CAFE Case Study

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Introduction:

The rising levels of pollutant emissions in Mexico are alarming. Road transportation is responsible for more than 19% (citation 1) of greenhouse gases emissions, which motivated different Mexican organizations and government agencies to study possible solutions that focus on the sector. One of the suggested answers is a fuel efficiency standard for the new automobiles with a complementary market where auto manufacturers can trade their efficiency surpluses and deficits. The suggestion seems rational and feasible but lacks the necessary literature to back it up. In an effort to build these needed theoretical foundations, CTS-Mexico is conducting an economic analysis of the proposal together with the Mexican National Institute of Ecology (INE). The part carried out by CTS-Mexico is financed by the Renewable Energy and Energy Efficiency Partnership (REEEP). Part of this study is contrasting the suggested solution to different alternatives such as the "Cap and Trade Markets" and the American "Corporate Average Fuel Economy" (CAFE) standards. This specific regulation will be the focus of the study at hands where its history, structure, results and limitations will be investigated.

The CAFE standard for a manufacturer is determined calculating the average fuel economy by firm using a harmonic function, as it is explained later, in this study and the result of that function is compared to the average standard set by the National Highway Traffic Safety Administration (NHTSA). NHTSA´s task of setting the CAFE standards was delegated by the Secretary of Transportation (Citation 3). Manufacturers with a CAFE below the determined level pay penalties depending on how far their average is from the standard. The exact formulas are discussed in subsequent sections. The CAFE system sets different standards for cars and light trucks and differentiates between domestic and imported vehicles as well as between vehicles running on traditional sources of energy, those using alternative sources and those that have dual systems (Citation3). These measures were designed to provide incentives for auto producers to improve the fuel efficiency of their vehicles.

However, the CAFE has been heavily criticized for various reasons. Under continuous questioning of its efficiency, many studies have been conducted to evaluate its outcomes. Yet, the separation of the effects of the CAFE and other factors revealed difficult but few studies succeeded in evaluating its results. Most of these came to the conclusion that the CAFE was not as efficient as expected. The most important criticism was that the transportation sector is still totally dependent on fossil fuel (Citation 2) and the fuel efficiency of private transportation increased by only 1.5 times while the amount of highway miles traveled increased by more than 2 times (Citation 43 & Citation 44). In addition, the regulation has been criticized for focusing on auto producers and providing no incentive for users to decrease their fuel consumption.

As part of CTS-Mexico's study, this paper will focus on analyzing the CAFE standards implementation and regulation in order to learn from their experience. The conclusions will aim to feed the design of the proposed fuel economy standard for Mexico and the associated market structure. The applicability, of the C.A.F.E conclusions, to the case of Mexico will be discussed in order to ground them into the national context.

History:

The evaluation of a policy cannot be accurate unless it takes into consideration the context in which that policy was implemented. The CAFE standards are no exception. The following section will discuss their history and how they came into being.

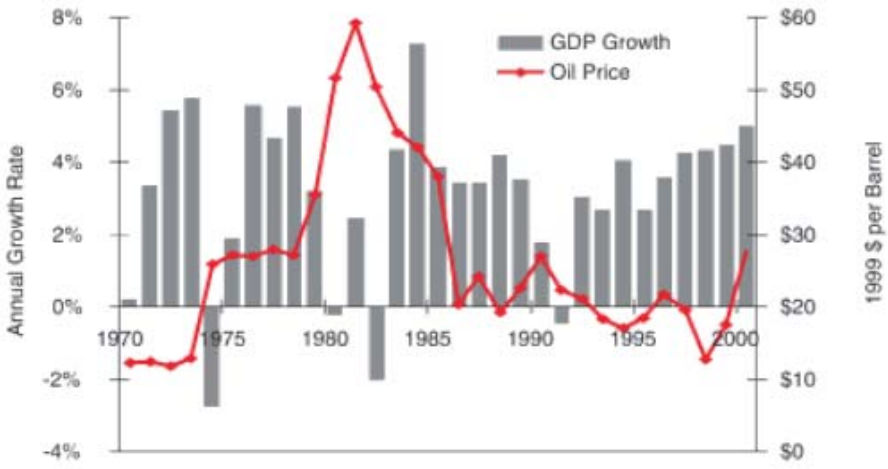
Transportation has always been a pillar of the U.S. economy. After World War II, the sector developed at exponential rates and during the 1960s, as part of that development, the American auto industry boomed contributing to the fast growth of the economy. However, this growth paid little attention to fuel efficiency since fuel was considered a cheap resource. Statistics show that between 1968 and 1974 the fuel economy fell from 14.8 Miles per gallon (mpg) to 12.9 mpg (citation 8). This situation turned against the U.S. in the early 1970s when the Organization of Petroleum Exporting Countries (OPEC) decided to raise fuel prices dramatically.

The crisis was given different names of which the Arab Oil Embargo and the 1970s energy crisis are the most famous. In 1973 specifically, the crisis resulted in tremendous increases in fuel prices in the U.S. which took its toll on the auto industry. As the industry made up for a large portion of the American gross domestic product, the economic growth of the U.S. economy fell sharply to reach -0.5% and -0.2% in 1974 and 1975 respectively, down from 5.3% and 5.8% in 1972 and 1973 respectively (Citation 5). In addition the Energy crisis pushed inflation rates to record high levels reaching 6.26%, 11.01% and 9.14% in 1973, 1974 and 1975 respectively (citation 6).

The resulting recession, the worse since the great depression, made the U.S. realize how dependent it was on foreign supplies of fossil fuel. Graph I-I illustrates this dependence by showing the historical negative correlation between the price of fossil fuel and the U.S. economic growth. As a response to correct this dependency, the fuel efficiency of vehicles was emphasized but it took two years for the Corporate Average Fuel Economy (CAFE) proposal to be signed into law by President Ford on December 22nd, 1975. The proposal was part of the Energy Policy and

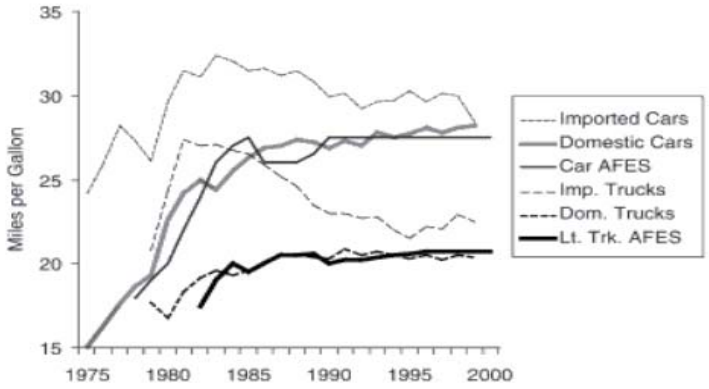
Conservation Act (citation 3) that added a new section to "*The Motor Vehicle Information and Cost Savings Act*" titled "*Improving Automotive Efficiency*". The new section detailed the fuel economy requirements for cars and light trucks while heavy duty trucks were exempted. It assigned management authority to the Secretary of Transportation who delegated it to the NHTSA on June 22nd, 1976. (Citation 7) or (citation 15).

Graph I-I: Oil Price Shocks and Economic Growth (Citation 2)



Although the CAFE was signed into law in December, 1975, it was not until 1978 that manufacturers were required to comply with its standards. The purpose of this gap was to give them enough time to adjust their processes to meet the CAFE requirements. The CAFE had preset standards for model years (MY) 1978, 1979, 1980 and 1985. The standards for the years between 1980 and 1985 were left for the NHTSA to set. The values were progressive between 1978 and 1985 and then fixed at 27.5 Miles per Gallon (mpg) for cars and 20.7 Miles per Gallon for light trucks starting 1985. However, in 1986 the requirements for cars were revised to lower levels but starting 1990 and until 2010 the CAFE standard was set at 27.5 mpg while for light trucks the requirements followed a different trend. They kept increasing until 1987 when they reached 20.5 mpg and were revised down in 1990 to 20 mpg and started increasing again to reach 20.7 mpg in 1996 where they stagnated until 2004. Then, in 2005 they started increasing again to reach 23.1 mpg in 2009. These fluctuations along with the trends of the actual levels of fuel economy are illustrated by graph I-II. (Historical Standards Values shown in Appendix I)

Graph I-II: Automotive Fuel Economy Standards and Manufacturers Fuel Economy levels (citation 2)



The stagnation of the CAFE values starting 1996 is the result of a provision annexed to the yearly *"Transportation and Related Agencies Appropriations Act"* that blocks the ability of the NHTSA to change the standards for cars (citation 9). On December 19th 2007, however, President G. W. Bush signed into law the *"Energy Independence and Security Act"*, setting the target CAFE for 2020 at 35 MPG (cars and light trucks combined) (citation10).

Recently, on May 19th 2009, President Barack Obama announced tougher measures. According to these new measures the CAFE standard will be 35.5 MPG to be achieved by 2016, four years earlier than the original date of 2020 (citation 11 & 12). President Obama's suggestions of a faster tightening of the CAFE standards was applauded by car manufacturers who found themselves compelled to accept the new regulations in the shade of a unique context that resulted from the economic recession and the dependence of the auto industry on bailout funds from the government; an economic situation that created a favorable political context for such tough changes.

Political and Institutional context:

Political context:

The successful implementation of any new policy requires a favorable political context. For the Corporate Average Fuel Economy Standards, the political situation between 1973 and 1975 provided the adequate context for it to become an effective regulation.

In the U.S. history, 1973 was marked by numerous political events that shaped the following years. On October 15th, 1973, the Arab members of the Organization of Petroleum Exporting Countries (OPEC) decided to raise an oil embargo on the United States. The decision came as a response to the U.S. assistance to Israel in the October War. The non-Arab members of OPEC soon realized that they have an ability to control oil prices too and decided to take advantage of the situation to raise their income from oil exports. The outcome was an oil price shock known today as the 1973 Energy crisis. It resulted in a sustained increase in the

price of oil that put many American industries in jeopardy. The gross domestic product of the U.S. shrunk, as a result, by -0.5% and -0.2% in 1974 and 1975 as stated previously. One of the most influenced sectors in the U.S. was the auto industry. As a result, it became imperative for legislators to come up with energy policies to reduce the industry dependence on foreign supplies of fossil fuel. That same year President Ford came into power after President Nixon resigned due to the Watergate scandal. This political atmosphere made the following two years a period for a set of new policies to correct the situation.

In an attempt to implement a regulation to avoid future energy crisis, a group of thirteen senators introduced bill S.622 to the Senate on February 7th, 1975. Its official goal was to:

Provide standby authority to assure that the essential energy needs of the United States are met to reduce reliance on oil imported from insecure sources at high prices and to implement U.S. obligations under international agreements to deal with shortage conditions. (citation 13)

About a month later, on March 12th 1975, the Senate agreed unanimously that the act is a necessary measure. The unanimous consent is another evidence of the political readiness for such regulation at the time. However, the bill did not include any measures to set fuel economy standards for car and light duty trucks manufacturers. It was Senator Magnuson, Warren G. from Washington who introduced bill S.1883 to the senate in June 5th 1975, co-sponsored by Sen. Montoya, Joseph M. from New Mexico (citation 14). The bill amended the S. 622 known as "the Energy Policy and Conservation Act" and aimed to:

Conserve gasoline by directing the Secretary of Transportation to establish and enforce mandatory fuel economy performance standards for new automobiles and light-duty trucks, to establish a research and development program leading to advanced automobile prototypes (citation 14).

The resulting regulation from this amendment is known today as the Corporate Average Fuel Economy (CAFE). Other amendments were introduced and the S.622 bill was cleared by the House and the Senate on December 17th 1975. Five days later, on December 22nd 1975, President Ford signed it into law.

Exactly six month later, on June 22nd, 1976, the Secretary of Transportation (SoT) delegated the authority to manage the CAFE program to the National Highway Traffic Safety Administration (NHTSA) which is an agency of the Secretary. It was created in 1970 by the Highway Safety Act to replace two agencies which are the "National Traffic Safety Agency" and the "National Highway Safety Agency" in addition to four other bureaus within the department of transportation (Citation 18). The CAFE program clearly fell within its functions. The next section discusses further the institutional context within which the CAFE was implemented.(Citation 16)

Institutional Context:

The institutional context was a critical element that allowed the implementation of the Corporate Average Fuel Economy Standards. The existence of a Department of Transportation and different affiliated agencies allowed the immediate implementation of the regulation. Bill S. 1883 introduced to congress as an amendment to bill S.622 had no issues specifying the right authority that would get the executive power for the implementation of the CAFE. As discussed previously, it specified the Secretary of

Transportation as the government body in charge of establishing and enforcing the bill's directives.(Citation 14)

The Secretary of Transportation then delegated this authority by a subsequent act to one of its agency that was most appropriate to manage the CAFE standards (Citation 19). This agency was the NHTSA that already existed since 1970. (Citation 17)

The NHTSA was already regulating aspects of the auto industry such as the motor vehicle safety standards and low-speed collision bumper standards. This established contact with the industry as a regulating body allowed a smooth implementation of the new regulation setting fuel economy standards (Citation 20).The NHTSA, however, did not have the technical expertise to develop the necessary tests to measure the fuel economy for different car manufacturers. Consequently, the conduct of the CAFE program was to be based on information provided by the Environmental Protection Agency (EPA) (Citation 22) which already existed since 1970. The EPA was an independent agency that takes care of the cleanliness of the environment through different programs. It had the expertise needed to develop a testing procedure to measure fuel economy. (Citation 21)

Despite the fact that the CAFE standards were new to the executive body of the U.S. no new institutions were created for its implementation. Its provisions fell within the capacities of institutions and agencies that already existed such as the Department of Transportation, the NHTSA or the EPA. The availability of these made of the implementation of the CAFE standard an unproblematic and quick process. The arrangements that were made later within the NHTSA are discussed later in the institutional arrangements section.

Industry Overview:

When Nicholas Joseph Cugnot designed the first automobile in 1769, he was unaware that he was marking the beginning of an auto industry that contributed to the prosperity of many economies. It took more than a century for the automobile production to have real effects on countries, but once started, it grew at exponential rates. One of the countries that largely benefited from this industry to boost its economy is the U.S.

It was at the beginning of the 20th century that cars became a mass production good. The fast rising demand for horseless carriages (cars) resulted in the incorporation of a number of auto manufacturers. In 1908, Henry Ford introduced model T as an affordable automobile benefiting from economies of scale of large scale production (Citation 25). The introduction of that model revolutionized the auto industry and made automobiles an affordable good for the masses. Later in 1913, Ford introduced assembly lines with conveyor belts setting a beginning for the mass production of automobiles. (Citation 25, look for another source)

By the 1920s, the auto industry became one of the pillars of the U.S. economy. However, World War II interrupted the growth of the industry. Two month into the war, in 1942, all auto manufacturers had shifted their production into military goods. They produced tanks, military trucks, guns and everything other than nonmilitary automobiles. It was not until 1946, that the auto manufacturers resumed their normal activities. By then, the demand had grown up to unprecedented levels and the supply was not

enough. The following years set new records for auto sales. In 1949, 4.8 million new cars were sold in the American market; an increase of 1 million units from the pre-war level. By 1955 the figure reached 7.2 million new cars. In the 1950s, American manufacturers moved to the production of bigger, more powerful and better designed cars generating more sales. The trend continued into the 1960s but a radical shift in tastes and preferences of the American customers interrupted that growth. (Citation 25).

When first introduced in the second half of the 1950s, European and Japanese cars had a hard time penetrating the American market. They were offering small and compact vehicles to customers who had an obvious preference for the bigger and more powerful American cars. However, the 1960s was a decade of change in the consumption culture. Americans started buying smaller, more fuel-efficient and trendy cars. The Volkswagen Beetle is an infamous example of that change. As a result, the American producers who were focused on big and less efficient cars saw their market shares shrink to the advantage of European and Japanese producers. Statistics of the Bureau of Transportation Statistics show that in 1965 the total U.S. production of Motor Vehicles was about 11.2 Million units. By 1970, under the tough European and Japanese competition, this figure had dropped to 8.3 Million units (Citation 23).

Under these tightening conditions, the American auto industry was struck by the 1973 Energy crisis. As discussed in previous sections, it hit the U.S. economy hard. The crisis resulted in a four-fold increase in oil prices. According to the Bureau of Transportation Statistics (BTS), in 1970, the transportation modes using highways consumed about 92.3 Million gallons of fuel in 1970 of which 80.2 Million gallons were consumed by passenger cars, motorcycles and light trucks (Citation 24). It was this dependency of highway transportation on fuel that made the legislators aim cars and light trucks with a regulation to improve their fuel economy. This regulation is known today as the Corporate Average Fuel Economy.

V- Regulation Characteristics:

Legal Framework:

The Energy Policy and Conservation Act of 1975 became Public Law 94-163 in December 22nd 1975, setting the legal framework for the implementation of the CAFE standards. Some of the characteristics of this regulation were discussed earlier while its legal provisions will be analyzed in this section. It will also discuss some of the provisions of the Energy Independence and Security ACT of 2007 that will not come into effect before model year 2011.

Categorization:

The regulation categorizes automobiles under different categories: Passenger and non-passenger automobiles, domestic and imported, emergency etc. Such categorization allows specific targeting of the right automobiles by different clauses.

The differentiation between passenger and non-passenger automobiles is obvious which made the legislator skip the definition of each type;

however, the separation between domestic and non-domestic automobiles is trickier. For the CAFE regulation, it is based on the country to which the cost can be attributed. It considers domestic automobiles for a model year (MY), any automobiles which cost has 75% value-added that is attributable to the U.S., Canada or Mexico. An exception is made for those automobiles imported into the U.S. from Mexico or Canada more than 30 days after the end of the MY. These are still considered domestic automobiles but for the next MY. The categorization also extends to the definition of emergency and executive agency automobiles.

Setting standards:

By P.L. 94-163, the Secretary of Transportation is required to set non-passenger automobiles CAFE standards at least 18 months before the model year (MY) allowing manufacturers enough time to adapt. According to the last amendment introduced in 2007, the mileage set as a standard is to be the maximum feasible level that manufacturers can achieve considering "economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, environmental impacts and the need of the United States to conserve energy" (Citation 30). This maximum level should not be set arbitrarily which is why the regulation requires the Secretary to set it at a level that "is technologically achievable, can be achieved without materially reducing the overall safety of automobiles manufactured or sold in the United States, is not less than the standard for that class of vehicles from any prior year and is cost-effective"(Citation 30)

For passenger automobiles, however, the average fuel economy was set by the initial act in 1975 to be 27.5 MPG after 1984 unless amended under the provisions of subsection (b). Such amendment by the Secretary of Transport is limited between 26 MPG and 27.5 MPG for cars. A fuel economy requirement that is below 26 MPG or above 27.5 MPG needs to be submitted to congress and follow the normal procedure of regulations' approval. The aim of this limitation was to reduce the ability of the Secretary of Transportation to take unilateral decisions that might have consequential results on the nation.

As a result, the historical values of the CAFE standards for passenger cars were set within this interval from 1983 to 2010. The Secretary of Transportation fixed the mileage at the highest possible level that does not require the regulation to go through the congress. As a result, it stagnated at 27.5 MPG for over 20 years.

32 years later, in 2007, President Bush signed into law the Energy Independence and Security Act of 2007 (P.L. 110-140) which, among other provisions, amended the Automobile Fuel Economy regulation. It gave the right to the Secretary to set fuel economy standards for both passenger and non-passenger automobiles without limiting it within an interval. It also set a target standard of 35 MPG to be achieved by 2020. (Citation 30)

The 2007 Energy act added some provisions that appeared for the first time on the fuel economy regulation. For instance, the emissions of green house gases were cited by this amendment as a criterion to consider for cost-effectiveness of a proposed standard. It also started the process of putting in place fuel economy standards for medium and heavy duty trucks that were previously exempted. However, the actual implementation for these categories will take at least seven years to become effective.

In the exercise of these powers, the Secretary of Transportation was given is required to consult other governmental bodies for different issues. For the setting of standards, for example, it is required to consult with the Secretary of Energy and provide them with enough time to comment. However, it is not required to implement their recommendations.

Exemptions:

With the implementation of any regulation, the side effects need to be taken into consideration. For the CAFE standards, an exemption clause was included to reduce these undesirable effects. The clause is explained in subsections (d) and (e) of the U.S. Code tiltle 49 (49 U.S.C.A. § 32902(d), 32902(e)) which stipulate that for car manufacturers producing less than 10 000 automobiles per year, or automobiles produced for emergencies, an exemption from the CAFE standards may be granted by the Secretary of Transportation (SoT). The automobiles used by the executive agency are also granted partial exemption. The authority of setting the fuel economy standard for these is given to the president but limited by a minimum of 18 MPG.

Credits:

Under section 32903 of title 49 (49 U.S.C.A. § 32903), the U.S. Code provides incentives for auto manufacturers to reach fuel economy levels that are higher than the standard. These incentives are in the form of credits that the manufacturer gets for every one tenth MPG above the standard average fuel economy level required by the NHTSA. Then the total is multiplied by the number of automobiles produced with that efficiency level to result in the total credits that the manufacturer gets. The formula looks as follows:

FORMULA V-I:

$$CAFE_{Credits} = (\text{Manufacturer Fuel Economy} - \text{CAFE standard}) * 10 * \text{Total number of cars produced}$$

These credits can be used for the three years before or following the Model Year (MY) in which they were earned. The Secretary of Transportation is required to notify the manufacturer of the use of credits and give them enough time to comment before actually using the credits.

However, this credits' system has been criticized for not giving real incentives for manufacturers to take their fuel efficiency beyond the standard. The critics will be discussed in details in the results and limitations sections of this study.

Calculation:

Section 32904 of the same title of the U.S. Code discusses the calculation of the fuel economy for manufacturers. It charges the administrator of the Environmental Protection Agency (EPA) of calculating the average fuel economy standard. However, the EPA administrator is not given the authority of choosing the calculation method. The regulation states that the average fuel economy for a manufacturer should be computed by dividing

the number of passenger automobiles manufactured by the manufacturer in a model year by the sum of the fractions obtained by dividing the number of passenger automobiles of each model manufactured by the manufacturer in that model year by the fuel economy measured for that model. (49 U.S.C.A. § 32903 (a)(1)(A))

In other words, the CAFE for a manufacturer is obtained by a harmonic function that divides the total production volume by the sum of fractions obtained by dividing the volume of production of each model divided by its average fuel economy (citation 3). This translates into the following formula:

FORMULA V-II:

$$CAFE_{Manufacturer} = \frac{\text{Total Production Volume}}{\frac{\text{Volume Vehicle A}}{\text{Fuel Economy Vehicle A}} + \frac{\text{Volume Vehicle B}}{\text{Fuel Economy Vehicle B}} + \frac{\text{Volume Vehicle C}}{\text{Fuel Economy Vehicle C}}}$$

However, the calculation of the fuel economy for electric cars using this method would be problematic since the fuel economy is calculated as miles per gallon of fuel. For that reason, the regulation requires the secretary to use a different method for electric cars. It states that the administrator of the EPA should consult with the Secretary of Energy to get petroleum equivalent values for different types of electric cars. It also lists different factors that the Secretary of Energy needs to take into account when establishing the equivalencies.

The calculation of the fuel economy is weighted 55% urban cycle and 45% highway cycle which is equivalent to the procedure used in 1975. Any change in the procedures used should give comparable results to calculation made using these weights. The calculation section (49 U.S.C.A. § 32904) ends with a statement of conditions for exemptions, decision reconsideration and appeals.

CAFE reform for light trucks:

The final rule of the reformed CAFE regulation for light trucks bases the fuel economy standard for a manufacturer on the footprint of its vehicles. The choice of footprint was not arbitrary. The text of the regulation discusses the use of weight and shadow of vehicles and their inefficacy in reaching the projected goals. The shadow or weight can be altered easily from one model year to another for a vehicle to be placed in a category with less stringent standards. With this less costly and evasive possibility, most manufacturers would focus on changing the shadow or weight of their vehicles instead of increasing their fuel economy. The footprint, however, reveals to be a more efficient solution. It is more "integral to vehicle design" and more difficult to alter from one model year to another. It gives more incentives for the manufacturer to increase fuel economy than to focus on evasive solutions. As a result, it serves better the goal of the regulation to reduce the fuel consumption of the country.

The definition of the footprint is, thus, central for an appropriate application of the regulation. The final rule states that "vehicle footprint is the area defined by vehicle wheelbase multiplied by vehicle track width". The wheelbase is "the longitudinal distance between front- and rear-wheel centerlines" and the track width is "the lateral distance between the centerlines of the tires at ground when the tires are mounted on rims with zero offset" (citation 33).

The first proposal for a reformed CAFE for light trucks based on footprint was heavily criticized. It sat standards for light trucks based on six footprint categories. The main critique was the categorization itself and the spread within categories. As a result, the final rule came with a continuous function that is based on the footprint of the vehicle and five other variables. The continuous function is a constrained logistic function that was chosen after surveying many

options. The final version of this function is as follows:

FORMULA V-III:

$$T = \frac{1}{\frac{1}{a} + \left(\frac{1}{b} - \frac{1}{a}\right)\frac{e^{(x-c)/d}}{1+e^{(x-c)/d}}}$$

Where:

- T = the fuel economy target (in mpg)
- a = the maximum fuel economy target (in mpg)
- b = the minimum fuel economy target (in mpg)
- c = the footprint value (in square feet) at which the fuel economy target is midway
- between a and b
- d = the parameter (in square feet) defining the rate at which the value of targets
- decline from the largest to smallest values
- e = 2.71891
- x = footprint (in square feet, rounded to the nearest tenth) of the vehicle model

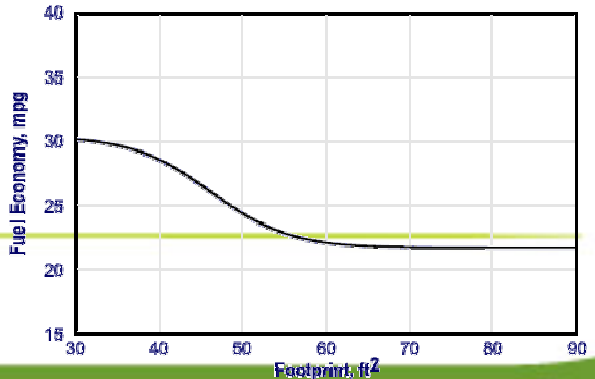
These parameters are defined by the regulation for the 2008-2011period as shown in table V-I.

TABLE V-I:

Parameter	Model Year			
	2008	2009	2010	2011
a	28,56	30,07	29,96	30,42
b	19,99	20,87	21,20	21,79
c	49,30	48,00	48,49	47,74
d	5,58	5,81	5,50	4,65

The graph of the resulting fuel economies versus the input footprint is an S-shaped curve. As illustrated by Graph V-I, the required fuel economy decreases from the maximum fuel economy target, a, to the minimum target, b, as the footprint increases.

GRAPH V-I: EXAMPLE GRAPH OF LIGHT TRUCKS REFORMED CAFE



This method is also used for determining the fuel economy standards for medium duty vehicles.

The period between 2008 and 2010 was set as a transition period where manufacturers can choose between using the reformed or unreformed standards. During this period the parameters of the continuous function of the reformed standards were not set at levels that make standards socially optimal but rather at levels that equalize reformed and unreformed standards. The goal from such measure is to facilitate the transition and minimize the costs for manufacturers during the transition period. In 2011, however, these parameters are set at levels that make standards socially optimal and all manufacturers are required to comply with the reformed standards.

Incentives for alternatively fueled automobiles:

Section 32905 of the regulation sets formulas for different types of cars using alternative fuels. Under the label alternative fuel automobiles, it distinguishes four types:

- Dedicated Automobiles
- Dual Fueled automobiles
- Gaseous fuel dedicated automobiles

- Gaseous fuel dual fueled automobiles

The formula used for every type of these automobiles results in a fuel economy that is higher than the result of the original CAFE function for automobiles running on conventional fuel only. The higher CAFE rating allows automobile manufacturers to improve the average fuel economy of their fleets. Adding a line of automobiles that uses alternative fuels to the mix makes the overall average fuel economy higher, even if the number of these is small. The purpose of such provision is to induce manufacturers to invest in alternative fuels' technologies.

This option is limited, though, by the following subsection of the same title. It limits the amount by which the average fuel economy of a manufacturer can be increased by introducing alternative fuel automobiles into the fleet. For the 1993-2010 period it is limited to a 1.2 MPG per model year. Then in 2011 and until 2014, the quota decreases to 0.9 MPG. These levels are revised down (or up) if the CAFE standard is changed from the 27.5 MPG level.

Manufacturer reports:

The auto manufacturers are required to submit reports to the Secretary of Transportation twice a year. The first one should be submitted during the 30 days before the beginning of the year and the second one 6 months later. On these reports, the manufacturer is required to state whether they will be complying with the standards set by the Secretary of Transportation, the measures they are undertaking to comply with the standards, and other information that is indicated by the Secretary of Transportation.

Another type of reports and records that auto manufacturers are required to keep is regulated by the EPA. It requires them to keep records, make reports and conduct tests. These are inspected by an officer of the EPA when the agency judges necessary.

Fuel Economy Information labels and booklets:

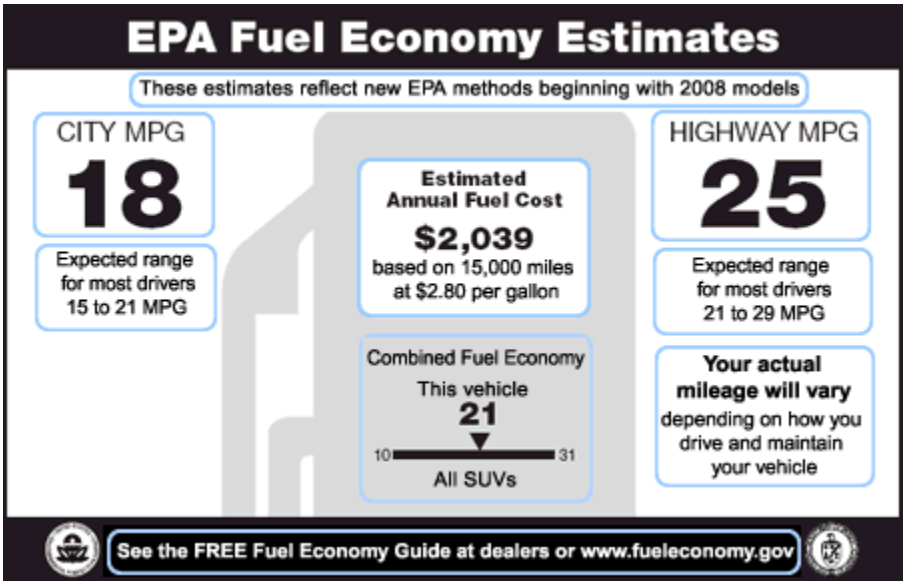
Under the CAFE regulation, it is mandatory for auto manufacturers to attach labels with fuel economy information to vehicles they produce. The labels should include:

A. The fuel economy of the automobile.
B. The estimated annual fuel cost of operating the automobile.
C. The range of fuel economy of comparable automobiles of all manufacturers.
D. A statement that a booklet is available from the dealer to assist in making a comparison of fuel economy of other automobiles manufactured by all manufacturers in that model year.
E. The amount of the automobile fuel efficiency tax imposed on the sale of the automobile under section 4064 of the Internal Revenue Code of 1986 (26 U.S.C. 4064).
F. Other information required or authorized by the administrator of EPA. (49 U.S.C.A. § 32908)

Under the amendment introduced by the Energy Independence and Security ACT of 2007 (H.R. 6 pp) the labels should also include information about green house gases emissions and other information favoring manufacturers with better fuel economy. The purpose of these labels is to inform end-consumers, at the time of purchase, about the fuel economy of their vehicles. It encourages them to choose more efficient cars reducing their fuel expenses and the dependency of the country on foreign sources of fuel. In addition, the disclosure of fuel economy information of other cars manufactured during the same model year allows a comparison of their labels. They show their fuel economy computed using the specific methods for dual fueled automobiles discussed in the calculation section previously in addition to the fuel economy using gasoline or diesel obtained by the simple CAFE function (see calculation section). They should also state all the fuels on which the automobile can be operated. These requirements insure the consumer gets the right information when making their decisions.

Requirement (D) for the information to include on the labels mentions the availability of a booklet with the dealer. That booklet is

FIGURE VI-I: FUEL ECONOMY LABEL (CITATION 27)



other existing options. Such measures help in the disclosure of relevant information to the consumer allowing them to make more rational decisions. Figure VI-I shows an example of the labels used currently.

The same rules apply to dual fueled automobiles. However, these have more information shown on

published and distributed by the administrator of the Secretary of Energy under the requirements of this title. The title lists the conditions under which the administrator is to publish the booklet. It states that the booklet:

A. shall be simple and readily understandable;

B. shall contain information on fuel economy and estimated annual fuel costs of operating automobiles manufactured in each model year; and
C. may contain information on geographical or other differences in estimated annual fuel costs.

For dual fueled automobiles the following additional information is to be included in the booklet:

i. the energy efficiency and cost of operation of those automobiles when operated on gasoline or diesel fuel as compared to those automobiles when operated on alternative fuel; and
ii. the driving range of those automobiles when operated on gasoline or diesel fuel as compared to those automobiles when operated on alternative fuel.
iii. information on the miles a gallon achieved by the automobiles when operated on alternative fuel; and
iv. a statement explaining how the information made available under this paragraph can be expected to change when the automobile is operated on mixtures of alternative fuel and gasoline or diesel fuel.

With all these details provided, consumers are better informed about how automobiles available in the market compare in terms of fuel economy. The comparison based on fuel economy pushes auto manufacturers to consider it as a criterion for competition. Overall, this increases the average fuel economy of automobiles.

Considering that the fuel economy of an automobile changes depending on the conditions in which it is used, its age, the driving style etc. a paragraph was included in the regulation to protect auto manufacturers from potential law suits by consumers whose automobiles consume more than what is shown on the label. It states that the values shown on the labels are not a warranty under the laws of the United States or a State.

It is also required that the administrator consults with the Federal Trade Commission, the Secretary of Transportation and the Secretary of Energy since they are the stakeholders in the administration of these labels.

Judicial review and administrative provisions:

Section 32909 of title 49 of the U.S. code describes the legal procedures related to an appeal on the provisions of the section, the authorities in charge and the time frames for each procedure. Then the following section details the power of the Secretary of Transportation to inspect manufacturer, copy or order reports and conduct hearings. It also states that, unless the information would cause significant competitive damage, the Secretary should disclose the information obtained through these processes. Such disclosure allows a transparency of the activities of the Secretary.

Civil Penalties:

The civil penalty for a person who violates the provisions of the title was capped by a maximum of $ 10,000 for each violation for each day. Then, with the Energy Independence and Security ACT of 2007, this amount was revised

up to $50,000. However, for auto manufacturers that violate the fuel economy standards, a different penalty is prescribed. For these, the penalty is $5.50 for every one tenth of a mile per gallon difference from the standard multiplied by the number of cars produced with that specific fuel economy and reduced by the number of credits the manufacturer holds. The formula looks as follows:

FORMULA V-III:

$5.50 * [(Standard – Fuel Economy) * 10 * Number of automobiles – Credits]

The Secretary is also given the authority to increase the penalty up to a level of $10 for every 0.1 MPG, if it judges that such rise

i. will result in, or substantially further, substantial energy conservation for automobiles in model years in which the increased penalty may be imposed;
ii. will not have a substantial deleterious impact on the economy of the United States, a State, or a region of a State;
iii. will not cause a significant increase in unemployment in a State or a region of a State;
iv. will not adversely affect competition;
v. will not cause a significant increase in automobile imports. (49 U.S.C.A. § 32912)

In some cases individual deals with manufacturers are authorized. The Secretary can strike a deal with a manufacturer if the violation is necessary to prevent bankruptcy, if it was caused by an event that is out of the control of the manufacturer such as an act of god, a strike or fire, or if it is necessary to prevent substantial lessening of competition. These exceptions to the rule are designed to protect domestic manufacturers from potential unnecessary damage.

Credit Trading Program:

A recent development in the CAFE regulation will correct some of its most important flaws. Since 1975, the CAFE regulation created a situation where some manufacturers accumulate credits that they never use. At the same time others pay a price fixed by government regulation ($5.5 civil penalty per 0.1 MPG) for non-compliance. This price does not vary and hence it does not equate to the marginal social cost or take into consideration the changing micro and macroeconomic conditions. In an attempt to polish the regulation in 2007, the Energy Independence and Security ACT and specifically SEC 506 (e) directed the Secretary of Transportation to establish a market where CAFE credits can be traded among manufacturers. The establishment of such market will provide more incentives to keep improving the average fuel economy since it will generate more revenues for those holding credits in surplus. In addition, the cost of non-compliance for the other manufacturers will be determined by the market giving it a more flexible, competitive and real value. However, the regulation does not set a specific timeframe for the implementation of the trading program which means that the time it will take to become a reality will be decided by the Secretary of Transportation at its own discretion.

This program is a movement towards a more market-oriented approach for the CAFE standard but still does not allow the auto industry to access Cap and Trade markets for emission certificates of other industries. The CAFE regulation measures automobiles' emissions in a way that is different from stationary emitters, thus, making it difficult to trade rights to emit across industries. Some studies and proposals to the congress (Lieberman-McCain Climate Stewardship Act) explored the possibility of integrating CAFE standards with more elaborate measurement methods to allow the auto industry access to Cap and Trade markets. This might be a further development for the new CAFE.

This chapter of the U.S. code creates a unique legal framework that regulates different aspects of the fuel economy standards and sets the rules within which it is conducted. It also defines a number of institutions that are involved in the application of the regulation creating an institutional framework which is necessary for execution.

Institutional arrangements:

As discussed previously, the implementation of the Corporate Average Fuel Economy regulation did not require the creation of any new institution. It benefited from an already existing set of institutions that had the necessary powers to conduct it. The main institution that has been directly involved with the CAFE standards since the beginning is the National Highway Traffic Safety Administration (NHTSA) which was created in 1970. It administers the CAFE regulation under a delegation by the Secretary of Transportation. The following discusses the institutional arrangements made for the administration of the CAFE regulation within the NHTSA.

According to an email interview with Mr. Anup Bandivadekar from the International Council on Clean Transportation (citation 42), within the office of rulemaking of the NHTSA there is a division called "International Policy, Fuel Economy, and Consumer Programs" which is responsible for the CAFE rule. The division works jointly with the Volpe center in the Department of Transportation. This center "is part of DOT's Research and Innovative Technology Administration and is an innovative, federal, fee-for service organization" (citation 41). It developed the model used for the analysis of the CAFE rules. The NHTSA also hires external consultants to perform certain tasks related to the CAFE regulation.

Within the NHTSA different employees, who are part of the office of enforcement but not assigned to one particular division, are responsible for the implementation and monitoring of the CAFE standards. There is also a division that carries out regulatory analysis and evaluation.

The discussion above describes the legal and institutional framework of the CAFE regulation; however, this description would not be complete without a discussion of its economic model.

Economic Model:

A study of the Corporate Average Fuel Economy cannot overlook the economic model on which it is based. A model that is more of a government mandate that one that follows the market. Various reasons justify such direction. For fuel economy, many resulting externalities and spill-over effects cannot be accounted for in individual transactions of users. In addition,

users have very low price sensitivity and a public good (environment) is involved in the problem as well. All these parameters create a situation where private costs are lower than social costs and where the market mechanisms are unable to correct the imbalance; a situation where lawmakers are more efficient than market makers in capturing the cost to the public into prices.

In this section, the different approaches used to set a value for the civil penalty imposed by the CAFE regulation will be discussed as well as the model that the regulation follows.

Civil Penalty Valuation:

The civil penalty imposed by the CAFE regulation for non-compliance is basically a safety valve. It sets a maximum cost beyond which investing in fuel economy is not cost effective. With this fact in mind the civil penalty, currently set at $5.5, is valuated using two approaches; one relies on the cost of investing in technology to improve fuel efficiency, the other uses fuel savings from the increase in fuel economy.

Using these two approaches, the current civil penalty is argued to be undervalued. When first set in 1975, it was set at $5.0 and was later adjusted to inflation ($5.5) but the adjustment did not set the value at its right level. Below is a discussion of the two approaches and the level at which the penalty should be set currently.

a. Penalty valuation based on technology cost:

A study of the National Academy of Sciences (citation 31) explored different scenarios for the cost of investing in technologies to improve fuel efficiency. The study came up with three cases: optimistic, pessimistic and mid-range. Table V-I summarizes the three cases.

TABLE V-I

EXAMPLE V-I:
ASSUMING A VEHICLE LIFE OF 12 YEARS, 8% DISCOUNT RATE, 15 000 MILES TRAVELED IN THE FIRST YEAR AND DECLINING AT 4.5% THEREAFTER AND A FUEL PRICE OF $1.50, AN INCREASE IN EFFICIENCY FROM 27 MPG TO 28 MPG SAVES $184 WHILE AN INCREASE FROM 33 MPG TO 34 MPG IN FUEL ECONOMY ONLY SAVES $124 OVER THE LIFE OF THE VEHICLE.

Combined Car/Truck fuel Economy	Pessimistic Technology Cas		
25 MPG	$ 170	$ 130	$ 120
30 MPG	$ 210	$ 140	$ 120
35 MPG	$ 250	$ 210	$ 150
40 MPG	$ 270	$ 260	$ 200

The NAS study also shows that depending on the assumption of the cost of gasoline, an efficiency level between 31 and 34 MPG can be achieved cost effectively. If we take the upper limit of this range as target efficiency (34 MPG), the cost estimated by the mid-range estimation of the NAS study would be $195/ MPG as a marginal technology cost (citation 32). This suggests that the current $55 level is far under the level where it should be creating a disincentive for manufacturers to invest in technologies to improve fuel economy. Even if we were to consider the most optimistic case, this cost would be $145/MPG (citation 32).

As discussed earlier, the value of the penalty can also be valued using fuel savings from the increase in efficiency. Though more complicated, it results in similar results.

b. Penalty Valuation based on fuel savings:

The use of this approach implies that the cost of technology is not involved in determining the value of the penalty. It assigns a value to every gallon of fuel consumption that is avoided. However, a complication surfaces when calculating fuel savings; at higher efficiency levels, the marginal fuel savings from a one unit increase in efficiency are lower. Example V-I illustrates such situation by a numerical example.

Using the same assumptions as in example V-I (the same as in the NAS study), we can compute the marginal savings from increases in the fuel economy from 27 MPG (close to the current standard of 27.5 MPG) to 34 MPG discussed earlier as the cost-effective goal. The results are listed in table V-II.

These results suggest that the civil penalty should be valued differently depending on the current level of efficiency of the manufacturer which is probably the most accurate solution. However, in the real world such regulation would be too complicated to implement. As a result, an average could be used to fix a value for the civil penalty regardless of the efficiency level of the manufacturer. Based on the data from table V-II, the average would be $151/MPG. It is worth noting that this figure is very close to the one computed based on technology cost ($145/MPG).

The estimate of the cost of gasoline largely influences these figures. The calculations made above assumed a cost of $1.5 per gallon which

can be judged too optimistic. Assuming a higher cost of $2 per gallon results in an average of $202/MPG, which is also close to the mid-range estimate based on technology cost ($195/MPG).

These two approaches are used for the valuation of the right civil penalty to impose for non-compliance with the standards. However, they both show that the current penalty is undervalued and gives little incentives to manufacturers to increase their efficiency. The implications will be further discussed later in the results section.

Results:

Previous sections of this study discussed different aspects of the Corporate Average Fuel Economy that have existed for more than three decades. The long existence of the regulation has certainly had an array of impacts on the United States. These can be categorized into environmental, economic and safety related. This section will discuss these based on the data collected in previous sections.

Environmental:

In 1975, when the Corporate Average Fuel Economy (CAFE) was put in place by the Energy Independence and Security Act, the environmental impact was not mentioned in any of the legal texts or the debates over the regulation. The positive environmental impact of the CAFE was an unintended benefit of a regulation aiming to reduce dependence on foreign suppliers of fossil fuel.

A study by the Board on Energy and Environmental Systems (BEES) (2002) (citation34) identified fuel economy and miles traveled as the most important factors underlying the release of greenhouse gases by automobiles. These two factors are directly related to the CAFE regulation. It is intuitive that the CAFE improves fuel economy and thus contributes positively to the reduction of vehicles' emissions holding the miles travelled constant, however, many studies argue that the improvement of fuel economy also increases the miles traveled. This effect, called the rebound effect, creates an uncertainty about the outcome of the CAFE.

The rebound effect, in the context of the CAFE, refers to the increase in the miles traveled as fuel economy increases. An improvement in fuel economy means that a driver can travel for longer distances using the same amount of fuel which creates an incentive for individuals to do so. If the miles traveled increase at the same rate as the increase in fuel efficiency then the latter is unproductive and useless. However, the BEES study shows that an increase of 10 percent in fuel economy only results in an increase of 1 to 2 percent in miles traveled (citation34).

Considering this trivial rebound effect, one can conclude that the improvement in fuel economy does reduce the overall consumption of fuel. Such reduction in the consumption of fuel directly results in a reduction of green house gases emissions from vehicles.

TABLE V-II:

MPG Improvement	Discounted Fuel Savings	Value of Discounted Fuel Savings
27 to 28	122	$ 184
28 to 29	114	$ 171
29 to 30	106	$ 160
30 to 31	100	$ 149
31 to 32	93	$ 140
32 to 33	88	$ 131

The positive effect on the environment resulting from the improvement of fuel efficiency in the U.S. is not only an accepted logic conclusion. It can be quantified. In this section we will consider the example of CO_2 emissions value. According to the study of the National Academy of Sciences "*Effectiveness and Impact of Corporate Average Fuel Economy*", if the effect of the improvement in fuel economy was completely cancelled by an increase in miles traveled, the U.S. would be consuming 55 billion gallons of gasoline per year above the current levels. In other words, the improvement of fuel economy in the U.S. is currently saving 55 billion gallons of gasoline per year. For every gallon of gasoline burnt by vehicles, $8.81*10^{-3}$ metric tons of CO_2 is released in the air (Citation 35). A simple calculation tells us that it is the equivalent of 484.55 Million metric tons of CO_2 that are not released into the air each year thanks to the improvement of fuel economy.

The American Clean Energy and Security Act of 2009 sets a minimum reserve auction price at $10 / Metric Ton of CO_2 (Citation 36). Estimates of the EPA also confirm this minimum value for 1 Metric Ton of CO_2. Taking this figure into consideration, the value of the 484.55 Metric Tons of CO_2 saved each year can be estimated to $4.85 billion as a minimum. Note that this value is based on a minimum price while the actual value might vary and be as high as five times this number if based on less optimistic estimates. This is a single example for the emissions of CO_2; emissions of other green house gases can be assigned a dollar value as well.

All the analysis above is based on the improvement of fuel economy. There is no doubt that some of it is the result of the CAFE standards but not necessarily all of it. The separation between what was the result of CAFE standards and what was the consequence of other factors is very difficult if not impossible. Many studies claim that most of the improvement is the result of oil price shocks rather than CAFE standards while others claim the opposite. In all this uncertainty, one fact can be agreed on, the CAFE standards contributed to the improvement of fuel economy.

Economic:

The Economic results of the Corporate Average Fuel Economy standards are numerous. These include positive and negative effects on multiple levels. From the most obvious savings on fuel consumption to the doubtful impact on employment in the auto industry or consumer preferences, several studies have explored the results of CAFE of which most found it difficult to separate the effect of the CAFE regulation from other factors (e.g. fuel prices).

Fuel Savings:

As stated earlier, without the improvement in fuel economy in the U.S from 1978, the country would be consuming 55 billion gallons of gasoline more than it is consuming today (citation 34). The U.S. average price for a gallon of fuel (all grades and all formulations) over the first 6 months of 2009 is $2.19 (Citation 37). Using this average retail price, the value of the fuel savings would be $120.45 billion per year.

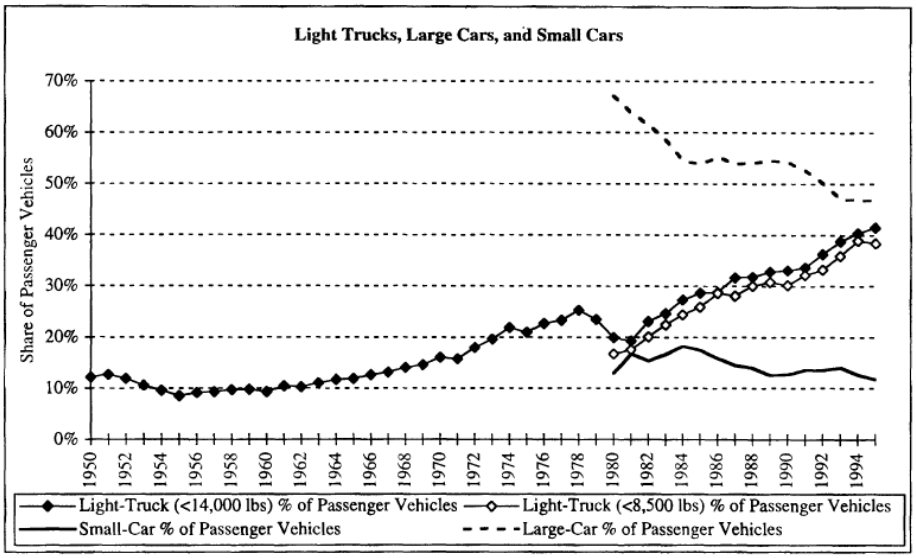
Auto Industry:

The CAFE regulation is directly related to auto manufacturers, thus, directly influencing the auto industry. Its effects were numerous due to changes not only in manufacturers' behavior but also in consumers' behavior.

The Corporate Average Fuel Economy has been usually appointed as a market disruption. Crandall (1992) argues that it raises the price of automobiles by including a fuel economy technology that the market is not requiring now, creating overpriced vehicles as a result. In addition, the higher prices come with even smaller cars which are not necessarily what consumers prefer. This creates a condition where consumers prefer to keep their old cars for longer, buy used cars, and avoid new cars. Consequently, the fuel efficiency is little affected by the regulation in the short-run. (Citation 38) On the other hand, the effects of the policy on the long-run are much disputed. While some studies argue that fuel efficiency increased substantially as a result of the CAFE standards, others argue for a different conclusion.

The initial goal of the CAFE regulation was to promote the use of small cars which are more efficient. However, looking at numbers in relative terms shows a different trend. "*The Regulation of Fuel Economy and the Demand for Light Trucks*" (citation 39) study shows that the share of small cars remained constant since the start of the regulation while the share of large cars decreased considerably. At the same time the share of light trucks mirrored that of large trucks with a substantial increase. Graph VI-I shows these trends.

GRAPH VI-I:



This was the result of a situation created by the CAFE regulation where "large cars are penalized, small cars subsidized and light trucks are largely unregulated" (citation 39); a situation that favors small cars and light trucks. However, considering consumers preference for safer vehicles, it was the light trucks demand that was mostly stimulated. This preference is usually referred to as "Peltzman's offsetting behavior". Therefore, CAFE standards increased the share of light trucks instead of increasing that of small cars. As discussed earlier, the shift from large cars to light trucks was relatively easy for manufacturers since it was done simply by increasing the weight of large cars. The result is an auto market where light trucks have the largest share. With this conclusion in mind, the often discussed negative impact of CAFE on the safety of automobiles is undermined.

From the discussion above, we can conclude that although the overall fuel economy increased as a result of the CAFE standards, it did not increase as planned for. The optimal would have been an increase in the share of small cars to the detriment of large cars and light trucks. This unintended effect led to a less than optimal improvement in fuel economy. Greene (1997) argues that without the effect of the CAFE regulation on the share of light trucks in the auto market, the overall fuel economy of automobiles in the U.S. in 1996 would have been between 1.5 and 2.0 MPG higher. This gap is certainly wider today.

Others justify the survival of CAFE for more than three decades with a different type of reasons. Godek (citation 39) argues that the CAFE regulation can be regarded as an "attempt to subsidize domestic car production disguised as a conservation policy". In other words, it is a protectionist policy to protect the domestic auto industry. This argument is based on the fact that the CAFE standards treat domestically produced automobiles and imported automobiles separately, inducing car manufacturers to manufacturer small and more efficient cars instead of importing them. In the absence of such

provision, compliance with the CAFE standards would have been easier by simply importing more efficient cars. This would have resulted in an American subsidy to foreign car manufacturers producing smaller cars. However, the CAFE regulation with its separating treatment subsidizes more efficient cars but only those domestically produced. Historical data shows that this subsidy was often to the detriment of foreign manufacturers which paid all the fines since the CAFE regulation started in 1978.

The fact that CAFE subsidized domestic manufacturing of small cars and at the same time induced manufacturers to produce these cars has contributed to the stabilization of employment in the American auto industry. Since the profit margins on small cars are tiny, it would have been more profitable for domestic manufacturers to cut the production of these lines and import them to comply with the CAFE standards. Such downsizing would have directly impacted employment in the industry. However, in order to avoid paying the penalty for non-compliance with the standards, auto manufacturers were obliged to maintain small cars production lines and, thus, the employees in these lines.

Safety:

Many studies have argued that the Corporate Average Fuel Economy had a very negative impact on the safety of automobiles. With the data discussed earlier in mind, this effect seems to be exaggerated. Most of these studies take the decrease in the average weight of automobiles as an indicator of a decline in their safety. There is no doubt that "occupants of lighter cars incur an elevated risk of serious injury and death in crashes compared to occupants of heavier cars" (Citation 40). However, these studies do not take into consideration that the reduction of the average weight was the result of the reduction of the weight of the heaviest automobiles while the weight of the smallest cars, on the other extreme, have increased.

In addition some of these studies only consider cars and ignore the trends in the sales of light trucks which are critical to draw an accurate conclusion. As shown in graph VI-I, the share of small cars in the auto market has remained almost constant while the main changes happened in the shares of large cars and light trucks. If one only considers the decrease in large cars, an easy and direct conclusion can be drawn on the drop in the safety of cars. However, one should also consider the considerable increase in the share of light trucks mirroring the decrease in large cars. These mirrored trends suggest that large cars were substituted for light trucks rather than small cars. As a result, the argued big impact of the Corporate Average Fuel Economy on safety is inaccurate. The regulation had certainly some implications on the safety of automobiles but they are not as important as claimed by most studies. Godek (citation39), who supports the same argument, states that

Such studies may overstate the effect of CAFE on safety not because those studies are wrong about the relationships between CAFE, car weight, and car safety but because they ignore the switch by consumers to an increasingly popular class of vehicles known as light trucks" (citation 40)

In addition, he particularly criticized the study by Robert W. Crandall and John D. Graham (citation 40) "*The Effect of Fuel Economy Standards on Automobile Safety*" which is often cited by studies as a reference on the subject.

It should be noted, though, that the unimportant effect of the CAFE standards on the safety of automobiles was the result of a dysfunction of the regulation. It was mostly the failure of the regulation to increase the share of small cars that limited its effect on automobiles' safety. If it had reached its initial goal of considerably increasing the share of small cars to the detriment of large vehicles, it would have had a larger impact on the safety of automobiles.

Limitations:

Throughout this study many limitations of the Corporate Average Fuel Economy Standards were cited directly and indirectly under different sections. These include the existence of more efficient alternatives, issues with incentives to producers and consumers, high costs and many others.

A major criticism that is directly related to the initial goal of the CAFE standards is the existence of more efficient alternatives. The goal of reducing fuel consumption and shifting consumer preference to more fuel efficient cars is argued to be achieved more efficiently using a fuel tax. At the conclusion of his study on the CAFE, Crandall (citation 38) states that "the existing empirical literature suggests that CAFE costs about 7 to 10 times as much as a petroleum tax that would induce comparable reductions in oil consumption". The high cost might be justified, as discussed previously, by a political willingness to protect employees in the American auto industry. However, the cost of this protection is even higher than the losses that would have been incurred without it. The costs of the regulation could also be justified by a willingness to reduce the emissions of CO_2. Concerning this presumed goal, not only can it be achieved similarly by a fuel tax but it can also be better achieved by a carbon tax. A carbon tax is even more efficient than a fuel tax in achieving the goals of the CAFE standards concludes Crandall (citation38). It costs at least 8.5 times less to the economy than CAFE (citation 38).

Even with these high costs, CAFE is criticized for its failure to "to equate the marginal costs of reducing fuel consumption across all uses, including usage of older vehicles and nonvehicular consumption" (citation 38). The penalty value set by government through a top-down process is also criticized for not capturing the right marginal cost that would push manufacturers to increase the fuel economy of their vehicles. As discussed earlier this penalty is set at $55 per 1 MPG of difference from the standards while a valuation of the value where it should be set shows a figure between $145 and $151 (see Economic Model Section). In addition, this value is fixed while the real value where it should be set fluctuates daily according to many market parameters.

Another critic is related to a decisive component of any regulation which is incentives. The CAFE incentives suffer many flaws. The most obvious and debated one is the incentive of improving fuel economy versus shifting the weight of vehicles. The CAFE categorizes vehicles into cars and light trucks setting less stringent standards for light trucks. The difference between the two categories is made solely on the basis of weight. For manufacturers, the shift in the weight of vehicles, especially large cars, costs considerably less than investing in fuel efficiency which led to the noticeable increase in the share of light trucks to the detriment of large cars. This outcome is totally opposite to the initial goal of the regulation (i.e. increasing the

share of small cars) because of the wrong incentives that the regulation created. Furthermore, the regulation creates no incentive at all for manufacturers to keep increasing their fuel efficiency beyond the standard. Once the manufacturer reaches the standard fuel economy, which has been stagnant for more than a decade, a further increase only means an accumulation of useless credits that expire within three years if not used. The standards create an incentive for manufacturers who have a fuel economy beyond the standard to produce less efficient cars in following years in order to use their accumulated credits.

Many of these limitations have been addressed by the Energy Independence and Security ACT of 2007. For instance, the Department of Transportation has been directed to create a credit trading program to eliminate the issues with incentives that cumulated credits create. Other limitations persist, though.

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Appendix I :

Historical CAFE Standards (Citation 45)

Model Year	Passenger Cars	Light Trucks		
		Combined	2 WD	4 WD
1978	18			
1979	19	17,2		
1980	20		16	14
1981	22		16,7	15
1982	24	17,5		
1983	26	19		
1984	27	20		
1985	27,5	19,5		
1986	26	20		
1987	26	20,5		
1988	26	20,5		
1989	26,5	20,5		
1990	27,5	20		
1991	27,5	20,2		
1992	27,5	20,2		
1993	27,5	20,4		
1994	27,5	20,5		
1995	27,5	20,6		
1996	27,5	20,7		
1997	27,5	20,7		
1998	27,5	20,7		
1999	27,5	20,7		
2000	27,5	20,7		
2001	27,5	20,7		
2002	27,5	20,7		
2003	27,5	20,7		
2004	27,5	20,7		
2005	27,5	21		
2006	27,5	21,6		
2007	27,5	22,2		
2008	27,5	22,5		
2009	27,5	23,1		
2010	27,5	23,5		
2011	30,2	24,1		

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