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Prospects for meeting the corporate average fuel economy standards in the U.S.

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ABSTRACT

Efforts to improve vehicle transportation efficiency and curb associated environmental emissions had led to the Corporate Average Fuel Economy (CAFE) standards introduced in 1975 for passenger cars and light trucks. The National Highway Traffic Safety Administration has phased in new standards that require an average combined fleet-wide fuel economy of 48.7–49.7 miles per gallon by 2025. The new legislation has the potential to reduce overall U.S. emissions by close to 6% should the 2025 goals be attained. The goal of this study was to assess the potential for CAFE to achieve the desired average fleet fuel economy goals set forth in the U.S., and evaluate its past effectiveness at reducing actual on-road fuel consumption and associated emissions and environmental impacts. The possibility of the 2017–2025 CAFE standards to be more or less successful than the 2011–2016 standards at meeting fuel economy goals were evaluated together with strategies that auto manufacturers would most likely use to meet the 2017–2025 CAFE standards. The study analyzed transportation efficiency trends, new vehicle sales data, fines paid to date by vehicle manufacturers, and their future projection models. Results demonstrate the effectiveness of the CAFE policy in controlling vehicle fleet efficiency in the U.S. However, the possibility of automakers adapting to presented changes quickly to meet the increasingly strict CAFE standards is unlikely, and cumulative annual fines paid by the industry may reach the order of $700 million by 2025 should current trends continue.

1. Introduction

The transportation sector accounts for 27% of U.S. greenhouse gas emissions, with no significant change from prior years (US EPA, 2013). The U.S. continues to strive for efficiency improvements in its transportation sector, both for domestic energy security as well as domestic and global environmental concerns. As per the 2015 Paris Agreement to Combat Climate Change, 187 countries have agreed to work together to keep global temperature rise below 2 degrees Celsius (UNFCCC, 2015). The agreement acknowledges that meeting this goal will require all countries to peak their greenhouse gas emissions as soon as possible. The U.S. has committed to reduce greenhouse gas emissions by 26–28% from the 2005 levels by year 2025 (The White House, 2015b; The White House, 2015a). Due to the significant share of emissions of the transportation sector, the goals set by the U.S. require significant emission reductions from the sector.

Efforts to improve vehicle transportation efficiency and curb associated environmental impacts has led to the revision of Corporate Average Fuel Economy (CAFE) standards for passenger cars and light trucks, which were first enacted by Congress in 1975 (NHTSA, 2012). The new legislation for model years 2017–2025 is a follow-up of a similar rule for model years 2012–2016, which the National Highway Traffic Safety Administration (NHTSA) has deemed a success (NHTSA, 2012). For 2017, the compliance level was set for 35.1–35.4 mpg, a level that few auto manufacturers appear ready to meet. The NHTSA will phase in the new standards by requiring an average combined fleet-wide fuel economy of 40.3– 41.0 miles per gallon (mpg) by 2021, and 48.7–49.7 mpg by 2025.

Despite decades of CAFE implementation, the U.S. still lags behind other developed countries in terms of average fuel economy (An et al., 2011; An and Sauer, 2004; Atabani et al., 2011). According to the United Nations Department of Economic and Social Affairs, in 2014, Europe had an average fleet-wide fuel economy of 50 mpg, China had 38 mpg, while the U.S. stood at 32 mpg (An et al., 2011). Despite technological and legislative developments following the Energy Policy and Conservation Act, fuel economy in the United States remained

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unchanged for the 15 years following that Act (Schipper, 2007). Increased fuel economy will continue to be a necessary component in reaching the emissions goals that were agreed upon at the 2015 Paris Agreement. Making adjustments to increase average fleet fuel economy would be the primary way for automakers to avoid the high fines imposed by CAFE and contribute positively to the United States' carbon emissions goals.

The goal of this paper is to assess the effectiveness of CAFE for meeting U.S. greenhouse gas emissions goals. Past effectiveness of CAFE at reducing actual on-road fuel use is evaluated, and the possibility of the 2017–2025 CAFE standards to be successful than the 2011–2016 standards at meeting fuel use reduction goals is also assessed. Strategies that auto manufacturers could implement to meet the 2017–2025 CAFE standards and their potential success in terms of actually meeting U.S. fuel use reduction goals are investigated.

This study conducted an analysis of the impacts of manufacturers not realizing the set CAFE standard limits within the proposed timeframe along with a study on past transportation efficiency trends and projected future trends. Additionally, this study identified ways in which automobile manufacturers could potentially reach the fuel efficiency goals set forth in the CAFE standards, or alternative measures that should be put in place of CAFE. The study reviewed issues with current standards, along with proposed technologies to reach the set standards as they currently exist, including the utilization of lighter and/or smaller vehicles, along with the adoption of alternative technologies such as hybrids and electric vehicles. A review of the literature on the effectiveness of fuel efficiency standards versus gasoline taxes to reduce overall carbon emissions was also carried out.

2. Factors influencing total fuel consumption

There are a variety of variables influencing the amount of vehicle fuel consumers use. These factors include vehicle size and weight, engine efficiency and performance, individual driving behavior, vehicle purchasing behavior, fuel prices, fuel types and alternative fuel technology, differences between on-road fuel economy versus test values, and methods used to track fuel use and emissions. Relationships between these listed factors and total fuel consumption are discussed in this section.

2.1. Vehicle size and weight

Weight has risen in vehicles, enough to counteract any improvements made in technological efficiency in the United States from the mid-1990s (Schipper, 2007). Thus, U.S. cars and light trucks are ranked as being the heaviest of any nation. In other developed countries of Europe, Sweden was found to have the heaviest cars while Italy had the lightest–this is thought to be due to taxation and existing car policies in the respective countries (Schipper et al., 1993). Reductions in vehicle weight through design and material selection, such as opting for high strength steel, aluminum, plastics, and composites, has important effects on vehicle fuel consumption as reductions in weight tackle losses from both inertial loads as well as rolling resistance (Plotkin, 2009). Such measures also improve life cycle management of resources used in vehicle manufacturing (Kumar and Sutherland, 2009; Diener and Tillman, 2016).

2.2. Engine efficiency and performance

Engine efficiency has increased over the past several decades, insinuating that fuel economy should have seen improvements far higher than observed. However, a simultaneous increase in vehicle size, weight, and power has counteracted any such performance improvements (Plotkin, 2009).

2.3. Fuel prices and driving behavior

It is important to understand the relationship between fuel prices and driving behavior. In the short-term, consumers respond in a predictable way to higher fuel prices, by decreasing mostly the amount of optional, as well as the most fuel-intense miles they drive (Lutter and Kravitz, 2003). However, the long-term impacts of an increase in fuel price are less straightforward, although more important to determine trends and for policy perspectives. Fuel prices may directly affect outcomes, as changes in total miles driven, or indirectly as an influence on a multi-car family's decision on which car to drive (Schipper, 2007).

2.4. Fuel prices, feebates, and other economic incentives

It is also important to understand how increased fuel prices influence car manufacturers in developing more fuel efficient vehicles (Schipper, 2007). When fuel prices are appropriately high, consumers will opt for vehicles with fuel saving technologies, thus driving demand for vehicle manufacturers to innovate and produce in this area (Portney et al., 2003). A study focusing on the European Union (EU) market identified that increased fuel prices were more effective at reducing fuel use than incentive programs for fuel efficient cars (Ryan et al., 2009). One such incentive program might be the feebate incentive, which imposes a fee on gas-guzzling vehicles and in turn applies that fee as a rebate for fuel efficient vehicles (Portney et al., 2003).

2.5. Purchasing behavior

Regarding the relationship between fuel prices and a consumer's car buying decision, recent studies indicate that U.S. consumers place more value on increased power rather than increased fuel efficiency. From an economic perspective, in the U.S., 2014's best-selling compact and midsize vehicle models with increased fuel economy were found to have a benefit-cost ratio of 0.72, a value less than 1.0, which does not incentivize purchasing these vehicles economically. The benefit-cost ratios reach 1.0 when annual driving distance was greater than 16,400 miles, or when fuel prices exceed $5.60 per gallon (Simmons et al., 2015). Studies also show that consumers do not act rationally when put in the position of considering the tradeoffs between vehicle costs and fuel efficiency; consumers have been found largely to ignore even attempting such an evaluation between tradeoffs, as well as demanding rapid payback periods when asked to consider opting for fuel saving technology (Turrentine and Kurani, 2007; Plotkin, 2009).

2.6. Differences between actual on-road fleet fuel economy and test values

Real world fuel economy, often referred to as "adjusted fuel economy" is lower than the values reported by the EPA (Simmons et al., 2015). Some real-world factors affecting the adjusted fuel economy are traffic congestion, aggressive driving behavior, and in-car accessory use, making a 35 mpg EPA rated vehicle test values be closer to 29 mpg on the actual road (Schipper, 2007). Discrepancies between fuel efficiency test values and on-road efficiency values also include those that can be incurred if tests do not simulate ambient hot and cold temperature extremes vehicles may be subject to operating in, as well as vehicle accessory use, such as air conditioning. The EPA redesigned their testing requirements beginning for model year 2008 vehicles, building in tests for aggressive driving, vehicle accessory use, cold environment driving, as well as traveling at speeds up to 80 miles per hour. It has been proposed that outfitting vehicle dashboards with real-time fuel economy indicators could improve driving style choices by drivers to the tune of 10% fuel economy improvement (Plotkin, 2009).

3. Development and progression of CAFE standards

CAFE standards were enacted in the U.S. in 1975 through the