Gearing Up

Smart Standards Create Good Jobs Building Cleaner Cars

BLUEGREEN ALLIANCE
ACEEE American Council for an Energy-Efficient Economy

This report is also available at **www.bluegreenalliance.org**.

The BlueGreen Alliance (www.bluegreenalliance.org) is a national, strategic partnership between labor unions and environmental organizations dedicated to expanding the number and quality of jobs in the green economy.

Launched in 2006 by the United Steelworkers and the Sierra Club, this unique labor-environmental collaboration has grown to include the Communications Workers of America (CWA), Natural Resources Defense Council (NRDC), Service Employees International Union (SEIU), National Wildlife Federation (NWF), Union of Concerned Scientists (UCS), Utility Workers Union of America (UWUA), American Federation of Teachers (AFT), Amalgamated Transit Union (ATU), United Auto Workers (UAW) and the United Food and Commercial Workers (UFCW). Acting together, through 14 million members and supporters, the BlueGreen Alliance is a powerful voice for building a cleaner, fairer and more competitive American economy.

BLUEGREEN ALLIANCE PARTNER ORGANIZATIONS

TABLE OF CONTENTS

Authors:

Chris Busch, John Laitner,
Rob McCulloch, Ivana Stosic

Acknowledgements

We are grateful for the assistance of David Friedman (Union of Concerned Scientists), Roland Hwang (Natural Resources Defense Council), Zoe Lipman (National Wildlife Foundation), Brad Markell (United Auto Workers), Ann Mesnikoff (Sierra Club), and Luke Tonachel (Natural Resources Defense Council). Thank you to Roger Bezdek (MIS, Inc.) and Steve Nadel (ACEEE) for their reviews. We also appreciate support and further insights from Therese Langer (ACEEE), and BGA colleagues David Foster, Yvette Pena Lopes, Eric Steen, and Meredyth Sanders. Photo on page 13 courtesy of United Auto Workers (UAW). Design by Winking Fish. Errors remain the responsibility of the authors.

June 2012

PREFACE

The story of American manufacturing is in the midst of an exciting chapter. After losing millions of manufacturing jobs in the run up to and during the Great Recession, the U.S. has added more than a half million manufacturing jobs over the past two years. As we transition to a 21st century economy, renewed pride in American manufacturing is warranted for its role as a key driver of our economic resurgence.

The recent trials and triumph of the auto industry is perhaps the brightest subplot of this story. From its low point in summer of 2009, U.S. automakers have added more than 140,000 jobs. In the darkest days of the downturn, autoworkers worried about whether their plant — or their company — would be around in the coming year. Now, factories are adding shifts, increasing production and U.S. automakers are again atop the world in sales.

This report shows that the new proposed standards for vehicles will continue the resurgence of the American auto industry and its deep supply chains, while also making progress on other important objectives: reducing our dependence on imported oil and limiting our greenhouse gas pollution.

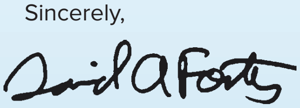
Other nations have recognized the competitive advantage that comes from lowered exposure to volatile oil prices, and historically have delivered cleaner, more efficient cars to the showroom floor in response to consumer demand.

The proposed vehicle standards examined in this report will help American automakers compete globally by fostering greater harmonization between the U.S. and global auto markets. They will set a clear investment horizon for automakers, helping ensure investments in more efficient technologies are rewarded in the marketplace.

The U.S. led the world in clean energy investment in 2011. Cleaner car standards are the largest single action our nation has taken in recent years to reduce our dependence on foreign oil and substantially reduce greenhouse gas pollution, and in the following pages, we'll detail how this will benefit consumers and our economy.

We can have good jobs and a cleaner environment. We are happy to present the work of a dedicated team of scientists and professionals that further lays out this case.

Sincerely,



David Foster
Executive Director, BlueGreen Alliance

EXECUTIVE SUMMARY

In 2011, the U.S. Department of Transportation (DOT) and Environmental Protection Agency (EPA) proposed joint fuel economy and greenhouse gas pollution standards for new cars and light trucks.

These proposed standards would reach the equivalent of 54.5 miles per gallon (mpg) and 163 grams of carbon dioxide per mile (g/mi) for the average new vehicle in 2025. Hereafter we refer to these proposed joint fuel economy and greenhouse gas pollution standards simply as ***"the proposed standards."*** In this report, we analyze the macroeconomic impacts of the proposed standards with particular attention to the net gain in U.S. employment.

Our analysis finds that the proposed standards will create an estimated 570,000 jobs (full-time equivalent) throughout the U.S economy, including 50,000 in light-duty vehicle manufacturing (parts and vehicle assembly) by the year 2030. Real wages are projected to increase even faster than job growth. This implies that the proposed standards will both lead to new jobs and, on average, higher-paying jobs across the U.S. economy. By 2030, we also find a net increase of about $75 billion in annual Gross Domestic Product (all monetary values in 2010 dollars).

The proposed standards create jobs by helping to save drivers money on transportation fuel through improved average fuel economy over time and increased variety of more fuel-efficient vehicles. These new, more fuel-efficient vehicles are incrementally more expensive due to technology upgrades, but fuel savings are expected to more than outweigh the added cost. Fuel and cost impacts and other assumptions are harmonized with the assessments of the relevant federal agencies to the greatest extent possible.

It is important to keep in mind that the proposed standards we analyze cover the period 2017-2025, building on the 2012-2016 standards, so the economic benefits quantified here are only a fraction of the total benefits that will be delivered by stronger performance standards for vehicles. The 2016 standards themselves would be expected to deliver greater job growth and other macroeconomic benefits than the proposed standards since the net fuel savings (fuel savings minus costs) are even higher for that regulation.

Vehicle manufacturing has been one of the country's top performing sectors in recent years. From the seasonally-adjusted low point of June 2009 through May 2012, the nation gained 146,000 jobs in motor vehicle manufacturing (including parts suppliers) and when auto dealers are included the job gains amount to 219,000. The nation's largest automakers are investing billions in retooling and expanding to produce the cleaner cars that consumers are demanding.

It's not just domestic consumers that are demanding cleaner, more fuel-efficient vehicles. An underappreciated benefit of the proposed standards is that they will close the gap between U.S. standards and those of other major car markets, including China, Japan, Korea, and the European Union. All these countries have more ambitious vehicle performance standards than the U.S., and they will continue to outperform the U.S. in this area even assuming the proposed standards are implemented. However, the proposed standards will bring U.S. vehicle performance closer to that of other major auto producers, ensuring steady progress toward greater harmonization with potential export markets. This should strengthen the position of U.S. vehicle makers in the international market.

To further explore potential economic benefits of the proposed standards, we consider two alternative auto-manufacturing scenarios in addition to our main policy case. We investigate the manufacturing employment results that would follow from increased vehicle sales. ***We estimate that if light-duty vehicle sales were to increase by 4 percent in 2030, light-duty vehicle manufacturing employment would increase by 19,000.***

We also explore the question of how many more jobs would be created if the domestic content (the amount of a vehicle's value that is produced in the United States) could be increased. We focus on one slice of the light-duty vehicle market, the jobs associated with the new more fuel-efficient technologies that will be used to achieve compliance with the new standards. Currently about 60 percent of the value added in light-duty vehicle production is captured domestically, so we assume that as the starting point for the manufacture of new energy-efficient technologies analyzed in this scenario. ***We find that if domestic content for these new components was to increase to 75 percent in 2030, then about 4,100 jobs would be added in light-duty vehicle manufacturing (including parts suppliers). The economic ripple effects create jobs in other sectors of the economy amounting to 9,000 jobs, more than twice the number of jobs directly created***.

Our domestic content scenario is not a prediction but a what-if scenario. It illustrates the benefits that would follow from a trend toward higher domestic content. What could actually bring such a result about? Smart policy is crucial. There is an immediate need for the Department of Energy to process and disperse funding already allocated to the Advanced Technology Vehicle Manufacturing Program. Policies that support greater industrial energy efficiency will also assist international competitiveness by lowering long run energy costs and reducing vulnerability to energy fuel spikes. In the preface to the report, David Foster sketches a larger policy vision for capturing more of the manufacturing jobs associated with the transition to cleaner energy.

1. INTRODUCTION

In 2011, the U.S. Department of Transportation (DOT) and Environmental Protection Agency (EPA) proposed joint fuel economy and greenhouse gas pollution standards for new cars and light trucks. These proposed standards would reach the equivalent of 54.5 mpg and 163 grams of carbon dioxide per mile (g/mi) for the average new vehicle in 2025. Hereafter we refer to these proposed joint fuel economy and greenhouse gas pollution standards simply as ***"the proposed standards."***

In this report, we analyze the macroeconomic impacts of the proposed standards with particular attention to employment effects. We use the federal agencies (DOT/EPA) assessment of the fuel and cost impacts of the proposed standards as inputs to a macroeconomic analysis. Our results suggested that, by 2030, the proposed standards will lead to additional job creation of about 570,000 jobs across the economy, including approximately 50,000 in light-duty vehicle manufacturing (parts and assembly).

It is important to keep in mind that the proposed standards we analyze cover the period 2017-2025, building on the 2012-2016 standards, so the economic benefits quantified here are only a fraction of the total benefits that will be delivered by stronger performance standards for vehicles. The 2016 standards themselves would be expected to deliver greater job growth and other macroeconomic benefits than the proposed standards since the net fuel savings (fuel savings minus costs) are even higher for that regulation. The literature review in Section 3 reviews the evidence as it relates to the employment impacts of the 2012-2016 standards.

Why give special attention to manufacturing? There is good reason to believe that manufacturing clean technologies offers great potential as a source of good jobs. By effectively competing for and capturing clean technology manufacturing jobs, the United States can maximize the economic benefit associated with the transition to cleaner energy sources. Installation, operation, and maintenance jobs tend to be domestically sourced, while manufacturing can occur anywhere and so deserves special attention from policymakers.

The U.S. manufacturing sector gained more jobs in the first quarter of 2012 than any other time in more than 20 years. By April of 2012, the manufacturing sector had gained 539,000 jobs since the low point of the recession in February 2010.[1] The American auto industry takes a leading position in this trend. From the seasonally-adjusted low point of June 2009 through May 2012, the nation gained 146,000 jobs in motor vehicle manufacturing (including the parts suppliers) and when auto dealers are included the job gains amount to 219,000. The three largest American automobile companies have returned to record profitability, with workers sharing the profits and billions of dollars being invested in retooling and expanding American assembly and parts factories. General Motors has reclaimed its role as the global production leader.

Recent job gains are recovering what was lost during the most recent recession. However, there are promising signs of a more fundamental reversal of the long-term trend of steady losses in the manufacturing industry. Clean technology manufacturing offers a promising economic development target. Unlike their predecessors, these manufacturing facilities are highly automated and capital intensive, which means they tend to be unconstrained by labor costs. For these factories, the cost of borrowing to finance upfront costs is much more important than labor costs, which make up a relatively small proportion of overall cost. This will allow manufacturing companies to create jobs in the U.S. rather than moving production to countries with lower labor costs. Other fundamental economic trends are contributing to the resurgence in American manufacturing as well.[2]

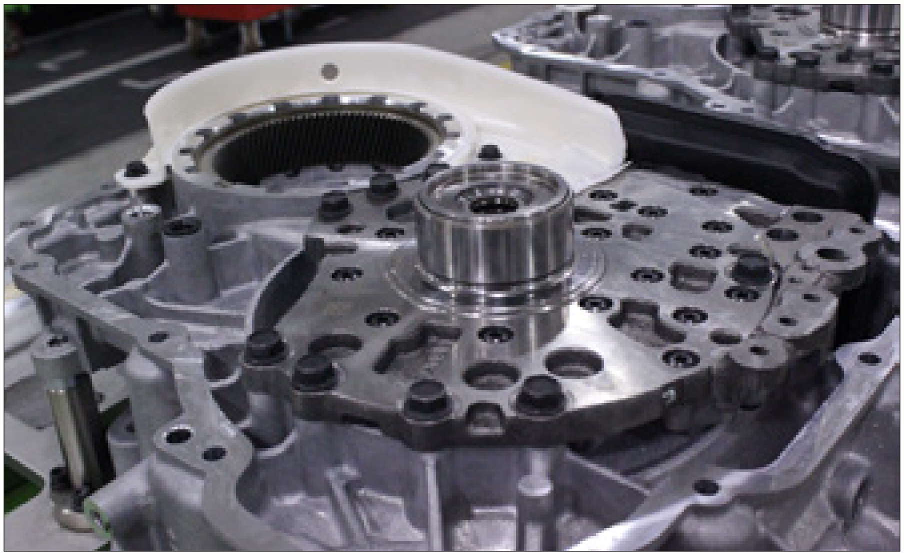
Public policy must reinforce these positive trends. Smart policy has already played a role in recent vehicle manufacturing jobs gains. Tens of thousands of jobs have been preserved and created since 2009 through the Advanced Technology Vehicles Manufacturing Loan Program. This program offers loans at government treasury bills rates to cover the cost of retooling an existing plant or building a new factory. The federal Battery and Electric Drive Component Grant Program has also helped to jump start domestic industry for these new components that will play a role in pushing fuel economy to new levels. In 2009, the U.S. held two percent of the global market for vehicle batteries. Today, the figure is approximately 20 percent and on track to reach 40 percent by 2016.[3]

The greater availability of more fuel-efficient vehicles, driven in no small part by the vehicle performance standards analyzed in this report, is also proving a boon to automakers. Automakers have already begun a renewed push for energy innovation in response to the 2012-2016 standards for fuel economy and tailpipe emissions that were adopted in 2009. And these new vehicles offerings, including both cars as well as the most efficient light trucks in the marketplace, have positively reinforced industry progress.

It is notable that the main approach to achieving compliance with the proposed standards is forecasted to be improvements to internal combustion engine (ICE) technology. The compliance pathway forecasted by EPA and DOT suggests that automakers could achieve compliance largely via advanced ICE technology. Their market forecast for 2025 under the proposed rule suggests that 82 percent of the market would be comprised of vehicles driven by ICE technology, 15 percent by hybrid technology and three percent by battery electric vehicles (EPA, DOT, California Air Resources Board 2010).

Overview of the remainder of the report. Next, we provide historic context for the proposed standards. In section three, we review the most relevant research literature related to its implementation. We then move on to describe our methodology and key inputs and assumptions for this economic analysis. In section five we discuss the results of our analysis, and then offer summarizing thoughts in section six. After a list of references, the technical appendix provides further detail on the modeling approach.

2. BACKGROUND ON FUEL ECONOMY/ GHG EMISSIONS REGULATION



The proposed standards build on decades of progress in harmonizing state and federal requirements to increase fuel economy and reduce greenhouse gas pollution. The Corporate Average Fuel Economy (CAFE) program was enacted by Congress in 1975 in the wake of the 1973 Arab Oil embargo with the goal of improving the fuel economy of passenger cars and light trucks sold in the U.S. The program was established as a fleet average (weighted by sales volume and harmonically distributed) of a manufacturer's line of vehicles for a given model year, and to ensure compliance, automakers not achieving this average are subject to financial penalty. The program is currently administered jointly between the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) in regards to fuel economy and safety considerations, and the EPA in regards to source emissions for greenhouse gases as covered under the Clean Air Act.

President Gerald Ford originally signed the CAFE program into law, and it — combined with parallel measures to control tailpipe emissions — has delivered broad consumer benefits, improvements to energy security and the environment, and a clearer investment horizon for the auto industry. President George W. Bush signed the first increase in many years into law with the Energy Independence and Security Act of 2007, and beginning in 2009, President Obama set the stage for significant ramp-up of fuel economy and pollution standards for model year 2011 vehicles and beyond, emphasizing engagement among a broad set of stakeholders — including automakers, labor leaders and environmentalists — to set ambitious yet achievable vehicle standards.

In May 2010, the Obama Administration established standards for 2012-2016 model year cars and light trucks[4] (defined as passenger vehicles up to 8,500 pounds and medium-duty sport-utility vehicles, pickup trucks, and passenger vans up to 10,000 pounds). This set of standards (also referred to as Phase I of the National Program to implement more stringent GHG pollution standards and CAFE standards) would achieve slightly more than four percent annual improvements in energy efficiency with corresponding reductions in pollution.

The average emission rate for model year 2009 light-duty vehicles was 337 grams of carbon dioxide per mile traveled (gCO_2e/mile), which will be reduced to 250 gCO_2e/mile for model year 2016 vehicles under the Phase I standards — effectively a 26 percent reduction in GHG pollution. The 2012-2016 standards also regulate fuel economy, which is expected to increase from 26.4 mpg for model year 2009 vehicles to 34.1 mpg for model year 2016 — an effective increase of 29 percent. It should be noted that standards vary by vehicle type and size for both the 2012-2016 standards and the proposed standards analyzed here.

In May 2010, EPA and DOT commenced Phase II of the National Program, setting fuel economy and GHG pollution standards for model year 2017-2025 light duty vehicles. Building from the engagement among the auto industry, regulatory agencies, labor unions, consumer advocacy groups and environmentalists established in Phase I, the Obama Administration's efforts to craft strong vehicle standards culminated in the target of achieving a standard equivalent to 54.5 mpg for light-duty vehicles by 2025. President Obama announced the target on July 28, 2011, and the two agencies are expected to finalize them in summer 2012. These proposed standards will benefit drivers as they, in conjunction with the 2012-2016 standards, nearly double average light-duty fleet fuel economy in approximately a 15-year timeframe, and this generally continues the trajectory of over four percent efficiency improvement and pollution reduction on an annual basis throughout Phases I and II.

3. LITERATURE REVIEW

Our assessment builds on a body of work examining the estimated impacts of improved vehicle fuel economy and pollution standards to consumers and across the auto industry, economy and environment. Here, we review four recent independent studies relevant to our understanding of the effects of 2012-2016 and the 2017-2025 fuel economy and pollution standards as applied by EPA and DOT. Additionally, the documents prepared by these agencies as part of the regulatory process, such as the draft Regulatory Impact Analysis and Technical Support Document, do an excellent job of providing coverage of the extensive literature that supports the proposed standards.

It isn't news that cost-effective improvements in fuel economy can result in significant macroeconomic gains, including increased jobs creation. Evidence has suggested such possibilities as early as the 1970s. Consequently, we identify for the interested reader a few foundational articles that explain how policies that spur energy-saving investments can create broad macroeconomic benefits before we move to the literature that is directly relevant to the currently proposed fuel economy standards. These include Bezdek and Hannon (1974), Geller, DeCicco and Laitner (1992), Goldberg et al. (1998), Bezdek and Wendling (2005a), and Bezdek and Wendling (2005b). All of these earlier studies point to a net increase of jobs and other economy-wide benefits as a result of energy efficiency improvements.

3.1) RESEARCH RELEVANT TO THE 2012-2016 STANDARDS

Creating Jobs, Saving Energy, and Protecting the Environment

A report by the Union of Concerned Scientists (2007) — published before the 2012-2016 rule had been proposed — estimates the economic benefits of a fuel economy standard that is quite close to the adopted regulations. This study bases its estimates on a standard that would increase average fuel economy for light-duty vehicles to 35 mpg by 2018, while the adopted 2012-2016 standards mandate an increase in fuel economy to 34.1 mpg by 2016. The level of fuel economy proposed by this study is slightly less stringent than the adopted standards, but it is a close approximation nevertheless. The report also calculates estimates based on a lower standard, but we focus on the more ambitious policy scenario that more closely resembles what was actually adopted. The researchers ran their own stock model to determine fuel savings and a modified version of IMPLAN developed by MRG & Associates to evaluate the impacts on jobs and other macroeconomic areas.

The report predicts that, if fuel economy of 35 mpg is reached by 2018, the net increase in jobs will be 241,000 in 2020 and 370,300 by 2030. The results suggest that all sectors with the exception of the mining, petroleum refining, and wholesale trade will experience net job gains, though job gains overwhelm job losses in these sectors. The greatest job gains are expected in the Retail Trade and Services sectors, while the auto industry would see about 10 percent of the net increase.

Driving Growth: How Clean Cars and Climate Policy Can Create Jobs

In 2010, the Natural Resources Defense Council, the United Auto Workers, and the Center for American Progress published a report called "Driving Growth: How Clean Cars and Climate Policy Can Create Jobs" (Baum, A. & Luria, D. 2011). This report analyzes the expected economic impacts of the 2012-2016 rule with an emphasis on how the manufacturing sector would be affected under different levels of domestic content. The analysis assumes that fuel economy improvement occurs at a 4 percent annual rate (based on the trajectory of 2012-2016 model year standards currently being implemented) to achieve a fuel economy level of 31.5 mpg by model year 2014, and that this same annual rate of improvement is sustained through 2020. Their analytical approach is bottom-up and engineering-based. The particular technologies that are likely to be crucial to compliance with the regulation are anticipated along with their labor intensity in order to judge manufacturing job creation.

The report finds that the rule will result in an additional $11.3 billion in investment in vehicle content due to the production of more fuel-efficient vehicles. This will create approximately 62,000 vehicle manufacturing jobs in 2014. The extent to which these jobs are located in the United States is not predicted. Depending on the share of domestic content, approximately 20,000-54,000 of these jobs could be created in the United States. By model year 2020 — when the light-duty vehicles fleet will have achieved a fuel economy level of about 40 mpg — investment in fuel-efficient vehicles will add an additional $15.4 billion in spending on vehicle content. This will create a total 191,000 vehicle manufacturing jobs above 2008 employment levels. Of these jobs, 49,000-151,000 will be located in the U.S.

This large variation in estimated potential job creation reflects uncertainty regarding the extent to which the new advanced technology components that will enable these fuel economy gains will be manufactured in the United States. The report estimates that the United States could produce 25 to 75 percent of total technology value, and gain 25 to 75 percent of the job creation benefits. This effectively highlights the potential payoff from policies that encourage the development of domestic supply chains.

3.2) RESEARCH RELEVANT TO THE PROPOSED STANDARDS FOR 2017-2025

More Jobs Per Gallon: How Strong Fuel Economy/ GHG Standards Will Fuel American Jobs

In July 2011 Ceres published the study "More Jobs Per Gallon: How Strong Fuel Economy/GHG Standards Will Fuel American Jobs," (Ceres 2011) which estimates the national, state, and regional impacts of the proposed standards under four different reduction scenarios ranging from three to six percent annual improvement. The analysis is conducted with an input-output (I/O) model that is similar to the one used in our research. Of course there are some differences between DEEPER, the modeling system we are using, and the model used by Ceres, a system developed and run by the firm Management Information Systems, Inc. Their approach includes a particularly detailed representation of the different regional economies represented by the 50 states, enabling comprehensive state-level forecasts.

The Ceres study is national in scope, but also offers a sophisticated state-level forecast. At the national level, the results show that job creation, gross economic output, personal income, and tax receipts are all expected to increase under each of the four scenarios, with the best outcomes under the most ambitious policy, the six percent improvement level. Increases range from 352,000 to 684,000 for net job gains, $15.5 billion to $31.2 billion for gross economic output, $10.2 billion to $20.5 billion for personal income, and $9.3 billion to $18.8 billion for local, state, and federal tax revenue. The study also breaks down job gains and losses across sectors of the economy, finding expected net job gains in Motor Vehicles and Parts, Retail Trade, Hospitals and Nursing Facilities, Construction, and Educational Services under each of the four scenarios. The largest gains are in Retail Trade and Hospitals and Nursing Facilities, with Construction and Educational Services experiencing net job gains under each of the four scenarios. On the other hand, some industries — including Rental and Leasing Services, Mining Support Activities, Oil and Gas Extraction, Pipeline Transportation, and Petroleum and Coal Products — are expected to experience small job losses. On balance, the study predicts that job gains will overwhelmingly exceed job losses as indicated by the aggregate numbers.

The study then analyzes the economic impacts of the proposed standards at the state level, finding that the majority of states experience job gains and GDP growth under each of the four scenarios, with highest gains under the six percent scenario. In fact, under all four scenarios, every state other than Wyoming is expected to experience net job gains. Most states are also predicted to experience increases in GDP under each of the four scenarios, with Michigan, Indiana, and Ohio experiencing the highest increases.

As this research is the closest to that being reported on in this paper, we will offer some further comparative thoughts on the differences and similarities between our work and this study's methodology and findings when we discuss our results.

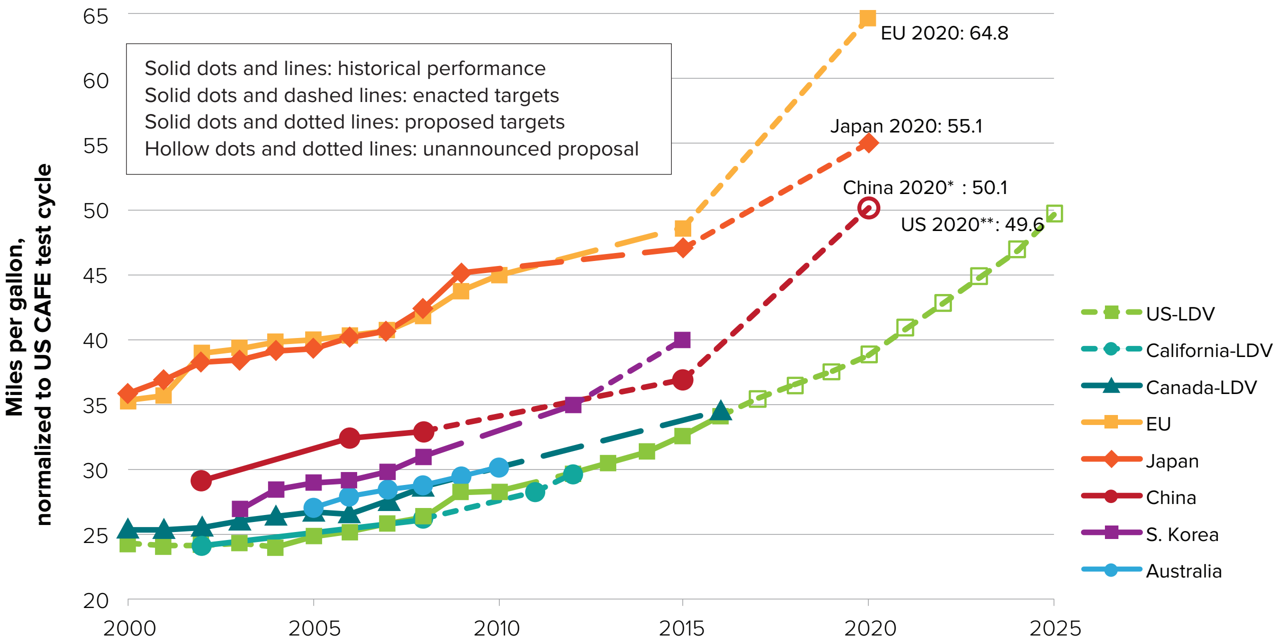
Fuel Economy Focus: Industry Perspectives on 2020

"Fuel Economy Focus: Industry Perspectives on 2020," (Citi Investment Research 2012) was published by Ceres in April 2012. The study analyzes how the proposed standards would affect auto industry profits and vehicle sales. They use a sophisticated econometric approach that accounts for 70 variables, and find that implementation of the proposed standards would increase both sales and profits in 2020. For the U.S. industry as a whole, sales are forecasted to increase by three percent and profits by six percent. Ford, General Motors, and Chrysler, also known as the Detroit 3 (D-3), are expected to see bigger gains than other big automakers. The analysis indicates that sales will increase by four percent and that profits will climb by six percent for the D-3.

The higher profit numbers from Ceres' 2012 report reflect their conclusion that that sales revenue is expected to increase. The study concludes that "The increase in fuel economy may actually somewhat increase vehicle demand as consumers embrace the reduced operating cost of vehicles that obtain more miles per gallon than would otherwise be available without fuel economy requirements," (p. 10). Higher profits also reflect assessments of variable cost and the complex interplay of the econometric model.

There are two driving forces behind the D-3's higher performance gains. The first is that the proposed standards are expected to narrow the existing fuel economy gap between the D-3 and the rest of the industry. In other words, there is more low-hanging fruit available to the D-3. The second reason is that light trucks and larger cars are expected to contribute the most to added consumer value generated by more stringent standards, and the D-3 has a large market share in precisely those vehicles.

FIGURE 1. International Trends in Light-Duty Vehicle Fuel Economy and Greenhouse Gas Standards[5]



* China's target reflects gasoline fleet scenario. If including other fuel types, the target will be higher.

** US and Canada light-duty vehicles include light-commercial vehicles.

Source: Global comparison of light-duty vehicle fuel economy/GHG emissions standards. (ICCT 2012).

3.3) THE INTERNATIONAL CONTEXT

Looking outside the domestic arena, another important benefit of the proposed rule is that it will increase U.S. competitiveness internationally, putting U.S. automakers in a better position to compete with their foreign counterparts. The proposed standards will help close the gap that has emerged and has been widening between fuel economy standards in the United States and other major markets, such as China, Japan, and the European Union. As shown in Figure 1 above, graphics borrowed from work by the International Council on Clean Transportation (ICCT 2012), the U.S. has historically lagged behind China, Japan, Korea, and the EU in achieving higher fuel economy and in reducing vehicle greenhouse gas emissions. Although the proposed standards are not expected to close either of these gaps entirely, they are expected to allow U.S. automakers to begin catching up to their foreign counterparts. Narrowing the fuel economy and greenhouse gas emission gaps between the U.S. and China, Japan, and the EU will put domestic automakers in a better position to compete globally, and further strengthen the U.S. auto industry.

4. METHODOLOGY

We use an input-output (I/O) model — essentially a recipe of how different sectors of the economy buy and sell to each other — in order to explore the expected future impacts of the new 2017-2025 light-duty vehicle performance standards. We estimate policy impacts as the result of changes in demand for required inputs including raw materials and finished products. We focus particular attention on the employment effects along different segments of the supply chain. We describe our macroeconomic modeling approach further in the following section, 4.1. In section 4.2, we discuss the inputs and assumptions used in the analysis. Section 4.3 describes the alternative scenarios that we test using different assumptions about domestic content and vehicles sales. Section 4.4 discusses the issue of labor productivity and our approach to its incorporation in the model.

4.1) THE DEEPER MODEL

We use the proprietary Dynamic Energy Efficiency Policy Evaluation Routine (DEEPER) model system, a quasi-dynamic input-output analytical tool.[6] The model was developed by Skip Laitner, now director of American Council for an Energy-Efficient Economy's (ACEEE) Economic and Social Analysis Program and used routinely on behalf of various ACEEE assessments. It has a 20-year history of use and development, though it was recently renamed.

We have reconfigured the modeling, highlighting sectors most affected by the 2017-2025 light-duty vehicle rule and breaking out a separate light-duty vehicle parts supply sector. The version of the model used in this assessment is a 15-sector model, which includes an Iron and Steel sector that is relevant to the raw material segment of the supply chain, as well as sectors representing vehicle sales and maintenance, oil extraction, and oil refining. The full set of sectors (14 economic sectors plus a household sector) will be listed when we present the results of our analysis.

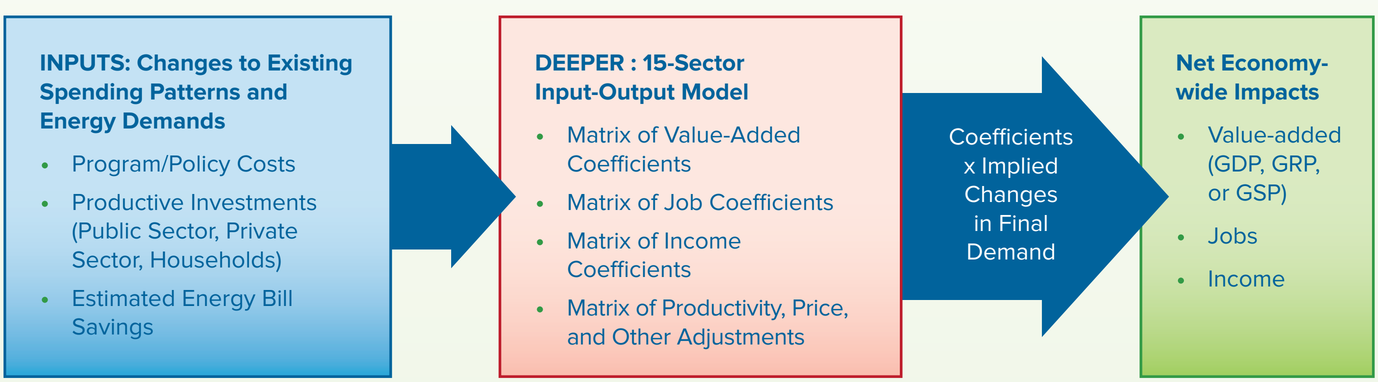
The appendix provides a mathematical description of the model. The model functions as illustrated in the flow diagram marked Figure 2.

The DEEPER model provides an understanding of how the economy is likely to perform given changes in energy demands, alternative investment and spending patterns, and pricing caused by a given policy. The effect of the policy can then be evaluated as the difference between a baseline (i.e. reference case or business as usual) scenario and the policy scenario. Although the DEEPER Model, like all input-output models, is not a general equilibrium model,[7] it does provide accounting detail that balances changes in investments and expenditures within a sector of the economy. With consideration for goods or services that are imported, it balances the variety of changes across all sectors of the economy.[8]

The model represents production — including capital (or investment) and labor and energy resource flows — for a given "base year," in our case 2010, for which the most recent comprehensive national data is available. DEEPER uses a set of economic accounts that specify how different sectors of the economy buy (purchase inputs) from and sell (deliver outputs) to each other.[9]

In this analysis, results are driven by changes in investment, demand, energy use, government spending and taxation implied by the 2017-2025 light-duty vehicle rule. The resulting positive and negative changes in spending and investments in each year are converted into sector-specific changes in aggregate demand.[10] These results then drive the I/O matrices utilizing a predictive algebraic expression known as the Leontief Inverse Matrix.[11] The implicit production function, or economic recipe, is a fixed

Figure 2. Diagram of the DEEPER Model



proportion production function based on the concepts first developed by Nobel laureate Wassily Leontief.

In sum, the DEEPER model traces how changes in spending will ripple through the U.S. economy in each year of the assessment period. The end result is a net change between the reference and policy scenarios in jobs, income, and value-added. Employment forecasts are adjusted according to the anticipated labor productivity improvements based on forecasts from the Bureau of Labor Statistics. Failing to take this step would overestimate the size of employment impacts.

Like all economic models, DEEPER has strengths and weaknesses. It is robust by comparison to some I/O models because it can account for price and quantity changes over time and is sensitive to shifts in investment flows. It also reflects sector-specific labor intensities across the U.S. economy. At the same time, it is arguably less sophisticated in its treatment of price changes than Computable General Equilibrium models. However, the idea that markets should always be forced to equilibrium by price changes is debatable. While mathematically convenient, evidence of disequilibrium abounds. Further, more complicated forecasting methods have not been found to be more accurate than simpler ones.[12]

It is important to remember when interpreting results from DEEPER, or any model, that the results rely heavily on the quality of inputs and assumptions used. Like any prediction of the future, they are subject to an array of uncertainties.

4.2) INPUTS AND ASSUMPTIONS: MACROECONOMIC ANALYSIS

Our macroeconomic model is specified using social accounting matrices[13] from the Minnesota IMPLAN Group,[14] using the most recently available (2010) data for this research. We also obtained energy use data and forecasts from the U.S. Energy Information Administration's (EIA) early release version Annual Energy Outlook 2012 (AEO 2012),[15] and employment and labor productivity data from the Bureau of Labor Statistics (BLS).

Our policy assumptions largely draw on the work of the federal agencies EPA and DOT, and California Air Resources Board (CARB). (EPA, DOT, CARB 2011; EPA, DOT 2011; EPA, DOT 2012). In particular, we use the findings of the draft Regulatory Impact Analysis for fuel savings and for the incremental additional cost for new vehicles.[16] Additional costs do cover the costs to industry. We assume that costs associated with the higher vehicle price are financed by consumers over a five-year period at an annual rate of 5.51 percent, again reflecting the technical work of EPA/DOT/CARB.

To apportion the reductions in final demand resulting from fuel savings, we use data from EIA for 2010 that indicates the division of gasoline revenue across the gasoline value chain: crude oil extraction, refining, marketing and distribution, and state and federal taxes. We adjust future values based on the AEO's forecast of the future price path for crude oil, assuming that other components stay the same in constant dollars.

We assume that fuel savings will be distributed across different sectors of the economy in proportion to 2010 consumption. Our approach to estimating 2010 consumption starts with the last household survey conducted by the DOE, the Residential Transportation Energy Consumption Survey (EIA 2001). To update 2001 data and to estimate fuel use outside of household consumption, we use Department of Transportation statistics on vehicle purchase by sector[17] and on fleet composition in the commercial and government sectors.[18]

The fuel savings from the proposed rule come from what is effectively an investment in the technology upgrades that enable vehicles to provide superior fuel economy. The analysis requires an estimation of how increased spending on advanced vehicles is spread across sectors in the value chain. We assume that 80 percent of the spending will go to vehicle parts and supplies while 20 percent will go to vehicles. This is based on data from the 2009-2010 Annual Census of Manufacturers conducted by the U.S. Census Bureau, which indicates the current value going to parts is approximately 78.5 percent.[19] Since we know that fuel-saving technologies tend to be somewhat more parts intensive, we round this figure up to 20 percent.

We considered more research-intensive approaches to assessing this question. However, there is significant uncertainty regarding the particular shape that compliance will take due to the flexibility of the regulation. The new regulation consists of performance standards that require steady improvement over time, but no particular technologies are prescribed. Given the lack of certainty that any particular compliance pathway will be realized, our less time- and resource-intensive approach to this required estimation seems the most sensible.

Another input to the modeling is the estimated cost to the government of administering the program, which we estimate to be about $30 million per year (2010 dollars) for each year of the program 2017-2025. EPA and DOT factored in increased program costs starting in FY2009 in preparation for the 2012-2016 rule, resulting in a 21 percent increase for CAFE from the previous year for EPA, and five percent for DOT. We take this annual increase in funding, approximately equal to the $30 million, as the difference in government spending from the reference case. Arguably, much of this cost could be entirely attributed to the 2016 rule. Given the difficulty of separating out some portion to assign to the 2025 rule, we take the conservative route and attribute the full value to the policy we are analyzing. Finally, to assess the economy-wide changes that follow from the policy we need a reference case (i.e., the expected future path of the economy if the regulation were not to be implemented, sometimes called the business-as-usual scenario). We use the macroeconomic forecast that is part of the AEO 2012 as our benchmark.

4.3) SCENARIOS EXPLORING ALTERNATIVE SCENARIOS IN AUTO MANUFACTURING

In addition to the core macroeconomic analysis described above, we also explore alternative scenarios particularly relevant to auto manufacturing.

Increased Vehicle Sales

In the EPA analysis of the 2012-2016 fuel economy and greenhouse gas standards for light-duty vehicles and in an earlier regulatory assessment of the potential impacts of the proposed standards for 2017–2025 (EPA, DOT 2011), an increase in future vehicle sales was forecasted to follow from implementation of the policy. The rationale for the change is unclear as no new compelling study or consensus has emerged since their prior work was done (Greene 2010). The EPA's prior approach concluded that vehicle sales would increase based on the idea that vehicle purchasers value fuel savings. The cost of acquiring a new vehicle is not the only cost that matters in a purchase decision. By lowering the cost of owning a vehicle, such vehicle standards in effect make vehicle ownership more affordable.

To operationalize this approach, the EPA develops a definition of price elasticity of demand for new vehicles that takes into account the net present value of five years of fuel costs in the price. The price elasticity is assumed to equal minus one. So, a one percent decrease (increase) in price would lead to a one percent increase (decrease) in sales. The agencies considered two discount rates, three percent and seven percent, to find a present value of gasoline savings over five years. The following increased vehicle sales are projected, and are the basis of our assessment of the potential employment impacts in this scenario.

Morgenstern, Pizer, and Shih (2002) offer a framework to think about ways that policies can affect employment. They identify three causal pathways:

1. **Demand effect:** higher demand for vehicles, in this scenario we contemplated an increase in vehicles sales.
2. **Incremental cost effect:** more spending on more fuel-efficient vehicles in this instance.
3. **A factor shift effect:** factors in this instance refer to factors of production, labor, capital, and materials. We don't identify factor shift effects due to the regulation. However, the labor productivity trend reflected in our results does have the effect of shifting the mix of factor inputs. So factor shifts are captured in the overall analytical framework.

The Morgenstern, Pizer, and Shah approach is reflected in our main policy case, and we also use it to evaluate the vehicle manufacturing employment impacts that would follow from an increase in vehicle sales. Our approach involves calculating demand and incremental cost effects as a function of the changes in sales given in Table 1, and estimating how these effects translate into changes in employment.

The incremental cost effect is the product of higher spending per vehicle and the change in vehicle sales. We use the same incremental cost estimates and the same approach to allocating the higher spending (i.e. 80 percent to parts, and 20 percent to assembly) as was used in the main policy case.

The demand effect is the product of a reference case purchase price and the change in vehicle sales. To estimate a range for the demand effect, we calculate a lower bound and an upper bound scenario. For the lower bound scenario, we use the seven percent discount rate and assume that the purchase price for vehicles stays the same in future years. Under this "flat purchase price" scenario, we fix the price at the 2008 level, $23,864 (2010 dollars) — the most recent data from Oak Ridge National Laboratory's (ORNL) transportation databook (ORNL 2011). To calculate the upper bound, we use the three percent discount rate and consider the incremental technology cost of the final 2012-2016 standards. Under this "higher purchase

Table 1. Data inputs for Incremental Cost Effects[20]

		2017	2020	2025	2030
Car sales reference		8,984,000	9,554,000	10,740,000	11,800,000
Truck sales reference		6,812,000	6,336,000	6,470,000	6,702,000
3 percent discount rate	Change in car sales	0.0%	1.9%	2.8%	3.0%
	Change in truck sales	0.6%	1.5%	5.7%	4.8%
7 percent discount rate	Change in car sales	0.0%	1.8%	2.6%	2.8%
	Change in truck sales	0.5%	1.4%	5.4%	4.6%

price" scenario, we increase the 2008 vehicle price by the incremental technology cost to auto manufacturers of meeting the 2012-2016 standards. We use the revised estimated cost of the incremental technology to achieve the 2016 standards determined in the course of the rulemaking for the proposed standards through 2025 (EPA 2010, table 4-7).

Domestic content. Our core policy scenario implicitly assumes that the domestic content indicated by the 2010 IMPLAN data holds constant in future years as well. The IMPLAN data indicates that 58 percent of the goods and services in light-duty vehicle manufacturing (i.e. assembly) and 60 percent of those in light-duty parts supply are generated by domestic suppliers. These future domestic content levels could be higher if more effective policy supports the retention and attraction of manufacturing jobs. We explore the employment implications of a steady increase to 75 percent domestic content by 2030 for the more fuel-efficient vehicle value created under the proposed standards. That is to say, we only consider the effect that a change in domestic content would have on the jobs created as a result of the need for compliance with the new standards. We do not explore the implications of a large-scale shift in domestic content for the entire industry, which would create many more jobs. We assume a linear increase from the level of domestic content implied by our IMPLAN data in 2017 to the 75 percent domestic content level by 2030. The 75 percent target is the same upper bound tested in the *Driving Growth* report.

4.4) DISCUSSION OF LABOR PRODUCTIVITY ISSUES

Since our DEEPER model is specified using 2010 economic accounts, we need to take into account expected future increases in labor productivity, defined as the amount of output per unit of labor input. Most macroeconomic models do not factor in the steady trend of increasing labor productivity. However, failing to do so can lead to overestimates of future job creation. DEEPER uses a three-step process to capture labor productivity effects. First, the model evaluates future changes in investment and consumer spending. Second, it estimates how those spending changes impact sector employment given the 2010 economic relationships. Finally, the annual sector employment totals are adjusted to reflect labor productivity improvements. For example, if a given sector has a 1.5 percent annual rate of labor productivity improvement, 2030 employment totals would be adjusted downward to 74.2 percent of the initial value.[21]

We have used labor productivity data from the BLS, which projects future labor productivity gains through 2020. We extend the trend they find through 2030 for this analysis, however it should be noted that there are concerns that these data sources overestimate labor productivity gains in manufacturing. Temporary workers are not counted among the manufacturing workforce. When these workers are factored in, this lowers average manufacturing productivity growth in the 1990s from four percent to about 3.5 percent per year.[22] We considered an adjustment downward to manufacturing labor productivity inputs to our modeling to reflect this research, but decided against. As a result, job gains in manufacturing, both auto-related and otherwise, should be viewed as being somewhat understated. This approach should serve to bolster overall confidence in the job gains that are reported.

5. RESULTS AND DISCUSSION

5.1) MAIN POLICY CASE

Our main policy case harmonizes assumptions with the work of the federal agencies to the greatest extent possible. Table 2 presents the financial impacts of our policy assessment. Most are discussed in greater detail in the methodology section. Program costs reflect the added expense to the government to run the program implementing and enforcing the proposed standards. The investment category reflects added spending due to the incremental cost of more fuel-efficient vehicles, which can be thought of as an investment in upgraded technology that returns energy savings. Annual payments illustrate what is due to creditors under the financing assumption explained in the methodology section. Fuel savings reflect the undiscounted value of reduced expenditures on gasoline and diesel fuels. Net savings reflect fuel savings minus payments, and the cumulative category adds these annual values up from the inception of the program.

Net savings are the principal determinant of the macroeconomic benefits that we estimate in this report. These reach $61 billion dollars in 2030, similar to other estimates.[23]

Table 3 then provides our macroeconomic results across key indicators.

Table 2. Financial Impacts

In Millions of 2010 Dollars (except as noted)	2017	2020	2025	2030
Program Cost	30	30	30	30
Investments	2,300	8,700	35,000	37,000
Annual Payments	530	5,200	30,000	43,000
Fuel Savings	710	8,600	49,000	103,000
Net Savings	140	3,300	20,000	61,000
Cumulative Net Fuel Savings	140	5,900	65,000	270,000
Average Net Household Savings (in 2010 dollars)	1	26	150	430

Note: Numbers may not appear to add up due to rounding of two significant figures.

Table 3. Macroeconomic Results

	2017	2020	2025	2030
Employment (net change)	16,000	76,000	320,000	570,000
Percent change from reference	0.01%	0.04%	0.18%	0.30%
Wages (Million 2010 dollars)	1,200	6,000	27,000	49,000
Percent change from reference	0.01%	0.07%	0.28%	0.46%
GDP (Million 2010 dollars)	1,900	9,000	41,000	75,000
Percent change from reference	0.01%	0.05%	0.19%	0.30%

We estimate that the proposed rule will lead to a net gain of approximately 320,000 jobs by 2025 and 570,000 jobs by 2030. Compared to the reference case (the pathway the economy would be expected to take in the absence of the proposed standards), this represents increases of 0.19 percent and 0.30 percent by 2025 and 2030, respectively. Job gains are smaller in earlier years when fuel savings are only beginning to accumulate. Because the proposed standards affect only new car sales, it takes time for the effect on the stock of vehicles to materialize. It is important to keep in mind that the proposed standards for 2025 builds on the 2016 standards, which themselves would deliver greater job growth than the estimate here since the energy saved to incremental cost ratio is even higher for that regulation.

We also analyze impacts of the proposed standards on wages and GDP, estimating a net wage increase of $49 billion (in 2010 dollars) and a net GDP increase of $75 billion (in 2010 dollars) by 2030. The net change in wages represents a 0.46 percent increase from the reference case, while the net change in GDP represents a 0.30 percent increase. This result implies that the proposed standards lead to rising wages.

Our numbers are similar to earlier work by Ceres (2011). Their four percent scenario is the closest to our main policy case,[24] and returns aggregate jobs gains of 484,000 by 2030. We understand differences to be due to (1) labor productivity, and (2) treatment of domestic content in oil supply. Our incorporation of increasing labor productivity has the effect of lowering future employment projections. However, this effect is more than outweighed by our assumption that reductions in oil demand lower imports first, increasing the domestic content of the oil supply sector. Our auto manufacturing job impact estimates are also similar to Ceres (2011), which projects 43,000 auto manufacturing jobs gained by 2030. We estimate 50,000 auto manufacturing jobs gained by 2030.

Next, we report a breakdown of employment effects across different economic sectors, in Table 4.

Sector specific estimates from our main policy case show that the proposed standards are expected to generate net job gains for the vast majority of economic sectors. By 2030, the Vehicle Parts Manufacturing sector gains 45,000 jobs and the Light-Duty Vehicle Manufacturing sector gains an additional 5,100 jobs. Other Manufacturing gains 35,000 jobs. There is also a net increase of 68,000 jobs in Vehicle Sales and Services by 2030. Overall, the biggest gain is in the Business and Personal Services sector, which is projected to see a total net increase of 310,000 jobs by 2030. Oil and Gas Production and Oil Refining are both forecasted to see small net job losses due to the regulation, though these losses are more than overwhelmed by gains in other sectors.

We find that the retail sector does well under the rule, experiencing job gains overall, which differs from results included in a report released by the National Association of Convenience Stores (2012), which says that the proposed standards will cause harm to retail markets. Our model does include reduced sales of gasoline and diesel fuel as an input as compared to the reference case. However, in our results, these retail sales effects are netted out against other gains in retail trade.

Table 4. Sector Specific Employment Impacts

	2017	2020	2025	2030
Agriculture	320	1,400	5,500	8,200
Oil and Gas Production	14	-200	-1,300	-2,500
Mining	80	290	1,100	1,200
Transportation and Public Utilities	420	2,000	8,800	15,000
Construction	160	700	3,000	4,900
Manufacturing	1,800	7,100	27,000	35,000
Oil Refining	-1	-24	-120	-190
Iron and Steel Products	160	610	2,300	2,500
Light-Duty (LD) Vehicle Manufacturing	420	1,500	5,300	5,100
LD Vehicle Parts Manufacturing	4,200	14,000	49,000	45,000
Wholesale and Retail Trade	1,100	2,800	8,400	16,000
Vehicle Sales and Services	620	7,000	35,000	68,000
Business and Personal Services	4,900	30,000	140,000	310,000
Government	1,900	8,500	39,000	63,000
Total Jobs Impacts*	**16,000**	**76,000**	**320,000**	**570,000**

Note: Numbers may not appear to add up due to rounding.

5.2) INCREASED VEHICLE SALES SCENARIO

We use the increased vehicles sales scenarios and methodologies described in section 4.3 to investigate the direct and indirect (not induced) jobs that would be created in auto manufacturing under such circumstances. We emphasize that these are estimated employment gains to these sectors from others and are therefore not net gains to the economy as a whole. They represent the shifting of spending to the purchase of more light-duty vehicles, and away from other types of spending. We do not provide specific information about the aggregate effects or the sector impacts outside of auto manufacturing because to do so correctly would require complicated assessments of the indirect effects on vehicle miles traveled and gasoline consumption. Table 5 reports the direct and indirect job gains from the incremental higher spending associated with the increase in vehicle sales (reported in Table 1).

By 2025, the total increase in auto manufacturing jobs is approximately 1,500 under the seven percent discount rate scenario and 1,700 under the three percent discount rate scenario — with about 90 percent of the jobs going to the parts supply sector and 10 percent of the jobs going to the assembly sector. By 2030, the total increase in auto manufacturing jobs is 1,300 under the seven percent discount rate scenario and 1,400 under the three percent discount rate scenario — once again with parts supply jobs greatly exceeding assembly jobs. The decrease in direct employment gains from 2025–2030 can be explained by increasing labor productivity in the years after the proposed standards reach their maximum by 2025. This follows from an implicit assumption that fuel economy reaches a plateau by 2025. As a result, spending on advanced vehicles and vehicle sales levels out while labor productivity continues to increase.

Table 5. Incremental Cost Effect

	2017 (7%)	2017 (3%)	2020 (7%)	2020 (3%)	2025 (7%)	2025 (3%)	2030 (7%)	2030 (3%)
Assembly Jobs	0	0	19	20	140	150	130	130
Parts Supply Jobs	4	4	210	220	1,400	1,500	1,200	1,300
Total*	4	4	230	240	1,500	1,700	1,300	1,400

Source: Author's calculations. EPA and EIA data on vehicle sales reference, vehicles sales increase, cost.

Note: Numbers may not appear to add up due to rounding.

Table 6. Demand Effects on Auto Manufacturing Employment

	2017	2020	2025	2030	2017	2020	2025	2030
	Lower Bound (7 percent discount rate and flat purchase price)				*Upper Bound (3 percent discount rate and higher purchase price)*			
Increased spending ($MM2010)	880	6,400	15,000	15,000	930	7,000	16,000	17,000
Below are employment results of above spending								
Iron and Steel Production	50	350	760	740	53	380	820	810
Parts Manufacturing for LD Vehicles	1,300	8,500	16,000	14,000	1,400	9,200	18,000	16,000
LD Vehicle Manufacturing	100	700	1,400	1,300	110	760	1,500	1,400
Below is the sum of the above sectoral employment effects								
Total Auto Manufacturing Supply Chain*	1,500	9,600	18,000	16,000	1,600	10,000	20,000	18,000

Note: Numbers may not appear to add up due to rounding.

Table 6 presents the resulting employment impacts associated with the "base" spending on the increased numbers of vehicles sold. By base spending, we mean the price of a vehicle in the reference case. Since this price is roughly at least an order of magnitude larger than the incremental cost, the employment gains are also larger.

Finally, in Table 7 (following page), we sum up the results of the demand and incremental cost effects that would result from increased vehicle sales.

We estimate a gain of 17,000 to 19,000 jobs by 2030, and slightly higher numbers by 2025. Employment gains increase through 2025, but thereafter, as we've seen before, the leveling out of spending and continuation of labor productivity increases lead to somewhat smaller employment gains over the reference case by 2030 as compared to 2025.

These can be thought of as the partial equilibrium employment results from the higher spending on vehicles implied under the increased vehicle sales scenario. Aggregate job gains would not be expected to increase commensurately. In fact, aggregate job gains should stay roughly the same. What is captured in these partial equilibrium results is a shift of spending towards more fuel-efficient light-duty vehicles and away from other types of consumption.

5.3) INCREASED DOMESTIC CONTENT SCENARIO

More effective public policies and other factors may in the future allow U.S.-based facilities to capture a larger proportion of value created in the manufacturing supply chain. Our quantitative analysis focuses on the incremental spending on more fuel-efficient technologies for compliance with the proposed standards. We explore the employment implications of an increase from the domestic content levels observed in our IMPLAN data to a level of 75 percent in both parts and assembly. More precisely, the scenario contemplates a linear annual increase to 75 percent from 58 percent domestic content in assembly and 60 percent in parts.

We track not only the direct manufacturing jobs created, but also those created due to intermediate demand (i.e. required inputs), as well as induced job creation (i.e. re-spending of income gained from additional direct and indirect jobs). We consider a scenario where domestic content increases to 75 percent in both the parts and assembly sectors, and report the impact of this increase on net job gains.

Table 8 (following page) presents the results of our higher domestic content scenario. The additional number of auto manufacturing jobs gained under the increased domestic content scenario is 3,300 by 2025 and 4,100 by 2030. These are the direct jobs created due to additional domestic production. This additional manufacturing activity spawns added economic activity due to increased demand for production inputs and also respending of additional income. Compared to the main policy case, the additional number of aggregate jobs gained under the increased domestic content scenario is 10,000 by 2025 and 13,000 by 2030. The direct impacts spawn larger economic development ripple effects. Unlike the results from the increased vehicle sales scenario, the increased domestic content scenario results show an increase in the number of auto manufacturing jobs created from 2025 to 2030. This occurs because the domestic content effect outweighs the productivity effect. In contrast, under the increased vehicle sales scenario, the additional vehicle spending is relatively flat from 2025 to 2030, which means that the labor productivity effect dominates.

5.4) FURTHER DISCUSSION

The economy is a very complex system, so any modeling exercise inherently ignores some of its elements. Here we discuss some of the relevant impacts of the proposed standards that we have not addressed in our analysis.

Table 7. Estimated Impact of Cost Plus Demand Effects with Increased Vehicle Sales

	2017	2020	2025	2030
Lower estimate	1,500	9,800	20,000	17,000
Upper estimate	1,600	10,000	22,000	19,000

Table 8. Employment Impacts of Increased Domestic Content.

	2017	2020	2025	2030
Auto manufacturing jobs (parts and assembly)	110	590	3,300	4,100
Aggregate jobs (includes auto manufacturing)	300	1,700	10,000	13,000

In Section 2 we covered the international context for the proposed standards. The reduction in the gap between U.S. standards and other major markets should be an advantage for the D-3 as major markets are increasingly demanding more fuel-efficient vehicles.

The proposed standards will reduce our dependence on the international market for crude oil. There are two separate potential benefits to this. The first is related to the possibility that the analysis underestimates the expected future price of oil, and the other potential benefit is related to price volatility.

Future oil price forecast. The AEO 2012 forecast that we and the federal agencies use to value fuel savings is predicated on relatively stable prices for oil and petroleum products going forward. The forecast predicts that gasoline will cost $3.88 and $4.04 per gallon by 2025 and 2030 respectively (2010 dollars). These arguably low prices reduce the value of the gas savings that the proposed standards will yield.

The EIA does recognize uncertainty about future prices, and it also forecasts alternative price scenarios. Using a high oil price scenario, their high price estimates for gasoline are $5.12 by 2025 and $5.26 by 2030. Under a low oil price scenario, they also forecast lower gasoline prices of $2.12 by 2025 and $2.24 by 2030. It is also worth noting the EIA's tendency in recent years to underestimate future prices. Their own reviews have concluded, "The crude oil price projections in the *AEOs* completed after 1997 tended to be underestimated" (EIA 2010).

Another wrinkle related to the future price of oil concerns the downward pressure on fuel prices that the proposed standards would create by reducing U.S. demand for oil. This is also not captured in this analysis. As a major oil importer, the United States has historically had monopsony power in the global petroleum market. In economics, when a single purchaser of a product can affect the price of that product, it is said that the purchaser can exercise "monopsony power."

Following a methodology developed by Oak Ridge National Laboratory, the EPA calculated the lower spending on oil that the nation would experience due to this effect (technically referred to as the monopsony premium). These calculations suggest that the price effect will be approximately $11.12 (2009 dollars) less in overall oil expenditures per each barrel of reduced oil consumption. So due to the price effect, for each barrel by which the U.S. reduces oil consumption, the country will save an additional $11.12 in oil expenditures compared to the amount it would have spent otherwise. To be clear, this does not imply that the price of a barrel of oil falls by that amount. It is the overall change in oil expenditure reflecting a very small reduction in the price of a barrel of oil. The EPA also estimated this premium as $11.26 by 2025 and $10.91 by 2030 (2009 dollars) (EPA, DOT 2011).

Oil price volatility. The smooth price path implied by the EIA's modeling approach and results implies another limitation of this work and other work relying on AEO forecasts. The empirical reality of large fluctuations in prices of petroleum and petroleum products is not recognized, and it is not captured in this analysis. Transportation fuel price spikes periodically cause significant public stir, by all accounts delivering significant economic harm. The intensity of the consumer disutility when fuel prices spike may be related to a feeling of helplessness, of being locked in an economic and technological pattern that offers no alternative as prices rise. The proposed standards will offer the added benefit of reducing the economic cost of price spikes.

There is debate over whether oil price spikes alone trigger recessions, but some analysts have found a role for oil price spikes in the onset of economic recessions in the United States. Economic recessions also typically lead to decreases in vehicle sales as large durable good purchases are often delayed in times of economic uncertainty. At a micro level, higher gasoline prices leave less disposable income for vehicle-based commuters. The proposed standards could improve the robustness of the future economy and help avoid the decline in demand for light-duty vehicles that has occurred previously when recessions hit. Figure 3 (following page) is a graph illustrating these dynamics.

As Figure 3 shows, spikes in U.S. oil expenditures as a percentage of GDP tend to coincide with recessions. Furthermore, increased oil expenditures also seem to be associated with decreases in car sales. By improving light-duty vehicle fuel economy, the proposed standards may decrease the incidence of recession and help to maintain steadier vehicle sales.

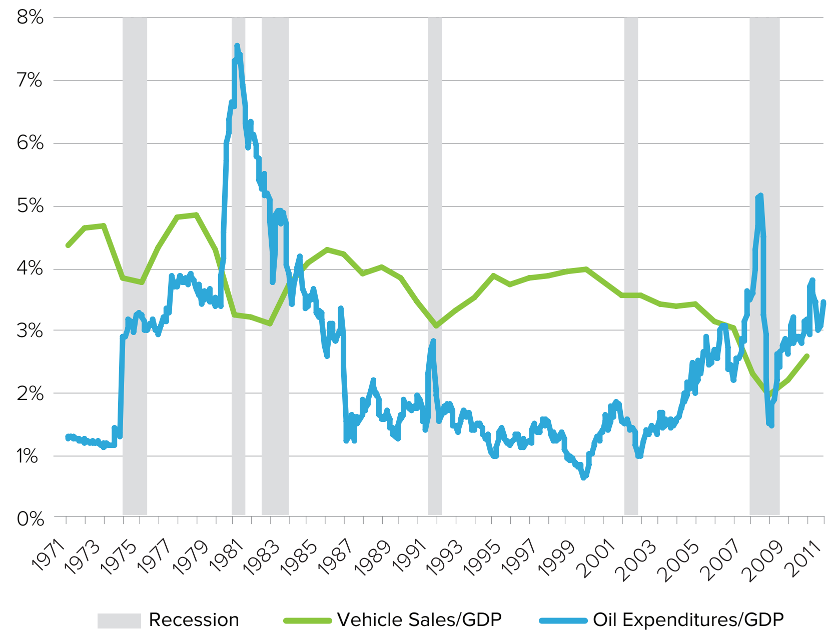
A microeconomic assessment by Sexton, Wu, and Zilberman (2011) explores the impact that the rapid increase in gas prices had in the most recent economic recession, and it finds that rising prices played an important causal role. They find evidence to suggest that "unanticipated increases in gas prices increased the cost of work commutes, lowering the value of homes away from the city center and increasing foreclosure rates as homeowners either could not afford mortgage payments amid elevated gas expenditures or sought to abandon underwater homes" (p. 1).

So, we have reviewed evidence that increasing gas prices play a role in the onset of economic recessions. Next, we develop a bit further the link between the state of the economy, consumer confidence, and the fate of the vehicle market. Figure 4 presents data on consumer confidence and new car sales from January 1980 to March 2012.

There is a significant correlation between consumer confidence and vehicle sales. This suggests that if the proposed standards help strengthen the economy and insulate it from energy price spikes — and that in turn helps consumer confidence — then proposed standards could bolster new vehicle sales (and reduce cyclical fluctuations in the vehicle market as well).

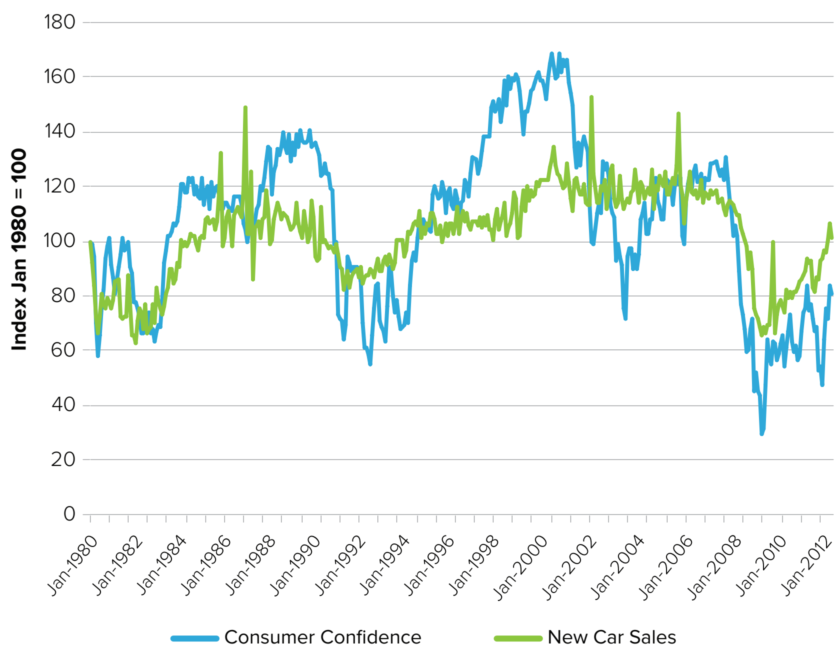
Ancillary environmental and energy security benefits. We have spent considerable time analyzing broad economic benefits and implications for auto manufacturing, but the proposed standards may have many other impacts not considered here. For example, an additional unconsidered advantage of the proposed standards includes the benefit that they offer to national security by reducing U.S. consumption of foreign oil. Most would agree that a share of U.S. military expenditures can be attributed to the need to avoid disruptions in global oil markets, and the proposed standards may help reduce the need for that spending. The value of environmental benefits is also not directly included in our analysis. We have not factored in reduced damage from climate change or other clean air benefits. In some parts of the country — the West Coast for example — transportation emissions are the main source of air pollution. The proposed standards will result in fewer greenhouse gas emissions, which will also reduce related public health threats such as heat waves, floods, and local air pollution.

FIGURE 3. Oil Price Spikes, the Incidence of Economic Recessions, and Falling Vehicles Sales.



Source: Energy Information Agency (EIA), the National Bureau of Economic Research (NBER), the Federal Reserve Bank of St. Louis (FRED), and the Bureau of Economic Analysis (BEA).[25]

FIGURE 4. The Link Between Consumer Confidence and Vehicle Sales.



Source: Bureau of Economic Analysis (BEA), The Conference Board.[26]

6. CONCLUSION

Following a detailed analysis of the proposed light-duty fuel economy standards for 2017-2025, we model the macroeconomic ripple effects of the expected changes in the costs of new vehicles and the resulting fuel savings. The analysis finds that the proposed standards will both save money for consumers and produce meaningful employment gains — 570,00 jobs across the economy as a whole including approximately 50,000 auto manufacturing jobs. These results are entirely consistent with other relevant research.

If a broader range of impacts was considered, we expect that the economic benefits offered by the standards would grow. We do not consider a host of other positive economic impacts likely to result from the rule: the reduced exposure to higher and more volatile world oil prices; the improved financial position of the Detroit 3 as U.S. automakers close the gap in a worldwide market that is demanding ever cleaner and more fuel-efficient vehicles; and the improved public health and avoided climate change damages resulting from lower fuel consumption.

From a technology perspective, the proposed standards are completely flexible. They do not pick technologies but instead encourage innovation. They only require a steady rate of energy performance improvement. Should innovation occur faster than expected, the cost of compliance will be reduced and the net benefits should be even higher.

Looking at U.S. job growth between 1990 and 2008, Nobel Prize winner Michael Spence (2011) found almost no job growth in sectors — such as automobile manufacturing — that are subject to international competition. We have documented the surge in vehicle manufacturing employment in recent years, but what could bring about a longer term trend like that illustrated in our alternative domestic content scenario in which U.S.-based producers account for an increasing share of the value of a new vehicle? Smart policy is crucial. As a starting point, there is an immediate need for the Department of Energy to process and disperse the funding already allocated to the Advanced Technology Vehicle Manufacturing Program to support the large investments needed. Policies that support greater industrial energy efficiency will also assist international competitiveness, by lowering long run energy costs and reducing vulnerability to energy fuel spikes. In the preface to the report, David Foster describes a larger policy vision for capturing more of the manufacturing jobs associated with the transition to cleaner energy.

LIST OF REFERENCES

Baum, A. and Luria, D. (2010). "Driving growth: How clean cars and climate policy can create jobs." The Planning Edge and Michigan Manufacturing Technology Center. Report prepared for the Natural Resources Defense Council, United Auto Workers, and Center for American Progress.

Bezdek, R. H. and Hannon, B. (1974). "Energy, manpower, and the highway trust fund." *Science*, 185, 669-675.

Bezdek, R. H. and Wendling, R. M. (2005a). "Fuel efficiency and the economy." *American Scientist*, 93, 132-139.

Bezdek, R. H. and Wendling, R. M. (2005b). "Potential long-term impacts of changes in US vehicle fuel efficiency standards." *Energy Policy*, 33: 407-419.

Ceres. (2011). *More jobs per gallon: How strong fuel economy/GHG standards will fuel American jobs*. Washington, D.C.: Management Information Services, Inc.

Citi Investment Research (2012). "U.S. autos & auto parts – Fuel economy focus: Industry perspectives on 2010."

Conference Board. *Consumer Confidence Survey 1980-2012*. <http://www.conference-board.org/data/consumerconfidence.cfm>.

Daw, C. S., R. L. Graves, R. M. Wagner, and Canton, J. A.. (2010). "Report on the Transportation Combustion Engine Efficiency Colloquium Held at USCAR, March 3–4. 2010." Oak Ridge National Laboratory.

Estevão, M. M. and Lach, S. (1999a). "Measuring temporary labor outsourcing in U.S. manufacturing (NBER Working Paper 7421)." National Bureau of Economic Research.

Estevão, M. M. and Lach, S. (1999b). "The evolution of the demand for temporary help supply employment in the United States (NBER Working Paper 7427)." National Bureau of Economic Research.

Ettlinger, M. and Gordon, K. (2011). "The importance and promise of American manufacturing: Why it matters if we make it in America and where we stand today." Center for American Progress.

Energy Information Agency. (2001). *Household Vehicle Energy Use: Latest and Trends*. <http://www.eia.gov>. (See table A1, U.S. number of vehicles, motor fuel consumption and expenditures).

Energy Information Administration). (2010). "Annual Energy Outlook Retrospective Review: Evaluation of Reference Case Projections in Past Editions (1982-2009): Report No: 0640."

Environmental Protection Agency. (2010). "Final rulemaking to establish light-duty vehicle greenhouse gas emission standards and corporate average fuel economy standards: regulatory impact analysis." (Docket: EPA-420-R-10-009). Washington, D.C.

Environmental Protection Agency, Department of Transportation. (2011). "Draft joint technical support document: proposed rulemaking for 2017-2025 light-duty vehicle greenhouse gas emission standards and corporate average fuel economy standards." (Docket: EPA-420-D-11-901). Washington, DC.

Environmental Protection Agency and Department of Transportation. (2011). "Executive Order 12866 Review: 2017 and later model year light-duty vehicle greenhouse gas emissions and corporate average fuel economy standards." (Docket: EPA-HQ-OAR-2010-0799; FRL-9618-5; DOT-2010-0131). RIN 2060-AQ54; RIN 2127-AK79. Washington, D.C.

Environmental Protection Agency and Department of Transportation. (2012). "Draft regulatory impact analysis: proposed rulemaking for 2017-2025 light-duty vehicle greenhouse gas emission standards and corporate average fuel economy standards." (Docket: EPA-420-D-11-004). Washington, DC.

LIST OF REFERENCES (continued)

Geller, H., DeCicco, J., and Laitner, S. (1992). *Energy efficiency and job creation*. Washington, D.C.: American Council for an Energy–Efficient Economy.

Goldberg, M., Kushler M., Nadel, S., Laitner, S., Elliott, N., and Thomas, M. (1998). *Energy efficiency and economic development in Illlinois*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Greene, David L. (2010). "How Consumers Value Fuel Economy: A Literature Review, Oak Ridge National Laboratory." (EPA Contract No. DE-AC05-00OR22725)

Hanson, D. and Laitner. J. (2009). "Input-Output Equations Embedded within Climate and Energy Policy Analysis Models." *Input-Output Economics for Industrial Ecology*. Dordrecht, Netherlands: Springer.

Helper, S., Krueger, T., and Wail, H. (2012) *Why does manufacturing matter? Which manufacturing matters? A policy framework.* Washington, D.C.: The Brookings Institution.

Hanson, D. & Laitner, J. (2005). "Tripling the nation's clean energy technologies: a case study in evaluating the performance of energy policy models." ACEEE Summer Study on Energy Efficiency in Industry. Washington, D.C..

The International Council on Clean Transportation. (2010). *U.S. Light-Duty Vehicle GHG and CAFE Standards: Final Rule Summary.*

The International Council on Clean Transportation. (2012). *Global comparison of light-duty vehicle fuel economy/GHG emissions standards.* (March).

Markradis, S., and Hibon, M. (2000). "The M3-competitions: results, conclusions, and implications." *The International Journal of Forecasting*, 16, 451-476.

Markradis, S., Chatfield, C., Hibon, M., Lawrence, M., Mills, T., Ord, K., and Simmons L. F. (1993). "The M2-competition: a real-time judgmentally based forecasting study." *Journal of Forecasting*, 1, 111-153.

Meyerson, H. (2011, December). "Back from China?" *The American Prospect*, 4-13.

MIG, Inc., IMPLAN System [Software and Data]. 1725 Tower Drive West, Suite 140, Stillwater, MN 55082. Available from www.implan.com

Miller, R. and Blair, P. (2009). *Input-Output Analysis: Foundations and Extensions (2nd ed.)*. Cambridge UK: Cambridge University Press.

National Association of Convenience Stores. (2012). *The Future of Fuels: An Analysis of Future Energy Trends and Retail Market Opportunities.* Alexandria, VA. (March)

ORNL (Oak Ridge National Laboratory). (2011). *Transportation Energy Data Book, Edition 30*

RTI International and Transportation Research Institute University of Michigan. (2009). "Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers." EPA Docket: EPA-420-R-09-003.

Sexton Steve, JunJie Wu,and David Zilberman (2011), "How High Gas Prices Triggered the Housing Crisis: Theory and Empirical Evidence." Working Paper (November 13) <http://ecnr.berkeley.edu/vfs/PPs/Sexton-Ste/web/housing_gas.pdf>.

Sirkin, H. L., Zinser, M., and Hohner, D. (2011). *Made in America, again: Why manufacturing will return to the U.S.* The Boston Consulting Group.

Spence, M. (2011). "The Impact of Globalization on Income and Employment." *Foreign Affairs*, 90(4), 28-41.

Swezey, D. and McConaghy, R. (2011). *Manufacturing growth: Advanced manufacturing and the future of the American economy.* Third Way and The Breakthrough Institute.

Union of Concerned Scientists. (2007). *Creating jobs, saving energy, and protecting the environment: An analysis of the potential benefits of investing in efficient cars and trucks.* Cambridge, MA.

Vyas, A., Santini, D., and Cuenca, R. (2000). *Comparison of Indirect Cost Multipliers for Vehicle Manufacturing: Technical Memorandum in Support of Electric and Hybrid Vehicle Cost Estimation Studies.* Argonne, Illinois: Argonne National Laboratory.

APPENDIX. ADDITIONAL TECHNICAL DESCRIPTION OF THE DEEPER MODEL

DEEPER uses a Leontief production function based on the 2010 economic accounts for the United States. The policy scenario outcomes are driven by changes in physical intensities such reduced gasoline consumption. These and other implications of the different policy scenarios are translated into changes in spending and investment. The model also factors in an exogenous trend reflecting improvements in labor productivity over time. Once the mix of positive and negative changes in spending and investments has been established, the net spending changes in each year of the model is converted into sector-specific changes in final demand. This then drives the input-output relationships according to the following predictive model:

$X = (I-A)^{-1} * Y$

where:

X = total industry output by sector

I = an identity matrix consisting of a series of 0's and 1's in a row and column format for each sector (with the 1's organized along the diagonal of the matrix)

A = the matrix of production coefficients for each row and column within the matrix (in effect, how each column buys products from other sectors and how each row sells products to all other sectors)

Y = final demand, which is a column of net changes in spending by each sector as that spending pattern is affected by the policy case assumptions (changes in energy prices, energy consumption, investments, etc.)

This set of relationships can also be interpreted as

$\Delta X = (I-A)^{-1} * \Delta Y$

which reads, a change in total sector output equals the expression $(I-A)^{-1}$ times a change in final demand for each sector.[27] Employment quantities are adjusted annually according to exogenous assumptions about labor productivity in each of the sectors within the DEEPER Modeling System (based on Bureau of Labor Statistics forecasts; see BLS 2012). From a more operational standpoint, the macroeconomic module of the DEEPER Model traces how each set of changes in spending will work or ripple its way through the U.S. economy in each year of the assessment period. The end result is a net change in jobs, income, and GDP (or value-added) for each year of the analytical time horizon (i.e., 2010 to 2030 for the transportation scenario evaluated in this assessment). The model then reports changes in employment, labor income, and valued-added contributions to GDP.

For a review of how an I/O framework might be integrated into other kinds of modeling activities, see Hanson and Laitner (2009). While the DEEPER Model is not an equilibrium model — as explained previously in this appendix — we borrow some key concepts of mapping technology representation for DEEPER, and use the general scheme outlined in Hanson and Laitner (2009). Among other things, this includes an economic accounting to ensure resources are sufficiently available to meet the expected consumer and other final demands reflected in different policy scenarios.

ENDNOTES

1 All jobs numbers are provided by the Bureau of Labor Statistics unless otherwise noted.

2 The Brookings Institution report *Why Does Manufacturing Matter? Which Manufacturing Matters? (*Helper, S., Krueger, T., and Wail, H; 2012) sums up the trends this way: "Recent case studies show that reasons for 're-shoring' work include rising oil prices, longer shipping times, rising wages in coastal Chinese cities, intellectual property leakage, the desire to create innovation hubs, and a fuller appreciation, based on years of experience of the downside of offshoring. American firms are now more likely to appreciate the 'hidden costs' of production abroad, such as administrative costs, legal costs, risks and complexities," p.13. For more discussion, see these articles under the list of references: Sirkin, H., Zinser, L., and Hohner, D. (2011), Ettlinger, M. and Gordon, K. (2011), Meyerson, H. (2011), and Swezey, D. and McConaghy, R. (2011).

3 "It had to start almost from scratch. In 2009, the U.S. made less than 2 percent of the world's lithium-ion batteries. By 2015, the Department of Energy projects that, thanks mostly to the government's recent largess, the United States will have the capacity to produce 40 percent of them." (Gertner, J. August 24, 2011. "Does America need manufacturing?" *The New York Times*.) "From a negligible portion of the world's advanced battery manufacturing today, U.S. production capacity for advanced vehicle batteries will amount to more than 20 percent of global production capacity estimated to be online in 2012." (White House. 2010. *The Recovery Act: transforming the American economy through innovation*. Washington, D.C. Retrieved from <http://www.whitehouse.gov/sites/default/files/uploads/Recovery_Act_Innovation.pdf>)

4 For more information, see The International Council on Clean Transportation (ICCT). 2010. "U.S. Light-Duty Vehicle GHG and CAFE Standards: Final Rule Summary."

5 Data on fuel economy were normalized to the Corporate Average Fuel Economy test cycle developed in the United States, and a standardized score was assigned to each country to allow for cross-country ranking and comparisons. Greenhouse gas emission standards translated to mpg equivalent.

6 Input-output models use economic data to study the relationships among producers, suppliers, and consumers. They are often used to show how interactions among all three sets of economic actors will impact the macroeconomy.

7 General equilibrium models operate on the assumption that a set of prices exists for an economy to ensure that supply and demand are in an overall equilibrium.

8 When both equilibrium and dynamic input-output models use the same technology assumptions, both models should generate a reasonably comparable set of outcomes. See Hanson and Laitner (2005).

9 Further details on this set of linkages can be found in Hanson and Laitner (2009).

10 This is the total demand for final goods and services in the economy at a given time and price level.

11 For a more complete discussion of these concepts, see Miller and Blair (2009).

12 There is remarkably little ex-poste assessment of the accuracy of forecasting, but some excellent work has been done on this topic by Markradis and Hibon (1993) and Markradis et al. (2000), who find that statistically sophisticated or complex methods do not necessarily provide more accurate forecasts than simpler ones.

13 A social accounting matrix is a data framework for an economy that represents how different institutions — households, industries, businesses, and governments — trade goods and services with one another.

14 See <http://implan.com/V4/Index.php>. The entire IMPLAN database for the U.S. economy can be expanded to more than 400 sectors as needed.

15 The early release version was the only option available to us.

16 For more information about vehicle cost, see page 5-8 of the draft Regulatory Impact Analysis, Table 5.1-9 Industry Average Vehicle Costs Associated with the Proposed Standards. For more information about reductions in fuel consumption over time (i.e. fuel savings), see page 5-11, Table 5.4-1 Fuel Consumption Impacts of the Proposed Standards and A/C Credit Programs.

17 Data from Research and Innovative Technology Administration (RITA), Bureau of Transportation Statistics (BTS). (2011). Table 1-18: Retail sales of new cars by sector, National Transportation Statistics 2011. Retrieved from <http://www.btw.gov>.

18 Data from Automotive Fleet. 2010-MY registrations: U.S. new car & truck fleet registrations, Research and Best Practices. Retrieved from www.automotive-fleet.com.

19 Data available at <http://www.census.gov/manufacturing/asm/index.html>

20 Data from tables III-82 and III-86 in the preamble document, by which we mean the document that was submitted to the Office of Management and Budget (EPA, DOT 2010).

21 The calculation would be 1/(1.015)(2030-2010) * 100% equals 74.2 percent.

22 These findings were published by Estevão and Lach (1999a), who find that in the late 1990s manufacturing firms employed approximately 890,000 uncounted temporary workers, which adds to the reported 18.5 million manufacturing workers at the end of the 1990s. When Estevão and Lach (1999b) recalculated the productivity numbers and included these uncounted workers, they found that the official manufacturing productivity growth figures were overstated by about half of a percentage point per year. In other words, including all of the workers lowered average manufacturing productivity growth in the 1990s from 4 percent to about 3.5 percent per year. While this is a valid technical point, we also note that this difference is not exceptionally large. Consider the following thought experiment: Assume 100 jobs without temporary workers, and then assume 110 jobs with temps. If we apply 3.5 percent productivity rate to job numbers without temporary workers and a four percent with, and evaluate over a 20-year time horizon, then we get a net gain of 50.3 jobs if we do not include the temporary workers. The gain with temporary workers included would be 50.2 jobs.

23 The Natural Resource Defense Council (NRDC) has also analyzed the net savings, and estimates $68 billion saved in 2009 dollars. This number is larger because their analysis also incorporates a "monopsony premium." This is discussed further in Section 5.4, but in sum the NRDC work anticipates that fuel prices will be somewhat lowered by reduced oil consumption in the United State. After accounting for the different approach to fuel prices and inflation, the NRDC net savings correspond to those in Table 2. <http://www.nrdc.org/energy/files/relieving-pain-at-the-pump.pdf>

24 Though the five percent scenario appears closer in terms of stringency, ex-poste changes to cost assessments mean that their four percent is the closest to ours.

25 Data was obtained from the Energy Information Agency (EIA), the National Bureau of Economic Research (NBER), the Federal Reserve Bank of St. Louis (FRED), and the Bureau of Economic Analysis (BEA). Approximate consumption of crude oil is calculated as the sum of total U.S. field production of crude oil and crude oil imports, with data obtained from the EIA. Crude oil expenditures are calculated by multiplying oil consumption by the spot oil price of West Texas Intermediate, obtained from the FRED. Data on GDP was also obtained from the FRED. Finally, data on vehicle sales was obtained from the BEA, and data on U.S. business cycles was obtained from NBER.

26 Data on vehicle sales was taken from the BEA, and data on consumer confidence was taken from The Conference Board's Consumer Confidence Index.

27 Perhaps one way to understand the notation (I-A)-1 is to think of this as the positive or negative impact multiplier depending on whether the change in spending is positive or negative for a given sector within a given year.

BLUEGREEN
ALLIANCE