

# **Achieving Vehicle Fuel Efficiency: The CAFE Standards and Beyond**

Abstract: As a series of political objectives converge and call for enhanced domestic automobile fuel efficiency, it is time to reassess the United States Corporate Average Fuel Economy (CAFE) standards and compare future options for limiting gasoline consumption. Unlike the situation in 1975 when CAFE standards were first imposed to limit America's oil dependence, now the greatest motive is to curb greenhouse gas emissions. Because climate change is necessarily a global issue, the developing world must work with the United States to enhance automobile fuel efficiency as part of a greater effort to promote sustainable development. This paper uses China to demonstrate the challenges faced by developing countries and also studies the particular opportunities China represents as the world's fastest growing automobile market. The paper concludes with four main recommendations for the United States and China: rework minimum fuel efficiency standards, raise the gasoline tax, implement a feebate system and create a binding bilateral agreement between the United States and China to achieve these policies.

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## **Executive Summary**

Automobile fuel efficiency is one of the few issues in the greater global warming debate where stricter regulations are politically feasible because of the convergence of other policy goals. In particular, the United States' massive reliance on foreign oil and the coming crunch of global oil supplies have politicians concerned about energy security calling for increased automobile fuel efficiency. In addition, environmentalists have long sought more efficient vehicles and there is also a growing awareness among segments of the population of the threats caused by increased greenhouse gas emissions. Polls consistently show that the US population supports higher fuel efficiency rates by a two to one ratio and that there is growing support for an increase in the federal gas tax even as sales of gas-guzzling vehicles remain high. Further, fuel efficiency is one of the few areas in the climate change debate where the government has a history of regulation that can easily be relied upon as a basis for new standards. Finally, the transportation sector accounts for 23% of carbon dioxide emissions worldwide, so an increase in automobile fuel efficiency would significantly affect carbon concentration in the atmosphere.

The current fuel efficiency situation in the United States is largely defined by the Energy Policy and Conservation Act, which established Corporate Average Fuel Economy (CAFE) standards for 1978-1981 and 1985 with the goal of doubling total fleet fuel efficiency by 1985 at 27.5 mpg. Unwilling to impose a gas tax in addition to already high oil prices in the midst of the Arab Oil Embargo, the government chose instead to mandate minimum fleet fuel efficiency levels. The NHTSA which currently administers the CAFE standards, defines them as the "sales weighted average fuel economy, expressed in miles per gallon, of a manufacturer's fleet of passenger cars or light trucks with a gross vehicle weight rating of 8,500 lbs or less, manufactured for sale in the United States, for any model year." (NHTSA, 2006) Unfortunately, these standards have not been significantly raised since 1984 and are in need of reform.

On the other hand, China first passed fuel efficiency regulations in 2004 but the laws are already stricter than those on the books in the United States. The Chinese regulations set varying standards for automobiles in different weight classes that by 2008 will be as high as 43 mpg for

the lightest vehicles. Unlike the CAFE standards, the Chinese regulations mandate that all vehicles as opposed to all fleets meet their weight class' standard. Though these standards are obviously a step in the right direction, they are still lower than levels in the EU and Japan and should be reformed along with the American regulations. The Chinese automobile market is predicted to grow to be the world's largest by 2020, making China's current choices on automobile fuel efficiency standards among the most important in determining atmospheric carbon concentrations over the next century.

This paper recommends four major policy overhauls to improve fuel efficiency in both the United States and China. First, fuel efficiency standards in both countries should be increased to 36 mpg by 2015 (around a 40% increase for both countries) as outlined in the 2002 McCain-Kerry fuel efficiency proposals. This should be a fleet wide standard with tradable credits so improvements can occur at least cost. Second, though politically difficult to achieve in both the United States and China, a higher gas tax would curtail unnecessary driving and reduce fuel consumption while raising automobile fuel efficiency. This paper recommends that both the United States and China impose gas taxes so that the average tax burden per gallon of gasoline is \$1.20. This is the most economically efficient option as it would incorporate the externality costs of gasoline consumption. Third, both nations should implement a feebate system that subsidizes highly fuel efficiency vehicles with taxes raised on low emissions ones, eliminating market failure by bring total gasoline lifecycle costs to the fore-market. Finally, the United States and China should commit to a bilateral agreement which obligates both countries to implement these policies in unison and so solves the free rider problem that each individual country faces in its effort to curb automobile carbon emissions.

## **The Case for Increased Fuel Efficiency**

The challenge of sustainable development is to “meet the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Report, 1987). This is achieved by linking the processes of economic growth and social reform with the constraint of environmental protection, which form the three “interdependent and mutually reinforcing pillars” of the theory, to ensure that progress today does not come at the cost of environmental degradation tomorrow (World Summit, 2005). Unfortunately, the achievement of these three components is increasingly in opposition. As more of the world’s inhabitants are able to attain a quality of life previously available only in the developed world, the strain on international resources is growing. Fundamentally, the world is stuck between a commitment to support the development of the least advantaged countries and a practical need to ensure the protection of the environment and its natural resources for years to come.

Most central to the tenets of sustainable development is the idea that the earth cannot support economic growth worldwide as it has been practiced in the developed world since the industrial revolution. Instead, the population of the world will need to start making hard decisions about who should be able to grow, how and at what cost? These questions, in turn, relate back to greater issues of justice. Intergenerationally, how much should future disutility be weighed against current utility and how much can we rely on technological progress to eliminate the problems we are pushing off for a future generation to solve? Intra-societally, how should the benefits of development be allocated within a nation and inter-societally, how can we limit the use of environmentally damaging technologies in the developing world when the developed world used and is continuing to use those same technologies to generate growth? This paper aims to tackle a part of one of these problems: how does the world limit automobile greenhouse gas emissions while promoting increased automobile ownership in the developing world?

One of the gravest threats to sustainable development worldwide is the growing presence of greenhouse gases in the atmosphere. Since 1955 carbon emissions have more than tripled from slightly less than two billion tons emitted per year to greater than 7 billion tons annually. These rates are expected to double by 2055 in the absence of limiting action (Socolow, 2006). As a

result of these emissions, the concentration of CO<sub>2</sub> in the atmosphere has risen from 310 parts per million (ppm) to 380 ppm in the last 50 years and will rise to 850 ppm based on current estimates by 2055 (Socolow, 2006). Global temperatures have already risen around one degree Celsius and could rise an additional 10 degrees within the next half-century because of this dramatic increase of carbon in the Earth's atmosphere (Socolow, 2006).

The United States is the greatest culprit, releasing a quarter of the world's CO<sub>2</sub> emissions despite representing only 5% of its citizens. Ninety-eight percent of these CO<sub>2</sub> emissions can be traced to the burning of fossil fuels. In the United States fossil fuels are used for transportation (32%), industrial processes (32%) and the commercial and residential sectors (36%) (Energy Information Administration, 1998). Internationally, transportation is responsible for 23% of greenhouse gas emissions, but this value is expected to rise as cars become economically viable for millions of citizens of developing countries (Socolow, 2006). Therefore, a reduction in automobile carbon emissions would significantly impact national and global greenhouse gas emissions and is certainly an important part of the management of global climate change.

There are a number of ways to limit automobile carbon emissions, the most effective being the introduction of cars which are driven with non-carbon containing or carbon neutral energy sources. But barring unpredicted scientific breakthroughs, the internal combustion engine with the possible addition of hybrid technology will likely remain the most widely used motor of individual transportation for the next two decades, necessitating continued reliance on fossil fuels (Socolow, 2006). This paper aims to find the right mix of policy incentives to make consumers and producers willing to drive and produce more fuel efficient automobiles as defined by reducing carbon dioxide emissions per vehicle-mile.

Automobile fuel efficiency is a good place to begin the effort to limit greenhouse gas emissions because several different policy objectives independent of climate change push for decreased consumption of oil. In particular, politicians concerned about the national security implications of the massive importation of Middle Eastern oil, economists concerned about the importation's effect on the current account deficit, and public health experts concerned about the effect of automobile exhaust on cancer rates and respiratory disease all recognize harms in the nation's consumption of oil (Collina, 2005). For these reasons, the public has consistently

supported efforts to mandate higher fuel efficiency by a two to one ratio even as they purchase inefficient gas-guzzling vehicles (Public Citizen, 2002). Finally, fuel efficiency is one of the few areas in the climate change debate where the government has a history of regulation which it can rely upon to legitimize its call for fuel efficiency and utilize as a mechanism of change.

## **Current State of US Automobile Fuel Efficiency**

### **CAFE Regulation and Other Policies**

The Arab embargo of 1973-1975 and the consequent trebling of the price of crude oil first displayed America's reliance on cheap foreign oil. A net oil producer for most of the twentieth century, America developed an appetite for large, over-powered and gas-guzzling vehicles. New car fuel efficiency had declined from a high of 14.8 miles per gallon (mpg) in 1967 to 12.9 mpg in 1974 as America's domestic oil production was gradually replaced by Middle Eastern imports (Bamberger, 2005). When the Arab exporters turned off the tap to protest the West's support of Israel in the Yom Kippur, American consumers faced skyrocketing gasoline prices, mile-long queues at gas stations and a new economic evil in stagflation.

America and its allies responded with a variety of largely permanent measures to reduce oil dependency. In 1974 Richard Nixon appointed William Simon the nation's first "energy czar" and in 1977 a cabinet level Department of Energy was created. Efforts were split between finding new sources of dependable production, largely met through offshore drilling in the North Sea and enhanced recovery of old oil fields, and maximizing end-use efficiency. The federal government launched a sophisticated advertising campaign to promote more efficient energy use, led by the Advertising Council tagline "Don't be Fuelish." The National Highway Traffic Safety Administration (NHTSA) targeted automobile fuel efficiency by immediately reducing the maximum speed on the nation's highways to 55 miles per hour, unintentionally reducing traffic fatalities 23% between 1973 and 1974 (Bamberger, 2005). Though this national speed limit was eventually repealed in 1995, a more important effort to mandate minimum fuel efficiency levels for the nation's automobile fleet continues till today.

The Energy Policy and Conservation Act established Corporate Average Fuel Economy (CAFE) standards for 1978-1981 and 1985 with the goal of doubling total fleet fuel efficiency by 1985 at 27.5 mpg (NHTSA, 2006). Unwilling to impose a gasoline tax on top of already high oil prices, Congress chose instead to mandate minimum fleet fuel efficiency levels. The NHTSA which currently administers the CAFE standards, defines them as the “sales weighted average fuel economy, expressed in miles per gallon (mpg), of a manufacturer’s fleet of passenger cars or light trucks with a gross vehicle weight rating (gvwr) of 8,500 lbs or less, manufactured for sale in the United States, for any model year” (NHTSA, 2006).

Minimum fuel efficiency standards for cars and light cars are set at different levels and so the definitions of these two types of automobiles are of critical importance. “A passenger car is any 4-wheel vehicle not designed for off-road use that is manufactured primarily for use in transporting 10 people or less. A light truck is any 4-wheel vehicle which is designed for off-road operation (has 4-wheel drive or is more than 6,000 lbs. gvwr and has physical features consistent with those of a truck); or which is designed to perform at least one of the following tasks: transport more than 10 people; provide temporary housing; provide open bed transport; permit greater cargo-carrying capacity than passenger-carrying volume; or with the use of tools can be converted to an open bed vehicle by removal of rear seats to form a flat continuous floor” (NHTSA, 2006). This definition clearly leaves great discretion at the hands of the manufacturer to define its vehicles as trucks or cars. Many sport utility vehicles (SUVs) produced today which never leave the suburbs are classified as light trucks, allowing their manufacturers far greater leeway to meet CAFE standards.

These standards have changed little since the 1985 goal date of the original legislation. Currently each manufacturer’s fleet of cars must meet at least 27.5 mpg, while light trucks have to meet a standard of 20.7 mpg, rising to 22.2 by 2008. The mandated fuel efficiency level for cars has been stable since 1989 as decreed by Congress, after dipping slightly down to 26.5 mpg in the late 1980s when Reagan era economists pushed for greater free market control. On the other hand, light truck standards have been slowly creeping up since the original 1975 legislation at the discretion of the NHTSA which is ordered to place them at the “maximum feasible level” as defined by Congress to take into “consideration four factors: technological feasibility;



economic practicability; the effect of other standards on fuel economy; and need of the nation to conserve energy” (NHTSA, 2006). NHTSA has followed this legislation by increasing minimum light truck fleet efficiency very conservatively from 17.2 mpg in 1979 to 22.2 in 2008 (NHTSA, 2006). Currently the NHTSA is legally obligated to set standards for both cars and trucks by the feasibility standard, but in practice the agency has publicly stated a willingness to protect domestic manufacturers, which disproportionately produce fuel inefficient cars, explaining the NHTSA’s wariness to increase standards (NHTSA, 2006).

Manufacturer fleet efficiency is calculated in a slightly confusing fashion. First, 30% of car models are randomly selected by the Environmental Protection Agency (EPA) for fuel efficiency testing. These vehicles are chosen off the lot and their exhaust is monitored for CO<sub>2</sub> levels while driven in controlled conditions to test for “laboratory fuel efficiency.” Any discrepancy between manufacturer stated fuel efficiency and the value the EPA finds is punishable (NHTSA, 2006). Manufacturers test the remaining 70% of vehicles. Then the fuel efficiency ratings of each model are averaged together, weighted by their sales volume, to create three fleet averages for each manufacturer. Each of these three fleets, domestic cars, imported cars and light trucks, for each of the manufacturers must meet its own standard (NHTSA, 2006). Domestic cars are defined as having over 50% of their total components manufactured in the United States; anything less is counted as an imported car. Finally, dual fuel vehicles that can run on gasoline or another non-refined crude oil fuel (ex. ethanol) have special rules that enable them to report significantly higher efficiency ratings (NHTSA, 2006).

The penalty for non-compliance is currently \$5.5 for every 0.1 mpg under the standard per vehicle (NHTSA, 2006). So if a manufacturer’s imported car fleet of 100,000 cars only makes 27 mpg, the company must pay a fine of  $(5.5 * 5 * 100,000) = \$2.75$  million. Over the history of the program domestic and Japanese manufacturers have never paid a penalty while some luxury European producers have treated the fee as simply the annual cost of doing business in America. Civil penalties for the CAFE standards have exceeded \$618 million over the life of the program (DeGaspari, 2004).

### **Problems with Current Regulation**

The most obvious and important disappointment of current automobile fuel efficiency regulation has been its inability to increase total fleet fuel efficiency significantly since 1985. Overall fleet fuel efficiency in the United States peaked in 1987 at 26.2 mpg but has decreased since to 25.2 mpg today (Gerard et al., 2003). Further, United States crude oil consumption has risen from its 1982 low of 6.2 million barrels a day (mmbd) to 9.1 mmbd as of October 2005 (CRS, 2005). In short, the CAFE program has failed to wean Americans off oil. Four main elements drive this failure to significantly affect fossil fuel consumption and continue to limit the effectiveness of CAFE standards.

First, Americans continue to buy more cars and drive them more miles as economic growth increases household incomes and population growth increases the number of potential drivers. Just as economic growth is leading to increased demand for personal transportation in the developing world, higher incomes have led to greater demand for automobiles in America. The number of vehicles on the road has increased from 147.5 million in 1988 to 191 million in 2005 (Energy Information Administration, 2006). Further, the number of miles each car is driven per year has increased from 10,200 miles to 12,040 miles (Energy Information Administration, 2006). These changes are attributable to the decreased marginal cost of driving (partially the result of higher fuel efficiency, as well as greater reliability), the greater sprawl of suburbs around urban areas and the direct effect of increased income on driving consumption.

Second, Congress has shown a continued interest in limiting the NHTSA's ability to raise fuel efficiency standards as new technologies make higher fuel efficiency levels feasible. In 1994 NHTSA initiated the process of raising CAFE standards by issuing a notice of proposed rulemaking on light duty trucks. Congress responded in fiscal years 1996 through 2001 by outlawing any expenditure in each year by the Department of Transportation, which oversees the NHTSA, on studying changes of CAFE rules thereby freezing the standards (Bamberger, 2005). In 2001 Congress changed its mind and agreed to a one-time National Academy of Sciences (NAS) report on the standards to be submitted June 30, 2001. That report advocated an expansion of the program and recognized a potential 40% improvement in car and light truck fuel economy in the next 10-15 years using existing and available technology with zero cost over the lifecycle of the vehicle (Portney, 2002). Following this report, Senators McCain and Kerry

agreed to jointly sponsor a bill that would mandate a 36 mpg minimum fuel efficiency standard across the entire automobile fleet by 2015, but the Senate instead voted for the NHTSA to study CAFE standards again (Kerry, 2002). NHTSA proposed a more modest increase in light truck fuel efficiency, but this too was limited by a bill sponsored by Senator Miller to allow “pickup trucks” to remain at the old 20.7 mpg standard (Bamberger, 2005). Politicians generally oppose any enhancements of the CAFE standards because of intense lobbying by the oil or automobile industries who claim they will be disproportionately affected compared to their foreign competitors. In particular, the big three Detroit automakers, which are already in bad financial shape, are almost totally reliant on profits from gas-guzzling SUVs; some politicians feel that more stringent standards would push the industry off the edge of the cliff and into bankruptcy. Surveys of citizens, on the other hand, show that even rural, “red state” Republicans strongly favor higher fuel efficiency standards (Public Citizen, 2006).

Current regulation places the passenger car CAFE standard at 27.5 mpg through 2008 and mandates 22.2 mpg for light trucks by that year excluding pickup trucks (NHTSA, 2006). The NHTSA has now mandated new rules for 2009-2011 that break the light truck segment into six categories as differentiated by footprint, calculated by wheelbase multiplied by track width. Each of these categories will face higher fuel efficiency requirements and the smallest light trucks will actually be required to surpass passenger car fuel efficiency minimums (NHTSA, 2006). These rules are a step in the right direction, but there is no guarantee Congress will not intervene again to limit their effectiveness.

Third, the dramatic growth in the light truck portion of the market has led to a decrease in overall fleet fuel efficiency. In 1979 total sales volume was 1.16 million for light trucks and 10.75 million for passenger cars. By 2004, the order had flipped and light trucks surpassed passenger cars in sales volume 8.38 million to 8.02 million (Finneran, 2005). Surveys suggest that consumers prefer the roominess of SUVs, the largest component of the light truck segment, and their 4-wheel drive capability (Bamberger, 2005). Further, lower fuel efficiency standards may have allowed manufacturers to place the money they would have spent on efficiency for a passenger car to invest in superior performance for a SUV. In other words, the lower CAFE standards for light trucks may have actually made them more appealing to consumers as

compared to cars. Whatever the reason, the dramatic migration from passenger cars to light trucks has affected total fleet fuel efficiency. As of 2005 the total passenger car fleet operated at 30.0 mpg, while the total light truck fleet operated at 21.8 mpg (Finneran, 2005). Clearly, a shift from the former to the latter will decrease total automobile fleet fuel efficiency.

Finally, CAFE standards fail to address the underlying market dynamics that lead consumers to purchase gas-guzzling vehicles even as they appear to support higher fuel efficiency in polls. One of the major reasons fleet fuel efficiency levels remain so low is that consumers fail to adequately consider fuel efficiency savings when purchasing a new vehicle. The 2001 NAS study concludes that consumers only consider the first three years of fuel savings when choosing a new car, though the average vehicle's life is 14 years (Portney, 2002). The result is a 60% underestimation of fuel savings, creating a marketplace that only demands fuel efficiency technology up to 40% of the breakeven price. This analysis is reflected in the internal documents of auto companies: Honda of America, for example, models consumer preferences so that they only consider fuel savings potential over the first 50,000 miles of an automobile (Portney, 2002). A result of this irrationally short payback period is the cost savings potential of fuel efficiency technologies on the margin. In other words, currently available technology could raise fuel efficiency and lower the total lifecycle price of vehicles. This technology is proven effective and already being used; higher fuel efficiency regulations in Europe show that the United States could easily increase its fleet fuel efficiency 40% with no lifecycle cost increase (Portney, 2002). David Greene sums up the data when he explains "there may be an important market failure with respect to consumers' decision-making about fuel efficiency" (Greene et al., 2005). So long as the market fails to demand fuel efficiency technologies, no level of government regulation will succeed in forcing them on the public. The problem is not the technology, but the economic incentives.

Another major problem with current fuel efficiency regulations is their detrimental effect on passenger safety. The 2001 NAS report attributed 1,300-2,600 additional fatalities to the decrease in average vehicle weight concurrent with the increase in CAFE standards in the 1970s and 1980s (Portney, 2002). The working theory explaining the fatalities is that manufacturers cut vehicle weight to meet the rising minimum fuel efficiency levels through using lighter and

weaker materials that increased fatality risk. Though this was certainly not the only way to comply, it may have been the cheapest option available to manufacturers. Robert Noland's literature review confirms this analysis that in the "early years of the CAFE standards there was an increase in fatalities associated with improvements in fuel efficiency" (Noland, 2004). Noland also finds, however, that the results are "consistent with suggestions that increased bimodal weight distributions in the vehicle fleet explain much of the effect on fatalities of changes in the fuel efficiency standards" (Noland, 2004). In other words, safety is not directly harmed by lighter cars, but rather by the greater weight difference between light and heavy cars. The current CAFE regulations offer manufacturers incentives to either raise vehicle weight above 6,000 lbs. to gain a light truck classification or to lower weight as much as possible to improve fuel efficiency within the passenger car classification. The overall effect has been a bimodal distribution of vehicle weights which has led to increased fatality risk for drivers of the lighter automobiles. Therefore, current efforts to increase light truck CAFE standards relative to passenger car standards may increase safety by narrowing the weight gap between light trucks and passenger cars.

Finally, current fuel efficiency efforts in the United States fail to address the growing international complexity of the issue, relying on a purely domestic approach that will lose effectiveness as the United States' dominant share of the automobile market subsides. CAFE standards and the other energy conservation efforts of the 1970s and 1980s were enacted primarily to secure America's energy independence from Middle Eastern producers. Though energy security still plays a role in justifying the fuel efficiency standards, the primary current challenge is to curb global transportation greenhouse gas emissions. It does not matter whether CO<sub>2</sub> is released in California, China or Indonesia; the effect on the global climate remains the same. Projections indicate that though the United States is currently responsible for about half of global personal transportation greenhouse gas emissions, the developing world will quickly become the largest contributor. As China and India join the global economy their demand for cars is bound to increase dramatically. Goldman Sachs predicts that by 2050 one third of all vehicles will be operated in these markets (Asia Times, 2005). Unless more stringently regulated now, these vehicles are also likely to be among the least efficient and thus the largest contributors to greenhouse gas emissions. Therefore, any effort to decrease automobile greenhouse gas

emissions must incorporate the developing world or risk failure. This paper will briefly analyze the situation in China as an example for potential policy options for the developing world.

## **Current State of Chinese Automobile Fuel Efficiency**

As the world's most populous country, China's rapid economic growth poses grave dangers to the global effort to curb carbon emissions. The choices China makes now in how it develops its energy services infrastructure are among the most crucial in determining global greenhouse gas emissions over the next half century. Unfortunately, though Chinese government officials recognize the existence of human influenced global warming and its potential threat to China, they do not rank curbing emissions as high a priority as most of the developed world does. Nonetheless, the convergence of other policy goals may allow the Chinese to become a leader in automobile fuel efficiency regulation and consequently an ally in the effort to curb emissions. In particular, China is very concerned about its growing reliance on foreign oil and the environmental effects of a continued increase in the number of personal automobiles.

China is now the world's second largest consumer of crude oil and the third largest importer after the United States and Japan (He et al., 2005). Oil demand has increased 40% since 2001 to 7 mmbd and is expected to double by 2025 to 14.2 mmbd (Washington Times, 2006). A 2003 internal study by the Chinese government concluded that this growth in consumption cannot be met with domestic production and that Middle Eastern oil imports will dramatically increase, equaling half of oil consumption by 2007 (China Daily, 2003). Transportation is one of the central causes of this dramatic increase as passenger and freight road transportation have grown 8 and 15 times, respectively, over the last twenty years and automobiles have become a dominant part of the transportation infrastructure (Wang, 2000). This trend will increase over the next twenty years as the three primary drivers of increases in vehicle fleets are all present in China: population growth, urbanization, and economic growth (Walsh, 2003). These factors are predicted to lead to an increase in China's vehicle fleet to 120 million automobiles by 2030 and to make it the world's largest market for new automobiles by 2025 (He et al., 2003) (Automotive Industries, 2004). Further Kevin He explains, "even though the share of oil consumption by

China's road transport out of its total oil consumption is much lower than that in developed countries, the share in China will certainly increase in the future" (He et al. 2005) .

China addressed this rapid growth in the transportation sector's oil consumption in 2004 by imposing the country's first fuel efficiency standards on new automobiles. The most critical difference with the CAFE standards is that the Chinese regulations apply to every model, not each manufacturer's fleet, so a company cannot offset a gas-guzzling model with a fuel efficient one. To allow for heavier and less naturally fuel efficient vehicles, the Chinese regulations apply different standards to sixteen different weight classes using a system similar to the reformed CAFE light truck standards but substituting weight for footprint. In addition, manufacturers must separately meet the standards for their standard and automatic transmission automobiles. The standards applied immediately to new cars in model year 2005 at levels ranging from 19 mpg for the heaviest trucks to 38 mpg for the lightest cars and they are scheduled to increase to 21 mpg and 43 mpg, respectively, in 2008 (Richard, 2005). The standards are stricter than their equivalents in the United States but less stringent than regulations in Europe and Japan. An analysis by the World Resource Institute finds that the Chinese standards represent a 5% increase over current United States automobile fleet fuel efficiency and will be a 10% improvement in 2008 (Sauer, 2004). One of the largest remaining issues is uncertainty over whether and to what degree Chinese authorities will enforce the regulations. Although all manufacturers have met the 2005 standards, it is unclear whether China will impose the 2008 regulations on time and also how the government will penalize non-compliance (Sauer, 2004). These issues will become increasingly more pressing as 2008 approaches and manufacturers face difficult choices between pulling vehicles from their lineups and investing in new fuel efficiency technology. As of now, General Motors and DaimlerChrysler both appear unlikely to meet the higher regulations (Sauer, 2004).

## **Policy Recommendations**

Because the current automobile fuel efficiency situation is much the same in the United States and China now that China has imposed fuel efficiency standards, this paper's first three

recommendations are the same for each country—a reworking of fuel efficiency standards, an increase in the gas tax, and the imposition of a feebate system. Much of the current literature on fuel efficiency focuses on choosing among these options. The following analysis will show the relative advantages and drawbacks of each, but I think it is foolish to pursue only one solution to the problem. I contend that each of these three policy options has unique merits in either its feasibility or efficacy and that because of this each mutually reinforces the others to strengthen all three policies' effect on fuel efficiency. Therefore, I advocate all three policies but recognize that each one individually achieves the majority of the benefits of the total package. The final recommendation tackles the international aspect of the issue by calling for a bilateral agreement between the United States and China to impose these new policies together. Representing the world's largest and fastest growing automobile markets, the United States and China could implement a *de facto* global standard for automobile fuel efficiency if they acted together in implementing this paper's first three proposals. Further, a bilateral agreement would force both countries to comply with the plan to improve fuel efficiency and so would solve the free rider problem that each individual country faces in its effort to curb automobile carbon emissions.

**First, the United States should raise and reform CAFE standards and suggest improvements in Chinese fuel efficiency standards.** For all their problems, CAFE standards have a crucial benefit in their current existence. Unlike the other options to be explored later, the CAFE system has a functioning bureaucracy and series of rules that can be easily expanded and wielded to enforce higher fuel efficiency standards through direct regulation of manufacturers. Further, the public has shown strong support for CAFE standards since their inception in the 1970s and Congress has shown a recent willingness to stiffen them. Unlike passing a gas tax or feebate system, reforming CAFE is politically possible, and thus must be seen as the first option in increasing fuel efficiency. Similarly, China's recent fuel efficiency regulations show that imposing standards is politically feasible there even as China tries to enhance personal ownership of automobiles. Further, the recent nature of the legislation and the scheduled 2008 alterations of it offer an opportunity to institute the reforms I suggest here.

Beyond the political expediency of the option, reforming fuel efficiency standards exclusively enables directly setting minimum fuel efficiency levels, sidestepping consumers who



fail to consider total fuel savings over the life of a vehicle. Greene explains that “setting fuel economy standards would be a more effective approach [than increasing the gasoline tax] because regulation circumvents the market failure” of consumers and instead “manufacturers would accurately weigh the costs and benefits of increasing MPG so as to avoid fees and capture rebates” (Greene et al., 2005). Further, CAFE standards guarantee success in achieving whatever fuel efficiency level the government demands. Because the other options indirectly affect consumer behavior by taxing fuel use or fuel efficiency rather than setting efficiency levels, the government cannot easily determine what the exact effect of these policies on fuel efficiency will be. The costs of gasoline and vehicles fluctuate independent of potential taxes. A market based approach would thus result in fluctuating fuel efficiency levels. The only way to guarantee a minimum fuel efficiency level is through instituting standards through a reformed CAFE system and an equivalent in China.

In the United States recently agreed upon rules for a reformed CAFE system in 2009 are steps in the right direction, but they must be followed by a greater transformation that simplifies the standards. Starting in 2009, car manufacturers will have the choice of complying with either the traditional “unreformed” light truck standard of 23.1 mpg, or a “reformed” sliding scale of standards determined by a vehicles’ footprint (NHTSA, 2006). These changes will enable the NHTSA to more accurately target specific types of light trucks for fuel efficiency improvements. Small SUVs, which are clearly capable of high fuel efficiency, can be regulated at a higher level than massive cargo hauling trucks that are more difficult to make highly efficient. Further, the change diminishes the incentive manufacturers have to develop a fleet with a bimodal weight distribution as fuel efficiency minimums more smoothly increase as size increases.

Though I believe this effort a strong start, the ultimate goal for fuel efficiency standards should be a unified standard for the entire fleet. Collapsing the passenger car and light truck segments will force manufacturers to deal with the increased popularity of SUVs by either making them more efficient or raising their price to stimulate more passenger car purchases. The imported and domestic fleet distinction should also be removed. Instead, all manufacturers should face a single 36 mpg standard for all of their vehicles by 2015 as suggested by the proposed Kerry-McCain fuel efficiency legislation of 2002 (Kerry, 2002). A 36 mpg target

approximates the 40% increase the NAS report found would not increase total vehicle lifecycle costs (Portney, 2002). Further, the plan already has bipartisan support in the Senate and should be used as a starting point for fuel efficiency standards reform. The NHTSA and its Chinese equivalent should set standards for the intervening years ramping up to this fuel efficiency goal. A quick back of the envelope calculation suggests that implementing this plan would ultimately lower gasoline consumption by 25% in the United States and China once the car infrastructure totally transitions to the new standard over a period of fourteen years assuming exogenous forces do not affect the market (Parry, 2005).

To make sure fuel efficiency is increased resourcefully, the new standards should allow credit trading between car manufacturers. For example, if in 2015 the Nissan fleet of 100,000 new vehicles sold in China exceeds the 36 mpg standard by 1 mpg, Nissan should be able to sell this excess fuel efficiency to Kia whose fleet of 50,000 vehicles averages 2 mpg below standards. Kia could then claim the excess efficiency credits bought from Nissan when complying with fuel efficiency standards. Though manufacturers can trade credits between models and model years under the current CAFE system in the United States, they are unable to trade them between each other, and in China companies can't even trade credits between models because every model must meet the standard. Credit trading would allow the marketplace to increase fuel efficiency only where it is cheapest to do so, minimizing the cost of fuel efficiency increases. The Congressional Budget Office finds that allowing credit trading on a theoretical 10% increase in CAFE standards would save \$600 million in total welfare annually (Austin, 2003).

To ensure that companies trade credits rather than accept annual penalties as certain luxury European manufacturers currently do, the penalty rate should quadruple to \$22.00 per 0.1 mpg over the standard per vehicle. This rate is roughly equivalent to the inflation adjusted original 1975 penalty and should be effective in promoting trading rather than non-compliance (NHTSA, 2005). All manufacturers should be forced to ensure that their fleet complies with standards by either increasing its fuel efficiency or buying credits from a fleet that exceeds the standard. If significant numbers of manufacturers continue to fail to comply the penalty should be raised until virtually all manufacturers meet the standard through innovation or trading.

Finally, the NHTSA and its Chinese equivalent should set up committees that verify that design changes made to reach the higher standards do not affect vehicle safety. Reworking standards may improve safety in the United States by eliminating the weight gap between light trucks and passenger cars. On the other hand, manufacturers may be tempted to improve efficiency by decreasing vehicle weight below a safe level. Therefore, if the NHTSA or Chinese safety committee deems a new, lighter vehicle design detrimental to passenger safety, the manufacturer should be punished by removing the vehicle from its fleet fuel efficiency calculation provided that the vehicle surpasses the fuel efficiency standard.

**Second, The United States should raise the federal gasoline tax so that the total tax burden averages out to \$1.20 a gallon across the country and should suggest raising gas tax rates in China to similar levels.** Despite their unpopularity, excise taxes on gasoline have a long history in American politics. Oregon enacted the first tax on motor fuels in 1919 and by 1932 every state and the District of Columbia had imposed a levy of between two and seven cents on each gallon pumped within their borders. The federal government followed suit in that same year with a one cent tax to address a budget shortfall caused by the disappearance of liquor taxes during prohibition (Talley, 2000). Currently, total gasoline tax rates vary by state from 26.4¢/gallon in Alaska to 53.5¢/gallon in Hawaii with a national average of 42¢/gallon (API, 2002). On the other hand, China has never had a fuel tax and currently charges no more than the VAT and consumption tax it imposes on all consumer purchases. However, there is increasing pressure to levy one at around 60¢/gallon to ward of a potential energy crisis by easing the growth in gasoline consumption (Dashan, 2004). By way of contrast, the Netherlands imposes a tax of \$3.25/gallon exclusive of their 19% VAT, making two thirds of the price of gasoline directly attributable to the Dutch government (Wikipedia, 2006). Most of the developed world has tax rates close to the Dutch model, demonstrating the considerable room for growth in American and Chinese gas tax rates.

The externality costs born by society of gasoline consumption should be incorporated into the price of gasoline through greater taxation. In the most complete study to date, Ian W.H Parry and Kenneth Small determined what they termed the “proper rate of gasoline taxes” by estimating the cost per vehicle mile of various externalities, converting these costs to a per gallon

basis and accounting for the endogeneity of fuel economy, that is that higher taxes will lead consumers to purchase more fuel efficient vehicles in addition to driving fewer miles (Parry, 2005). Parry and Small conclude that the market would allocate resources most efficiently if the United States set gasoline taxes at \$1.01/gallon (Parry, 2005). These rates include a 6¢/gallon charge for greenhouse gas emissions derived from a theoretical \$25 tax on each ton of carbon emitted. The other major externality costs include, in order of importance: traffic congestion, traffic accidents and local air pollution (Parry, 2005). Although the study suggests that current gasoline taxes are too low, it does not even consider the significant externality cost inherent in the United States' dependence on foreign oil and, further, it uses a carbon tax rate half of the conventional value of \$50/ton emitted. For these reasons, I view this \$1.01/gallon estimate as the lower bound of an efficient gas tax estimate and advocate a slightly higher \$1.20/gallon rate which incorporates a 13¢/gallon charge for energy security externalities as well as a 12¢/gallon charge for greenhouse gas emissions which is equivalent to \$50/ton of carbon emitted. Though this is only a rough and ready estimate, I find it hard to believe that the energy security costs of gasoline consumption are less than 13¢/gallon when the relative costs of foreign policy entanglements in the Middle East are compared to the combined costs of congestion and traffic accidents (responsible for 29¢/gallon and 24¢/gallon respectively) (Parry, 2005). I further claim that the externality costs of gasoline consumption in China are comparable to those in the United States so that a \$1.20/gallon tax is applicable there as well. Therefore, gasoline taxes in the United States can be nearly tripled and in China they should be enacted for the first time at \$1.20/gallon. The impact of this tax on gas consumption would depend on the price of gasoline, but a back of the envelope calculation suggests that in the United States the imposition of the tax in addition to the recent increase in the price of gasoline from ~\$1.80/gallon to the current \$3/gallon would decrease gasoline consumption in the long-term by 42.2% as compared to 25.3% if the tax were not implemented (Parry, 2005).

A major benefit of imposing a gasoline tax rather than improving fuel efficiency through directly raising fuel efficiency standards is the elimination of the “rebound effect” which leads to increased driving when the marginal cost per mile decreases. By increasing the fuel efficiency of vehicles, a higher standard would lead consumers to choose to drive more because each

additional mile is cheaper as fuel costs per mile decrease. This effect is variously estimated at between 10% and 40% but is generally found to hover around 20% (Van Dender, 2005). Therefore an increase in fuel efficiency to 36 mpg from the current fleet-wide 25.2 mpg in the United States would only reap 80% of the benefits in fuel consumption shrinkage and would be equivalent to an increase to 33.8 mpg if driving habits remained the same (Finneran, 2005). Increasing the gasoline tax directly raises the price of vehicle travel and therefore is a more effective mechanism to reduce gasoline consumption and hence greenhouse gas emissions. Further, a gasoline tax affects all drivers immediately while an increase in fuel efficiency standards only affects drivers of new cars. Therefore, a gasoline tax is a far more effective mechanism in the near-term to decrease gas consumption. A recent joint study by the Century Foundation and Brookings Institution confirmed these benefits of a tax over direct regulation when they found that imposing a 25¢/gallon increase in the gasoline tax in 1975 would have saved more oil than the entire CAFE system since its inception (Nivola, 2000).

On the other hand, the major drawbacks of a gasoline tax are its political infeasibility and regressive wealth distribution effects. With gasoline prices skyrocketing, Congress is looking into legislation that would subsidize gasoline, not tax it further and suggesting gasoline taxes has long been a road to political suicide. China has also had difficulty in imposing a gas tax as farmers and their supporters have galvanized a populist movement against them (China Daily, 2003). Further, there is a fear that higher gasoline taxes would tend to affect individuals fairly equally across the income spectrum and hence would proportionately hit the poor hardest. Any increase in gasoline taxes could significantly affect the tax burdens of different income classes, making the tax code more regressive unless other taxes are altered accordingly to offset the change. However, a 1991 study by MIT economist James Poterba concluded that “low expenditure households devote a smaller share of their budget to gasoline than do their counterparts in the middle of the expenditure distribution” (Mankiw, 1999). Further, European countries have combined extremely high gasoline taxes with a social structure far more progressive than that of the United States by providing tax breaks for the poor through other means. The United States could follow this model if there are concerns about income distribution effects.

**Third, the United States and China should implement a feebate system that subsidizes fuel efficient vehicles with revenues raised from fines on gas-guzzling ones.**

Though enacting a gasoline tax would be effective in increasing the marginal cost of driving and thus pushing greenhouse gas emissions down as drivers choose to drive less, it would not address the market failure where consumers of new automobiles fail to consider the total lifecycle costs of their new vehicle. Instead of discounting the total fourteen year operating costs of a new automobile, consumers seem only to consider the first three years of costs (Portney, 2002). David L. Greene, Philip Patterson, Margaret Singh and Jia Li find that without this irrational decision making the total fleet fuel-efficiency would currently be 32 mpg (Greene et al., 2005).

Therefore, I propose that the United States and China impose a feebate system which eliminates consumer irrationality by pushing total lifecycle costs up the point of purchase. The system would work by setting a subsidy and tax rate for each unit of fuel efficiency a vehicle is above or below the pivot point between subsidized and taxed vehicles. In the system I propose, the government would set this level at \$1,000 per .01 gallons per mile (gpm). Therefore, if the pivot point was set at 20 mpg, an automobile that operated at 25 mpg would be subsidized \$1,000 and a vehicle that operated at 16.7 mpg would be taxed \$1,000. One of the major benefits of this system is that depending on where the pivot is set, the government can make the entire policy a tax, a subsidy, or revenue-neutral. I propose that the pivot point be originally set at the fuel efficiency regulation standard and then raised accordingly each year to ensure revenue-neutrality. This system at \$1,000 per .01 gpm would ultimately result in a fleet-wide fuel efficiency of 32.3 mpg, approximating the fuel efficiency level the market would allocate without irrational behavior (Greene et al., 2005). The proposal would result in a 21.6% decrease in annual fuel consumption by 2030 assuming exogenous factors did not affect the market (Greene et al, 2005).

In addition to rectifying a market inefficiency, a feebate system would also provide a constant incentive for innovation in fuel efficiency technology for all manufacturers. Though the reformed fuel efficiency standards explained in this paper offer an incentive to manufacturers already complying with fuel efficiency regulations to continue to improve fuel efficiency so they can sell their credits to non-complying manufacturers, the worth of these credits is dependent on the fuel efficiency level of the total vehicle fleet. If most manufacturers are complying with the

standard, then the price complying manufacturers can sell credits for decreases and there is little incentive to improve fuel efficiency. On the other hand, this feebate system sets a price for fuel efficiency improvements at \$1,000 per .01 gallons per mile and promotes any improvement in fuel efficiency that is cheaper than this rate. In short, it would lead to greater innovation and fuel efficiency from manufacturers who already meet the fuel efficiency standard and thus have a track record in successfully developing fuel efficiency technology.

These three proposals combined offer very powerful incentives to increase fuel efficiency. Increasing fuel efficiency standards provides a minimum floor for efficiency improvements and is by far the most political feasible option. This proposal offers clear guidelines to manufacturers and guarantees a certain level of success. A higher gas tax rate leads to market efficiency and decreases vehicle miles driven by increasing the marginal cost of driving. Once a car is purchased this proposal is the most effective in limiting greenhouse gas emissions. Further, it has the most immediate effect as it applies to all cars, not only new ones. Finally, a feebate system solves the consumer irrationality issue by pushing total lifecycle costs to the purchase point. This proposal also provides a constant incentive to manufacturers to innovate and develop new fuel efficiency technologies for the future. The final proposal maximizes the effects of these first three.

**Finally, the United States and China should agree to a binding agreement to implement these policies simultaneously in both countries and use the revenues raised by the policies on a joint project to develop more fuel efficient vehicles.** If the United States and China opted to work together and implement these policies on a timeline, virtually every car manufactured around the world would have to meet them as these two countries represent the present and future of the automobile industry. Further, an agreement solves two major impediments to progress in the fuel efficiency effort. First, it limits the effectiveness of internal interest groups to limit or alter the policy goals. As time passes and the immediacy of the current oil crunch subsides, oil companies, car manufacturers and other interest groups may be more successful in convincing both the Chinese and American governments to limit policies intended to improve fleet-wide fuel efficiency for their own particular interests. A bilateral agreement backed by the various trade penalties either country can impose on the other commits both

nations to the effort and ensures that the policies will be implemented and enforced. Second, an agreement eliminates the free-rider problem. Because greenhouse gas emissions affect the entire earth, the incentive of any one nation to limit its own emissions is not as large as the incentive the entire earth has to limit them. This tragedy of the commons dilemma whereby each country feels no need to limit its own emissions because of their insignificant effect on the total problem leads to inaction and finger pointing. A bilateral agreement between the United States and China would eliminate this problem by committing a good portion of the world to the effort to curb gasoline consumption.

In addition, China and the United States should seize the opportunity this agreement provides to work together in developing more fuel efficient vehicles. In particular, under the agreement the countries should pool a portion of the revenues raised from gasoline taxes and penalties in this plan to fund laboratories investigating further fuel efficiency innovation. Finally, some of this revenue should be allocated to facilitate technology transfer from the United States to China, using the technological expertise and resources of the United States to help China meet and implement the reformed fuel efficiency policies.



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