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The Impact of Attribute-Based Corporate Average Fuel Economy (CAFE) Standards: Preliminary Findings

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16. Abstract

This report is the first rigorous analysis of the economic impacts of current legislative proposals to raise CAFE under the reformed "attribute-based" structure. Whereas historic CAFE standards set one standard for every automaker, the reformed system fundamentally alters the impact of the standards on individual companies. Under the reformed CAFE structure, which applies to light trucks starting next year and is the leading proposal under discussion in Congress, each vehicle is assigned a fuel economy target based on vehicle attributes. Light truck targets are a function of the truck's "footprint" – that is, the area defined by the truck's wheels. Each automaker's truck CAFE target will be a sales-weighted average of the targets for its truck models – automakers that market larger vehicles will face a less stringent standard.

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Summary

This report is the first rigorous analysis of the economic impacts of current legislative proposals to raise CAFE under a reformed "attribute-based" structure. Whereas historically CAFE set one standard for all automakers, the reformed system fundamentally alters the impact of CAFE on individual companies by setting standards based on a vehicle attribute, such as size.

Companies that market larger vehicles (e.g., the Big 3) will face a less stringent standard under a reformed CAFE design. For example, Markey-Platts sets an overall CAFE target of 35 miles per gallon in 2018, but we estimate the Detroit automakers would have to achieve only 33 miles per gallon while their competitors would need to achieve 38 miles per gallon (see Table ES-1).

Table ES-1

Alternative CAFE Standards by Automaker (Miles per gallon)				
	Base	Markey-Platts	H.R. 6	Hill-Terry
	2005	2018	2020	2022
Chrysler	22.0	33.3	33.3	30.9
Ford	22.1	32.9	32.9	30.7
GM	22.1	33.4	33.4	31.1
Honda	28.2	39.2	39.2	34.3
Nissan	24.0	36.5	36.5	32.6
Toyota	26.5	37.5	37.5	33.3
Others	27.4	39.3	39.3	34.3
U.S. Market	**23.7**	**35.0**	**35.0**	**32.0**
Memo:				
Big 3	22.1	33.2	33.2	30.9
Non-Big 3	26.7	38.2	38.2	33.7

A reformed CAFE could yield dramatically different impacts for the competitive position of individual automakers than the current system. Our preliminary findings suggest several key conclusions regarding attribute-based CAFE increases currently under consideration:

- Increasing CAFE is cost-effective. Higher standards will require automakers to install more expensive equipment on vehicles; however, higher initial costs will be more than offset by fuel savings. For example, the cumulative cost of raising fuel economy

to 35 mpg by 2018 is $0.55 per gallon saved—about one-sixth of today's fuel price.

- Increasing CAFE can boost automakers' profits. Higher CAFE standards can increase vehicle profits since vehicle prices will need to rise to pay for added fuel-saving technologies, and profits per vehicle will also rise (assuming ordinary profit margins). This is partially offset by slower growth in total vehicle sales caused by the higher prices. The net result in our analysis is automakers' cumulative profits over the next decade increase by $9 - $23 billion.

- Detroit's automakers stand to receive most of the profit gains from higher CAFE. The value of an incremental one-mile-per-gallon improvement is higher for vehicles with lower initial fuel economy because more fuel will be saved over the life of the vehicle. In addition, profit margins are higher for higher priced vehicles. With product portfolios that are more concentrated in vehicle segments with lower fuel economy and higher prices (SUVs and pickups), Detroit automakers will be making improvements that have higher market value and higher profit margins. Their profits will be correspondingly higher (see Table ES-2).

Table ES-2

Change in Automakers' Cumulative Profits 2008-2017 by Scenario
($Billions)

	Markey-Platts	H.R. 6	Hill-Terry
Chrysler	$3.2	$2.7	$1.4
Ford	$4.7	$3.9	$2.0
GM	$6.6	$5.5	$2.9
Honda	$1.5	$1.3	$0.4
Nissan	$1.6	$1.3	$0.6
Toyota	$2.6	$2.2	$0.8
Others	$2.4	$2.1	$0.7
U.S. Market	**$22.5**	**$18.9**	**$8.7**
Memo:			
Detroit 3	$14.4	$12.0	$6.3
Non-Detroit 3	$8.1	$6.8	$2.4

Introduction

This report is the first rigorous analysis of the economic impacts of current legislative proposals to raise CAFE under the reformed "attribute-based" structure. Whereas historic CAFE standards set one standard for every automaker, the reformed system fundamentally alters the impact of the standards on individual companies. Under the reformed CAFE structure, which applies to light trucks starting next year and is the leading proposal under discussion in Congress, each vehicle is assigned a fuel economy target based on vehicle attributes. Light truck targets are a function of the truck's "footprint" – that is, the area defined by the truck's wheels. Each automaker's truck CAFE target will be a sales-weighted average of the targets for its truck models—automakers that market larger vehicles will face a less stringent standard.

To compare the impacts of the main Congressional CAFE proposals we estimated the CAFE target for each vehicle by using a hypothetical function that we applied consistently across ALL vehicles, both cars and light trucks. Our results clearly show that the proposals create a DIFFERENT type of CAFE than in the past. Many in Washington are discussing the old form of CAFE, and are not directly dealing with the new reformed, attribute-based CAFE that legislative proposals would actually create. There are big differences.

The most important difference is that the Detroit automakers will not have to meet the same standard as their foreign-owned competitors. Because their vehicles are larger, the Detroit automakers will face lower CAFE targets. For example, Markey-Platts sets an overall CAFE target of 35 miles per gallon in 2018, but the Detroit automakers would have to achieve only 33 miles per gallon in our analysis while their competitors would need to achieve 38 miles per gallon.

The new attribute-based CAFE is not one size fits all. It takes into account the differences between vehicles and light trucks, which will have lower targets than cars.

Most analyses of CAFE have emphasized the increases in vehicle costs or consumer prices created by new technologies to improve fuel economy. In contrast, our analysis looks at the profits the automakers will earn from these new technologies and finds that all automakers will have higher profits under the proposed CAFE enhancements. The Detroit automakers will need to invest in improved fuel economy, but by narrowing their competitive fuel economy disadvantage they will gain market share and reap more profits than their competitors.

Detroit automakers have not been losing profits and eliminating jobs because CAFE forced them to produce vehicles with better fuel economy--they have been losing profits and eliminating jobs because the rising fuel prices over the last several years revealed that their vehicles have worse fuel economy than consumers want. The enhancements to CAFE are motivated by widely shared bipartisan concerns over global warming and national security. Our research shows that addressing these concerns will also improve the competitive position of American automakers and workers.

This summary report presents highlights of the results of a broader study that will be published in more detail in September 2007. This report compares the CAFE provisions of three current alternatives assuming that whatever is ultimately enacted would be implemented through an attribute-based CAFE system.

The report is organized as follows. The CAFE elements of the proposals are listed using their common names. Then each automaker's unique fuel economy target under the alternatives are compared. This is followed by an examination of the implications of the attribute-based CAFE system on the fuel economy of aggregate vehicle segments. Then we summarize the impacts on automaker profits and on billions of gallons of fuel saved by vehicles sold from 2008 through 2017. We then review the implications of the attribute-based system on the fuel economy needed by automaker and segment to meet a market-level CAFE target of 35 miles per gallon. The sales-weighted average targets for an automaker's vehicles define the automaker's CAFE target, but the automaker is allowed to manage the fuel economy improvements as it sees fit. This means that the actual fuel economy for any vehicle need not equal its individual target, so long as the automaker attains its overall target. Automakers can use this to increase their profits.

CAFE Scenarios

For this report we examined three scenarios that represent the alternatives being considered by the Congress. We are simulating only the CAFE elements of each alternative, which we assume are binding on all automakers. This means that we also assume neither "exit ramps" nor much regulatory discretion to be exercised by the Secretary of Transportation. The scenarios are:

1. **Markey-Platts** is the most aggressive of the proposals. This House proposal calls for a market-level average fuel economy of 35 miles per gallon by 2018. From 2018 through 2025 it calls for annual improvements of 4% at the market level, making the 2025 average fuel economy 46.1 miles per gallon.
2. **H.R. 6** is also called the CLEAN Energy Act of 2007 that was passed by the Senate on 6/21/07. It also calls for a market-level average fuel economy of 35 miles per gallon, but not until 2020. After 2020 it sets no mandatory increases so we assume the target remains at 35 miles per gallon.
3. **Hill-Terry** is the weakest of the proposals. It sets a market-level average fuel economy target of 32 miles per gallon in 2022 with an upper limit of 35 miles per gallon. We assumed that no further improvements would be required after 2022.

In running the simulations and in predicting the impact of raising CAFE standards we modeled all three proposals as if they established binding numerical targets for fuel economy measured at the total U.S. market level. This means that we are comparing each proposal's best-case outcome for improvements in fuel economy with each other. If Hill-Terry were more likely to permit not meeting its target that the other proposals, for example because it extends CAFE credits for flexible-fuel vehicles that could run on E85 but seldom do, then comparing best cases would understate the difference between Hill-Terry and the others.

Analytical Framework

Our findings are based on a hypothetical reformed CAFE program that we developed for this report and an economic simulation model of the U.S. light vehicle market. The hypothetical CAFE program uses the same type of function that will be used to set light truck CAFE targets beginning in 2008 as described in NHTSA (2006). We assume that future CAFE regulations will be defined for all light vehicles, rather that separately for cars and trucks. A single size-based function was applied to all vehicles to set each automaker's CAFE standard for the simulations.

The assessment of each CAFE proposal was carried out through the following steps:

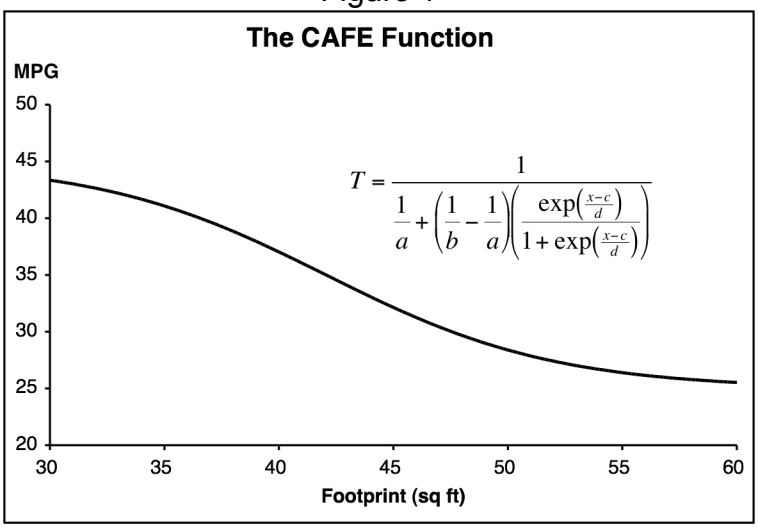
1. Define a hypothetical CAFE function to set fuel economy targets for individual vehicles. The function needs to set vehicle targets so that the average (weighted by sales) equals the market level CAFE standard.
2. Defined the CAFE standard for each automaker as the average target (weighted by sales) of its vehicle's.
3. Estimate the impact of the CAFE standards on vehicle sales, prices, fuel economy, and profits with a market simulation model.
4. Using the results of the market simulation along with some important simplifying assumptions; estimate the path that fuel economy, sales, prices, and profits will follow for the next decade.

The Hypothetical CAFE Function

CAFE is introduced into the market simulation using a mathematical function that defines a fuel economy target for each vehicle based on its footprint. These targets are then used to define the CAFE standards for automakers. The function is described in the final rule for 2008-2011 model year light trucks NHTSA (2006).

The fuel economy target, T, for a specific vehicle with a fuel economy of x and a footprint of c is defined by the mathematical function plotted in figure 1.

Figure 1



The parameters of the function are: the highest targeted mpg (a), the lowest targeted mpg (b), the footprint (c) that is midway between the footprints that correspond to the highest and lowest mpg targets, and the curvature (d).

The overall CAFE standard that is binding on an automaker is the sales-weighted average mpg target that the function sets for its vehicles. We used this functional form for the hypothetical CAFE function and applied it to both cars and trucks in the market simulation. The automakers do not need to meet all the individual vehicle targets, just their overall CAFE standard.

	Market CAFE Standard	
	35.0 mpg	**32.0 mpg**
Highest target	49.00	45.25
Lowest target	24.25	25.55
Mid-point footprint	49.00	45.00
Curvature	5.00	6.00

We established the hypothetical CAFE function for each market level CAFE standard through an iterative process that ensured that the base sales weighted fuel economy target is equal to the market level CAFE standard. We started by making initial guesses for the four parameters, calculated the fuel economy targets for the base vehicles, and the computed the sales weighted average of these initial targets. If the initial sales weighted target was not equal to the market level CAFE standard then we revised the parameters and computed the sales weighted average fuel economy target again. We continued the iterations until the difference between the sales weighted average target and the market level CAFE standard was less than 0.05 miles per gallon. The parameter values that resulted from this process are shown in the table above. (There are three CAFE alternatives but both Markey-Platts and H.R. 6 mandate 35 miles per gallon, though Market-Platts makes the industry achieve it two years earlier.)

The Market Simulation

To estimate the impact on the vehicle market of an attribute based CAFE standard, we use a market simulation model. The simulation starts with the market in equilibrium prior to the change in the CAFE standards. This means that for each vehicle, given its price and fuel economy, supply equals demand. The introduction of the higher CAFE standards leads to a new equilibrium that is reached in the simulation through two steps. In the first step, automakers choose how much to change the fuel economy of their vehicles. In the second step, sales quantities and prices adjust to bring supply and demand back into equality.

The supply function for fuel economy improvements defines the minimum price the automaker needs to receive for the vehicle to cover the incremental costs of labor and materials as well as the normal profit margins for this type of technology. We base our supply functions on the fuel economy technologies / vehicle price curves that Greene et al. (2005) derived from NAS (2002).

We use a data driven discrete choice model to predict the changes in consumer demand in response to CAFE driven changes in fuel economy. The consumer demand model uses UMTRI-AAD's Consumer Choice Model (CCM). The CCM is a mixed multinomial logit (MML). The MML is a very flexible format that recognizes that not all consumers have the same preferences for vehicle characteristics. The parameters of the CCM were estimated with market data for 2002-2005.

Projections 2008-2017

To project the impacts of the CAFE changes for the years 2008-2017, we used the market simulation results to create a linear extrapolation from base conditions (applied to 2008) to predicted conditions in the year in which the increase in the CAFE is completed (2018 for Markey-Platts, 2020 for H.R. 6, and 2022 for Hill-Terry). The base projections assume no growth in vehicle sales and no change in vehicle mix. These assumptions let us isolate the CAFE impacts from trends in sales and mix.

Summary Tables

Alternative CAFE Standards by Automaker (Miles per gallon)				
	Base	Markey-Platts	H.R. 6	Hill-Terry
	2005	2018	2020	2022
Chrysler	22.0	33.3	33.3	30.9
Ford	22.1	32.9	32.9	30.7
GM	22.1	33.4	33.4	31.1
Honda	28.2	39.2	39.2	34.3
Nissan	24.0	36.5	36.5	32.6
Toyota	26.5	37.5	37.5	33.3
Others	27.4	39.3	39.3	34.3
U.S. Market	**23.7**	**35.0**	**35.0**	**32.0**
Memo:				
Big 3	22.1	33.2	33.2	30.9
Non-Big 3	26.7	38.2	38.2	33.7

New Equilibrium Average Fuel Economy by Segment Under Alternative CAFE Standards (Miles per gallon)				
	Base	Markey-Platts	H.R. 6	Hill-Terry
	2005	2018	2020	2022
CAR	28.9	41.6	41.6	37.6
CUV	25.7	37.2	37.2	33.7
MINIVAN	23.7	35.6	35.6	32.1
PU	19.2	29.7	29.7	27.5
SUV	19.8	29.4	29.4	27.0
VN	17.7	27.3	27.3	25.4
Market	23.7	35.0	35.0	32.0
TRUCK	21.0	31.5	31.5	28.9

New Equilibrium Market Shares Under Alternative CAFE Standards (Miles per gallon)				
	Base	Markey-Platts	H.R. 6	Hill-Terry
	2005	2018	2020	2022
Chrysler	13.5%	13.6%	13.6%	13.6%
Ford	20.0%	20.1%	20.1%	20.0%
GM	26.2%	26.4%	26.4%	26.3%
Honda	8.6%	8.5%	8.5%	8.5%
Nissan	6.4%	6.3%	6.3%	6.4%
Toyota	13.3%	13.2%	13.2%	13.2%
Others	12.0%	11.9%	11.9%	12.0%
U.S. Market	100.0%	100.0%	100.0%	100.0%
Memo:				
Big 3	59.7%	60.1%	60.1%	59.9%
Non-Big 3	40.3%	39.9%	39.9%	40.1%
Total Sales (Thousands)	16,912	16,487	16,487	16,596

Gallons of Fuel Saved 2008-2017 by Scenario and Automaker (billions)			
	Markey-Platts	H.R. 6	Hill-Terry
Chrysler	28.2	24.5	17.8
Ford	39.4	34.1	25.0
GM	53.9	46.8	34.1
Honda	11.2	9.7	5.0
Nissan	12.2	10.6	6.9
Toyota	19.4	16.7	9.6
Others	17.5	15.1	8.2
U.S. Market	**181.9**	**157.5**	**106.6**

Gallons of Fuel Saved 2008-2017 by Scenario and Automaker (billions)			
	Markey-Platts	H.R. 6	Hill-Terry
Chrysler	28.5	24.7	15.2
Ford	40.1	34.7	21.5
GM	54.6	47.3	29.2
Honda	12.0	10.4	4.6
Nissan	12.6	10.9	6.0
Toyota	20.6	17.8	8.7
Others	18.5	16.0	7.4
U.S. Market	186.9	161.8	92.5
Memo:			
$ Cost per Gallon saved	$0.55	$0.51	$0.42

Change in Automakers' Cumulative Revenue 2008-2017 by Scenario ($Billions)			
	Markey-Platts	H.R. 6	Hill-Terry
Chrysler	$17.5	$14.1	$7.3
Ford	$25.0	$20.2	$10.7
GM	$34.0	$27.4	$14.3
Honda	$9.9	$8.0	$2.9
Nissan	$8.8	$7.1	$3.2
Toyota	$16.2	$13.1	$5.3
Others	$14.7	$11.9	$4.4
U.S. Market	**$126.0**	**$101.9**	**$48.0**
Memo:			
Detroit 3	$76.4	$61.7	$32.3
Non-Detroit 3	$49.5	$40.2	$15.7

Change in Automakers' Cumulative Profits 2008-2017 by Scenario ($Billions)			
	Markey-Platts	H.R. 6	Hill-Terry
Chrysler	$3.2	$2.7	$1.4
Ford	$4.7	$3.9	$2.0
GM	$6.6	$5.5	$2.9
Honda	$1.5	$1.3	$0.4
Nissan	$1.6	$1.3	$0.6
Toyota	$2.6	$2.2	$0.8
Others	$2.4	$2.1	$0.7
U.S. Market	**$22.5**	**$18.9**	**$8.7**
Memo:			
Detroit 3	$14.4	$12.0	$6.3
Non-Detroit 3	$8.1	$6.8	$2.4

Cumulative Costs of Technologies 2008-2017 by Scenario ($Billions)			
	Markey-Platts	H.R. 6	Hill-Terry
Chrysler	$14.30	$11.40	$5.90
Ford	$20.30	$16.30	$8.70
GM	$27.40	$21.90	$11.40
Honda	$8.40	$6.70	$2.50
Nissan	$7.20	$5.80	$2.60
Toyota	$13.60	$10.90	$4.50
Others	$12.30	$9.80	$3.70
U.S. Market	**$103.50**	**$83.00**	**$39.30**
Memo:			
$ Cost per Gallon saved	$0.55	$0.51	$0.42
Memo:			
Detroit 3	$62.00	$49.70	$26.00
Non-Detroit 3	$41.40	$33.40	$13.30

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