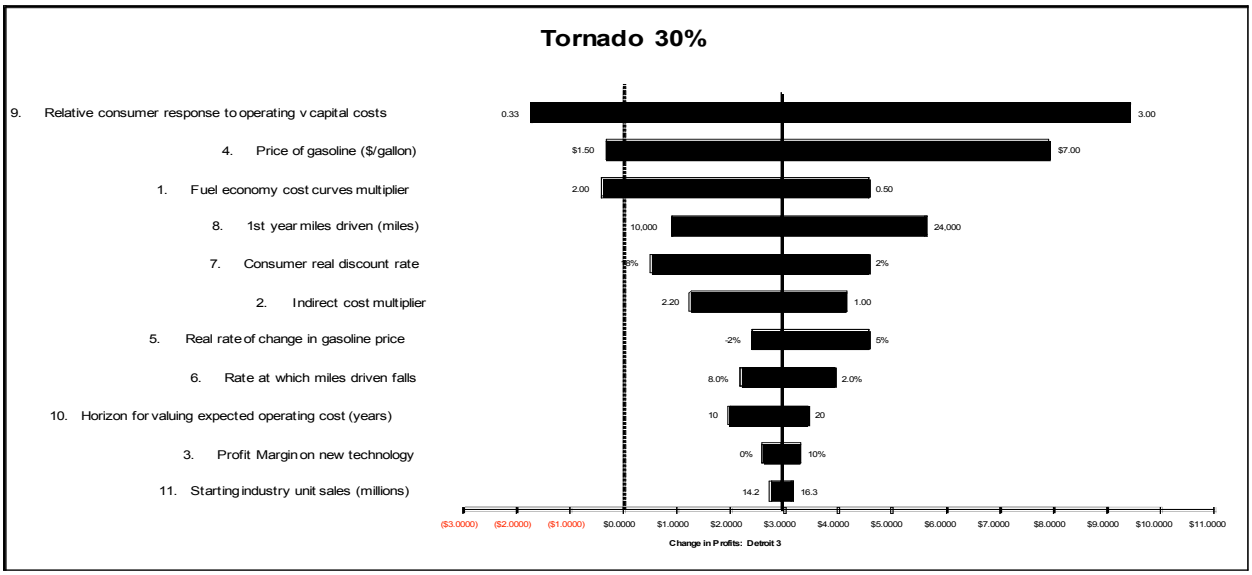
A sensitivity analysis was used to understand the robustness of our results. As far as we can ascertain, no one has taken a thorough look at the impact of uncertainty over the key inputs on sales and profits. People debate what the best single value of a parameter might be but they have such widely different prior beliefs that empirical analysis is always unpersuasive. Rather than add to the noise, we wanted to incorporate the full range of opinion into the results and see how the outcome changes.

The table below lists the factors and the ranges used in the sensitivity analysis. They can be grouped into three categories: costs and margins, consumer expectations, and consumer preferences. The range encompasses the debate over each of these issues. As example, to examine the range of debate on the costs of improving fuel economy, the Mesler cost curves, we used a multiplier. The base case is a one, but we also examined the cases where costs might be twice as much and half as much.

	Sensitivity Analysis: Factors Subject to Uncertainty			
	Factors	Range Used in Sensitivity Analysis		
		Unfavorable	Base	Favorable
Cost & Margins	Fuel economy cost curves multiplier	2	1	0.5
	Indirect cost multiplier	2.2	1.5	1
	Profit Margin on new technology	0%	5%	10%
Consumer Expectations	Price of gasoline ($/gallon)	$1.50	$3.00	$7.00
	Real rate of change in gasoline price	-2.00%	0.00%	5.00%
	Rate at which miles driven falls (Scrappage)	8.00%	5.20%	2.00%
	1st year miles driven (Future miles)	10,000	15,000	18,000
Consumer Preferences	Consumer real discount rate	18.00%	7.00%	2.00%
	Relative consumer response to operating v capital costs	0.33	1	3
	Horizon for valuing expected operating cost (years)	10	15	20
Industry	Industry size (millions of units)	14.2	15.2	16.3

The findings are very similar for all three scenarios. The 30% case is displayed below as a "tornado" chart; the charts for the other two cases are in the appendix. The range of bar reflects the impact on Detroit 3 profits as the uncertainty swings from unfavorable to favorable; the bars are ordered by the size of their impact. There is a vertical line at zero. If the bar crosses this line, then the impact would be to decrease profitability, but if it is on the right, the profits are still positive, even at the unfavorable value.

The robustness of the results is quite striking and sheds light on the debate. Most of the uncertainties did not impact the basic result that increasing mandated fuel economy would increase Detroit 3 profits, but three did. If consumers valued fuel economy at half the value of a "rational man", gas prices were less than $1.50 a gallon, or the costs of improving fuel economy were twice the base case, then a 30% increase in CAFE would lower Detroit 3 profits. But none of the other uncertainties would affect the basic conclusion. The same results hold true for a 40% or 50% increase in fuel economy. Where you stand on these results depends somewhat on your beliefs about these three key parameters, but you would have to fall on the extremes to believe that improving CAFE would lower Detroit 3 profits.



The total risk and reward profile is more important to understand the impact of individual factors. The total risk is the combination of the individual risk factors in all the possible scenarios with their associated likelihood. To calculate the total impact we assumed that the range between the high and low captured 80% of the possibilities; in other words, there is a 10% chance the outcome on the factor could be worse than the "unfavorable" level and a 10% chance it could be higher than the "favorable". The ranges we used are broad but do permit outcomes even more extreme. The table below gives the probability that the mandated increase in fuel economy is less than zero and greater than $6 billion; this analyzes the chance the outcome could be a loss or more than twice the base value.

	30% Increase	40% Increase	50% Increase
Probability Change in Profit < $0	7%	10%	15%
Probability Change in Profit > $6bn	6%	13%	18%

There is a 7% chance that profits would be less than zero if CAFE were increased 30%, a 15% of a loss if it were 50%. As intuition would suggest, the larger mandate increases the downside risk. But it also offers greater upside opportunity, as the chance that the increase profits could exceed $6 billion is 18%, but is only 6% for the 30% increase in fuel economy. The total uncertainty attached to the larger increase is greater, which means both more upside and more downside.

Overall, the risk and reward profile of these scenarios is very positive, with only a small chance of losing and a very large probability of gain.

Summary of Findings and Discussion

A broad consensus has emerged in the current crisis that the Detroit 3 automakers need to be transformed. The business model they have followed since the 1970's is clearly broken. Reliance on gas-guzzling SUVs and large cars for domestic profit was risky in several ways. Cutting prices to offset gradually rising gasoline prices from 2000 through 2006 while spending billions to engineer the next generation of these vehicles left GM and Chrysler with no margin for error. There never was a high volume international market for SUVs and the large cars the Detroit 3 automakers became dependent upon, so when the price of gasoline soared in 2008 and the domestic market for them collapsed, the Detroit 3 automakers could not avoid the worst of the downside. Ford was hit as hard as GM and Chrysler, but had established expanded credit lines before the credit crunch and has been able to finance its cash-burn independent of the government assistance needed by GM and Chrysler.

While the need for transformation is widely accepted, there is still disagreement about the scope and pace of change, and some voices in the industry and in government are suggesting that fuel economy and greenhouse gas regulations should be lowered or delayed. We studied two general themes in the research reported here: the nature of change in a crisis and its impact on the way transformations should be done, and the impact of higher fuel economy regulations on costs, consumer demand for vehicles, and automakers' profits. Our findings support rapid, wide-reaching change in business models. The key to a long-term recovery is executing an excellent portfolio of products, and we find evidence that increasing fuel economy standards encourages automakers to create a portfolio of products that is more likely to raise the profits of the Detroit 3 automakers than to lower them.

Our research on turnarounds in a crisis found that:

- Change should be wide-ranging and fast.
- The existing management team should be replaced.
- Changing the culture is vital and necessary.
- The path to long-term success is built on executing an excellent portfolio of products.

We assessed GM on how well it is making the right changes and whether it is moving fast enough. Our view is that GM is still not prepared to change enough, fast enough to achieve the transformation it needs to make.

Fuel economy standards should not be relaxed in the current crisis. There is compelling evidence that systematically underestimating the value of fuel economy to customers is part of what created the crisis in the first place. There is general agreement that the future portfolio of products needs to be more fuel-efficient that today's portfolio. Change should include improving fuel economy of vehicles.

Because Detroit 3 automakers have long underestimated the consumer value of fuel economy, raising fuel economy standards would not cost more than consumers would be willing to pay. We found that an industrywide mandated increase in fuel economy of 30% to 50% would increase Detroit's gross profits by roughly $3 billion per year, and reduce increase sales by the equivalent of two large assembly plants.

The sensitivity analysis of the impacts on profits showed that only a few factors could reverse our finding that profits of the Detroit 3 automakers would increase under higher fuel economy standards: relative value consumers put on fuel costs compared to vehicle price, the future price of fuel, and the level of direct costs to improve fuel economy. While the three factors could result in losses rather than gains in profits, the potential losses are relatively small, and all three factors have much more upside than downside. The total risk and reward profile of these scenarios is very positive, with only a small chance of losing and a very large probability of gain.

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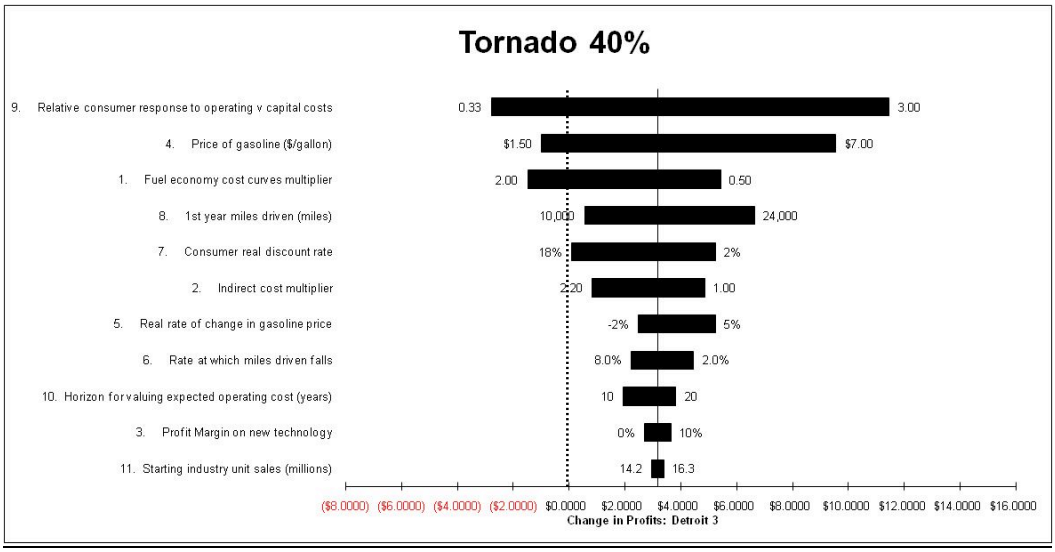
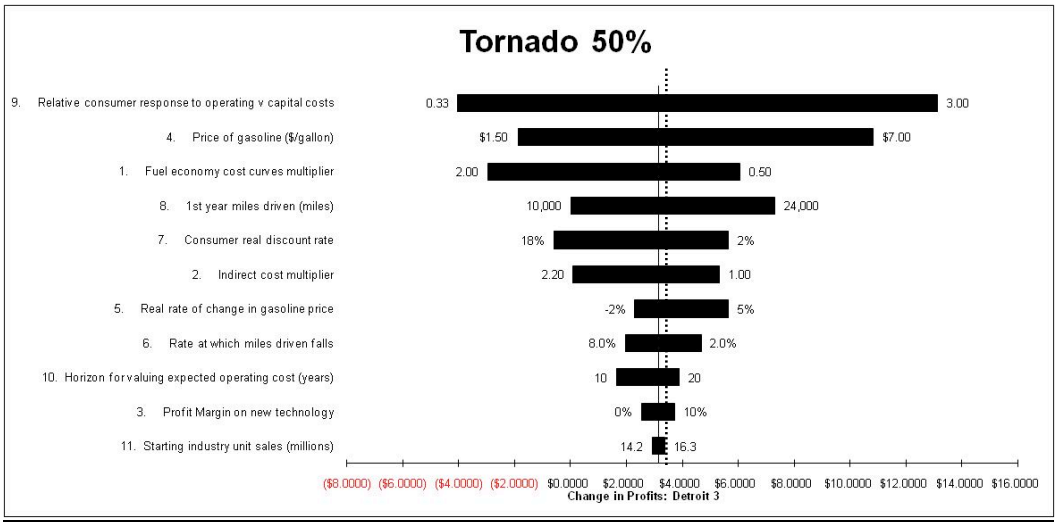
Appendix


Tornado 40%
9. Relative consumer response to operating v capital costs
4. Price of gasoline ($/gallon)
1. Fuel economy cost curves multiplier
8. 1st year miles driven (miles)
7. Consumer real discount rate
2. Indirect cost multiplier
5. Real rate of change in gasoline price
6. Rate at which miles driven falls
10. Horizon for valuing expected operating cost (years)
3. Profit Margin on new technology
11. Starting industry unit sales (millions)
0.33
3.00
$1.50
$7.00
2.00
0.50
10,000
24,000
18%
2%
2.20
1.00
-2%
5%
8.0%
2.0%
10
20
0%
10%
14.2
16.3
($8.0000) ($6.0000) ($4.0000) ($2.0000) $0.0000 $2.0000 $4.0000 $6.0000 $8.0000 $10.0000 $12.0000 $14.0000 $16.0000
Change in Profits: Detroit 3


Tornado 50%
9. Relative consumer response to operating v capital costs
4. Price of gasoline ($/gallon)
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0.33
3.00
$1.50
$7.00
2.00
0.50
10,000
24,000
18%
2%
2.20
1.00
-2%
5%
8.0%
2.0%
10
20
0%
10%
14.2
16.3
($8.0000) ($6.0000) ($4.0000) ($2.0000) $0.0000 $2.0000 $4.0000 $6.0000 $8.0000 $10.0000 $12.0000 $14.0000 $16.0000
Change in Profits: Detroit 3