IN THE TANK

How Oil Prices Threaten Automakers' Profits and Jobs

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The Earth's Best Defense

Natural Resources Defense Council

July 2005

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The Natural Resources Defense Council is a national nonprofit environmental organization with more than 1.2 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, and San Francisco. Visit us at www.nrdc.org.

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Since the late 1990s, Detroit's three big U.S. automakers—General Motors Corp., Ford Motor Company, and DaimlerChrysler—have relied heavily on large, truck-based sport utility vehicles to drive company profits. But with gasoline prices now at near-record highs, consumer demand for mid- and full-size SUVs is sinking fast. What if higher gas prices are here to stay and the trend away from gas-guzzling vehicles continues? To help automakers and policymakers evaluate the consequences of high oil prices, we modeled potential effects of average gasoline prices at $2.86 a gallon ($80 a barrel) and $3.37 a gallon ($100 a barrel) against a baseline of $1.96 a gallon ($45 a barrel). This report says that sales, profits, and American jobs are at risk if Detroit automakers continue with their current business strategy in the face of higher oil prices and recommends actions that automakers, government, and investors can take to mitigate the risks.

Key findings include the following:

▸ **Profits at Detroit's Big Three will shrink by $7 billion to $11 billion.** Reductions in vehicle sales, especially SUVs, will lead to an industry-wide decline in pretax profits of $11.2 billion to $17.6 billion. Detroit's Big Three will absorb $7 billion to $11 billion in total reductions because of their dependence on SUV and pickup sales.

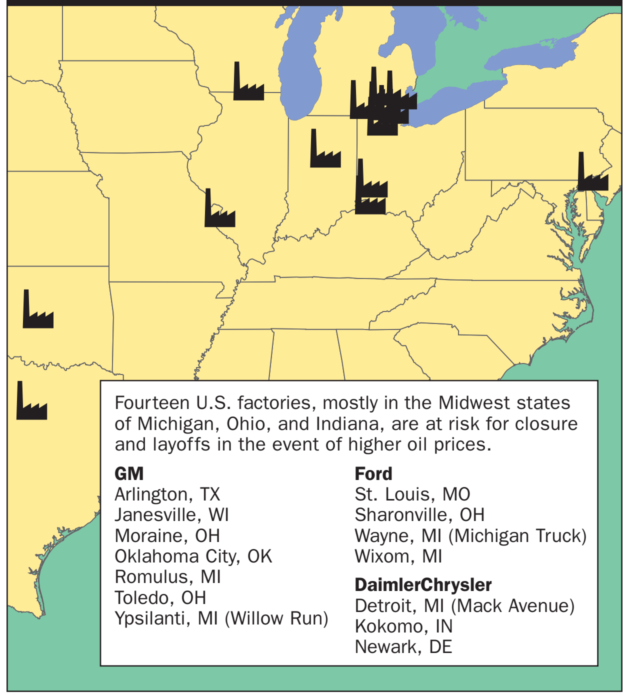
▸ **Detroit's Big Three will absorb nearly 75 percent of the decline in total sales volume.** Without deeper discounts, sales volumes in the North American car and light truck market will shrink between 9 and 14 percent, or 1.9 to 3.0 million vehicles, because of the overall effect of higher oil prices on the economy. Detroit's Big Three automakers absorb nearly 75 percent of the sales decreases.

▸ **Fourteen U.S. factories, mostly in the Midwest, and two Canadian factories, are at risk for closure and layoffs.** Especially vulnerable are GM, Ford, and DaimlerChrysler plants in Arlington, TX, Jamesville, WI, Oklahoma City, OK, and Wayne, MI, that build mid- and full-size SUVs, large cars, 8-cylinder engines, and rear-wheel drive transmissions .

▸ **At least 297,000 jobs are on the line, 37 percent of them in Michigan, Ohio, and Indiana.** North American auto-related employment in 2009 would drop by 9.8 to 15.3 percent if gas prices rise to $2.86 or $3.37 a gallon. Approximately 110,000 of the jobs at risk are in only three states: Michigan, Ohio, and Indiana.

FIGURE ES.1

U.S. Auto Plants Most at Risk from Higher Oil Prices



HIGH OIL PRICES ARE A KEY DRIVER IN THE U.S. VEHICLES MARKET

In just the first five months of 2005, sales of the Chevrolet Suburban fell by 31 percent, the GMC Yukon by 28 percent, and the Ford Expedition by 22 percent. GM cited falling U.S. SUV sales as the main culprit in its $1.1 billion first-quarter loss; its shares are trading at 12-year lows. Falling sales also contributed to a 38 percent first-quarter profit plunge at Ford, which has seen its U.S. market share decline for 25 consecutive months.

In a bid to prevent sales from decreasing, U.S. automakers have offered steep consumer incentives. In fact, research shows that U.S. automaker incentives between 2001 and 2004 correlate almost exactly to increases in fuel operating costs during the same time.

Although incentives help move inventories of unsold cars and trucks, they also eat into profits, weaken brands, and mask a deeper sales slump. Without these large incentives, both Ford and GM will likely continue to suffer sales declines and lose market share to foreign rivals.

Oil prices have more than doubled since 2001 and have risen to more than $60 by early June 2005. In fact, with almost no spare oil production capacity, it would take only one major event to disrupt world oil supplies, sending prices to $80 per barrel or more. And with geopolitical tensions remaining high in critical oil-producing regions, a supply disruption is a growing possibility.

AUTOMAKERS, INVESTORS, AND LAWMAKERS SHOULD ACT NOW

Fortunately, several policy measures could stem these future job losses and declining sales. Automakers, government, and the investment community should come together to address the negative effects of sustained higher oil prices on U.S. automakers in the following ways:

▸ **Automakers should make fuel efficiency job number one.** Fuel efficiency will increasingly be a key determinant of automaker competitiveness in the near future. Betting on low oil prices might have been a good strategy a decade ago, but today it's a gamble that places companies, workers, investors, and communities at grave risk. Without a product mix that meets changing consumer demand in response to high oil prices, Detroit will pay a heavy toll.

▸ **Investors should recognize fuel efficiency's role in protecting shareholder value.** Investors can identify, quantify, and, therefore, better manage their risk exposure in the vehicles market if they have more information about fuel efficiency. As with recent investor-led actions on climate change concerns, investors should require greater transparency from U.S. automakers and demand analyses that consider fuel economy.

▸ **Lawmakers should raise fuel economy through incentives and standards.** Making our economy less vulnerable to high oil prices by reducing oil dependency is a national priority, and it merits public investment and commitment. Financial incentives to retool factories to build more fuel-efficient vehicles would help raise fuel efficiency levels and increase U.S. automaker competitiveness. It is crucial that the states most vulnerable to factory closings and job loss—Michigan, Ohio and Indiana—lead efforts to retool the U.S. auto industry.

CHAPTER 1

High Oil Prices are a Key Driver in the U.S. Vehicles Market

A surge in oil prices, from $10 a barrel in 1998 to more than $60 in July 2005, has prompted talk of a new era of sustained higher prices. Many analysts believe that the combination of tightening global oil supply, limited production capacity, and increasing global oil demand will keep gasoline prices high by historical standards for some time to come. High oil prices are already having a significant effect on vehicle demand, vehicle choice, and automaker profits in the United States as American car buyers avoid gas-guzzling sport utility vehicles (SUVs).

In only the first five months of 2005, U.S. SUV sales dropped 14 percent as compared with the same period last year, while sales of the most fuel-efficient market segment—hybrid electric vehicles—rose 143 percent. The trend away from truck-based SUVs has serious consequences for U.S. automakers, especially Detroit's three big automakers: General Motors Corp., Ford Motor Company, and DaimlerChrysler, more commonly known as Detroit's Big Three.[1]

These three companies dominate truck-based SUV sales, which are the most fuel-inefficient market segment in the auto industry. In fact, Detroit's Big Three accounted for almost 80 percent of truck-based SUV sales in 2004. As SUV sales continue to slump, it is becoming increasingly clear that all automakers, but especially Detroit's Big Three, need to make producing more fuel-efficient vehicles a higher priority.

DETROIT'S BIG THREE ARE HARDEST HIT BY SLUMPING SUV SALES

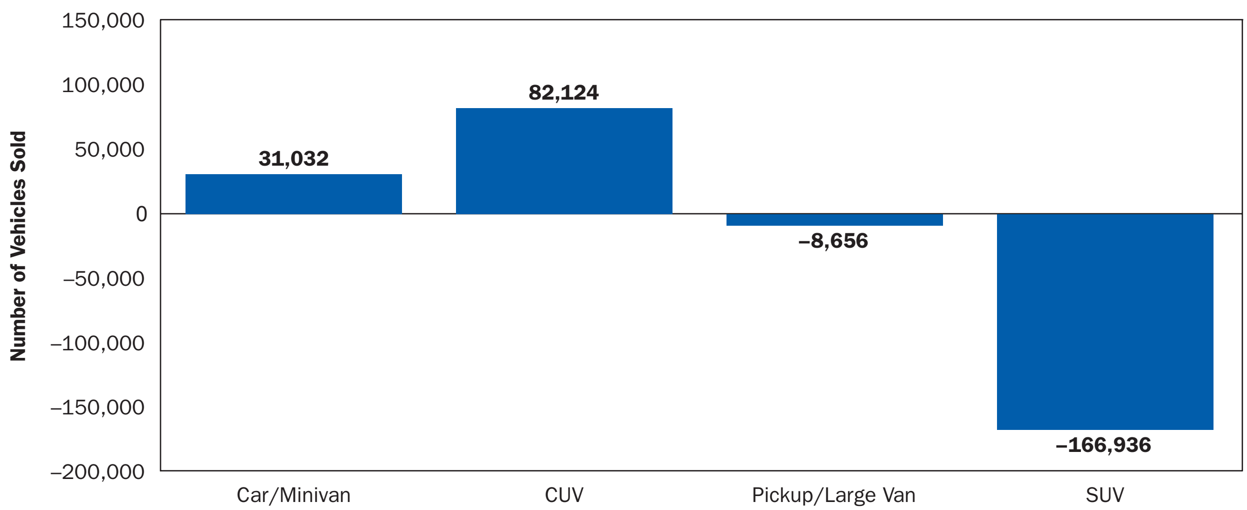
The U.S. automotive market is shifting toward more fuel-efficient new cars and light trucks. Instead of truck-based SUVs, consumers are purchasing more fuel-efficient vehicles, including crossover utility vehicles (CUVs), minivans, and cars. Similar in look to SUVs, most CUVs are front- or four-wheel-drive vehicle models built on car platforms that do not have heavy, rear-drive axles or frames like traditional SUVs. This makes CUVs lighter and more fuel-efficient. CUVs average 22.5 miles per gallon (mpg) versus only 16.9 mpg for SUVs. Popular CUV models are the Honda CR-V, the Toyota RAV4, the Ford Escape and Freestyle, and Chrysler's Pacifica.

In the first five months of 2005, this dramatic shift away from truck-based SUVs continued (see Figure 1.1, Table 1.1). Compared with the same period a year ago when gasoline averaged $1.64 per gallon, sales of truck-based SUVs in the United States slumped by 14 percent, or 167,000 vehicles. Sales of some of the most popular full-size SUV models, such as the GM Yukon, Chevy Suburban, and Ford Expedition, are off by 22 to 31 percent in the first five months of 2005 compared with the same period in 2004 (see Table 1.2). Consumer purchases shifted to more fuel-efficient cars, minivans, and car-based crossovers. CUVs were the fastest-growing segment, at 11 percent (82,000 vehicles) growth above 2004. Passenger cars and minivans grew slightly by 31,000 vehicles, or about 1 percent.

Sales of pickup trucks remained essentially unchanged from 2004. This trend makes intuitive sense because there is not a clear car-based substitute for pickups, which are often used for commercial purposes. If automakers had not increased incentives for fuel-inefficient SUVs and pickups, the shift would have been more pronounced.

FIGURE 1.1

Change in U.S. Automaker Sales by Market Segment (Jan–May 2005 Versus 2004)



Source: The Planning Edge, based on *Ward's Automotive Reports* raw data.

TABLE 1.1
U.S. Retail Sales by Market Segment, Jan-May 2005 Versus 2004

	SUV	CUV	Pick Up/Large Van	Car/Minivan	Total
2004 Jan–May	1,188,990	747,999	1,406,071	3,598,420	6,941,480
2005 Jan–May	1,022,054	830,123	1,397,415	3,629,452	6,879,044
% Change	–14.0%	11.0%	–0.6%	0.9%	–0.9%

Source: The Planning Edge, based on *Ward's Automotive Reports*.

TABLE 1.2
Change in Sales of Top Five Full- and Midsize Truck-based SUVs, Jan–May 2005 Versus 2004

			2005 Jan–May	2004 Jan–May	Change in Sales
Full-size	GMC	Yukon	25,825	35,941	–28%
	Chevrolet	Suburban	32,299	47,122	–31%
	Dodge	Durango[a]	52,469	54,419	–4%
	Ford	Expedition	48,999	62,552	–22%
	Chevrolet	Tahoe	56,410	75,279	–25%
		Total	**254,685**	**323,225**	**–21%**
Midsize	GMC	Envoy	40,715	53,665	–24%
	Jeep	Liberty[b]	68,824	72,740	–5%
	Jeep	Grand Cherokee[b]	83,590	82,201	2%
	Chevrolet	TrailBlazer	87,847	103,493	–15%
	Ford	Explorer	105,925	141,625	–25%
		Total	**386,901**	**453,724**	**–15%**

[a] In early 2005, DaimlerChrysler increased consumer incentives on Durangos by about $2,000 compared to a year earlier (based on data from Automotive News data center, http://www.autonews.com/datacenter.cms).

[b] The Liberty and Grand Cherokee are relatively more fuel-efficient options in the midsize SUV segment. For example, the 2005 model year Grand Cherokee has a 6-cylinder option (accounting for about 50 percent of sales) that achieves 17 and 21 mpg on the city and highway cycles. The GM and Ford options are significantly less efficient.

Some automakers—most notably General Motors—insist that steep declines in SUV sales are the result of many vehicles reaching the end of the product life cycle. Although product age does influence consumer purchases, some newer models are also suffering including Ford's Expedition and Explorer, and GM's TrailBlazer and Envoy. Sales of these newer models are down 15 to 25 percent. Sales of Dodge Durango, Jeep Liberty, and Jeep Grand Cherokee appear to be less affected because of an increase in incentives or better fuel economy.

On the other hand, sales of hybrid vehicles grew to more than 73,000 units—a 143 percent increase—in the first five months of 2005 compared with the same period in 2004, retiring the hybrid's classification as a niche market (see Table 1.3). In fact, sales of the Toyota Prius (43,686 vehicles) rivaled the sales of popular large SUV models; only slightly fewer vehicles were sold than the Ford Expedition (48,999 vehicles) and considerably more units than the Chevy Suburban (32,299 vehicles). This growth has primarily benefited the Japanese automakers, which had 91 percent of hybrid sales in the first five months of 2005. Of the eight hybrid models on the market—the Ford Escape and the Mercury Mariner; the Honda Civic, Accord, and Insight; and the Toyota Prius, Highlander, and Lexus RX 400h—only one is manufactured by a U.S. automaker.

TABLE 1.3
Conventional Versus Hybrids, U.S. Retail Sales, Jan–May 2005 Versus 2004 (Thousands of Vehicles)

	All Vehicles	Hybrids	Japanese	% Japanese
2004 YTD	6,941,480	30,194	30,194	100%
2005 YTD	6,879,044	73,335	66,827	91%
Increase in Sales	–62,436	43,141	36,633	

Sources: The Planning Edge, based on *Ward's Automotive Reports* data and auto company press releases.

The shift away from truck-based SUVs has hit Detroit's Big Three automakers the hardest because they are so concentrated in the largest, most gas-guzzling segments of the SUV market. The Big Three also dominate sales of the most fuel-inefficient market segments—large and luxury SUVs that average 16 mpg. GM is particularly dependent on large and luxury SUV sales; GM accounts for almost half of the total sales in the large and luxury segments (see Table 1.4).

Profit figures reflect GM's dependence. For the past decade, profitability of Detroit's Big Three rested almost entirely on SUV and pickup sales—helped, no doubt, by the long period of relatively low oil prices from the mid-1980s through the late 1990s. Pretax profits for North American vehicle operations based on 2004

TABLE 1.4
Share of U.S. Market Segment by Major Automaker, 2004

	Fuel Economy (mpg)	GM	Ford	DCX	Toyota	Nissan	Honda
SUVs (all)	16.9	33%	20%	23%	8%	6%	0%
SUV (lux+large)	16.0	48%	23%	13%	10%	5%	0%
Pickups+Vans	16.1	38%	35%	16%	6%	5%	0%
CUVs	22.5	15%	16%	10%	23%	4%	19%
Cars+Minivans	24.8	22%	15%	13%	13%	8%	11%

Source: The Planning Edge, based on *Ward's Automotive Reports* data for 2004 sales.

TABLE 1.5
Estimated Share of Total Company's Pretax Profits from SUVs and Pickups, 2004

	GM	Ford	DCX	Toyota	Nissan	Honda[a]
Truck-based SUVs	27%	21%	25%	17%	20%	0%
Pickups and Vans	36%	40%	23%	9%	14%	0%
Total	62%	61%	49%	26%	34%	0%

Source: Authors' calculation based on *Ward's Automotive Reports* data for 2004 sales and pretax variable profit estimates by Walter McManus.

[a] The Honda Pilot, Honda Ridgeline, and Acura MDX are classified as crossover utility vehicles because they are built on car platforms.

sales data and pretax profit estimates by vehicle segment were modeled. Our results showed that GM and Ford are the most dependent on SUVs and pickups for their pretax profits, at about 60 percent, followed by DaimlerChrysler (DCX), at about 50 percent (see Table 1.5).

AUTOMAKERS MASK DROP IN SUV DEMAND WITH LARGE SALES INCENTIVES

There is little question that higher gasoline prices affect overall consumer demand for vehicles, especially in the most fuel-inefficient SUV and pickup market segments. Until now, automakers managed to offset slumping demand by boosting sales through rebates and other profit-eating sales incentives. Although actual sales of large SUVs dropped precipitously in late 2004 and early 2005, it is likely that consumer demand for these vehicles began falling as early as 2002 as gasoline prices began to rise.

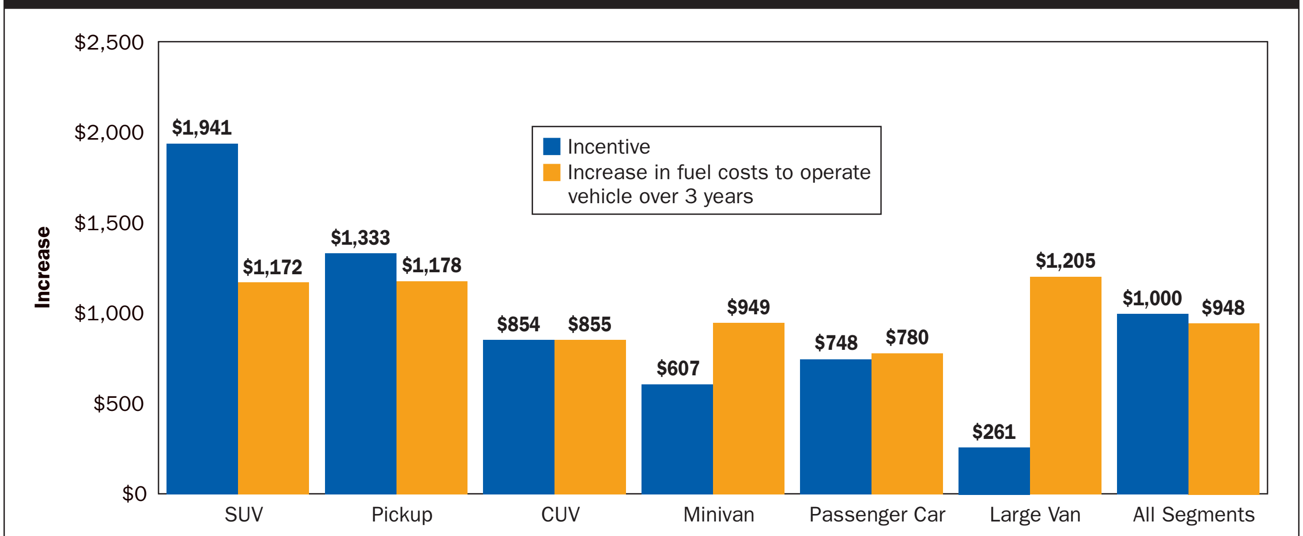
When gasoline prices started rising in 2002, automakers were forced to boost incentives to offset the pinch consumers saw on their fuel bills. Not surprisingly, automakers had to offer the largest incentives for vehicles that use the most fuel: SUVs and pickups. In fact, for most segments, the increase in incentives that automakers were forced to offer was nearly exactly equivalent to the additional gasoline bill a driver could expect to pay over the first three-year period of ownership (see Figure 1.2). Between calendar year 2001 and 2004, automakers increased their average incentives by $1,000, essentially equivalent to the $948 increase in gasoline costs over a three-year period.

For vehicles with greater fuel economy (cars, minivans, and crossovers), which consumers increasingly demanded, the incentives were about the same or lower than the gasoline cost increase. However, not only did the incentives for the most fuel-inefficient vehicles increase the most, but in some cases automakers had to offer incentives that exceeded the fuel cost increase. For SUVs, incentives increased by $1,941, about $770 greater than the fuel cost increase. For pickups, incentives rose by $1,333, about $155 greater than the fuel cost increase. The market for large commercial vans is less price-sensitive.

If automakers had not increased incentives, sales of SUVs and other vehicles would have been lower than they actually were. A recent study by the University of

FIGURE 1.2

Consumer Incentives Versus Increased Vehicle Operating Costs (2001–2004)



Source: McManus 2005

Note: The vehicle's full price to the consumer is defined as purchase cost plus the increase in the cost of gasoline from 2001 to 2004 needed to operate the average vehicle in the segment for 15,000 miles per year for three years.

Michigan Transportation Research Institute shows that market share of truck-based SUVs would have dropped from 17.4 percent in 2004 to about 16.8 percent, a drop of 0.6 percentage points, if automakers had kept incentives at 2002 levels.[2] Between calendar year 2002 and 2004, before the plunge in early 2005, automakers managed to keep the sales decreases for SUVs to just 2.9 percent as gasoline prices rose by 18 percent. If automakers had not increased incentive levels, the market would have seen a drop in sales of about 7.4 percent.

HIGHER OIL PRICES OF $40 TO $50 PER BARREL ARE HERE TO STAY

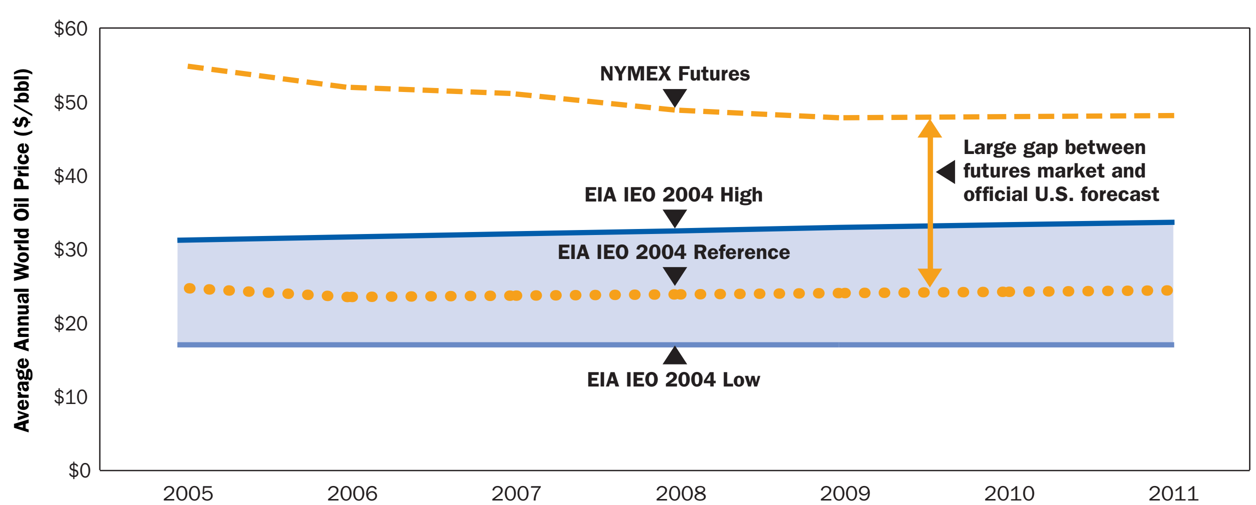
Most analysts agree that market fundamentals of high demand and limited supply, and not speculation or market hysteria, are the primary reason for today's high oil prices. These prices can be explained, in part, by explosive growth in oil demand, especially from China. Oil demand has grown a robust 5 percent since 2003, despite a doubling of oil prices during that period. It appears likely that increased global oil demand and tight global oil supplies will keep fuel prices high for the next several years.

There is little spare oil production capacity to cushion a sudden loss in supply and the mix of easily extractable crude oil is moving away from "light, sweet" toward more "sour" grades that fewer refineries can handle. Considering these factors, oil prices may abruptly jump even higher, as happened during the first two oil crises of 1973–75 and 1979–81. But unlike these last two oil crises, important oil market fundamentals could favor a higher price lasting for much longer—and perhaps becoming a permanent feature of the environment.

One reason we can expect sustained high oil prices is that we have limited spare capacity. Historically, producers were accused of holding back supplies when prices rose. But most industry experts agree that the Organization of the Petroleum-Exporting Countries (OPEC) and other suppliers are now pumping at or near the upper limits of their capability. Indeed, there are concerns that rapid exploitation degrades the long-term viability of some oil fields.[3] Spare capacity, often used to cushion oil price spikes, is essentially gone. Saudi Arabia, which has kept most of the world's spare capacity, had a policy of maintaining a pumping rate of 1.0 to 1.5 million barrels per day (mbd) but is now pumping out as much oil as the world's refineries can handle.[4] Major expansions of capacity, such as the recent announcement by Saudi Arabia that it will

FIGURE 1.3

Oil Price Forecasts from U.S. Department of Energy and NYMEX Futures Market



Source: U.S. DOE's Energy Information Agency, Annual Energy Outlook 2005; NYMEX 5/03/05) spend $50 billion to expand production by 1.5 mbd, will take years to begin affecting supply.[5]

There is less certainty among experts about how long global demand will keep oil prices high. Some experts, such as those at the International Energy Agency (IEA), believe that high oil prices are not sustainable and that prices will be driven back down as demand softens and supplies increase in response.[6] The 2004 forecast released by U.S. Energy Information Administration's (EIA) projects prices to fall to $34 per barrel in 2005 and to $25 per barrel by 2010.[7]

Other evidence suggests that current pricing is more than a bubble; high prices will persist for the next several years. The strongest indication is from OPEC, which is targeting a higher oil price. Saudi Arabia's oil minister said that Saudi Arabia, which controls the world's largest sweet crude reserves, is interested in a target price between $40 and $50 per barrel.[8]

Market traders are also strongly wagering on higher future prices, suggesting that the pessimists may be right. The price of futures contracts for delivery of oil as far forward as five years has risen dramatically over the past several years. In early May 2005, the forward contract price of a benchmark crude oil (West Texas Intermediate) for delivery in December 2010 stood at around $47 per barrel (see Figure 1.3)—substantially higher than the EIA projection.[9] The futures market seems to reflect the growing concern about balancing medium-term supply and demand, and not just OPEC's pricing and production policies.[10]

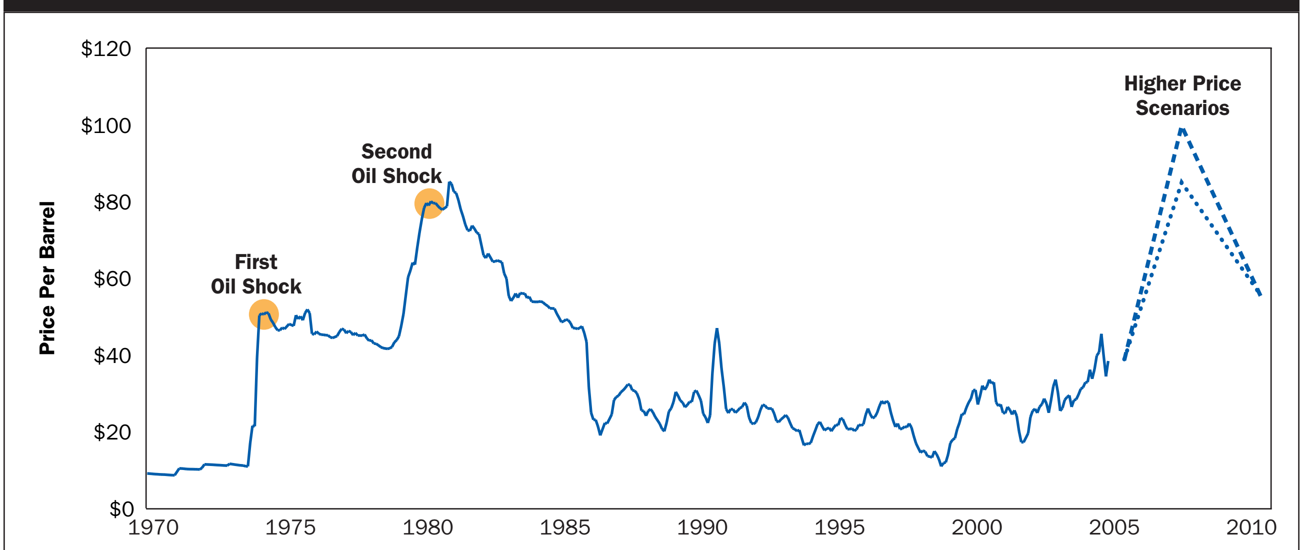
PRICES COULD GO AS HIGH AS $80 A BARREL IF SUPPLIES ARE DISRUPTED

Some experts warn that prices could go even higher if expansion of supply fails to keep up with demand or if there is a supply disruption. One assessment by the investment banking and securities firm Goldman Sachs, warns that oil prices could rise as high as $105 per barrel before demand declines enough that spare capacity can be restored and prices can fall.[11] The report also notes that had it not been for the doubling of Russia's crude output between 1998 and 2004, global non-OPEC output would have been "essentially flat." Considering the recent troubles in Russia's oil industry, it is unclear whether Russia can maintain this level of growth.

The precarious balance between supply and demand, along with rising geopolitical tensions in oil-producing regions, magnifies the risk of a sharp

FIGURE 1.4

Past and Estimated Future Oil Price Levels with Supply Distribution



Sources: Official price of Saudi Light for 1970–1972; U.S. refiner acquisition costs for imported crude for 1973–2004.

price increase that would follow even a minor supply disruption. With little or no spare capacity, experts warn "a terrorist attack on Saudi oil infrastructure could send [oil prices] past $100."[12] A long-term disruption of a year or more would be even more devastating to the world's economies (see Figure 1.4).

With more oil being traded between regions, the IEA is also concerned about a growing "risk of a supply disruption at the critical chokepoints through which oil must flow."[13] For example, 13 million barrels of oil flow every day through the Strait of Hormuz, the entrance to the Persian Gulf from the Indian Ocean. As the Institute for the Analysis of Global Security and others have documented, terrorists are already targeting such oil infrastructure.[14] Since the middle of 2003, there have been more than 200 attacks against oil pipelines, installations, and personnel in Iraq. Because of concerns about disruptions in the former Soviet Union, the U.S. Department of Energy is sponsoring a new risk assessment in that area.[15]

Nor are the Middle East and Central Asia the only regions of concern. Venezuela, Nigeria, and the former Soviet Union countries are all major oil producers that have experienced instability. For example in late 2002, political unrest in Venezuela removed 2.1 mbd from the world oil market. Even today, Venezuela's output of roughly 2.9 mbd remains more than 20 percent below its 1998 peak. Oil prices in mid-June 2005 jumped on news of possible terrorist strikes in Nigeria.

Based on estimates of short-run supply and demand elasticities computed by Paul Leiby at the Oak Ridge National Laboratory, we estimate that a supply disruption of 2.2 to 5.8 mbd would produce an average benchmark oil price of $80 per barrel that could be sustained for a year.[16] Likewise, a $100 per barrel price scenario could result from a 4.3 to 8.9 mbd oil supply disruption. These estimates assume that disruptions that last for about a year or more prevent strategic reserves from playing a significant role in dampening prices. We conservatively assume a "fear premium" adds an additional $10 to each barrel, but some experts believe it could already be as high as $15 per barrel.[17] If the "fear premium" was $20 per barrel, the supply disruptions needed to reach the price levels would be roughly 1 mbd less.

Disruptions of these magnitudes could result from a single, major event in a key oil-producing country or at transportation infrastructure chokepoints in Saudi Arabia or Iran, or a combination of two or more smaller events, perhaps in any number of equally troubled oil-producing states such as Venezuela, Nigeria, the United Arab Emirates, or Kuwait.[18]

To illustrate how vulnerable oil prices are to supply disruptions, in June 2005, Securing America's Future and the National Commission on Energy Policy sponsored a cabinet-level simulation called "Oil Shock-Wave."[19] In this simulation, oil prices rise from $80 to $120 to $150 per barrel (monthly average) because of successive supply disruptions. The disruptions, including a production shutdown in Nigeria because of cold weather and terrorist attacks on infrastructure in Saudi Arabia and Alaska, lead to oil supply losses in excess of 3.4 mbd. Analysts at a well-respected investment research and management firm, Bernstein, developed the oil price estimates, which they describe in a July 2005 paper for investors. One participant of the simulation, former CIA director Robert Gates, said "the scenarios portrayed were absolutely not alarmist; they're realistic."

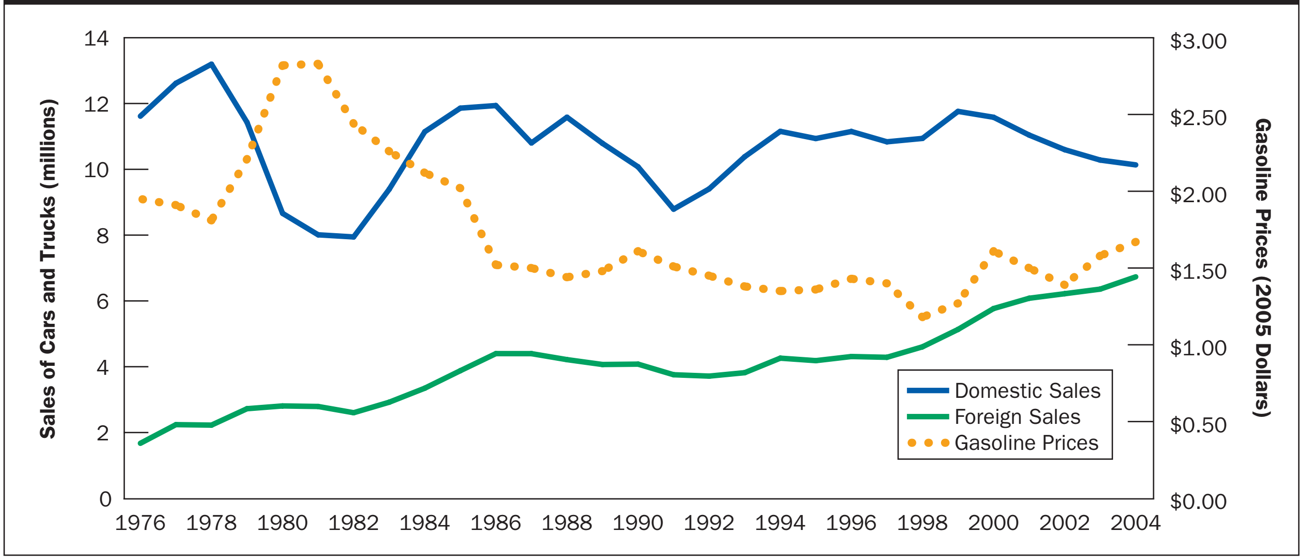
PAST OIL SHOCKS LED TO DRAMATIC DECLINES IN U.S. AUTOMAKER MARKET SHARE

In inflation-adjusted terms, such increases in oil prices rival the spikes of the 1970s. The second oil shock, which began in December 1978 with an oil workers' strike in Iran, removed more than two million barrels of oil per day from the world market. Oil production in Iran has still not recovered to its pre-1978 levels. The Iran-Iraq war subsequently reduced exports by another 5.6 mbd. Oil prices eventually hit $85 per barrel in early 1981 (in 2005 dollars), nearly doubling the real price of oil in 1978. It took nearly eight years for prices to return to their preshock levels.[20]

A repeat of those crises could have a profound affect on the world economy and on U.S. automakers in particular. When gasoline prices jumped by as much

FIGURE 1.5

Gasoline Prices Versus U.S. Automaker Market Share



Sources: Motor Vehicle Manufacturer's Association, McManus LLC

as one dollar a gallon (in real 2005 terms) and prices peaked in 1981, the overall U.S. car and light truck market fell by nearly 30 percent (see Figure 1.5). More importantly, drivers also began shunning large, gas-guzzling cars made by American automakers in favor of fuel-efficient cars built in Japan and Germany. Between 1978 and 1981, U.S. automaker sales dropped by 40 percent, a decline of about 5.2 million units.[21]

Employment plunged along with automobile sales. It dropped 30 percent from 1978 to 1982, for a total loss of more than 300,000 jobs in direct auto and part manufacturing jobs—and even more jobs were lost if auto-related jobs are considered.[22] And the Detroit Big Three suffered record losses. In 1980, GM lost $762 million, Ford lost $1.7 billion, and Chrysler lost the most, $1.8 billion. Chrysler's situation was so bad that in 1979 Congress agreed to bail out the company with $1 billion in loan guarantees.[23]

Worse, when gasoline prices returned to preshock levels, U.S. automakers failed to regain their lost market share in passenger cars. Indeed, the three periods of sharpest growth in import market share, 1973–75, 1979–81, and 2003–present, coincide precisely with the largest increases in per-gallon gasoline prices. Despite the harsh lessons of past oil shocks, Detroit's Big Three are repeating the mistakes of the past by becoming overly dependent on the sales of fuel-inefficient vehicles.

CHAPTER 2

Methods and Assumptions of the Model

The purpose of this study is to assess the magnitude of the risk that automakers face in the event of higher gasoline prices in the next five years. We do not assess the probability or predict whether gasoline prices will increase. However, it is clear that because of limited global spare production capacity and the continued importance of the Middle East in supplying the world's oil, the risk that oil prices will remain high or spike is increasing.

To estimate the effects that higher oil prices could have on U.S. automakers, we did the following:

1. Developed scenarios of higher oil prices based on plausible scenarios of oil supply disruptions, and then estimated the impact on oil and gasoline prices.

2. Estimated the impact of higher gasoline prices on the total size of the market for passenger vehicles sold in North America, on the sales of various vehicle segments, and on the vehicle mix within segments.

3. Estimated the impact on individual automakers of higher gasoline prices on the sales of various vehicle segments, on the vehicle mix within segments, and on changes in market shares by vehicle model.

4. Estimated the impacts of higher fuel prices on each automaker's revenues and pretax profits, based on estimates of revenue and variable profit by segment and company.

5. Estimated the impact of lower sales and production levels on employment for the United States and for three particularly auto-intensive states (Michigan, Ohio, and Indiana) using a regional economic model.

Determining Higher Oil Price Scenarios

In this study, we adopt three oil prices scenarios: a base case of $45 per barrel and two higher scenarios of $80 and $100 per barrel (see Figure 2.1). As discussed in Chapter 1, these higher price levels could be reached through plausible supply disruptions and maintained for a year or more. Crude oil prices of $80 and $100 per barrel (bbl) would translate into average U.S. gasoline prices of $2.86 and $3.37 per gallon, respectively (see appendices). This is $1.00 to $1.50 per gallon higher than the average 2004 gasoline price, and $0.90 to $1.40 per gallon higher than the fourth quarter 2004 price of $1.96. The $2.86 scenario for 2009 is our primary higher-price scenario. Note that this price is the same, in real January 2005 dollars, as in 1981.

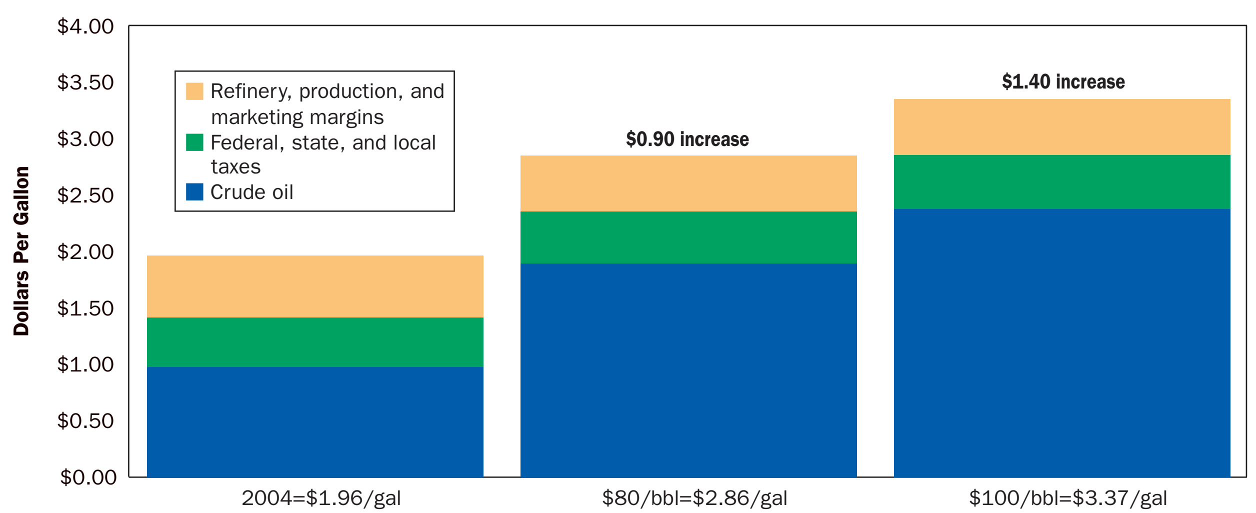
Estimating the Impact on Total Passenger Vehicle Sales

To model the impact of higher fuel prices three to five years out, we used an independent forecast of 2009 U.S. sales. The Planning Edge, a Birmingham, Michigan-based automotive analysis and forecasting firm, provided a midrange forecast level of 16.81 million U.S. cars and light trucks.

We modeled the impact of higher fuel prices on GDP growth as if higher oil prices represented a tax in place in 2009 that had not been levied in 2008.[24] An increase in West Texas Institute (WTI) crude prices from approximately $45/bbl in fourth quarter 2004 to $80/bbl in 2009 amounts to a tax of roughly $258 billion ($35/bbl

FIGURE 2.1

Gasoline Price Rise by $0.90 and $1.40 in Our Price Scenarios



Compared to forecast base case levels at $1.96/gallon.

× 20 mbd × 365 days). That $258 billion calculates to 1.84 percent of a $14 trillion economy; we estimated the $14 trillion GDP figure for 2009 (in January 2005 dollars) by assuming 3 percent annual growth from 2004's GDP level.

Note that we are not disputing the judgment of many analysts who argue that, unlike in 1974–75 or 1979–81, higher oil prices will not have nearly as much effect on the U.S. economy. Energy is a smaller proportion of GDP today, and will be in 2009 as well, than it was in the 1970s and early 1980s. A reduction in GDP growth of 1.84 percent (from a projected growth rate of 1.66 to 3.5 percent) due to an oil price hit is not the description of a recession. In fact, as discussed in Chapter 3, the 10 percent reduction in overall auto sales forecast in this study is less than one-third of the 30 percent drop during the second oil shock 25 years ago.

Estimating Changes in Market Shares by Vehicle Segment, Vehicle Mix Within Segments, and Automaker

We use an econometric model called a "discrete household choice" or "multinomial logit" model to predict the impact of higher fuel prices on consumer vehicle choice. The multinomial logit model is the most widely used discrete choice model used by economists due to its simple structure and ease of estimation.[25] In this approach, the choice of vehicles is modeled at the consumer or household level as a discrete choice in a multistep process. The model is calibrated to 2002–2003 data following the procedure described in a recent study by Oak Ridge National Laboratory.[26]

The Planning Edge (TPE) generated the data on model year 2009 vehicle attributes. TPE's production forecasting model includes all 2009 vehicles in automakers' product plans, as well as the engine-and-transmission combinations announced or anticipated for use in those vehicles. We then incorporated EPA data from model year 2005 for combined city-highway fuel economy for every vehicle-engine-transmission-drive type (e.g., all-wheel drive versus front-wheel drive, or four-wheel drive versus rear-wheel drive), and made estimates of miles-per-gallon figures for 2009 based on the vehicle-engine-transmission-drive types produced and sold in that year.

In addition, we forecast hybrid vehicle volumes for those manufacturers having that technology in their vehicle plans, and we estimated fuel economy figures for those vehicles. The distribution among engine-transmission-drive types for a particular vehicle is based on the current distribution of those vehicles currently in production (e.g., the 4- versus 6-cylinder production mix), allowing for changes in marketing and manufacturing plans between now and 2009 (e.g., Escape hybrids to displace V6-powered Escapes). For vehicles not in production, fuel economy figures were estimated based on similar vehicle-engine-transmission-drive type combinations currently in production.

Modeling Manufacturer's Revenues and Pretax Profits

In this study, we estimate the impact of specific changes in gasoline prices on automakers' sales and pretax variable profits. The economic success of an enterprise is measured by its profit—the difference between the revenue it receives from customers for its products and the total costs of producing, selling, and distributing its products. For a specific change in market conditions, the change in the enterprise's success is measured by the resulting change in profits. Because our focus is on changes in profits rather than levels, we do not need measures of fixed costs for our analysis. This is because the change in total pretax profits is equal to the change in variable pretax profit.

Variable profit per unit is defined as a vehicle's wholesale price minus the cost of the materials, labor, and energy inputs used to produce the vehicle. Variable profit does not consider the substantial fixed costs associated with building and selling automobiles, such as the amortization of capital equipment (i.e., factories and tools); legacy costs (i.e., pension and medical costs for retirees); marketing costs; and research, development, and engineering costs. A manufacturer can have substantial variable profits from its automotive operations but still post total pretax losses if its fixed costs are greater than its variable profits before taxes. However, the change in total profit resulting from a change in units sold is always equal to the change in variable profit.

This can be mathematically shown in the following manner.

Let Q be number of units sold, NP be net profit, VP be variable profit, P be wholesale price, VC be variable cost per unit, and FC be fixed cost. By definition,

(1) $VP = Q(P - VC)$ and

(2) $NP = VP - FC$.

Therefore,

(3) $NP = Q(P - VC) - FC$.

The first term in equation (3) is a function of Q, the number of units sold. In addition to the direct relationship because Q appears in the term, wholesale price (P) and variable cost per unit (VC) are themselves functions of Q. P is a decreasing function of Q because to sell more units the company must lower the price, and VC is an increasing function of Q because to increase production the company bids up the costs of materials, energy, and other inputs. Fixed costs (FC) by definition do not vary with the number of units sold (Q). The equivalence of changes in total profit and variable profit is shown by comparing the total differential of net profit (NP) with the total differential of variable profit (VP).

(4) $d(NP) = [(P-VC) + (dP/dQ - dVC/dQ)]dQ - d(FC)/dQ = [(P-VC) + (dP/dQ - dVC/dQ)]dQ$

(5) $d(VP) = [(P-VC) + (dP/dQ - dVC/dQ)]dQ$

The differentials are equal, because $d(FC)/dQ$ is zero by definition.

In (4) and (5) dY/dX is the derivative of Y with respect to X, and dZ is the differential of Z.

The estimates of variable profit for vehicles sold in North America that we use in this study were derived under the leadership of the Office for the Study of Automotive Transportation, a division of the University of Michigan Transportation Research Institute. As shown in Table 2.1, estimates at the level of segment and manufacturer group were made for Detroit's Big Three automakers, Japan's Big Three, European, and others (includes Korean and second tier Japanese: Hyundai, Isuzu, Kia, Mazda, Mitsubishi, Subaru, Suzuki). We assume that the cost structures are similar across companies within a given production region. The highest variable profits are generally associated

TABLE 2.1
Variable Profit per Unit Estimates Used in This Study

Segment	Detroit Three	Europe	Japan Three	Other
Small Car	$2,000	$4,500	$3,100	$2,800
Midsize Car	$3,800	$5,100	$4,700	$3,300
Luxury Car	$8,100	$10,300	$8,200	$4,600
Minivan	$4,800	—	$7,000	$3,300
Small CUV	$2,800	—	$5,500	$4,200
Midsize CUV	$4,600	—	$7,200	$4,200
Luxury CUV	$5,500	—	$9,400	$9,600
Small Pickup	$3,700	—	$3,800	$3,400
Large Pickup	$5,500	—	$6,500	—
Large Van	$4,400	$6,900	—	—
Small SUV	$4,600	—	—	$4,700
Midsize SUV	$4,100	$10,900	$6,700	$4,700
Midsize Luxury SUV	$6,200	$13,200	$11,000	$4,200
Large SUV	$6,300	—	$10,900	—
Large Luxury SUV	$11,300	$13,000	$13,700	—
Weighted Average	$4,494	$9,438	$5,762	$3,423

with the most fuel-*inefficient* categories, namely SUVs and pickups. At this stage of the research, individual manufacturers were not identified.

We shared preliminary estimates with industry analysts, who gave us their opinions as to whether the estimates were credible and roughly accurate.[27] Once we had estimates that passed this screen, we derived the estimates of the changes in variable profit from 2001 to 2004, when consumer incentives soared to unprecedented highs. Multiple sources of information on the growth in incentives by manufacturer group and segment were used. Further details on how these estimates were derived can be found in a new report from the University of Michigan Transportation Research Institute.[28]

Modeling Regional Economic Effects and Job Loss

To gauge economic impacts, the project team employed the model used by well-respected 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 U.S. Census of Transportation.

REMI's forecasting and policy analysis system integrates interindustry transactions, long-run equilibrium features, and economic geography. It includes substitution among factors of production in response to changes in relative factor costs; migration responses to changes in expected income; labor participation rate responses to changes in real wage and employment conditions; wage rate responses to labor market changes; consumer consumption responses to changes in real disposable income and commodity prices; and local, regional, and market share responses to changes in regional production costs.[29]

We used the REMI model for three classes of finished vehicles: (1) those assembled in the United States by GM, Ford, and DaimlerChrysler, (2) those assembled in Canada or Mexico by the same three automakers, and (3) those assembled in North America by other automakers. Based on reasonable estimates of U.S. parts content by vehicle type, we treat the second and third of the three groups as equivalent to half the U.S. content, and hence jobs, of the first group. We also used the REMI model to model the impact on the United States and three particularly auto-dependent states: Michigan, Ohio, and Indiana. However, we did not calculate the production

Table 2.2
Estimate of Number of U.S. Jobs per 100,000 Vehicles

Traditional U.S.-Made Vehicles	Transplant and Canada/Mexico-Made Vehicles	Engines	Transmissions
21,270	10,635	1,458	1,094

of the engines and transmissions that would have gone into light vehicles not sold because of the sales decline and market share mix changes caused by higher fuel prices.

Based on customized REMI runs performed for this study and another run completed late 2004, the number of U.S. jobs *throughout the economy* (automotive, other manufacturing, service sector, and spin offs) associated with making or not making 100,000 units of each vehicle type is 21,270 for traditional domestics assembled in the United States, and half that figure, or 10,635, for transplant vehicles and vehicles assembled in Canada or Mexico.[30]

For purposes of this study, therefore, we have counted each light vehicle sold in the United States but assembled in Canada or Mexico, or in the United States if assembled by a Europe-, Korea-, or Japan-based automaker, as having only half as much (40 percent) U.S. labor content. A typical GM, Ford, or DaimlerChrysler U.S.-assembled car or light truck has about 80 percent U.S. labor content. Europe-, Korea-, and Japan-based automakers assembling cars and light trucks in North America make some of their engines, most of their transmissions, and about half of their other parts outside the region.

Because our sales and output analysis is not based on vehicles as models or nameplates, but instead on vehicle-engine-transmission combinations, each of which has a different fuel economy, we also use the REMI model to calculate the number of U.S. jobs associated with North American production of 100,000 engines and 100,000 transmissions. In rolling these figures up to total jobs at risk in higher-fuel price scenarios, we subtract engine and transmission jobs from total vehicle jobs to avoid double counting. Table 2.2 summarizes these per-100,000 employment calculations.

Profits and Jobs at Detroit's Big Three are Most Vulnerable to High Oil Prices

Our analysis shows that the effects of continued, systemic oil price increases would have substantial and lasting effects on the U.S. auto market, especially on the Big Three and their employees. We analyzed two scenarios: one in which gas prices are $2.86 per gallon (equivalent to $80 per barrel of oil) and a second in which gas prices are $3.37 per gallon (equivalent to $100 per barrel of oil). The results demonstrate that Detroit's Big Three automakers are the most vulnerable to higher oil prices:

- Overall car and light truck sales will decline between 9 and 14 percent, but Detroit's Big Three automakers will absorb nearly 75 percent of total lost sales.
- The Big Three automakers will see a decline in market volume of 11 to 17 percent, whereas declines for Honda, Nissan, and Toyota declines will be about half of Detroit's Big Three.
- Detroit automakers will absorb 62 percent of the pretax profits losses of $11 billion to $17 billion.
- At least 297,000 jobs are on the line, 37 percent of them in Michigan, Ohio, and Indiana.

DETROIT'S BIG THREE WILL ABSORB NEARLY 75 PERCENT OF SALES VOLUME DECLINES

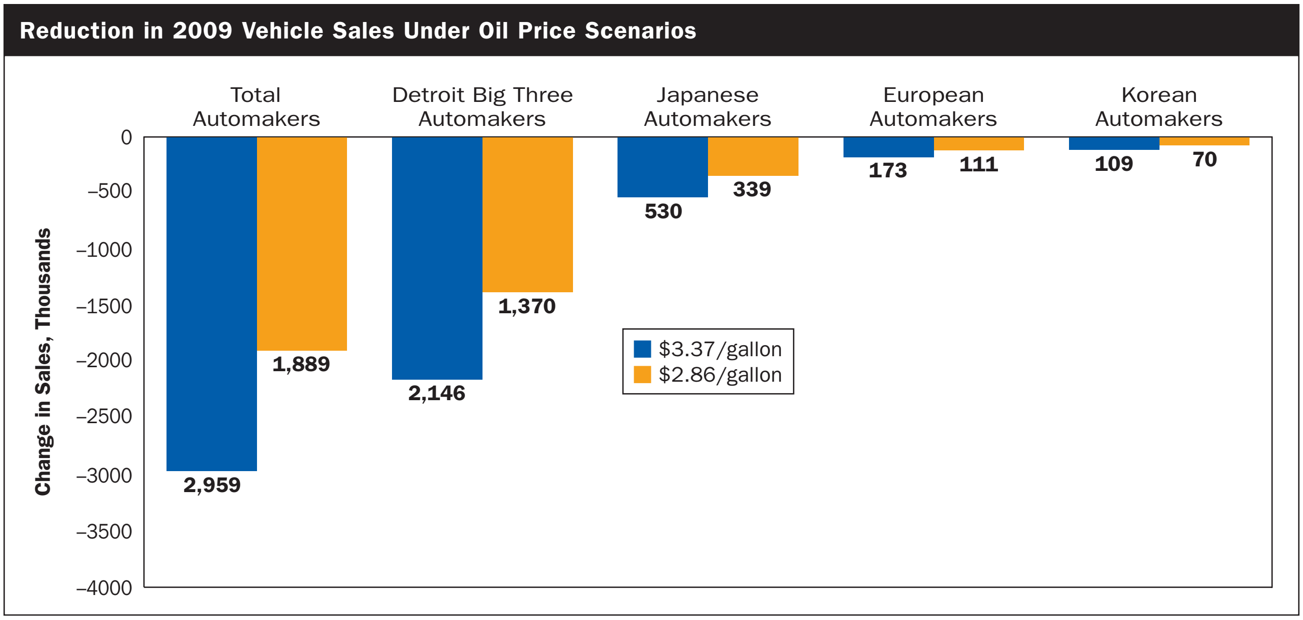
We estimate that if gasoline prices increase to $2.86 to $3.37 per gallon, the 2009 North American car and light truck market (North American production plus imports) will shrink by 9.0 to 14.1 percent, a decline of approximately 1.9 to 3.0 million vehicles compared with business-as-usual projections (see Figure 3.1).[31] Of course, automakers could choose to mitigate their sales reductions by lowering prices or raising incentives, as they have done over the past three years. We do not model this strategy because the ultimate effects on revenue and variable profits are similar.

A 9 percent decline in vehicle sales at $80 per barrel represents only one-third of the sales plunge that occurred during the second oil shock of 1979–1981, when oil prices reached the same level in real terms. The main cause of this lower impact on total vehicle sales is that the U.S. economy is less dependent on oil than it was in 1978, when the oil energy intensity (defined as the amount of oil per dollar of GDP) was about twice as high as today's level.[32] Consequently, the same price of oil in real terms will reduce today's GDP and household income by a lesser amount.

The vast majority of the sales reduction, nearly 75 percent of total losses, will be absorbed by Detroit's Big Three automakers because of their heavy reliance on SUVs and pickups. On a percentage basis, losses among the Big Three automakers are about 11 to 17 percent, for a total reduction of 1.4 to 2.1 million vehicles.

Japanese automakers fare better, losing about half as many sales on a percentage basis, 6 to 8 percent, and only one-quarter of the total sales lost by Detroit. Compared with today's volumes, the Detroit Big Three will continue to shrink, whereas the Japanese Big Three actually will grow slightly, even under the highest

FIGURE 3.1



Compared to forecast base case levels at $1.96/gallon.

TABLE 3.1
Results for North American Production and Import Sales by Manufacturer

	NORTH AMERICAN PRODUCTION PLUS IMPORT SALES				CHANGE IN VOLUME COMPARED TO 2009 BASE CASE	
	2004 Actual	**2009 Baseline**	**2009 at $2.86**	**2009 at $3.37**	**2009 at $2.86**	**2009 at $3.37**
GM	5,246,548	4,967,320	4,417,800	4,106,400	–11.1%	–17.3%
Ford	4,052,549	4,207,800	3,747,100	3,486,100	–10.9%	–17.2%
DCX	2,951,088	3,236,700	2,877,000	2,673,300	–11.1%	–17.4%
Toyota	2,452,335	2,652,100	2,546,600	2,486,800	–4.0%	–6.2%
Nissan	1,348,773	1,604,500	1,493,000	1,429,800	–6.9%	–10.9%
Honda	1,571,106	1,763,800	1,689,900	1,648,100	–4.2%	–6.6%
Other Japanese	529,423	550,500	502,900	475,900	–8.6%	–13.6%
Korean	857,077	864,500	794,700	755,200	–8.1%	–12.6%
European	977,514	1,107,520	996,500	933,800	–10.0%	–15.7%
Total	**19,986,413**	**20,954,420**	**19,065,500**	**17,995,400**	**–9.0%**	**–14.1%**

oil price scenario. The Japanese Big Three are far less dependent than Detroit on truck-based vehicle sales. In fact, Honda does not offer a truck-based passenger vehicle for the North American market. Therefore, Japanese automakers are less affected by the higher gasoline prices.

On a company-by-company basis, higher oil prices hit GM hardest, mainly because GM has the largest market share in fuel-inefficient vehicles (see Table 3.1). Even under the base case, GM production and import sales will decline by 5.3 percent compared with 2004 levels, whereas all other manufacturers are expected to grow slightly. The announcement by GM in early June 2005 that it plans to shrink its workforce confirms that this assessment is reasonable.

Under the higher gasoline price scenarios, GM will see a reduction in its North American market volume of 550,000 to 861,000 vehicles from 2009 base case levels. GM's projected market share under the higher oil price scenarios will drop to about 23 percent. In our analysis, GM's slightly better fuel efficiency in 14 of 15 vehicle segments, compared with that of Ford or DCX, will not mitigate the overall effect because a higher a proportion of GM's sales are in low-mpg segments.

Ford and DCX also fare poorly under the higher gasoline price scenarios. Ford's North American market volume drops by 461,000 to 722,000 vehicles under the higher gasoline price scenarios. DCX's market volume also declines, but by a lesser amount, 360,000 to 563,000 vehicles, reflecting its smaller market share. In total, Ford's and DCX's market shares remain about the same, at about 20 percent for Ford and 15 percent for DCX.

Of the Japanese Big Three, Nissan will be the most adversely affected because of its greater reliance on truck-based vehicles and general emphasis on class-leading horsepower, with its market share shrinking by 7 to 11 percent. Toyota and Honda will see the lowest decline of any of the major automakers, about 4 to 6 percent.

Our model predicts that Toyota and Nissan will see growth in truck-based models, but the growth is driven by their expansion into these markets; overall, the increase is still rather modest. At $1.96 per gallon of gasoline, Toyota would sell 59,000 more vehicles, and Nissan would sell 65,000 more vehicles.

PROFITS AT DETROIT'S BIG THREE WILL SHRINK BY $7 BILLION TO $11 BILLION

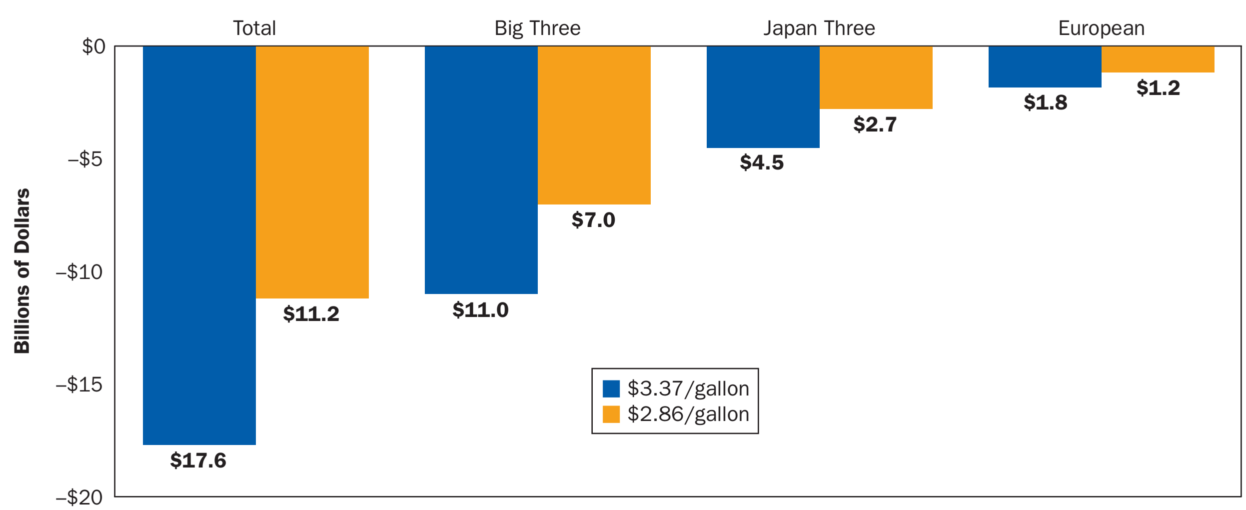
In our analysis, the reduction in total sales volumes of 9 to 14 percent will lead to an industry-wide decline in pretax profits of $11.2 billion and $17.6 billion under the two high oil price scenarios. We find that GM, Ford, and DaimlerChrysler are the most vulnerable to reductions in profits. Their pretax profits will shrink by $7 billion to $11 billion, a drop of 12 to 19 percent. Their reduced profits account for two-thirds of the total reduction, less than their 73 percent share of the sales losses, because their variable profits per vehicle are less than those of the Japanese or Europeans.

Pretax profits for Japanese automakers are expected to decline by a much lower amount: $2.8 billion to $4.5 billion, or about 7 to 12 percent. On a percentage basis, the European automakers' reductions in pretax profits are about the same as those of the Detroit Big Three, but their total reductions are much smaller due to their smaller market share.

On a percentage basis, the reductions in pretax profits is similar across the Detroit Big Three, but GM would see the biggest decline, $2.8 billion to $4.3 billion, because it is forecast to have the largest market share

FIGURE 3.2

Reductions in 2009 in Pretax Profits for North American Vehicle Operations



Compared to forecast base case levels at $1.96/gallon.

TABLE 3.2
Pretax Profit Reductions in 2009 Under Higher Gasoline Price Scenarios Compared with Base Case

	Pretax Profit Reductions (in billions)		Percentage Change	
Automaker	**at $2.86/gal**	**at $3.37/gal**	**at $2.86/gal**	**at $3.37/gal**
GM	2.8	4.4	–12.6%	–19.8%
Ford	2.3	3.6	–11.9%	–18.7%
DCX	1.9	3.0	–12.5%	–19.5%
Toyota	1.1	1.7	–6.8%	–10.7%
Nissan	0.9	1.4	–9.6%	–15.0%
Honda	0.6	1.0	–5.8%	–11.0%
Other Japanese	0.2	0.4	–9.1%	–14.3%
Korean	0.3	0.4	–8.9%	–13.9%
European	1.2	1.8	–12.0%	–18.8%
Total or Average	**11.2**	**17.6**	**–10.5%**	**–16.6%**

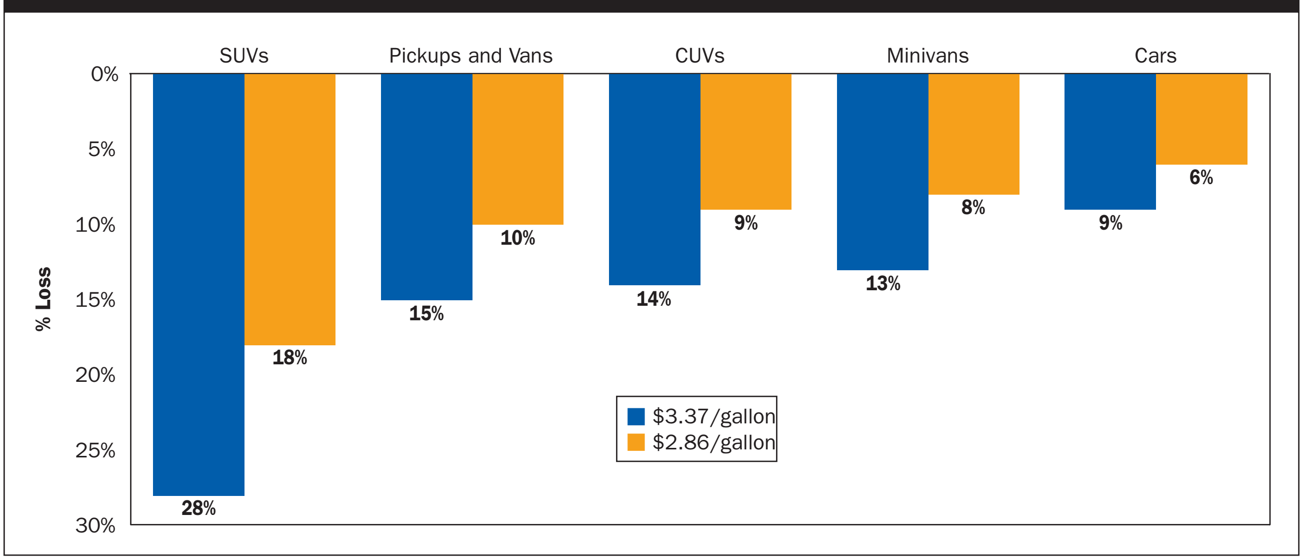
in the base case (see Figure 3.2, Table 3.2). GM's profit reductions are followed closely by Ford's profit declines ($2.3 billion to $3.6 billion) and DCX's ($1.9 billion to $3.0 billion). As with the impact on sales, Nissan is affected the most of the Japanese Big Three in terms of percentage reduction in profits (9.6 to 15 percent). Honda and Toyota, again, fare the best of the automakers, losing about half as much of their pretax profits as Detroit's Big Three.

To get a sense of how significant a profit shrinkage of $2.8 billion to $4.4 billion is for a company such as GM, it is useful to compare the figures to total pretax profits. GM's pretax profits on North American automotive operations averaged $1.79 billion per year from 2002 to 2004.[33] Ford's pretax profits averaged only $201 million for the same period. Consequently, the profit reductions estimated in our model would overwhelm North American automotive operation profits for these companies.

The explanation for the forecast decline in sales and profits is straightforward: at higher real fuel prices, total sales declines, and the sales mix shifts toward more fuel-efficient vehicle segments and models. In particular, truck-based SUVs and pickups lose 1.7 to 2.8 per-

FIGURE 3.3

Reduction in Sales Volume from 2009 Base Case, by Vehicle Segment



Compared to forecast base case levels at $1.96/gallon.

TABLE 3.3
North American Production and Sales and Market Share by Vehicle Segment

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37
Cars	8,936,507	8,854,520	8,358,000	8,076,700	44.7%	42.3%	43.8%	44.9%
Minivans	1,256,414	1,401,300	1,283,800	1,217,200	6.3%	6.7%	6.7%	6.8%
CUVs	2,376,140	3,202,200	2,920,000	2,760,100	11.9%	15.3%	15.3%	15.3%
SUVs	3,230,651	3,382,000	2,783,400	2,444,100	16.2%	16.1%	14.6%	13.6%
Pickups+Vans	4,186,701	4,114,400	3,720,300	3,497,000	20.9%	19.6%	19.5%	19.4%
Total	**19,986,413**	**20,954,420**	**19,065,500**	**17,995,100**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Car-based	12,569,061	13,458,020	12,561,800	12,054,000	62.9%	64.2%	65.9%	67.0%
Truck-based	7,417,352	7,496,400	6,503,700	5,941,100	37.1%	35.8%	34.1%	33.0%

cent of market share, and more fuel-efficient cars, minivans, and CUVs gain market share.[34] In percentage terms these changes may seem modest, but, for example, each percentage-point drop in the $2.86/gal scenario (corresponding to $80/bbl oil) represents a loss of about 190,000 vehicles.

CUV sales should dramatically increase by 2009 as SUV customers continue to switch to this more fuel-efficient alternative and as automakers increase their CUV product offerings.[35] Our base case for 2009 forecasts total CUV sales to increase by 35 percent from 2004 to 2009, or from 11.9 percentage points of market share in 2004 to 15.3 percentage points in 2009. In contrast, market share for truck-based SUVs are forecast to stall and slightly decline, with sales increasing at about the same rate of growth in the overall market. CUV market share comes at the expense of the car market, whose market share declines by about 2.4 percentage points.

At higher oil prices, the sales and market share of SUVs tumble dramatically. SUV sales fall by 18 to 28 percent, and overall, the truck-based sales volume shrinks by 13 to 21 percent. In contrast, the market for car-based vehicles is much less affected by the higher prices and the overall sales drop of 7 to 10 percent is much less than that of truck-based vehicles. The total market share of CUVs does not change, but within the CUV segment luxury and midsize models lose market share and smaller, more fuel-efficient CUVs gain market share. Not surprisingly, the most fuel-efficient segment—cars—sees the smallest decline in sales volume (6 to 9 percent) and increases market share compared with the 2009 base case.

SIXTEEN FACTORIES, MOSTLY IN THE MIDWEST, ARE AT RISK FOR CLOSURE OR LAYOFFS

Our analysis suggests that factories that depend on sales of fuel-inefficient products, especially medium and large SUVs and large cars, are most at risk for closure or layoffs in the event of higher oil prices. Because of the dependency of Detroit's Big Three on SUVs, it is their factories that are most at risk, including assembly, engine, and transmission plants in the Midwest. With the Big Three already operating many plants at well below full capacity, small changes in unit output will add tremendous pressure to consolidate production in fewer facilities when possible. Table 3.4 lists 16 Big Three plants we believe are most at risk of closure or layoffs because of their involvement in the production of the most vulnerable vehicle models.

With SUV sales slumping badly, some of these plants are already vulnerable. GM recently announced it will cut its U.S. manufacturing workforce by 20 percent, and among the most vulnerable GM plants are those that make full-size SUVs in Janesville, Wisconsin, and Arlington, Texas. Production at both of these facilities has been on the decline. GM also has two plants that make mid-size SUVs—in Oklahoma City, Oklahoma, and Moraine, Ohio—but production could probably be consolidated into one plant. If sales drop, Ford's and DaimlerChrysler's midsize SUVs factories could be

TABLE 3.4
U.S. Auto Assembly, Engine and Transmission Plants Most at Risk from Higher Oil Prices

Company	Plant	Product	Notes
GM	Arlington, TX	Large SUVs (Escalade, Suburban, Tahoe, Yukon)	Candidate for consolidation. GM has three North American plants that build large SUVs; the third is in Silao, Mexico and has lower labor costs.
	Janesville, WI	Large SUVs (Suburban, Tahoe, Yukon)	See above.
	Oklahoma City, OK	Midsize SUVs (TrailBlazer, Envoy)	OK and OH plants could be consolidated.
	Moraine, OH	Midsize SUVs (Bravada, Envoy, Rainer, TrailBlazer)	Probably less at risk than OK plant due to higher utilization rate (three crews) and only non-UAW factory in U.S.
	Toledo, OH	RWD Transmissions	Not at risk for closure, but could lose jobs
	Ypsilanti, MI (Willow Run)	RWD Transmissions	Not at risk for closure, but could lose jobs
	Romulus, MI	V8 engines	Not at risk for closure, but could lose jobs
Ford	St. Louis, MO	Midsize SUVs (Explorer, Mountaineer)	Candidate for consolidation. St. Louis already reduced to one shift and was previously scheduled for closure. The core Explorer plant is in Louisville, KY and could add Explorer production, as could Dearborn, MI.
	Wayne, MI (Michigan Truck)	Large SUVs (Expedition and Navigators)	Built on F-150 platform so could be consolidated with other plants to build F-150s.
	St. Thomas, Ontario, Canada	Large cars	St. Thomas and Wixom could be consolidated.
	Wixom, MI	Large and specialty cars	See above.
	Sharonville, OH	RWD transmissions	Not at risk for closure, but could lose jobs
	Essex, Ontario, Canada	V8 engines	Not at risk for closure, but could lose jobs
DaimlerChrysler	Newark, DE	Midsize SUVs (Durango)	Plant is underutilized and production could be consolidated at other plants that build RWD trucks.
	Kokomo, IN	RWD transmissions	Not at risk for closure, but could lose jobs
	Detroit, MI (Mack Avenue)	V8 engines	Not at risk for closure, but could lose jobs

consolidated into other factories that are building pickups that share the same platform.

AT LEAST 297,000 JOBS ARE ON THE LINE, 37 PERCENT IN MICHIGAN, OHIO, AND INDIANA

Based on our forecast of the probable model lineup of each automaker's car and light truck fleet, we estimate that between 297,000 and 465,000 jobs would be lost under the higher oil price scenarios (see Table 3.5). The job losses represent a 9.8 to 15.3 percent reduction in North American auto-related employment. The job losses are higher than the overall unit production declines we projected earlier (9.0 percent and 14.2 percent). This is because consumer demand will shift away from the larger, fuel-*inefficient* vehicles (where U.S. automakers have traditionally made higher margins), and hence production will shift away from Detroit's Big Three and toward vehicles having lower U.S. content.[36]

Because of the size and reach of the auto supply industry, nearly every state can expect to feel the effect of declining sales and shifting market segments brought on by increases in the price of gasoline. But three states stand to be hit the hardest by higher gasoline prices: Michigan, Ohio, and Indiana. As Table 3.6 shows, these states currently account for a large share of automobile production, especially engines and transmissions.

Although Michigan, Ohio, and Indiana host a much smaller proportion of North American parts production beyond engines and transmissions, they still

TABLE 3.5
Impacts of Three 2009 Fuel Price Scenarios on Jobs

	Total Number American Employment Tied to Production			Change in Employment	
	at $1.96/gal	**at $2.86/gal**	**at $3.37/gal**	**at $2.86/gal**	**at $3.37/gal**
Engines	227,775	206,925	195,110	–20,850	–32,665
Transmissions	141,648	127,373	119,282	–14,275	–22,366
Vehicles and Other Parts	2,672,182	2,410,448	2,262,136	–261,734	–410,046
Total, Net	**3,041,605**	**2,774,746**	**2,575,528**	**–296,859**	–465,077

TABLE 3.6
Regional Concentration of North American Light Vehicle Assembly, Engine, and Transmission Production, 2009 Baseline ($1.96/gal) Forecast (Millions of Units)

	Vehicles	**Engines**	**Transmissions**
MI, OH, IN	4.979	8.331	9.848
North America	17.226	15.622	12.948
MI, OH, IN as % of North America	28.90%	53.30%	76.10%

TABLE 3.7
Michigan, Ohio, Indiana Job Impacts of Higher Fuel Prices

	Total Number American Employment Tied to Production			Change in Employment	
	at $1.96	**at $2.86**	**at $3.37**	**at $2.86**	**at $3.37**
Engines	121,470	108,760	101,557	–12,710	–19,913
Transmissions	107,739	95,543	88,633	–12,196	–19,106
Vehicles & Other Parts	816,105	731,228	683,123	–84,877	–132,982
Total, Net	**1,045,314**	**935,531**	**873,313**	**–109,783**	–172,001

stands to lose nearly 37 percent of the U.S. jobs placed at risk by the prospect of sharply higher gasoline prices three to five years from now (see Table 3.7), Honda's less-than-average declines in output should offset some of the pain in parts of Ohio.

To put the potential loss of jobs and tax receipts in the Michigan-Ohio-Indiana region in perspective, the total non-farm workforce in these three states is 12.76 million, according to February 2005 data. Assuming that the rate of labor force participation stays the same as it is today, a $2.86 per gallon fuel price would raise the region's unemployment rate by 0.86 percentage points, or from 6.00 percent to 6.86 percent. At $3.37 per gallon of gasoline, unemployment would rise by 1.35 points, from 6.00 percent to 7.35 percent. Kentucky and Tennessee are also likely to suffer, but the relative strength of Toyota in Kentucky and Nissan in Tennessee will help offset job losses from U.S. automakers.

CHAPTER 4

Automakers, Investors, and Lawmakers Should Act Now

Recent news about the prospect that General Motors, America's largest automaker, could be forced to downsize rapidly is an unprecedented warning signal that U.S. automakers are in trouble. Beyond higher oil prices, the challenges faced by Detroit's three big automakers—GM, Ford, and the Chrysler-Dodge-Jeep portion of DaimlerChrysler—include rising pension and health care costs and increasing competition in the SUV and CUV market segments. In addition, vehicle pollution standards for greenhouse gases in North America and Europe are increasingly becoming an important driver for the production of clean and efficient vehicles. One-third of the North American market is potentially under new greenhouse gas emission standards, including the automakers' largest markets: California, New York, and Canada. Detroit automakers are now facing a "perfect storm" that requires reshaping their business model.

The solution starts with automakers building products that people want to buy, and it is becoming increasingly clear that consumers value fuel-efficiency. Investors and government also have a role in encouraging and ensuring that fuel efficiency becomes a higher priority, to protect investor value, secure U.S. jobs, enhance our national security, and reduce global warming pollution. To meet these goals, we recommend that the following actions be taken.

AUTOMAKERS SHOULD MAKE FUEL EFFICIENCY JOB NUMBER ONE

Although betting on low oil prices was a good strategy a decade ago, in today's environment such a gamble places companies, workers, investors, and communities at grave risk. Without a product mix that will meet changing consumer behaviors during periods of higher oil prices, Detroit could lose the customers it needs to support revenue streams and keep factories open. Automakers must realize that fuel efficiency is a key determinant of their competitiveness in the near future. The results of this study point to a simple plan to make fuel efficiency "job number one." Automakers should take the following steps to prioritize fuel efficiency.

▶ **Automakers, especially Detroit's Big Three, should become less dependent on the least fuel-efficient, most vulnerable market segments (truck-based SUVs and pickups) for their profitability.** Automakers can achieve this goal by prioritizing the development of attractive, competitive products that consumers are switching to, such as crossover vehicles and passenger cars. In an era of high gasoline prices, automakers need to prioritize development of products in the more fuel-efficient segments rather than truck-based SUVs. Toyota, Nissan, and Honda should reverse their trend toward building larger SUVs and pickups.

▶ **Automakers should accelerate the penetration of existing technologies that can make their products class leaders in fuel efficiency and make them more attractive to consumers when gasoline prices are high.** There is a long list of technologies available to automakers, including variable valve timing (VVT), continuously variable transmissions (CVT), cylinder deactivation, and lightweight and high-strength materials. Many of these technologies are already being adopted, but these technologies need to be accelerated by automakers.

▶ **Automakers should adopt and promote advanced technology, hybrid electric vehicle programs, which, in contrast to truck-based SUVs, is a growth market.** A recent study by Oak Ridge National Laboratory estimates that the hybrid electric vehicle market could capture up to 15 percent of the U.S. market by 2012 (about 2.5 million vehicles), and this is without considering today's higher oil prices.[37] GM in particular is lagging far behind in the fast-growing hybrid market and should accelerate its programs, especially its strong-hybrid technology. Currently, GM doesn't plan to have a hybrid vehicle on the market for at least two years.

LAWMAKERS SHOULD PROVIDE INCENTIVES AND STANDARDS TO RAISE FUEL ECONOMY PERFORMANCE

The impact of today's oil prices on automakers, especially GM, is rapidly making the debate over fuel efficiency versus jobs moot. Higher oil prices are reshaping the industry, prompting more serious transition problems for the industry than a well-designed, gradual increase in fuel economy levels would have had over the past decade. In Europe, where policies encouraging fuel efficiency have been in place for decades, automakers do not face the same competitive restructuring challenges as here in the United States when oil prices rise. European vehicle fleet mixes are already more fuel efficient, encouraged by greater attention to reducing global warming emission reductions and by higher fuel taxes.

U.S. policymakers should assist in the shift to a more fuel-efficient fleet by providing public financing assistance to automakers and suppliers for retooling factories and redesigning vehicles. It is especially crucial that policymakers in those states that are most vulnerable to factory closings and job loss—Michigan, Ohio, and Indiana—become leaders in the efforts to retool the industry so that it is better able to compete. We recommend the following:

▶ **Manufacturer tax incentives and other financing mechanisms should be provided to assist automakers and suppliers in retooling their factories to build fuel-efficient technologies (especially hybrids and clean diesels).** Incentives and other financing mechanisms are key to ensuring that all companies and workers have the opportunity to compete in an environment of higher oil prices.[38] The bipartisan National Commission on Energy Policy (NCEP) recommends making available $1.5 billion over 10 years to domestic and foreign companies to retool U.S. facilities, including both vehicle assembly and parts suppliers.[39]

▶ **Consumer purchase tax incentives should be extended and expanded.** These are important to prime the pump in supporting demand for highly fuel-efficient technologies, such as hybrids and clean diesels. Again, the bipartisan NCEP recommends spending $1.5 billion over five years, in the form of a variable tax credit of up to $3,000 based on a vehicle's fuel efficiency.

▶ **Fuel economy standards for cars and light trucks should be raised.** This strategy would provide certainty to manufacturers that invest in fuel efficiency technologies, and it would mitigate the risks of individual automakers moving forward alone with a higher fuel economy strategy. If done right, raising fuel economy standards can be an important part of a strategy to protect U.S. jobs from the risks of higher gasoline prices.

INVESTORS SHOULD RECOGNIZE THE ROLE OF FUEL EFFICIENCY IN SAFEGUARDING SHAREHOLDER VALUE

The investment community can play an important role in preserving shareholder value by signaling to automakers that fuel efficiency is a concern. Transparency about a company's financial risk in the event of higher oil prices will be of profound interest not only to investors, but also to autoworkers who are struggling to keep their jobs and policymakers who are struggling to maintain economic growth while reducing both pollution and oil dependence.

With additional information about risks, investors can identify, quantify, and therefore manage their exposure to the potentially massive swings in shareholder value described in this paper. The advent of coordinated requests by institutional investors for transparency and industry shifts suggests that shareholders can achieve the level of disclosure and new approaches suggested here. Potential models for this are recent investor-led actions on climate change concerns.[40] As with that topic, investors can require greater transparency from the automakers, seek more robust analyses, and encourage changes in the following ways.

▶ **Investors should demand automaker transparency regarding the financial risks connected with gasoline prices.** The most critical requirement from automakers is *disclosure,* in quarterly and annual filings and other public documents, of historical and expected fleet fuel efficiency, as well as how higher gasoline prices have affected profitability. We believe that most automakers have internally developed these analyses and can therefore easily provide them to the investment community.

▶ **Financial analysts should quantify the risks to shareholder value in the event of higher gasoline prices.** Securities analysts play a major role in developing and disseminating insights that inform the investment community and other market watchers and participants. They can serve investors by identifying the prospective impact of fuel prices on shareholder value, using tools similar to those used in this study. Interviews with equity analysts and a review of top-ranked analysts' reports demonstrate that this community is well aware that fuel prices affect automaker profitability. However, we have not yet seen any explicit quantitative analyses of risks connected with fuel prices.

▶ **Investors should require automakers to articulate strategies to address and mitigate the risks of higher fuel prices.** As automaker disclosure and financial analysts' studies begin to show the level of exposure faced by auto company shareholders with fuel price volatility, investors will be well served by evidence that automakers are prepared to manage an environment of high gasoline prices. More than a matter of corporate responsibility, effective approaches to this issue will be critical to every automaker's competitiveness. Automakers might develop strategies that start by including the three steps discussed earlier of "making fuel efficiency job number one."

An In-Depth Look at What is Driving Oil Prices

A number of factors drive oil prices. The most critical factors are the growth in global demand and the decline in spare global production capacity. It takes a long time to bring new supplies online, both in the sense of oilfields and of refining capacity, and prospects for greater spare capacity are extremely limited over the next five years or so. If, during this period, supply disruptions occur and have impacts that persist for a year or more, then strategic stockpiles, such as the U.S. Strategic Petroleum Reserve, will likely prove far too small to dampen oil prices.

RESTORING THE "CUSHION" OF SPARE CAPACITY IS THE ONLY ROUTE TO LOWER OIL PRICES

For oil prices to fall, either supply must expand faster than demand or demand must drop dramatically to recreate a cushion of spare capacity of about 3 to 5 mbd, similar in size to the cushion that existed during the oil deflationary period of 1986–1997. Under modest growth rate assumptions (1.7 percent per year, the historic long-term growth rate), the world will need at least another 7.4 mbd of oil production by 2010, or 1.5 mbd of increased capacity *per year,* just to meet new demand.[41] However, if demand does not cool and continues at the average rate projected by IEA for 2005 (2.1 percent), then world oil demand will grow by 9.2 mbd, or about 1.85 mbd per year.

The IEA believes that about 1.75 mbd of capacity will be added per year through 2010; this means that 9.75 mbd of capacity will be added by 2010 resulting in a total supply capacity of 93.1 mbd.[42] Not only do some analysts dispute whether such supply growth is feasible during this period, but also this rate of increased supply would at best, create a thin 1.4 mbd of additional spare capacity even under a modest growth rate scenario of 1.7 percent. The cushion would disappear if demand grows annually at 2005's projected rate of 2.1 percent per year.[43]

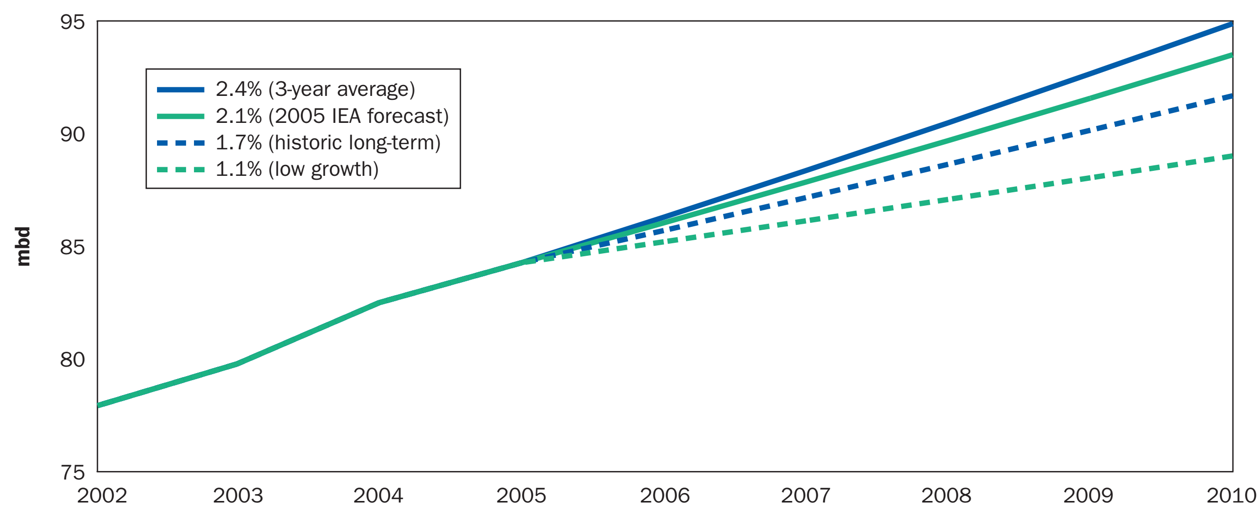
PRODUCTION IS UNLIKELY TO GROW ENOUGH TO RECREATE SPARE CAPACITY

It is not clear whether production will keep up with demand, even under the modest growth scenario (see Figure A.1 and A.2). The IEA estimate of increased supply is considerably higher than other recent estimates of global production by 2010, which range from 88 mbd to 91.1 mbd, raising the question of whether production investments will be made in time to meet surging demand.[44] The answer, according to *The Economist,* is "probably not." One reason is that it is unclear how strong demand will be. If a great deal of new capacity is built and if prices collapse as they did in the late 1980s, then companies could be caught with ruinous new fixed costs. This may explain why, even though they face $50-plus oil prices per barrel today, Western oil companies may be basing decisions about investing in additional capacity on the assumption of crude oil at $20 per barrel or less.[45] Ironically, because underinvestment would be rewarded with higher prices, the market does not necessarily punish companies that base their decisions on bad assumptions.

Some experts are concerned that countries are either unwilling or unable to make the investments necessary

FIGURE A.1

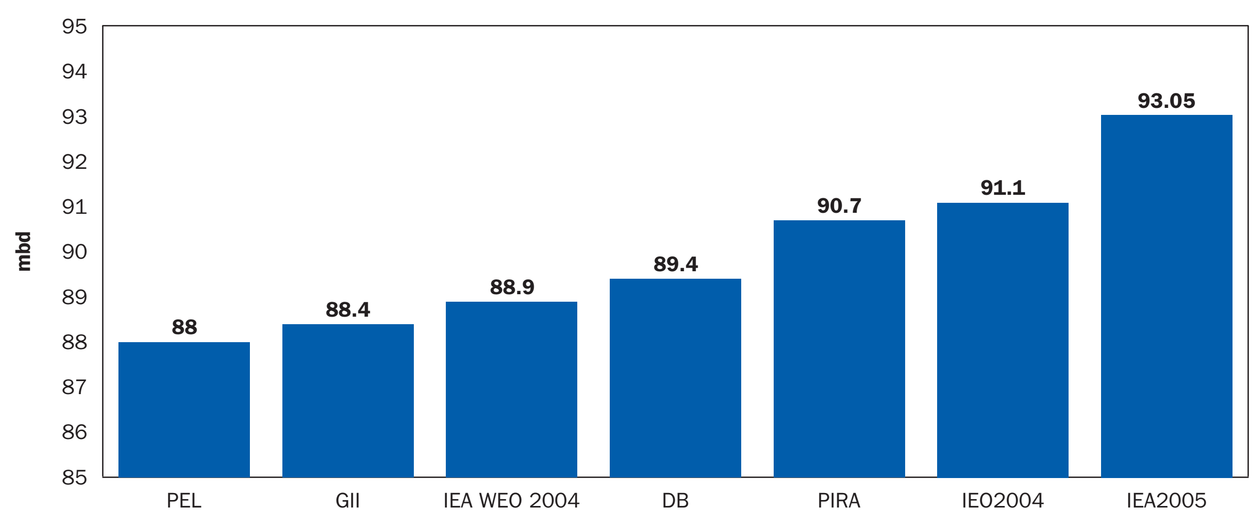
Uncertainty in Demand Makes Investments in New Capacity Risky



Source: Historic data from IEA.

FIGURE A.2

Restoration of Supply Cushion Is Unlikely Unless Demand Collapses



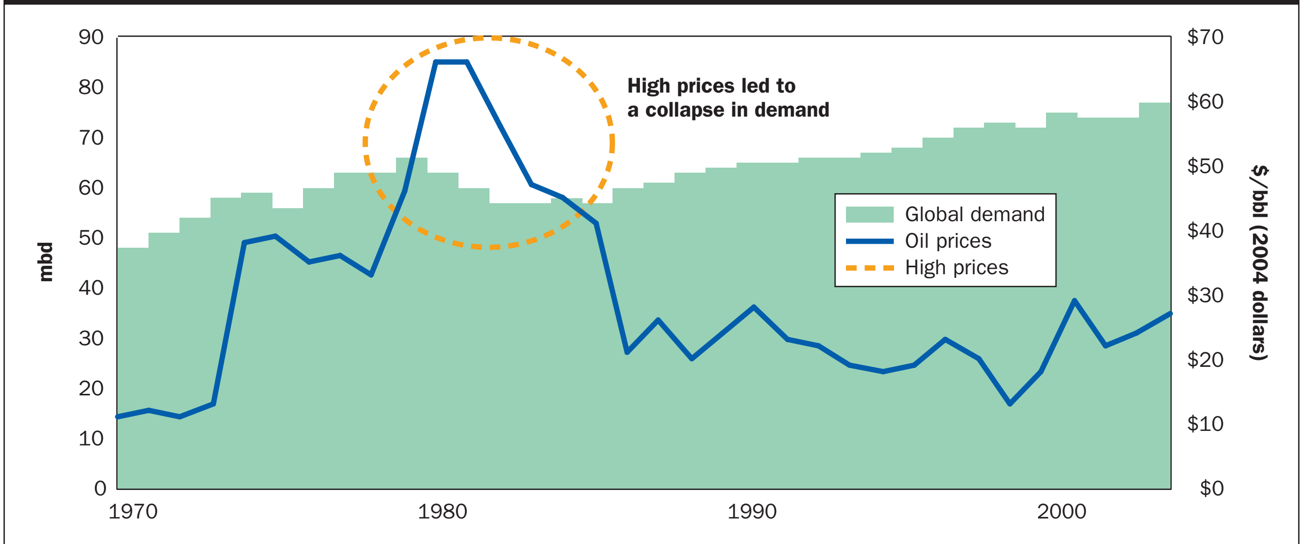
Source: EIA, IEA, and author's estimates.

to restore market balance. Because OPEC controls the vast majority of world oil resources and enjoys the lowest production cost, the burden of recreating spare oil capacity falls to it.[46] Saudi Arabia, the world's largest oil producer and holder of the world's largest reserves, plans to expand production by only 1.5 mbd, about 15 percent of the total supply necessary.

Many OPEC countries either restrict or ban outside investments, including Kuwait, Mexico, Saudi Arabia, Russia, Iran, and Venezuela. Others, such as Nigeria and Iraq, are considered extremely risky to outside investors. Finally and perhaps most obviously, the political situation in the oil-rich Middle East where most proven OPEC reserves are located, carries large downside

FIGURE A.3

Memories of Price Collapse After Demand Drop in the Early 1980s May Discourage Investments in New Capacity



Source: World oil demand from BP Statistical Review of World Energy 2004. Oil prices from EIA, *International Energy Outlook 2004*.

risks. With some of the highest population growth rates in the world, Middle East producer countries have strong incentives to make their reserves last longer, a goal that is abetted by higher rather than lower prices.

UNCERTAINTY ABOUT OIL RESERVES ADDS UPWARD PRESSURE ON PRICES

This issue of reserves deserves additional comment. Some experts are warning of the possibility that oil reserves may be smaller than current estimates that the costs of new production may be higher than expected, and that conventional oil production may soon peak. For example, Mike Rodgers of PFC Energy believes that it is possible that non-OPEC oil production will peak in the 2010–2015 time frame.[47] Another expert, Matt Simmons, claims that Saudi Arabia's massive Ghawar oil field, which produces about 5 mbd, may already have peaked, due in part to poor oil field management.[48] Although this study takes no position on when conventional oil production will peak, we note that if any of these claims turn out to be valid, each would have the effect of adding upward pressure on oil prices (see Figure A.3).

TIGHT GLOBAL REFINERY CAPACITY IS AN ADDITIONAL CONSTRAINT PORTENDING HIGHER GASOLINE PRICES

No new refining capacity has been added in the United States *for 30 years*.[49] In Asia, which accounted for 60 percent of the global refinery capacity added between 1995 and 2002, refineries are operating at more than 90 percent of capacity for the first time since the 1980s.[50] Refinery constraints have already accounted for 20 percent of the $1 increase in U.S. gasoline prices since 2002.[51] Industry consolidation and companies' reluctance to make capital investments in the face of price volatility seem likely to keep refinery capacity tight.

Estimating Oil and Gasoline Prices in the Event of Supply Disruption

In this study, we consider the impact on the consumer market of a long lasting (year or two) increase in oil prices. Consequently, our oil price model looks at the impact on oil prices average over a year, rather then shorter-term, such as monthly averages. We would expect that daily, weekly, or monthly average prices would greatly exceed the annual average increase. The annual average would be likely lower as production increases and demand presumably would be reduced by the higher prices.

According to the Energy Information Agency of the U.S. Department of Energy,[52] the short-run average (year or two) price response to a supply disruption is a function of the following factors:

- The net short fall after the spare capacity and strategic stocks are considered.

- The net elasticity, based on short-run elasticity of demand and the short-run elasticity of supply.

- The so-called "fear premium" which may already be perhaps $7 to 15/bbl on the oil futures markets.[53]

The "rule of thumb" according to the EIA, is that a 1 mbd net loss of supply (disruption minus spare capacity) at world oil prices of around $50/bbl will lead to $5 to $7/bbl increase in oil price. At $40/bbl, a 1 mbd net loss of supply would lead to $4-6/bbl increase. These price increases are based on estimates of the price increase necessary to reduce demand to match the lower supply capacity, so is likely best interpreted as only the demand elasticity. According to Paul Leiby of ORNL, EIA's "rule of thumb" at today's demand level equates to a demand elasticity of about –0.09 to –0.13. A reasonable short-run elasticity for non-OPEC oil supply, according to Leiby, is 0.06 and that OPEC supply, after utilization of any spare capacity can be assumed to be fixed.[54]

Assuming a short-run demand elasticity of –0.10 and a short-run elasticity of non-OPEC oil supply to be 0.06, yields a net elasticity of about –0.13. If oil supply capacity in non-OPEC countries is constrained and unable to produce more (supply elasticity of zero), then the net elasticity would be essentially –0.10. Hence a reasonable range for short-run elasticity might be –0.10 to –0.15, according to Leiby.

Using reasonable estimates for future demand (90 mbd) and oil prices ($45 to $55/bbl), $80/bbl prices would require a 3.3 to 5.8 mbd net supply disruption. Assuming a $10 "fear premium" reduces the net supply disruption required for $80/bbl to 2.2 to 5.8 mbd. Using the same range of assumptions yields a range of 4.3 to 8.9 mbd net disruption for $100/bbl.

Given the extremely limited prospects for recreation of spare capacity, it is not unreasonable to assume that global spare capacity will is essentially non-existent for the next five years. If the supply disruptions last for more than a year, the OECD stocks will also likely be insufficient to dampen oil prices in the event of supply disruptions of the magnitude being considered in this study.

$80–$100 PER BARREL OIL MEANS GASOLINE PRICES OF $2.86–$3.37 PER GALLON

Gasoline prices consist of four cost components: crude oil, federal and state taxes, refining, and marketing and distribution. Crude oil costs are converted by simply dividing the dollar price per barrel by the 42 gallons in a barrel. (Note: Our oil price scenarios are nominally based on the standard U.S. benchmark crude, West Texas Intermediate (WTI), a light, "sweet" (low-sulfur) crude that often commands a premium. The prices that refiners pay for crude may diverge from this benchmark, so it is not exactly accurate to translate WTI prices into gasoline prices. Thus, based on data from EIA, we estimate the U.S. refiner acquisition cost to be about $0.11 per gallon less than WTI cost.) Taxes are mostly a fixed dollar per gallon rate, but some states (notably California) charge sales taxes as a percentage of gasoline price. At today's gasoline price, taxes average about $0.44/gallon. They would be slightly higher at higher oil prices; about $0.46 at $80/bbl and $0.48 at $100/bbl.

Refining charges are probably the greatest unknown, because this component appears likely to increase over time due to limited capacity and the increasing role of sour crudes in refineries' input mix. Based on EIA data, refinery charges over the past four years averaged about $0.24/gallon, with 2004 levels being substantially higher at about $0.33/gallon. Finally, marketing and distribution costs have averaged $0.20 per gallon over the past four years, with 2004 levels again being slightly higher at about $0.22 per gallon. Assuming these two components rise only slightly over the next several years, we conservatively estimate charges for refining and marketing and distribution that total $0.50/gallon.

Discrete Consumer Choice (Nested Multinomial Logit Regression)

The multinomial logit model is the most widely used discrete choice model used by economists due to its simple structure and ease of estimation.[55] In this approach, the choice of vehicles is modeled at the consumer, or household, level as a discrete choice in a multi-step process. Figure C.1 below shows the highest-level decision tree.

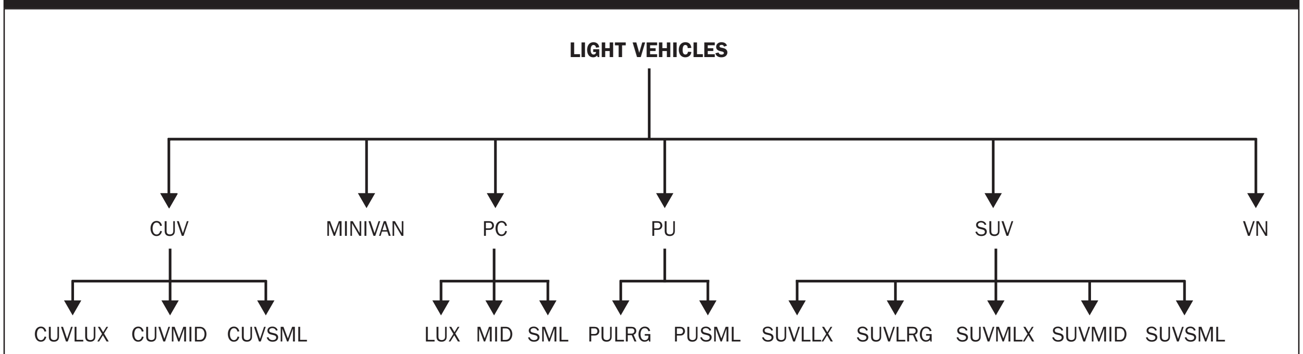
In the first step the consumer chooses which of the broad types of vehicles desired: crossover utility vehicle (CUV), minivan (MINIVAN), passenger car (PC), pickup (PU), sport utility vehicle (SUV), and large van (VN).The second step is the choice of a vehicle segment within the vehicle type and is conditional on which broad type of vehicle was chosen in the first step. For example, a consumer who chose the crossover vehicle type would then choose among luxury (CUVLUX), midsize (CUVMID), and small (CUVSML). And in the third step of this so-called nested multinomial model, the consumer chooses among the individual models within the segment.

DISCRETE CONSUMER CHOICE VERSUS STANDARD ELASTICITY MODELS

The structure of the discrete consumer choice model lets us describe the highly complex choice process with a minimum of parameter assumptions. This is in contrast to an unconstrained elasticity model, in which the number of parameters that need to be estimated is very large. In the 2004 baseline, for example, there are 287 individual models for the consumer to choose from. The unconstrained elasticity matrix for this choice would have $(287)^2$ = 82,369 own- and cross-price-elasticities to estimate. (The problem is made an order of magnitude worse by the fact that we are actually considering many different variants of each of

FIGURE C.1

High-Level Discrete Choice Decision Tree



the 287 models by taking account of the engines and transmissions that are chosen.)

In the research and policy literature on vehicle choice, these huge, unwieldy unconstrained elasticity matrices are reduced by imposing restrictions. The Congressional Budget Office's 2003 study, "The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax," December 2003, collapsed the full make-model choice set to 60 (6 makes and 10 segments). In the midsize car segment, for example, the study collapsed models from Chevrolet, Oldsmobile, Pontiac, Buick, and Saturn into a single aggregate called "GM Midsize Car." Even with this level of aggregation, the model required $(60)^2$ = 3,600 own- and cross-price-elasticity estimates.

For another example of the use of an elasticity model, see Andrew N. Kleit, "Impacts of Long-Range Increases in the Corporate Average Fuel Economy (CAFE) Standard," *Economic Inquiry*, 42:2 (April 2004), pp. 279–294 (originally distributed as a working paper by the AEI-Brookings Joint Center for Regulatory Studies, October 2002). Kleit uses a model with 11 vehicle segments and 4 aggregate makes (GM, Ford, Chrysler, and other), implying $(44)^2$ = 1,936 own- and cross-price-elasticities.

Replication of the models used by the CBO and Kleit studies was explored for this study, but turned out to be infeasible. Both studies rely on estimates of own- and cross-price-elasticities derived from models developed by economists at GM that are not publicly available. Kleit reports 121 elasticities at the segment level, and the CBO does not report any estimates of elasticities at all.

In addition to being incapable of being replicated, the Kleit and CBO models do not follow the conventional econometric approach to discrete choice (i.e., the multinomial logit model.) On the other hand, the multinomial logit model imposes the restriction that the distribution of the random error terms is independent and identical over alternatives. This restriction leads to the so-called "independence of irrelevant alternatives" property, which causes the cross elasticities between all pairs of alternatives to be identical. This representation of choice behavior produces biased estimates and inaccurate predictions in cases that violate these strict conditions. The most widely known model that relaxes this restriction is the nested logit model.[56]

DESCRIPTION OF MODEL USED IN THIS STUDY

The model used in this study to estimate the impact of changes in fuel prices and vehicle prices is a nested multinomial logit model. The number of elasticities that need estimates is 20 (the number of vehicle types plus segments plus 1). The model is calibrated to 2002–2003 data following the procedure described in a recent study.[57]

The essence of the model is captured by the vehicle ranking equation:

$$u_{ij} = b(A_i + \sum_{l=1}^{K} w_l x_{il} + e_{ij})$$

where u_Ij is the ranking score for the Ith vehicle for the jth individual, w_{ij} the weight of the l^{th} attribute, x_{il}, and e_{ij} *the j*th individual's random component for the ith make and model. By convention, the weight for vehicle price is 1, so that the units of $w_l x_{il}$ are dollars. Greene, Duleep, and McManus (2004) included several variables in their analysis, but the present study uses only two: vehicle price and fuel cost per mile. Transaction price in 2004 is the price paid by the buyer net of cash and other incentives. Fuel cost per mile is measured as the price of gasoline ($1.96 in 2004) divided by the segment average mpg.

In the equation, the term b is referred to as the "price slope" and is derived from the price elasticity. The "fuel cost per mile slope" in the equation is b•w, where b is the "price slope" and w the weight of fuel cost per mile in the equation. Assuming that consumers rank vehicles strictly according to the sum of the out-of-pocket transaction price and the present value of the anticipated fuel cost, w equals the present discounted value of the anticipated total lifetime vehicle miles. We use the CBO's assumptions for vehicle life (14 years), discount rate (12 percent), and rate of decline in miles driven with vehicle age (5.2 percent).

Many have suggested that consumers react differently to a $1 (present value) change in out-of-pocket cash than they do to a $1 (present value) change in fuel cost. To allow for this, we relaxed the assumption that consumers rank vehicles strictly according to the sum of the out-of-pocket transaction price and the present value of the anticipated fuel cost. The three-year calibrated model resulted in fitted values of w that were within 5 percent of what they would be under the strict assumption. The difference in impact on choice of cash and fuel cost is small.

Table C.2 gives the price, fuel economy, assumed price elasticity, price slope, and fuel cost per mile slope for the vehicle types and segments we examined.

TABLE C.2
Nested Logit Parameters for Consumer Segment Shifts

Type	Segment	Transaction Price 2004	Price Elasticity	Choices	Average Share	Price Slope	MPG	Fuel Cost Per Mile Slope
Total Light Vehicles		$26,335	(1.00)	6	16.7%	(0.00005)	20.0	(3.54)
CUV		$25,262	(2.00)	3	33.3%	(0.00012)	21.6	(9.27)
CUV	CUVLUX	$35,619	(3.00)	7	14.3%	(0.00010)	20.0	(7.88)
CUV	CUVMID	$25,966	(3.00)	12	8.3%	(0.00013)	20.6	(9.82)
CUV	CUVSML	$20,414	(3.00)	11	9.1%	(0.00016)	23.6	(12.45)
MINIVAN	MINIVAN	$25,942	(2.00)	18	5.6%	(0.00008)	20.1	(6.34)
PC		$23,569	(2.00)	3	33.3%	(0.00013)	24.7	(10.00)
PC	LUX	$39,146	(3.00)	71	1.4%	(0.00008)	21.6	(6.34)
PC	MID	$21,964	(3.00)	54	1.9%	(0.00014)	24.0	(10.82)
PC	SML	$15,668	(3.00)	30	3.3%	(0.00020)	29.3	(15.19)
PU		$27,657	(2.00)	2	50.0%	(0.00014)	15.8	(11.03)
PU	PULRG	$29,436	(3.00)	8	12.5%	(0.00012)	15.1	(8.90)
PU	PUSML	$20,964	(3.00)	10	10.0%	(0.00016)	19.0	(12.02)
SUV		$33,231	(2.00)	5	20.0%	(0.00008)	16.5	(5.87)
SUV	SUVLLX	$49,215	(3.00)	12	8.3%	(0.00007)	14.8	(5.34)
SUV	SUVLRG	$36,721	(3.00)	9	11.1%	(0.00009)	15.1	(7.18)
SUV	SUVMID	$28,348	(3.00)	18	5.6%	(0.00011)	17.6	(8.67)
SUV	SUVMLX	$43,750	(3.00)	12	8.3%	(0.00007)	16.4	(6.00)
SUV	SUVSML	$22,095	(3.00)	5	20.0%	(0.00017)	18.4	(12.86)
VN	VANLRG	$22,660	(2.00)	10	10.0%	(0.00010)	16.5	(7.37)

Detailed Planning Edge Sales, Revenue, and Variable Profit Forecasts by Manufacturer by Segment, 2009

GM

GM: North American Production and Import Sales

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	2,064,975	1,753,420	1,620,000	1,544,400	39%	35%	37%	38%
Minivans	160,148	218,900	197,600	185,500	3%	4%	4%	5%
CUVs	347,111	563,300	502,300	467,700	7%	11%	11%	11%
SUVs	1,072,452	991,500	803,100	696,400	20%	20%	18%	17%
Pickups+Vans	1,601,862	1,440,200	1,294,800	1,212,400	31%	29%	29%	30%
Total	5,246,548	4,967,320	4,417,800	4,106,400	100%	100%	100%	100%
Car-based	2,572,234	2,535,620	2,319,900	2,197,600	49%	51%	53%	54%
Truck-based	2,674,314	2,431,700	2,097,900	1,908,800	51%	49%	47%	46%

GM: Pretax Variable Profit on North American Vehicle Operations (Millions of Dollars)

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	6,409	5,758	5,215	4,907	28%	26%	27%	28%
Minivans	769	1,051	948	890	3%	5%	5%	5%
CUVs	1,460	2,104	1,873	1,743	6%	10%	10%	10%
SUVs	6,155	5,652	4,540	3,911	27%	26%	24%	22%
Pickups+Vans	8,144	7,413	6,624	6,176	36%	34%	34%	35%
Total	22,937	21,978	19,201	17,627	100%	100%	100%	100%
Car-based	8,638	8,913	8,037	7,541	38%	41%	42%	43%
Truck-based	14,298	13,066	11,164	10,087	62%	59%	58%	57%

FORD

Ford: North American Production and Import Sales

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	1,384,973	1,399,900	1,282,000	1,215,200	34%	33%	34%	35%
Minivans	173,860	199,800	181,900	171,800	4%	5%	5%	5%
CUVs	379,627	657,300	593,000	556,600	9%	16%	16%	16%
SUVs	661,900	598,200	490,200	428,900	16%	14%	13%	12%
Pickups+Vans	1,452,189	1,352,600	1,200,000	1,113,600	36%	32%	32%	32%
Total	4,052,549	4,207,800	3,747,100	3,486,100	100%	100%	100%	100%
Car-based	1,938,460	2,257,000	2,056,900	1,943,600	48%	54%	55%	56%
Truck-based	2,114,089	1,950,800	1,690,200	1,542,500	52%	46%	45%	44%

Ford: Pretax Variable Profit on North American Vehicle Operations (Millions of Dollars)

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	4,594	4,768	4,320	4,066	25%	25%	25%	26%
Minivans	835	959	873	825	5%	5%	5%	5%
CUVs	1,803	3,083	2,779	2,607	10%	16%	16%	17%
SUVs	3,803	3,559	2,906	2,536	21%	18%	17%	16%
Pickups+Vans	7,372	6,916	6,107	5,648	40%	36%	36%	36%
Total	18,407	19,285	16,985	15,681	100%	100%	100%	100%
Car-based	7,232	8,810	7,972	7,497	39%	46%	47%	48%
Truck-based	11,175	10,475	9,013	8,184	61%	54%	53%	52%

DaimlerChrysler

DCX: North American Production and Import Sales

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	829,570	908,500	827,700	782,000	28%	28%	29%	29%
Minivans	456,795	484,500	439,300	413,700	15%	15%	15%	15%
CUVs	249,450	322,400	304,500	294,400	8%	10%	11%	11%
SUVs	753,087	896,300	749,600	666,500	26%	28%	26%	25%
Pickups+Vans	662,186	625,000	555,900	516,700	22%	19%	19%	19%
Total	2,951,088	3,236,700	2,877,000	2,673,300	100%	100%	100%	100%
Car-based	1,535,815	1,715,400	1,571,500	1,490,100	52%	53%	55%	56%
Truck-based	1,415,273	1,521,300	1,305,500	1,183,200	48%	47%	45%	44%

DCX: Pretax Variable Profit on North American Vehicle Operations (Millions of Dollars)

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	4,364	4,307	3,815	3,537	30%	28%	28%	29%
Minivans	2,193	2,326	2,109	1,986	15%	15%	16%	16%
CUVs	863	1,068	996	954	6%	7%	7%	8%
SUVs	3,650	4,522	3,752	3,316	25%	29%	28%	27%
Pickups+Vans	3,393	3,142	2,777	2,570	23%	20%	21%	21%
Total	14,462	15,365	13,449	12,363	100%	100%	100%	100%
Car-based	7,419	7,701	6,919	6,477	51%	50%	51%	52%
Truck-based	7,043	7,664	6,529	5,886	49%	50%	49%	48%

TOYOTA

Toyota: North American Production and Import Sales

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	1,178,081	1,202,100	1,195,900	1,192,400	48%	45%	47%	48%
Minivans	189,343	189,400	175,800	168,100	8%	7%	7%	7%
CUVs	552,484	569,800	543,000	527,800	23%	21%	21%	21%
SUVs	266,274	283,200	233,700	205,700	11%	11%	9%	8%
Pickups+Vans	266,153	407,600	398,200	392,800	11%	15%	16%	16%
Total	2,452,335	2,652,100	2,546,600	2,486,800	100%	100%	100%	100%
Car-based	1,919,908	1,961,300	1,914,700	1,888,300	78%	74%	75%	76%
Truck-based	532,427	690,800	631,900	598,500	22%	26%	25%	24%

Toyota: Pretax Variable Profit on North American Vehicle Operations (Millions of Dollars)

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	5,583	5,761	5,601	5,511	38%	36%	38%	39%
Minivans	1,325	1,326	1,231	1,177	9%	8%	8%	8%
CUVs	3,775	3,925	3,687	3,552	26%	25%	25%	25%
SUVs	2,492	2,651	2,162	1,885	17%	17%	15%	13%
Pickups+Vans	1,342	2,170	2,073	2,018	9%	14%	14%	14%
Total	14,518	15,833	14,754	14,143	100%	100%	100%	100%
Car-based	10,683	11,011	10,519	10,240	74%	70%	71%	72%
Truck-based	3,835	4,822	4,235	3,903	26%	30%	29%	28%

NISSAN

Nissan: North American Production and Import Sales

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	805,623	877,000	848,700	832,700	60%	55%	57%	58%
Minivans	47,113	54,600	50,200	47,700	3%	3%	3%	3%
CUVs	106,564	170,800	157,000	149,200	8%	11%	11%	10%
SUVs	185,419	270,700	223,400	196,500	14%	17%	15%	14%
Pickups+Vans	204,054	231,400	213,700	203,700	15%	14%	14%	14%
Total	1,348,773	1,604,500	1,493,000	1,429,800	100%	100%	100%	100%
Car-based	959,300	1,102,400	1,055,900	1,029,600	71%	69%	71%	72%
Truck-based	389,473	502,100	437,100	400,200	29%	31%	29%	28%

Nissan: Pretax Variable Profit on North American Vehicle Operations (Millions of Dollars)

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	3,857	4,093	3,876	3,753	51%	45%	47%	49%
Minivans	330	382	351	334	4%	4%	4%	4%
CUVs	851	1,219	1,106	1,041	11%	13%	13%	13%
SUVs	1,525	2,178	1,780	1,553	20%	24%	22%	20%
Pickups+Vans	1,056	1,210	1,100	1,037	14%	13%	13%	13%
Total	7,618	9,083	8,212	7,718	100%	100%	100%	100%
Car-based	5,037	5,694	5,333	5,128	66%	63%	65%	66%
Truck-based	2,581	3,388	2,879	2,590	34%	37%	35%	34%

HONDA

Honda: North American Production and Import Sales

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	966,639	987,500	972,700	964,300	62%	56%	58%	59%
Minivans	159,512	180,400	174,000	170,400	10%	10%	10%	10%
CUVs	444,955	538,600	485,800	455,900	28%	31%	29%	28%
SUVs	-	-	-	-	0%	0%	0%	0%
Pickups+Vans	-	57,300	57,400	57,500	0%	3%	3%	3%
Total	1,571,106	1,763,800	1,689,900	1,648,100	100%	100%	100%	100%
Car-based	1,571,106	1,706,500	1,632,500	1,590,600	100%	97%	97%	97%
Truck-based	-	57,300	57,400	57,500	0%	3%	3%	3%

Honda: Pretax Variable Profit on North American Vehicle Operations (Millions of Dollars)

Market Segment	2004 Actual	2009 Baseline	2009 at $2.86	2009 at $3.37	2004 Actual	2009 Baseline	2009 $2.86	2009 at $3.37
Cars	4,303	4,421	4,269	4,183	51%	47%	48%	49%
Minivans	1,117	1,263	1,218	1,193	13%	13%	14%	14%
CUVs	2,980	3,547	3,193	2,992	35%	38%	36%	35%
SUVs	0	0	0	0	0%	0%	0%	0%
Pickups+Vans	0	218	218	219	0%	2%	2%	3%
Total	8,400	9,449	8,898	8,587	100%	100%	100%	100%
Car-based	8,400	9,449	8,898	8,587	100%	100%	100%	100%
Truck-based	-	-	-	-	0%	0%	0%	0%

Detailed Planning Edge Production Forecast for U.S. and Three Auto-Dependent States, 2009

TABLE E.1
North American Light-Duty Vehicle Production by Region

			UNITS PRODUCED IN:			
Product	**Type**	**Assembly**	**2004 Actual**	**2009 Baseline**	**2009 at $2.86**	**2009 at $3.37**
Vehicles	Trad Dom	US	8,398,169	8,112,020	7,222,000	6,717,600
Vehicles	Trad Dom	Canada	1,964,812	2,107,600	1,855,000	1,711,900
Vehicles	Trad Dom	Mexico	844,040	1,106,100	1,008,500	953,200
Vehicles	Transplant	US	3,297,014	4,235,000	3,933,600	3,762,900
Vehicles	Transplant	Canada	715,170	904,600	886,200	875,800
Vehicles	Transplant	Mexico	553,125	761,000	764,600	766,600
Memo: Vehicles	Import	Total	4,214,083	3,725,600	3,395,600	3,208,600
Engines	All	US	11,285,429	12,675,900	11,527,400	10,876,600
Engines	All	Canada	1,303,212	1,308,800	1,152,500	1,063,900
Engines	All	Mexico	1,942,023	1,637,720	1,512,500	1,441,500
Engines	Import	Total	1,241,666	1,603,900	1,477,500	1,405,900
Transmissions	Total	US	11,052,718	11,867,800	10,614,500	9,904,300
Transmissions	Total	Canada	795,432	673,920	635,300	613,400
Transmissions	Total	Mexico	36,807	406,000	393,000	385,600

TABLE E.2
Light Duty Vehicle Production, Michigan

		UNITS PRODUCED IN:			
Product	**Type**	**2004 Actual**	**2009 Baseline**	**2009 at $2.86**	**2009 at $3.37**
Vehicles	Trad Dom	2,198,868	2,223,700	1,974,200	1,832,800
Vehicles	Transplant	91,346	85,800	78,500	74,400
Engines	Total	4,808,059	5,059,200	4,461,500	4,122,800
Transmissions	Total	3,360,836	3,964,500	3,479,200	3,204,200

TABLE E.3
Light Duty Vehicle Production, Ohio

		UNITS PRODUCED IN:			
Product	**Type**	**2004 Actual**	**2009 Baseline**	**2009 at $2.86**	**2009 at $3.37**
Vehicles	Trad Dom	1,140,760	1,123,800	990,800	915,400
Vehicles	Transplant	726,996	857,200	834,400	821,500
Engines	Total	1,966,463	2,609,500	2,435,900	2,337,500
Transmissions	Total	3,850,295	3,507,500	3,153,500	2,952,900

TABLE E.4
Light Duty Vehicle Production, Indiana

		UNITS PRODUCED IN:			
Product	**Type**	**2004 Actual**	**2009 Baseline**	**2009 at $2.86**	**2009 at $3.37**
Vehicles	Trad Dom	439,042	394,000	354,900	332,700
Vehicles	Transplant	303,372	294,000	260,400	241,400
Engines	Total	518,623	662,600	562,100	505,200
Transmissions	Total	2,489,891	2,376,200	2,100,700	1,944,600

ENDNOTES

1 We use the term "Detroit Big Three" to denote GM, Ford, and the Chrysler-Dodge-Jeep portion of DaimlerChrysler, which we also sometimes refer to by its stock exchange symbol, "DCX." Despite Daimler's takeover of Chrysler, the factory operations feeding North American light vehicles badged with the Chrysler, Dodge, and Jeep brands remain overseen by Detroit and feature North American parts and labor content similar to those of GM and Ford plants in the region.

2 McManus, Walter S., "The Effects of Higher Gasoline Prices on U.S. Light Vehicle Sales, Prices, and Variable Profits by Segment and Manufacturer Group, 2001 and 2004," Office for the Study of Automotive Transportation, University of Michigan Transportation Research Institute, May 23, 2005.

3 Simmons, Matt. *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy,* John Wiley & Sons (2005).

4 According to EIA, Saudi Arabia is pumping about 9.5 mbd, and has about 1 to 1.5 mbd spare capacity. However much of that is "heavy/sour" (thick and high in sulfur), which there is insufficient refinery capacity to process.

5 According to Aramco, Saudi Arabia's national oil company, current field production is declining at about 0.7 mbd (IEA, 2004). Thus, for Saudi Arabia to increase production by 1.5 mbd by 2010, it will have to add about 5 mbd of new capacity.

6 IEA, *World Energy Outlook 2004,* p 122.

7 EIA, *Annual Energy Outlook 2005,* table 12 Petroleum Product Prices.

8 Reuters, "OPEC to Raise Output, Saudi Targets $40–$50 Oil," March 16, 2005.

9 Closing price on May 3, 2005. Source: New York Mercantile Exchange (NYMEX).

10 IEA, *World Energy Outlook 2004,* p. 122

11 Goldman Sachs, "Super spike period may be upon us: Sector attractive," March 30, 2005.

12 "Oil in Troubled Waters," *The Economist*, April 28, 2005.

13 IEA, *World Energy Outlook 2004.*

14 After a suicide boat attack on the French tanker *Limburg* in October 2002, al Qaeda issued a statement saying that "by hitting the oil tanker in Yemen the Mujahadeen hit the secret line—the provision line—and the feeding to the artery of the life of the Crusader nation." A recent IAGS brief quoted a jihad website that urges "brothers in the battlefields to direct some of their great efforts towards the oil wells and pipelines."

15 See Stanford Energy Modeling Forum, http://www.stanford.edu/group/EMF/research/index.htm.

16 See Appendix C for further details of assumptions and calculation; an alternative approach to developing our oil price scenarios that does not assume a supply disruption would be to adopt the Goldman Sachs "super spike" scenario. The price path of the super spike scenario starts at today's $50/bbl, rises to $75/bbl in 2006, peaks at $105/bbl in 2007, and drops to $75/bbl in 2008, before dropping to $30/bbl in 2009 after a cushion has been restored.

17 *Economist* 2005.

18 Production in March 2005 (IEA, 2005).

19 Securing America's Energy Future and National Commission on Energy Policy, "Oil Price Forecasts Using OECD Stock Levels and Risk Premia," Oil Shockwave: Oil Crisis Executive Simulation, June 27, 2005.

20 Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (New York: Simon & Schuster, 1991), p. 685

21 The second oil shock came six years after the first shock, which had led Congress in 1975 to adopt fuel economy standards (under the Energy Policy and Conservation Act of 1975, known as "EPCA"). This law required a doubling in passenger car efficiency to 27.5 mpg between 1978 and 1985. Some argue that the U.S. Big Three's share loss in this period would have been even worse had they not been forced to begin building at least some more fuel-efficient cars to comply with the new law.

22 Based on BLS data for SIC 317 (Motor Vehicles and Equipment) cited in University of Michigan, "Contribution of the Automotive Industry to the U. S. Economy in 1998: The Nation and Its Fifty States," a study prepared for the Alliance of Automobile Manufacturers, Inc. and the Association of International Automobile Manufacturers, Inc., Winter 2001.

23 Doyle, J., *Taken for a Ride,* the Tides Center, 2000, p. 173–4.

24 For more on the impact of oil price changes on economic growth, see among others Martin Schneider, "The Impact of Oil Price Changes on Growth and Inflation," *Monetary Policy & the Economy*, 2004, issue 2, pp. 27–36; James Hamilton, "What is an Oil Shock?" *Journal of Econometrics,* April 2003, vol. 113, pp. 363–398; John Muellbauer and Luca Nunziata, "Credit, the Stock Market and Oil: Forecasting US GDP," CEPR discussion paper DP 2906, reported in "America's Long and Tricky Road," *Financial Times*, May 1, 2001; Mark A. Hooker, "Oil and the macroeconomy revisited," No. 1999-43, Federal Reserve Finance and Economics Discussion Series, 1999, p. 43; Robert Barsky and Lutz Kilian, "Oil and the Macroeconomy Since the 1970s," NBER Working Paper No. 10855, October 2004.

25 See D. McFadden, "Conditional Logit Analysis of Qualitative Choice Behavior," in P. In Zaremmbka, *Frontiers in Econometrics* (New York: Academic Press, 1973

26 Greene, D.L., K.G. Duleep, W.S. McManus, "Future Potential of Hybrid and Diesel Powertrains in the U.S. Light-Duty Vehicle Market," 2004.

27 We believe that our estimates were improved by the feedback we received from the industry analysts, but any inaccuracies or inconsistencies in the estimates are the sole responsibility of OSAT. The final decisions about the numerical estimates to use in the report were made by OSAT acting alone. The following industry analysts reviewed and commented to us on our estimates. This listing of these analysts and their affiliations is not and should not be construed as their endorsement of the accuracy of the estimates, our conclusions about the profit position of any automaker, the overall conclusions of this report, or its policy recommendations. All that said, we thank them for their assistance. The analysts are:
Michael Bruynesteyn, Prudential Equity Group LLC
Stephen Girsky, Morgan Stanley
Maryann Keller, Maryann Keller & Associates

28 McManus, Walter S., "The Effects of Higher Gasoline Prices on U.S. Light Vehicle Sales, Prices, and Variable Profits by Segment and Manufacturer Group, 2001 and 2004," Office for the Study of Automotive Transportation, University of Michigan Transportation Research Institute, May 23, 2005.

29 Founded in 1980 by University of Massachusetts economist George Treyz, Regional Economic Models, Inc. is widely used by regional studies scholars and by policymakers evaluating the employment and fiscal impacts of investment and disinvestment events (e.g., base closings). For more information about the REMI model, please see www.remi.com.

30 "Fuel-Saving Technologies and Facility Conversion: Costs, Benefits and Incentives," Office for the Study of Automotive Transporation, University of Michigan, November 2004. This report shows the long-term cost savings, through job retention, of providing incentives to automotive manufacturers and suppliers to re-tool their existing plants to make in the United States hybrid and advanced diesel engines and components that would otherwise be produced offshore.

31 Some have argued that the higher prices since 2002 have not significantly affected vehicle sales; however, this is primarily due to the fact that automakers have greatly increased their incentives to artificially prop up demand in light of softening consumer interest (see Appendix A for further discussion).

32 NRDC calculation based on data from EIA, *Annual Energy Review* 2003, U.S. DOE.

33 Viewable at www.hoovers.com.

34 Technically, two vehicles in the "framed" group—the Jeep Grand Cherokee and the Honda Ridgeline — are unibody-constructed. But they clearly compete in, and achieve mpg close to the average of, vehicles in their respective framed-truck segments.

35 GM has recently announced that it will have 14 new crossovers on the market by the 2009 model year (Boudette, N. and J. White, "How slumping market for SUVs is hurting Detroit's bottom line," *Wall Street Journal*, May 13, 2005.) In the Planning Edge forecast for 2009, GM has 12 crossover models. The additional two models not in the forecast are likely a Buick model based on the Centienne concept car and a small model from Daewoo. These models would change the forecast by perhaps 60,000 units, not enough to make an appreciable difference in our analysis results.

36 Larger vehicles are also associated with slightly more jobs per unit, but the differences across segments are modest. "The Harbour Report, North America 2004," Harbour Consulting, Troy MI, June 2004, finds only small differences in assembly plant hours per vehicle based on vehicle segment or size.

37 Greene, David L., K.G. Duleep, and Walter McManus, "Future Potential of Hybrid and Diesel Powertrains in the U.S. Light-Duty Vehicle Market, August 2004.

38 For more information on manufacturer incentives, see National Commission on Energy Policy, "Ending the Energy Stalemate, A Bipartisan Strategy to Meet America's Energy Challenges," December 2004 and Hammet, P., et al., "Fuel-saving Technologies and Facility Conversion: Costs, Benefits, and Incentives," Office for the Study of Automotive Transportation, University of Michigan Transportation Research Institute, November 2004.

39 National Commission on Energy Policy, "Ending the Energy Stalemate, A Bipartisan Strategy to Meet America's Energy Challenges," December 2004.

40 The Carbon Disclosure Project (CDP), a three-year-old effort, seeks disclosure on global warming-related carbon emissions, including risks, opportunities, and emissions management, by surveying the world's 500 largest public companies on these issues. Some 143 institutional investors, representing $20 trillion in assets, have joined CDP; this represents a substantial increase from the 95 investors in 2004, representing (then) $10 trillion, and 35 investors in 2003 (the first year of the project), then representing $4.5 trillion (CDP press release, May 19, 2004). These investors are participating in an organization built on the belief that "climate change can impact shareholder value" (ibid.). CDP management credits the size and diversity of the investor group with increasing responsiveness from invited to survey participants: response rates increased to 59 percent in 2004 from 47 percent in 2003.

41 Based on oil demand growing at 1.7 percent and IEA's projection for 2005 of 84.3 (IEA, *Oil Market Report*, April 12, 2005), significantly slower than 2004's 2.72 percent growth rate.

42 Authors' estimate, based on IEA, *Oil Market Report*, April 12, 2005.

43 The average of 2003, 2004, and IEA's projection of 2005 is 2.11 percent.

44 See Table 10, EIA, *International Energy Outlook 2004*, US DOE.

45 *The Economist*, "Oil in troubled waters," April 28, 2005.

46 The IMF has recently told OPEC that it needs to increase global spare capacity to 3 to 5 mbd (*Economist*, April 28, 2005).

47 Mike Rodgers, "Recent Trends in Exploration Results and the Implication for Future Liquids Supply," April 2005 presentation, PFC Energy.

48 See Matt Simmons, *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy*, (New York: John Wiley & Sons, 2005).

49 "Country Analysis Briefs: United States of America." US Department of Energy, Energy Information Agency website (eia.doe.gov), 1/05.

50 "Asian Oil Refiners Near Full Tilt; Region Hits 90percent Capacity, Adding Likely New Strain On World Energy Market," *Wall Street Journal* 4/5/05.

51 Economy.com, cited in "Asian Oil Refiners Near Full Tilt," *Wall Street Journal*, 4/5/05.

52 EIA website, "Rules of Thumb for Oil Market Disruptions," 02 Sep 2004. http://eia.doe.gov/emeu/security/rule.html.

53 *Economist* 2005.

54 Personal communication, Paul Leiby, Oak Ridge National Laboratory, April 29, 2005.

55 See D. McFadden, "Conditional Logit Analysis of Qualitative Choice Behavior," in P. In Zaremmbka, *Frontiers in Econometrics* (New York: Academic Press, 1973.

56 See H.C.W.L. Williams, "On the Formulation of Travel Demand Models and Economic Evaluation Measures of User Benefit," *Environment and Planning*, 9A, No.3, pp.285-344, 1977.

57 Greene, D.L., Duleep, K.G., and McManus, W.S., "Future Potential of Hybrid and Diesel Powertrains in the U.S. Light-Duty Vehicle Market," 2004.