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Economic and Jobs Impacts of Enhanced Fuel Efficiency Standards for Light Duty Vehicles in the USA

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Abstract: ***This paper estimates the economic impacts of strengthening fuel economy and greenhouse gas (GHG) emission standards for passenger vehicles in the USA, and our research coincides with implementation of new fuel economy and GHG emission standards for passenger vehicles for 2017-2025. We find that enhanced standards -- more miles and fewer emissions per gallon -- would lead to increased U.S. economic and job growth, both within the auto industry and throughout the economy. We analyze the impacts of the different regulatory scenarios considered, and find that positive economic and jobs impacts will result from higher standards, and will be more pronounced as standards strengthen. Economic and jobs impact estimates are made for the year 2030 for each of the four alternative standards considered by the U.S. government. Consumer savings and GHG reductions from the alternative standards are estimated, and economic and jobs impacts are disaggregated by industry and by state.***

Key Words**: Vehicle fuel efficiency, CAFE standards, greenhouse gas emissions, economic impact, jobs impact.**

I. INTRODUCTION

The impacts of fuel consumption by light duty vehicles (LDVs) are significant, and the rapid rise in gasoline and diesel fuel prices experienced in recent years, in conjunction with concerns over greenhouse gas (GHG) emissions from mobile sources, have made vehicle fuel economy an important policy issue. U.S. corporate average fuel economy (CAFE) standards have saved substantial amounts of petroleum and have played an important role in reducing vehicle GHG emissions. However, until recently, revision of the CAFE standards has been blocked, in part, by concerns over the economic and job impacts of implementing higher standards.

Several recent U.S. legislative and regulatory initiatives have brought these issues to the forefront. The first major initiative was the mandate for increased CAFE standards under the Energy Independence and Security Act of 2007.[1] This legislation requires the National Highway Traffic Safety Administration (NHTSA) to increase vehicle fuel-economy standards, starting with model year 2011, until they achieve a combined average fuel economy of at least 35 miles per gallon (mpg) for model year (MY) 2020.

In May 2010, President Obama directed federal agencies to initiate further actions to facilitate a new generation of clean vehicles.[2] Among other things, the agencies were tasked with researching and then developing standards for MY 2017 through 2025 that would be consistent with the Environmental Protection Agency's and NHTSA's respective statutory authorities, in order to continue to guide the automotive sector along the road to reducing its fuel consumption and GHG emissions.[3]

The policy landscape has also been influenced by key legal rulings, including a Supreme Court decision,[4] finding that GHGs are pollutants under the Clean Air Act and subject to regulation by EPA, and district court cases upholding the right of California to adopt vehicle GHG standards and that of states to adopt California's standards.[5] In May 2009, the U.S. announced the first national policy governing both fuel economy and GHG emissions standards for cars and light trucks for model years 2012-2016. This program grew out an agreement between the automakers, California, and the Obama Administration, the Environmental Protection Agency (EPA) and NHTSA. Finalized on April 1, 2010, the rule requires that fleet averaged fuel economy reach an equivalent of 34.1 mpg and 250 grams of CO_2 per mile by model year 2016.[6]

In June 2011, the U.S. announced new performance standards equivalent to 54.5 mpg or 163 grams/mile of CO_2 for cars and light-duty trucks by MY 2025, with implementation being phased in beginning with MY 2017.[7] Since LDVs account for more than 40 percent of U.S. oil consumption, and nearly 60 percent of mobile source GHGs,[8] the new standards have important implications for U.S. transportation policy, energy security, oil consumption and imports, and GHG emissions.

Credible analysis and data are required to assess the energy, economic, and job impacts of enhanced CAFE and GHG standards to inform the policy debate and to assess the auto industry's contention that such tightening will hinder profits and cost jobs.[9] This paper addresses these concerns by estimating the likely economic and job impacts of increasing the CAFE and GHG standards for LDVs between 2016 and 2025. Our objective is to provide rigorous analysis of the economic impacts of proposed enhanced CAFE and GHG standards, and specifically, the research summarized here:

- Provides needed data and analysis on the energy, environmental, economic, and job impacts of enhanced CAFE and GHG standards
- Forecasts the impact of higher CAFE and GHG standards on job creation in 2030
- Analyzes four scenarios: 1) the EPA/DOT/ARB six percent annual scenario -- the

highest standard considered by the agencies, which implies a CAFE standard of about 62 mpg[10] by 2025; 2) a three percent annual scenario (the lowest considered) in 2025;[11] 3) a four percent annual scenario; and 4) a five percent annual scenario

- Estimates economic and job impacts at the national level and state levels
- Provides findings that can inform future CAFE policy debates, especially as they relate to economic and job impacts

II. TECHNOLOGIES AND COSTS FOR INCREASING VEHICLE FUEL EFFICIENCY

The U.S. National Academy of Sciences (NAS) found that a wide array of technologies and approaches exist for reducing fuel consumption, ranging from relatively minor changes with low costs and small fuel consumption benefits – such as use of new lubricants and tires – to large changes in propulsion systems and vehicle platforms that have high costs and large fuel consumption benefits.[12] NAS also found that automakers have the ability to produce much more efficient vehicles and that, although the efficiency of vehicle technology has improved steadily over the past three decades, these improvements have been used to offset the fuel consumption impacts of shifting to larger, heavier, and more powerful vehicles.[13]

To meet new federal standards, NAS determined that automakers will need to apply at least 75 percent of future efficiency improvements to reducing fuel consumption directly. If they are able to maintain that rate of improvement past 2020, gasoline consumption is expected to level off and then decrease, despite a predicted increase in vehicle miles traveled. Through 2020, most of these improvements will be made by increasing the efficiency of existing gasoline, diesel, and hybrid-electric engines. As these are already on the market, incremental advances in them have a larger immediate impact than the introduction of substantially new technologies that will have a small initial market share.

Advances in the gasoline-fueled spark-ignition engine, the most common type, could reduce an average vehicle's fuel consumption 10 to 15 percent by 2020. When combined with reductions in vehicle weight, drag, and tire rolling resistance, a vehicle with the same size and performance as today's conventional vehicles could use 35 percent less fuel by 2035. At the same time, hybrid engines (currently about three percent of the market) which are already up to 30 percent more efficient, will probably become less expensive relative to conventional vehicles. However, plug-in hybrid electric and battery electric vehicles are unlikely to enter the fleet in large numbers before 2020. Similarly, given the current state of fuel cell technology and of hydrogen storage onboard vehicles, and in view of the time, expense, and technical difficulty of establishing a nationwide hydrogen distribution system, NAS concluded that fuel cell vehicles are unlikely to comprise a large proportion of the light duty fleet for several decades. Small numbers of vehicles may join the fleet in the middle of the next decade in particular cities in response to regulations and technology advocates. As with all the advanced technologies, the market share of the fuel cell vehicle will result from competition among fuel types, regulations, performance, and technological progress.

EPA, NHTSA, and the California Air Resources Board (CARB) published a joint Technical Assessment Report (TAR) to inform the rulemaking process, reflecting input from an array of stakeholders on relevant factors, including viable technologies, costs, benefits, lead time to develop and deploy new and emerging technologies, incentives and other flexibilities to encourage development and deployment of new and emerging technologies, impacts on jobs and the automotive manufacturing base in the U.S., and infrastructure for advanced vehicle technologies.[14] The report provided an overview of key stakeholder input and presented the agencies' initial assessment of a range of stringencies of future standards.

EPA/NHTSA/CARB used distinct "technology pathways" to illustrate that there are multiple mixes of advanced technologies which can achieve the range of GHG targets analyzed.[15] Their approach of considering four technology pathways for this assessment was chosen for several reasons. First, in the stakeholder meetings with the auto manufacturers, the companies described a range of technical strategies they were pursuing for potential implementation in the 2017-2025 timeframe. Using multiple technology pathways allowed the agencies to evaluate how different technical approaches could be used to meet progressively more stringent scenarios. Second, this approach helps to capture the uncertainties that exist with forecasting the potential penetration of and costs of different advanced technologies into the light-duty vehicle fleet ten to fifteen years into the future at this time. The four technology pathways are:

- Pathway A portrays a technology path focused on hybrid electric vehicles (HEVs), with less reliance on advanced gasoline vehicles and mass reduction, relative to Pathways B and C.
- Pathway C represents an approach where the industry focuses most on advanced gasoline vehicles and mass reduction, and to a lesser extent on HEVs.
- Pathway B involves an approach where advanced gasoline vehicles and mass reduction are utilized at a more moderate level, higher than in Pathway A but less than in Pathway C. Pathway B is the most balanced path, and we use Pathway B cost levels in our analysis.
- Pathway D represents an approach focused on the use of plug-in hybrid electric vehicles (PHEV), electric vehicles (EV) and HEV technology,

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with less reliance on advanced gasoline vehicles and mass reduction.

The following two tables summarize the major EPA/NHTSA/CARB findings. As shown in Table 1, automotive technologies are available, or can be expected to be available, to support a reduction in GHGs, and commensurate increase in fuel economy, of up to six percent per year in the 2017-2025 timeframe. Greater reductions come at greater incremental vehicle costs. The per vehicle cost increase ranges from slightly under $1,000 per new vehicle for a three percent annual GHG reduction, increasing to as much as $3,500 per new vehicle to achieve a six percent annual GHG reduction.[16] However, consumer savings would also increase with the lower GHG emissions and higher fuel economy. For the different scenarios analyzed, the net lifetime savings to the consumer due to increased vehicle efficiency range from $4,900 to $7,400. The report found that the initial vehicle purchaser will find the higher vehicle price recovered in four years or less for every scenario analyzed.

Table 1.Projections for MY 2025 Per-Vehicle Costs, Vehicle Owner Payback, and Net Owner Lifetime Savings[17, 18]

Scenario	New Fleet g/mile CO2 Target (MPGe)[2]	Tech Path	Per-Vehicle Cost Increase ($)	Payback Period (years)	Net Lifetime Owner Savings ($)
3%/year	190 (47)	A	$930	1.6	$5,000
		B	$850	1.5	$5,100
		C	$770	1.4	$5,200
		D	$1,050	1.9	$4,900
4%/year	173 (51)	A	$1,700	2.5	$5,900
		B	$1,500	2.2	$6,000
		C	$1,400	1.9	$6,200
		D	$1,900	2.9	$5,300
5%/year	158 (56)	A	$2,500	3.1	$6,500
		B	$2,300	2.8	$6,700
		C	$2,100	2.5	$7,000
		D	$2,600	3.6	$5,500
6%/year	143 (62)	A	$3,500	4.1	$6,200
		B	$3,200	3.7	$6,600
		C	$2,800	3.1	$7,400
		D	$3,400	4.2	$5,700

Source: U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration, and California Air Resources Board, 2010.

EPA/NHTSA/CARB found that the increased vehicle efficiency would result in substantial societal benefits in terms of the GHG emission reductions and the petroleum use reductions. In the scenarios analyzed for 2025 model year vehicles, lifetime GHG emissions would be reduced from 340 million metric tons (3 percent annual improvement scenario) to as much as 590 million metric tons for a 6 percent annual improvement scenario. For the same range of scenarios, lifetime fuel consumption for this single model year of vehicles would be reduced by 0.7 to 1.3 billion barrels.

Table 2 illustrates the levels of technology required to achieve the different GHG and fuel economy levels that were analyzed in the EPA/NHTSA/CARB report. The types of vehicle technologies sold in 2025 to meet more stringent emission and fuel economy standards depend on the stringency of the adopted standards, the success in fully commercializing at a reasonable cost emerging advanced technologies, and consumer acceptance. The EPA/NHTSA/CARB analysis illustrated a wide range of possible outcomes, and these will likely vary by vehicle manufacturer. The potential fleet penetrations for gasoline and diesel vehicles, hybrids, plug-in electric vehicles, or electric vehicles may also vary greatly depending on assumptions about what technology pathways industry chooses.

Table 2. Technology Penetration Estimates for MY 2025 Vehicle Fleet

Scenario	Technology Path	New Vehicle Fleet Technology Penetration				
		Mass Reduction[1]	Gasoline & diesel vehicles	HEVs	PHEVs[2]	EVs
3%/year	Path A	15%	89%	11%	0%	0%
	Path B	18%	97%	3%	0%	0%
	Path C	18%	97%	3%	0%	0%
	Path D	15%	75%	25%	0%	0%
4%/year	Path A	15%	65%	34%	0%	0%
	Path B	20%	82%	18%	0%	0%
	Path C	25%	97%	3%	0%	0%
	Path D	15%	55%	41%	0%	4%
5%/year	Path A	15%	35%	65%	0%	1%
	Path B	20%	56%	43%	0%	1%
	Path C	25%	74%	25%	0%	0%
	Path D	15%	41%	49%	0%	10%
6%/year	Path A	14%	23%	68%	2%	7%
	Path B	19%	48%	43%	2%	7%
	Path C	26%	53%	44%	0%	4%
	Path D	14%	29%	55%	2%	14%

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1. Mass reduction is the overall net reduction of the 2025 fleet relative to MY 2008 vehicles.

2. This assessment considered both PHEVs and EVs. These results show a higher relative penetration of EVs compared to PHEVs. The agencies do believe PHEVs may be used more broadly by auto firms than indicated in this technical assessment.

Source: U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration, and California Air Resources Board, 2010.

As shown in Table 2, at the 3 or 4 percent annual improvement scenarios, advanced gasoline and diesel powered vehicles that do not use electric drivetrains may be the most common vehicle types available in 2025. In the 3 percent to 4 percent annual improvement range, all pathways use advanced, lightweight materials and improved engine and transmission technologies. This table also shows that hybrid vehicle penetration under the 3 and 4 percent annual improvement scenarios vary widely due to the assumptions made for each technology pathway, ranging from roughly 3 to 40 percent of the market in 2025.

Under the 5 or 6 percent annual improvement scenarios hybrids could comprise from 40 percent to 68 percent of the market. In Paths A through C, PHEVs and EVs penetrate the market substantially (4% - 9%) only at the 6 percent annual improvement scenario. In Path D, an unlikely scenario where a manufacturer makes no improvement in gasoline and diesel vehicle technologies beyond MY 2016, PHEVs and EVs begin to penetrate the market at the 4 percent annual improvement rate and may have as high as a 16 percent market penetration under the 6 percent annual improvement scenario. Pathway B represents an approach where advanced gasoline vehicles and mass reduction are utilized at a more moderate level, higher than in Pathway A but less than Pathway C.

III. METHODOLOGY

The economic and employment effects of enhanced CAFE standards were estimated using the MISI model, data base, and information system. A simplified version of the MISI model as applied here is summarized in Figure 1.

The first step in the MISI model involves translation of increased expenditures for reconfigured motor vehicles meeting the revised CAFE standards into per unit output requirements from every industry in the economy.[19] - Second, the direct output requirements of every industry affected as a result of the revised CAFE standards are estimated, and they reflect the production and technology requirements implied by the enhanced CAFE standards. These direct requirements show, proportionately, how much an industry must purchase from every other industry to produce one unit of output. Direct requirements, however, give rise to subsequent rounds of indirect requirements. The sum of the direct plus the indirect requirements represents the total output requirements from an industry necessary to produce one unit of output. Economic input-output (I-O) techniques allow the computation of the direct as well as the indirect production requirements, and these total requirements are represented by the "inverse" equations in the model.

Thus, in the third step in the model the direct industry output requirements are converted into total output requirements from every industry by means of the I-O inverse equations. These equations show not only the direct requirements, but also the second, third, fourth, nth round indirect industry and service sector requirements resulting from revised CAFE standards.

Next, the total output requirements from each industry are used to compute sales volumes, profits, and value added for each industry. Then, using data on manhours, labor requirements, and productivity, employment requirements within each industry are estimated. This allows computation of the total number of jobs created within each industry. Utilizing the modeling approach outlined above, the MISI model allows estimation of the effects on the economy and jobs.

The final step in the analysis assessing the economic and job impacts on individual states, which are estimated using the MISI regional model. This model recognizes that systematic analysis of economic impacts must also account for the inter-industry relationships between regions, since these relationships largely determine how regional economies will respond to project, program, and regulatory changes. The MISI I-O modeling system includes the databases and tools to project these interrelated impacts at the regional level. The model allows the flexibility of specifying multi-state, state, or county levels of regional detail. Regional I-O multipliers were calculated and forecasts made for the detailed impacts on industry economic output and jobs at the state level for 51 states (50 states and the District of Columbia). Because of the comprehensive nature of the modeling system, these states impacts are consistent with impacts at the national level, an important fact that adds to the credibility of the results since there is no "overstatement" of the impacts at the state level.

IV. ESTIMATES OF NATIONAL IMPACTS

A. Deriving the Estimates

Estimating the costs in 2030 of implementing the enhanced CAFE Standards is fairly straightforward. Using data from the EPA/NHTSA/CARB Technical Assessment Report and data provided by the Union of Concerned Scientists, including sales of cars and light trucks, and accounting for the per vehicle additional costs, provides estimates of the additional costs in the U.S. economy as a result of the new standards.[20] As shown in Table 3, the additional per vehicle costs range from about $850 (2009 dollars) light trucks and cars under the 3% scenario and increase to nearly $3,200 for cars and light trucks under the 6% scenario. The resulting additional costs to consumers range from $26.7

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billion under the 3% scenario to $58.6 billion under the 6% scenario.

Table 3. LDV Market in 2030 under CAFE Scenarios

	LDV Sales	Average Vehicle Cost	Cost of CAFÉ per Vehicle	LDV Sales	Change in LDV Expenditures
Case	thousands	('09$)	('09$)	billions ('09$)	billions ('09$)
Reference	17,957	27,960	-	502.1	-
3%	18,356	28,807	$847	528.8	26.7
4%	18,359	29,383	$1,423	539.4	37.4
5%	18,250	30,144	$2,184	550.1	48.1
6%	18,010	31,132	$3,172	560.7	58.6

Source: EPA/NHTSA/CARB Technical Assessment Report and the Union of Concerned Scientists, Reference Case and 3% through 6% Side Cases; and MISI; 2012.

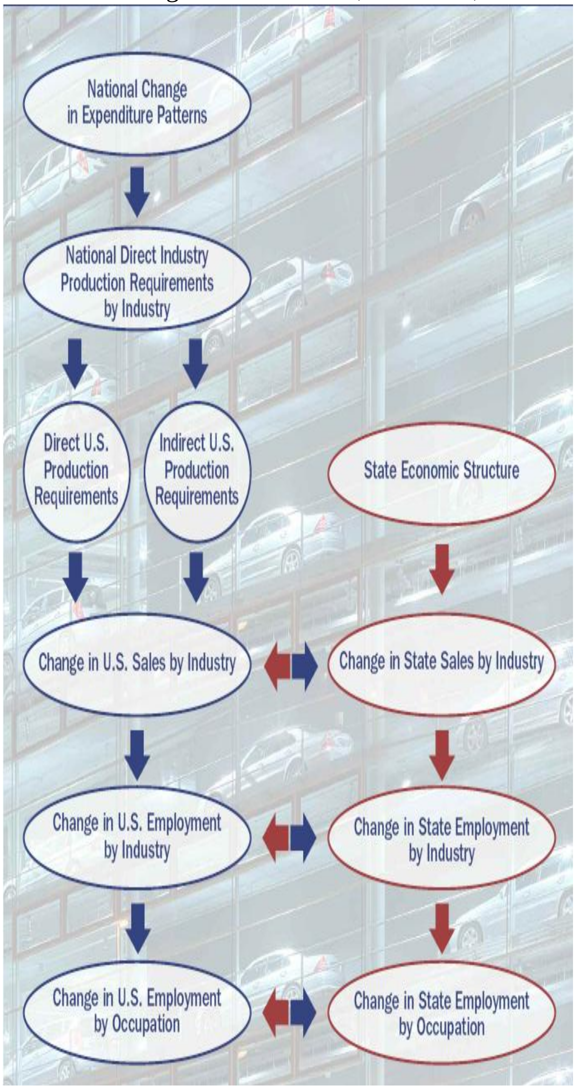

Fig.1. Use of the MISI Model to Estimate the Economic and Jobs Impacts of Increased CAFE Standards

Source: Management Information Services, Inc., 2012.

Estimating the costs of not implementing the CAFE Standards is not as straightforward. Without the new standards, LDV stock efficiency levels will stagnate and liquid fuel costs to the consumer will be higher. Taking the Reference Case miles traveled and applying it to the estimated stock efficiency estimates from the 2011 *Annual Energy Outlook* (AEO 2011), total U.S. fuel consumption levels can be estimated.[21] Comparing the 3-6% CAFE scenarios to the Reference Case results in estimated stock fuel savings which range from 20 billion gallons under the 3% scenario, to 39 billion gallons under the 6% scenario -- Table 4. In order to estimate a value of this savings to the U.S. economy, the AEO 2011 Reference Case price of $3.64 per gallon was used, and adjusted to decrease incrementally to $3.54 in the 6% case. This resulted in a range of estimates of fuel savings under the 3% and 6% scenarios of $78 billion to $152 billion.

B. Estimated National Impacts in 2030

For the modeling effort, the CAFE scenarios and respective costs (Table 3) were compared to the business as usual (BAU) scenarios and their respective costs (Table 4). Because in all CAFE scenario cases the additional costs in the U.S, economy of the vehicles are less than the additional costs of the fuel, residual consumer expenditures were allocated to the Final Demand category of Personal Consumption Expenditures. This methodology ensures that the application is a net analysis, comparing identical amounts spent by consumers in 2030, but with a very different expenditure pattern. Under the CAFE scenarios the consumer is purchasing more expensive LDV's outfitted with advanced technology, and under the respective BAU scenario the consumer is purchasing a higher level of liquid fuel for the vehicle.

Table 4. LDV Fuel Expenditures in 2030 under CAFE Scenarios

	Fuel Consumed	Average per Gallon	Fuel Cost	Change in Fuel Expenditures
Case	bil. gal.	('09$)	billions ('09$)	billions ('09$)
Reference	141	$3.64	513.1	-
3%	121	$3.60	435.5	-77.6
4%	113	$3.59	406.2	-106.9
5%	107	$3.56	379.8	-133.3
6%	102	$3.54	361.2	-151.9

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2011;* EPA/NHTSA/CARB Technical Assessment Report and the Union of Concerned Scientists; Reference Case and 3% through 6% Side Cases; and MISI; 2012.

Across all economic categories, the impacts of the CAFE 6%, 5%, 4%, and 3% scenarios higher economic and jobs impacts than the (BAU) case – Table 5. The net positive impacts of the 6% scenario on the U.S. economy are estimated to be:

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- Gross economic output (sales), $31.2 billion higher
- Employment, 684,000 higher
- Personal income, $20.5 billion higher
- Local, State and Federal taxes, $18.8 billion higher

Table 5. Summary of 2030 National Impacts

	3% Scenario	4% Scenario	5% Scenario	6% Scenario
Gross Economic Output (billions)	$15.5	$21.3	$26.6	$31.2
Jobs (thousands)	352	484	603	684
Personal Income (billions)	$10.2	$14.2	$17.6	$20.5
Tax Revenues (billions)	$9.3	$12.7	$15.8	$18.8

Source: Management Information Services, Inc., 2012.

The net positive impacts of the 5% scenario on the U.S. economy are estimated to be:

- Gross economic output (sales), $26.6 billion higher
- Employment, 603,000 higher
- Personal income, $17.6 billion higher
- Local, State and Federal taxes, $15.8 billion higher

The net positive impacts of the 4% scenario on the U.S. economy are estimated to be:

- Gross economic output (sales), $21.3 billion higher
- Employment, 484,000 higher
- Personal income, $14.2 billion higher
- Local, State and Federal taxes, $12.7 billion higher

The net positive impacts of the 3% scenario on the U.S. economy are estimated to be:

- Gross economic output (sales), $15.5 billion higher
- Employment, 352,000 higher
- Personal income, $10.2 billion higher
- Local, State and Federal taxes, $9.3 billion higher

The employment concept used is a full time equivalent (FTE) job in the U.S. An FTE job is defined as 2,080 hours worked in a year's time, and adjusts for part time and seasonal employment and for labor turnover. Thus, for example, two workers each working six months of the year would be counted as one FTE job. An FTE job is the standard job concept used in these types of analyses and allows meaningful comparisons over time and across jurisdictions.

As shown in Figures 2 to 5, each of the four enhanced CAFE scenarios results in substantial economic and jobs benefits to the U.S. economy in 2030. Further, the greater the increase in required mpg, the larger are the benefits. For example:

- Figure 2 shows that U.S. gross economic output (sales) increases from more than $15 billion (2009 dollars) under the 3% scenario to more than $31 billion (2009 dollars) under the 6% scenario.
- Figure 3 shows that the U.S. jobs created increase from more than 350,000 under the 3% scenario to nearly 700,000 under the 6% scenario.
- Figure 4 show that U.S. personal income increases from more than $10 billion (2009 dollars) under the 3% scenario to more than $20 billion (2009 dollars) under the 6% scenario.
- Figure 5 shows that U.S. federal, state, and local government tax revenues increase from more than $9 billion (2009 dollars) under the 3% scenario to nearly $19 billion (2009 dollars) under the 6% scenario.

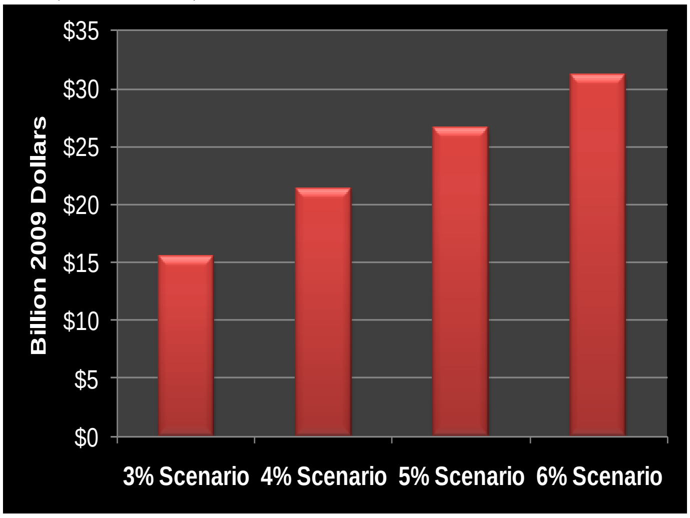

Fig.2.Impacts on U.S. Gross Economic Output (Sales) in 2030
Source: Management Information Services, Inc., 2012.

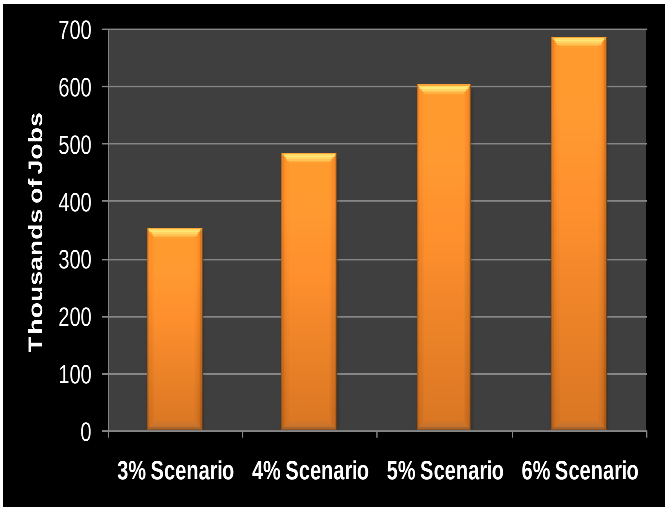

Fig 3. Impacts on U.S. Jobs in 2030
Source: Management Information Services, Inc., 2012.

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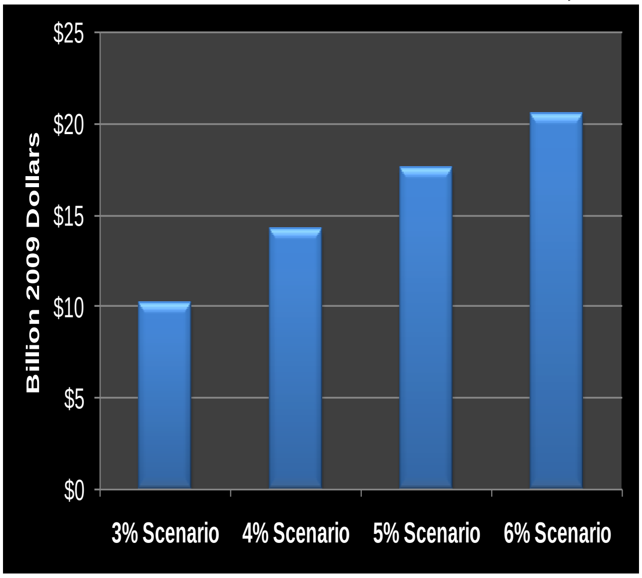

Fig 4. Impacts on U.S. Personal Income in 2030
Source: Management Information Services, Inc., 2012.

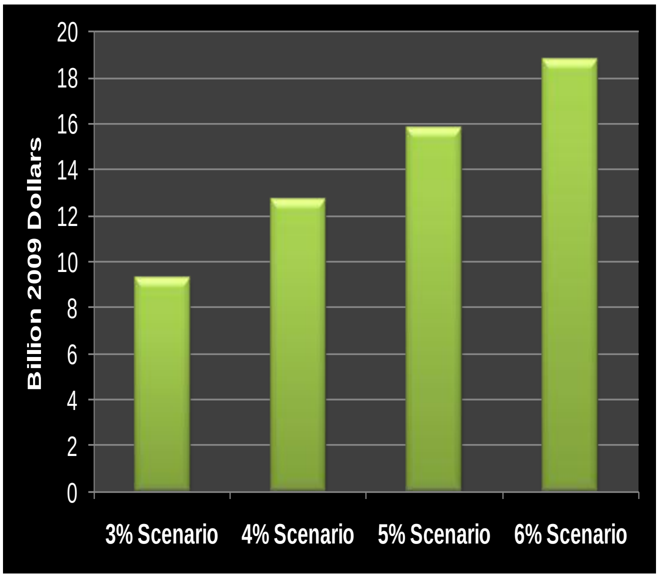

Fig 5. Impacts on U.S. Federal, State, and Local Government Tax Revenues in 2030
Source: Management Information Services, Inc., 2012.

C. Estimated Industry Impacts in 2030

We estimated the jobs impacts of the different scenarios in 70 NAICS industries.[22] While net employment in most industries increased under each scenario, net jobs were lost in some industries. As shown in Tables 6 and 7 and Figures 6 and 7, the jobs gained in various industries greatly exceed the jobs lost in others.[23] Some industries consistently gain jobs under each scenario; these include Retail Trade, Hospitals and Nursing Facilities, Motor Vehicles and Parts, Construction, and Educational Services. Other industries consistently lose jobs under each scenario; these include Rental and Leasing Services, Mining Support Activities, Oil and Gas Extraction, Pipeline Transportation, and Petroleum and Coal Products.

Table 6. Net Employment Impacts of 6% Scenario in Industries Most Affected (Thousands of FTE jobs)

Retail trade	77
Hospitals and nursing and residential care facilities	72
Food services and drinking places	66
Motor vehicles, bodies and trailers, and parts	63
Other services, except government	57
Ambulatory health care services	54
Construction	39
Social assistance	26
Wholesale trade	25
Educational services	24
-	
Petroleum and coal products	-2
Water transportation	-2
Federal Reserve banks, credit intermediation, and related activities	-3
Chemical products	-3
Pipeline transportation	-4
Computer systems design and related services	-15
Management of companies and enterprises	-16
Oil and gas extraction	-24
Support activities for mining	-26
Rental and leasing services and lessors of intangible assets	-31
Net Total	684

Source: Management Information Services, Inc., 2012.

Table 7. Net Employment Impacts of 3% Scenario in Industries Most Affected (thousands of FTE jobs)

Retail trade	43
Hospitals and nursing and residential care facilities	39
Food services and drinking places	35
Motor vehicles, bodies and trailers, and parts	31
Other services, except government	30
Ambulatory health care services	30
Construction	15
Social assistance	14
Educational services	13
Wholesale trade	13
-	
Water transportation	-1
Other transportation and support activities	-1
Federal Reserve banks, credit intermediation, and related activities	-1
Chemical products	-2
Pipeline transportation	-2
Management of companies and enterprises	-8
Computer systems design and related services	-8
Oil and gas extraction	-12
Support activities for mining	-14
Rental and leasing services and lessors of intangible assets	-16
Net Total	352

Source: Management Information Services, Inc., 2012.

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V. ESTIMATES OF STATE IMPACTS

A. *Deriving State Level Impacts*

We estimated the pattern of regional distribution of the national impacts. For this, state regional input-output location quotients were derived using comparable U.S. Bureau of Economic Analysis regional data for 2009 at the 70-order industry level. The national economic gross output impacts for the four scenarios were distributed by MISI's version of the state- and industry-level GDP accounts database. The national employment impacts for the four scenarios were distributed by MISI's version of the state- and industry-level employment database. These resulted in state-by-industry economic and employment impacts that were summed to derive state totals.

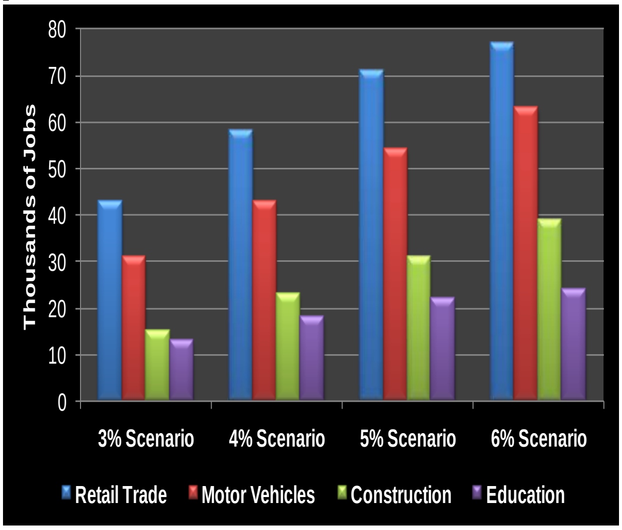

Fig 6. Net Job Gains in 2030 under the Scenarios: Selected Industries
Source: Management Information Services, Inc., 2012.

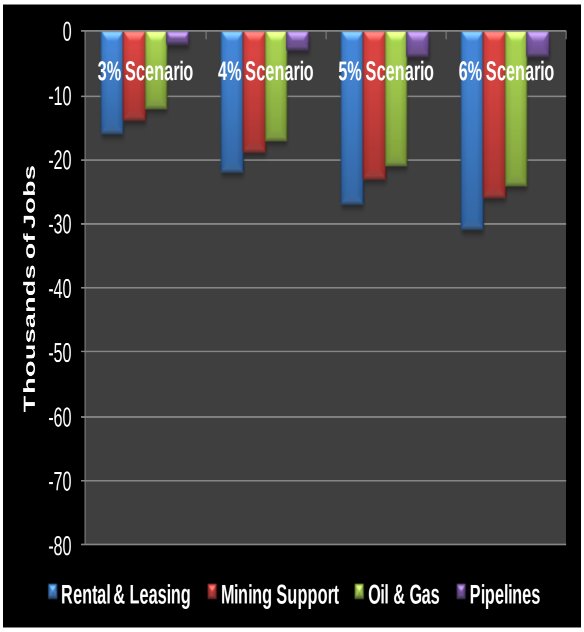

Fig. 7. Net Job Losses in 2030 under the Scenarios: Selected Industries
Source: Management Information Services, Inc., 2012.

B. *Impacts on States' GDP*

Tables 8 and 9 illustrate the net impact on each state GDP of the 6% and the 3% enhanced CAFE scenarios:[24] Table 8 shows the state GDP impacts of the 6% scenario and Table 9 shows the state GDP impacts of the 3% scenario.

Table 8: Net Impacts on State Gross Economic Output of the 6% Scenario (Millions of 2009 dollars)

	State GDP Impact	Rank
Alabama	1,620	9
Alaska	-4,350	51
Arizona	1,410	29
Arkansas	180	42
California	5,230	40
Colorado	-1,360	45
Connecticut	1,390	26
Delaware	190	39
District of Columbia	460	33
Florida	4,200	28
Georgia	3,150	16
Hawaii	260	35
Idaho	420	17
Illinois	4,110	23
Indiana	4,610	2
Iowa	1,400	7
Kansas	480	36
Kentucky	2,290	3
Louisiana	-8,490	49
Maine	340	21
Maryland	1,510	30
Massachusetts	2,410	22
Michigan	8,730	1
Minnesota	1,580	27
Mississippi	320	38
Missouri	2,160	11
Montana	0	43
Nebraska	740	13
Nevada	620	32
New Hampshire	430	18
New Jersey	1,980	34
New Mexico	-1,430	46
New York	7,370	20
North Carolina	3,500	12
North Dakota	-70	44
Ohio	4,750	8
Oklahoma	-4,360	48
Oregon	1,550	10
Pennsylvania	3,390	25
Rhode Island	320	19
South Carolina	1,950	4
South Dakota	310	14
Tennessee	2,740	5
Texas	-31,800	47
Utah	420	37
Vermont	200	15
Virginia	2,150	31
Washington	2,070	24
West Virginia	110	41
Wisconsin	2,520	6
Wyoming	-2,530	50
Net Total	31,200	

Source: Management Information Services, Inc., 2012

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Table 9: Net Impacts on State Gross Economic Output of the 3% Scenario (Millions of '09 dollars)

	State GDP Impact	Rank
Alabama	810	9
Alaska	-2,220	51
Arizona	710	29
Arkansas	90	41
California	2,650	40
Colorado	-710	45
Connecticut	720	25
Delaware	100	38
District of Columbia	230	33
Florida	2,160	28
Georgia	1,600	16
Hawaii	140	35
Idaho	210	17
Illinois	2,070	23
Indiana	2,310	2
Iowa	720	7
Kansas	240	36
Kentucky	1,150	3
Louisiana	-4,330	49
Maine	170	19
Maryland	770	30
Massachusetts	1,220	22
Michigan	4,370	1
Minnesota	800	27
Mississippi	160	39
Missouri	1,100	11
Montana	0	43
Nebraska	380	12
Nevada	310	32
New Hampshire	220	18
New Jersey	1,020	34
New Mexico	-730	46
New York	3,800	20
North Carolina	1,790	13
North Dakota	-40	44
Ohio	2,390	8
Oklahoma	-2,230	48
Oregon	770	10
Pennsylvania	1,710	26
Rhode Island	160	21
South Carolina	980	4
South Dakota	160	14
Tennessee	1,390	5
Texas	-16,300	47
Utah	200	37
Vermont	100	15
Virginia	1,080	31
Washington	1,050	24
West Virginia	50	42
Wisconsin	1,270	6
Wyoming	-1,290	50
Net Total	15,500	

Source: Management Information Services, Inc., 2012

The relative impacts on state GDPs of each of the scenarios are generally similar, and those states affected the most, negatively and positively, are generally the same under each scenario. Figures 8 and 9 illustrate the relative impacts on state GDP of the 6% scenario: Figure 8 shows the states with the relatively largest GDP increases under the 6% Scenario and Figure 9 shows the states with the relatively largest GDP decreases Under the 6% Scenario.

The rankings in these tables and figures are based on the percentage impact of the state's GDP. Under all of the scenarios, GDP increases in 43 states and decreases in only eight states.

Figure 8 shows that the states whose GDP is increased the most, on a percentage basis, from the 6% scenario (and generally the other scenarios as well) are Michigan and Indiana followed in descending order by Kentucky, South Carolina, Tennessee, Wisconsin, Iowa, Ohio, Alabama, and Oregon. This is not surprising because these states are home to vehicle and vehicle parts manufacturing and related facilities.

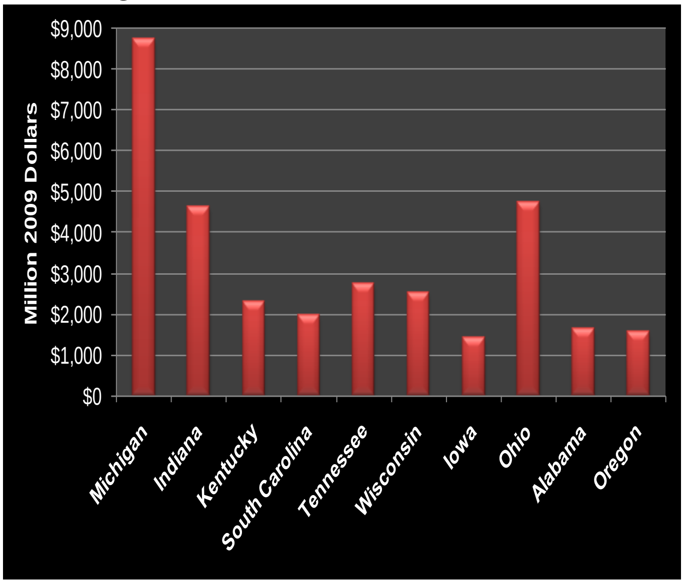

Fig 8. State GDP Increases Under the 6% Scenario (State Rankings Based on Percentage GDP Increases)
Source: Management Information Services, Inc., 2012

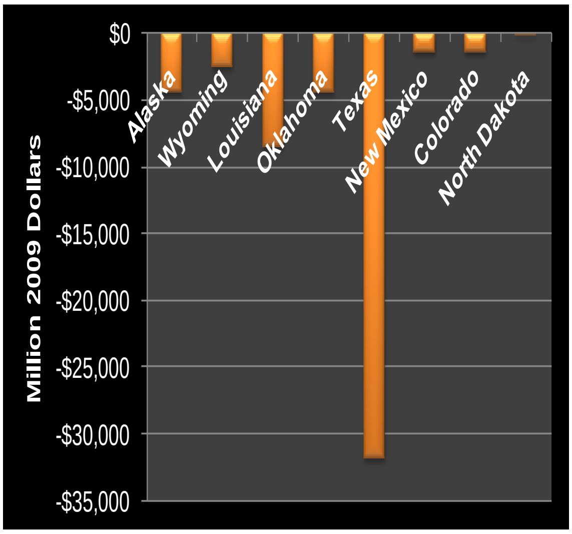

Fig 9. State GDP Decreases Under the 6% Scenario (State Rankings Based on Percentage GDP Decreases)
Source: Management Information Services, Inc., 2012

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Figure 9 shows that the eight states whose GDP is decreased the most, on a percentage basis, from the 6% scenario (and generally the other scenarios as well) are Alaska, Wyoming, and Louisiana, followed by Oklahoma, Texas, New Mexico, Colorado, and North Dakota. This is not surprising: Each of these eight states is a major oil producer and demand for oil will be reduced significantly by the enhanced CAFE standards.

C. Impacts on Jobs in Each State

Tables 10 and 11 show the net impacts on jobs in each state of the 6% and the 3% enhanced CAFE scenarios[25]: Table 10 shows the state job impacts of the 6% scenario and Table 11 shows the state job impacts of the 3% scenario.

The rankings in these tables are based on the percentage impact on state employment. The relative impacts on states' jobs of each of the scenarios are generally similar, and those states affected the most, negatively and positively, are generally the same under each scenario. Figures 10 and 11 illustrate the relative impacts on states' jobs of the 6% scenario: Figure 10 shows the states with the relatively largest job increases under the 6% Scenario -- the rankings in this figure are based on the percentage impact on state employment, and Figure 11 shows the states with the largest total job increases under the 6% Scenario. Figure 12 shows the differing impacts on jobs in four states – Michigan, Ohio, North Carolina, and Texas – of each of the four scenarios.

Comparison of these tables and graphs with the previous ones yields interesting results. One of the most salient findings is that while GDP declines in eight states under each of the four scenarios, jobs increase in each state across all four scenarios – except in Wyoming. This is due to the differences in labor productivity and job creation in the different industries and sectors that are gaining jobs and those that are losing jobs.

There is thus a disparity not only in size, but also in direction between the two projections of impacts in some states. For example, the disparity is greatest in the difference between the projected economic gross output loss of almost $32 billion in Texas under the 6% scenario, while at the same time Texas is projected to gain almost 28,000 jobs. Because ours is a net analysis, three general trends are occurring simultaneously and pulling the Texas economy in different directions:

- There is a loss of gasoline sales and thus a decrease in the demand for oil
- There is a stimulus to the motor vehicle industry as LDV's become more expensive
- There is a stimulus to the general economy driven by the consumer savings as a net impact of the change in consumer purchases for those two products

Because Texas accounts for well over half of U.S. economic activity in the oil and gas extraction industry, it will be severely affected by the decreased demand for oil.

The oil and gas extraction industry is one of the most labor extensive industries, with large contributions to the economy, but with relatively few employees per dollar of that economic activity. This is seen clearly in the Texas example. While the oil and gas extraction industry contributes over six percent to the state's GDP, the industry accounts for only about two percent of total employment in the state. Therefore, one can expect to see much larger changes in state GDP compared to employment. What we are seeing in Texas in our scenarios is that while GDP is decreasing due to volatile declines in the oil and gas extraction industry, employment is not decreasing as much and is actually being overwhelmed by the positive indirect employment impacts caused by the overall growth in the motor vehicles industry and the overall growth in the U.S. economy driven by the consumer surplus.

Figure 10 shows that, based on percentage job increases, under the 6% scenario (as is also true for the other three scenarios) Indiana and Michigan benefit the most from the enhanced CAFE standards. As a hypothetical example of the significance of the jobs impacts, consider that the current unemployment rate in Indiana is 8.2 percent and in Michigan is 10.3 percent. The jobs created under the 6% scenario would reduce unemployment in these states by nearly a full percentage point: The unemployment rate in Indiana would decrease from 8.2 percent to 7.4 percent and the unemployment rate in Michigan would decrease from 10.3 percent to 9.6 percent.

Other states whose jobs markets would benefit the most, in relative terms, include Alabama, Kentucky, Tennessee, Ohio, North Carolina, Vermont, New Hampshire, Oregon, New York, and Missouri. Vermont and New Hampshire gain relatively few jobs, but both states have small labor forces. Many of the large states impacted the most currently have unemployment rates at or well above the national average, and would welcome the additional job creation resulting from the enhanced CAFE scenarios – as would all states.

Figure 11 also yields an interesting perspective. This figure shows the states that gain the most jobs in absolute terms under the 6% scenario (these states also generally gain the most jobs under the other three scenarios). This ranking is, of course, dominated by the states with the largest labor forces, and it is instructive to compare these rankings with the percentage job rankings shown in Figure 10. In many cases, the states gaining the largest numbers of jobs rank relatively low in percentage job gains; for example:

- California gains, by far, the largest number of jobs (81,000), but in terms of percentage job gains ranks only 17th
- Texas gains nearly 28,000 jobs, but ranks near the bottom at 47th in terms of percentage job gains.

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- Florida gains over 37,000 jobs, but ranks 27th in terms of percentage job gains.
- New Jersey gains 18,000 jobs, but ranks 34th in terms of percentage job gains.
- Pennsylvania gains nearly 30,000 jobs, but ranks 24th in terms of percentage job gains.

Conversely, some of the states with the highest percentage job gains due to their relatively small labor forces experience relatively small total job increases; for example:

- Vermont gains only 1,800 jobs, but ranks 8th in terms of percentage job gains.
- New Hampshire gains only 3,600 jobs, but ranks 9th in terms of percentage job gains.

Thus, in assessing the jobs impacts by state it is important to assess both the relative impact on the state's job market as well as the total number of jobs created in each state. It is also important to realize that much of the total job growth will occur in states that rank relatively low in terms of percent job growth.

Figure 12 shows the differing impacts on jobs in four states – Michigan, Ohio, North Carolina, and Texas – under each of the four scenarios. It illustrates that, while there are some relative differences in job gains, states tend to benefit uniformly from the job creation under each scenario.

It is also important to note here that these are net job gains. Some jobs in certain sectors and industries will be lost under each scenario. However, these job losses will be far exceeded by job gains in the states in other sectors and industries.

Nevertheless, the bottom line is that the enhanced CAFE standards analyzed here will have strongly positive economic and job impacts, and several major conclusions emerge from this research. First, enhanced CAFE standards would increase employment, although some industries and sectors will lose jobs:

- Under the 3% scenario, net job creation in the U.S. will total 352,000, and every state except Wyoming will gain jobs.
- Under the 4% scenario, net job creation in the U.S. will total 484,000, and every state except Wyoming will gain jobs.
- Under the 5% scenario, net job creation in the U.S. will total 603,000, and every state except Wyoming will gain jobs.
- Under the 6% scenario, net job creation in the U.S. will total 684,000, and every state except Wyoming will gain jobs.

Second, jobs in most industries and sectors increase, but some industries and sectors would lose jobs, and even in those that gain jobs, some workers may be displaced.

Third, there are also regional implications. Every state except Wyoming will gain substantial numbers of jobs -- for example, under the 6% scenario Michigan gains more than 32,000 jobs, Ohio gains nearly 34,000 jobs, California more than 81,000, and Indiana nearly 24,000 jobs. However, job increases and decreases will be spread unevenly among different sectors and industries within each state, and there will thus be job shifts within states as well as among states.

Table 10: Net State Job Impacts of the 6% Scenario (FTE jobs)

	State Employment Impact	Rank
Alabama	13,600	3
Alaska	100	50
Arizona	11,000	38
Arkansas	5,700	33
California	81,000	17
Colorado	8,300	43
Connecticut	8,200	28
Delaware	2,100	29
District of Columbia	2,100	45
Florida	37,200	27
Georgia	21,100	23
Hawaii	3,000	37
Idaho	3,400	21
Illinois	31,100	19
Indiana	23,900	1
Iowa	8,400	14
Kansas	6,800	31
Kentucky	12,800	4
Louisiana	2,600	49
Maine	3,200	20
Maryland	11,900	35
Massachusetts	17,100	22
Michigan	32,300	2
Minnesota	14,500	18
Mississippi	5,300	36
Missouri	15,300	12
Montana	1,900	40
Nebraska	5,000	25
Nevada	5,700	30
New Hampshire	3,600	9
New Jersey	18,000	34
New Mexico	2,300	46
New York	48,100	11
North Carolina	25,500	7
North Dakota	1,300	44
Ohio	33,900	6
Oklahoma	2,600	48
Oregon	9,700	10
Pennsylvania	29,800	24
Rhode Island	2,400	26
South Carolina	10,200	16
South Dakota	2,300	13
Tennessee	17,900	5
Texas	27,800	47
Utah	5,300	39
Vermont	1,800	8
Virginia	15,600	41
Washington	14,300	32
West Virginia	2,600	42
Wisconsin	15,200	15
Wyoming	-400	51
Net Total	684,000	

Source: Management Information Services, Inc., 2012.

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Table 11: Net State Job Impacts of the 3% Scenario (FTE jobs)

	State Employment Impact	Rank
Alabama	6,900	3
Alaska	0	50
Arizona	5,700	38
Arkansas	2,900	33
California	41,700	18
Colorado	4,200	43
Connecticut	4,300	28
Delaware	1,100	27
District of Columbia	1,200	45
Florida	19,200	29
Georgia	10,800	25
Hawaii	1,500	37
Idaho	1,700	23
Illinois	16,000	19
Indiana	12,100	1
Iowa	4,300	14
Kansas	3,500	31
Kentucky	6,500	4
Louisiana	1,300	49
Maine	1,700	16
Maryland	6,100	36
Massachusetts	8,900	21
Michigan	16,400	2
Minnesota	7,500	17
Mississippi	2,800	35
Missouri	7,900	12
Montana	1,000	40
Nebraska	2,600	26
Nevada	2,900	30
New Hampshire	1,900	9
New Jersey	9,400	34
New Mexico	1,200	46
New York	25,000	11
North Carolina	13,000	7
North Dakota	700	44
Ohio	17,300	6
Oklahoma	1,300	48
Oregon	5,000	10
Pennsylvania	15,600	22
Rhode Island	1,300	24
South Carolina	5,200	20
South Dakota	1,200	13
Tennessee	9,100	5
Texas	14,300	47
Utah	2,700	39
Vermont	900	8
Virginia	8,000	41
Washington	7,400	32
West Virginia	1,400	42
Wisconsin	7,800	15
Wyoming	-200	51
Net Total	352,000	

Source: Management Information Services, Inc., 2012.

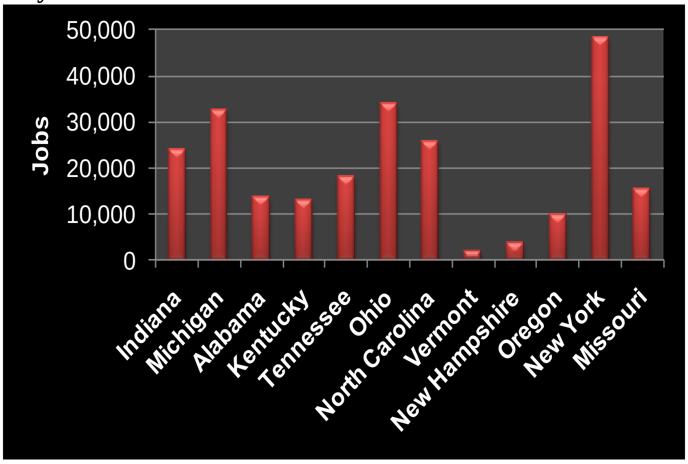

Fig 10. State Job Increases Under the 6% Scenario (State Rankings Based on Percentage Employment Increases)
Source: Management Information Services, Inc., 2012.

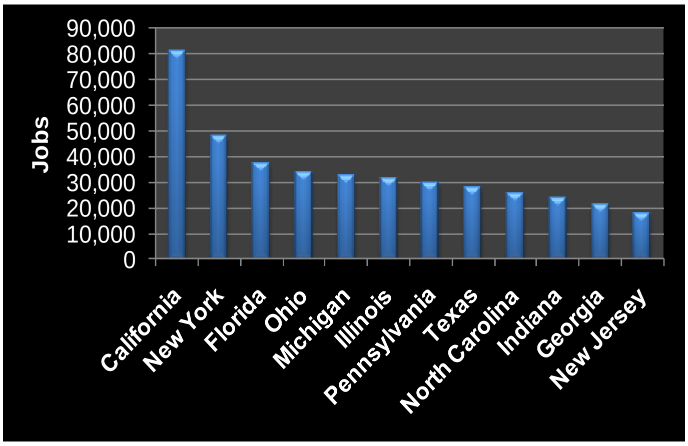

Fig 11. State Job Increases Under the 6% Scenario (State Rankings Based on Total Employment Increases)
Source: Management Information Services, Inc., 2012.

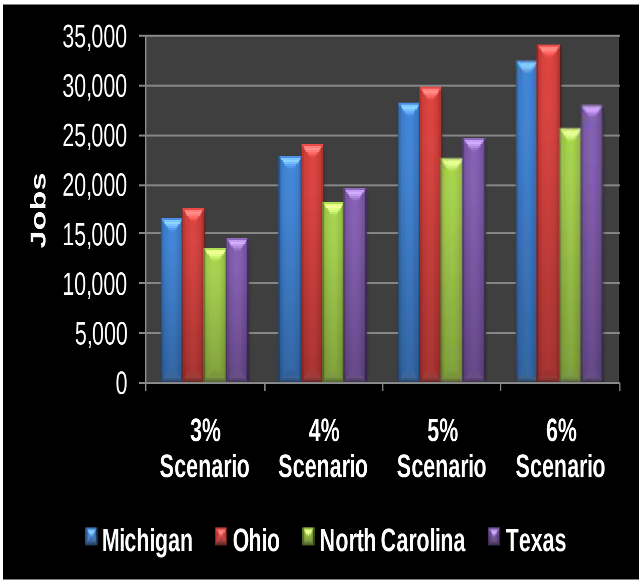

Fig 12. Job Impacts in Selected States across the Four Scenarios
Source: Management Information Services, Inc., 2012.

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VI. FINDINGS AND CONCLUSIONS

From the research summarized here, we derive the following major findings and conclusions:

- Each of the four scenarios covering the range of new standards assessed for CAFE mileage and GHG emissions improvements -- annual emissions reductions and fuel-economy improvements of three, four, five and six percent per year for the years 2017-25 -- would yield substantial economic and job benefits for the U.S. economy in 2030. This includes net jobs gains in 49 states.
- The greater the improvements in fuel economy and GHG emissions, the greater the economic benefits. For example, nearly 700,000 new jobs would be created under the six percent scenario, compared to only about 350,000 jobs under the three percent scenario.
- Domestic U.S. auto industry job creation would increase under all four scenarios, including 63,000 new, full-time domestic auto jobs in 2030 under the six percent scenario.
- Stronger fuel economy and GHG standards would produce broad economic benefits. These include significant consumer savings at the pump, which would shift significant consumer spending away from the oil industry and towards other parts of the economy, such as retail trade, food, and health care.
- The six percent scenario would generate an estimated $152 billion in fuel savings in 2030 compared to business as usual. Of the $152 billion saved at the pump, $59 billion would be expected to be spent in the auto industry, as drivers purchase cleaner, more efficient vehicles. The remaining $93 billion will be spent across the rest of the economy, from retail purchases, to more trips to restaurants to increased consumer spending on health care.
- All of the scenarios would deliver net job gains in 49 states, with the biggest winners on a percentage basis being Indiana, Michigan, Ohio, and New York. Other states that would see the most job growth on a percentage basis include Alabama, Kentucky, Tennessee, North Carolina, Vermont, New Hampshire, Oregon and Missouri. In terms of the total number of new jobs, California and New York would see the biggest gains, and other winners would include Florida, Ohio, Michigan Illinois, Pennsylvania, Texas, North Carolina, Indiana, Georgia and New Jersey. Wyoming is the only state that would lose jobs.
- Effects on national and state GDP would be overwhelmingly positive. States seeing the biggest percentage GDP gains under the strongest fuel efficiency standard have large auto industry sectors. The biggest gainers would be Michigan and Indiana, followed by Kentucky, South Carolina, Tennessee, Wisconsin, Iowa, Ohio, Alabama and Oregon. Some states would see net GDP decreases under this same scenario. These are primarily oil-producing states such as Alaska, Wyoming and Louisiana, followed by Oklahoma, Texas, New Mexico, Colorado and North Dakota. However, all these states, except Wyoming, would see net job gains as money is shifted away from the oil industry to sectors of the economy that deliver more jobs per dollar spent by consumers.

In sum, the research summarized here indicates that enhanced CAFE standards would have strongly positive economic and job benefits. Our findings indicate that increased CAFE standards will not harm the U.S. economy or destroy jobs. Hopefully, the information provided here can inform future policy debates over CAFE standards.

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