Energy Policy 37 (2009) 3168–3170

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Fuel efficiency of vehicles on US roads: 1923–2006

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ARTICLE INFO

Article history:
Received 19 February 2009
Accepted 2 April 2009
Available online 5 May 2009

Keywords:
Road transportation
Fuel efficiency
Vehicle classes

ABSTRACT

This article documents and analyzes the changes in fuel efficiency of vehicles on US roads between 1923 and 2006. Information about distances driven and fuel consumed was used to calculate the on-the-road fuel efficiency of the overall fleet and of different classes of vehicles. The overall fleet fuel efficiency decreased from 14 mpg in 1923 to 11.9 mpg in 1973. Starting in 1974, efficiency increased rapidly to 16.9 mpg in 1991. Thereafter, improvements have been small, with efficiency reaching 17.2 mpg in 2006. The information for 2006 was used to calculate the fuel-efficiency improvements in different classes of vehicles that would be needed to achieve a given percentage reduction in the total amount of fuel consumed by all vehicles.

1. Introduction

Previous studies on fuel efficiency of vehicles in the US examined either the nominal (test) performance of new vehicles (e.g., National Research Council, 1992; Environmental Protection Agency, 2008), or presented information about the actual (on-the-road) performance for a limited time period (e.g., Parsons, 1986; Noland, 2004). The main contribution of this article is to document and analyze the annual changes in the actual fuel efficiency of vehicles on US roads for a 64-year period from 1923 to 2006. In addition to presenting the trends for the overall vehicle fleet, fuel-efficiency information is also analyzed separately for cars and different types of trucks. The information for 2006 is then used to calculate the fuel-efficiency improvements in different classes of vehicles that would be needed to achieve a given percentage reduction in the total amount of fuel consumed by all vehicles.

2. Method

The data for this analysis consisted of estimated miles driven per gallon of fuel for each year from 1923 through 2006. For 1923 through 1935, fuel efficiency was calculated by dividing the estimated fuel consumption for highway use (Department of Commerce, 1957) into the estimated miles driven (National Safety Council, 2007). For 1936 through 1985, fuel efficiency was calculated from the information in Department of Transportation (1987). Finally, online versions of annual statistics (Department of Transportation, annual) were the sources of the information for 1986 through 2006.

For 1923 through 1935, fuel-efficiency information is available only for the overall fleet of all vehicles. For 1936 through 1965, separate estimates are available for cars and trucks. For this time period, "cars" included motorcycles as well. However, the mileage driven by motorcycles represented only a negligible fraction of the total mileage. This is evidenced by the fact that in 1966 (the first year for which separate mileage information for motorcycles is available), motorcycles accumulated 0.3% of the combined mileage for cars and motorcycles (Department of Transportation, annual).

Starting in 1966, the truck category was divided into light trucks (other two-axle four-tire vehicles), medium trucks (single-unit two-axle six-tire or more trucks), and heavy trucks (combination trucks). The light truck category originally included only pickup trucks (many used as passenger vehicles), but was expanded to include minivans and sport-utility vehicles when they were introduced. (The sales of light trucks have recently exceeded those of cars (Ward's Automotive Group, 2007).)

3. Results

Fig. 1 shows the changes in fuel efficiency between 1923 and 2006. The main findings are as follows.

3.1. Overall fleet (including cars, motorcycles, trucks, and buses)

From 1923 through 1935, fuel efficiency stayed approximately constant at around 14 mpg. (1 mpg = 0.425 km/L.) Starting in 1936, fuel efficiency gradually declined, falling to the lowest level of 11.9 mpg in 1973—the year of the oil embargo. Starting in 1974,

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doi:10.1016/j.enpol.2009.04.001

the efficiency increased rapidly to 16.9 mpg in 1991. Thereafter, improvements have been small, with the efficiency reaching 17.2 mpg in 2006.

3.2. Cars

The data for 1936 through 1991 follow a pattern similar to that of all vehicles. As with the overall fleet, there were major improvements from 1973 to 1991 (from 13.4 to 21.2 mpg). (The first Corporate Average Fuel Economy [CAFE] standards for new light-duty vehicles were enacted in 1975 and became effective with 1978 model vehicles.) The improvements from 1991 to the present were substantially smaller than those prior to 1991 (achieving 22.4 mpg in 2006), but they were greater than the improvements for the overall fleet. (By comparison, the CAFE standard for 2006 model year passenger cars was 27.5 mpg.)

3.3. All trucks

For all trucks combined, the fuel efficiency decreased from 10.2 mpg in 1936 to 7.8 mpg in 1965. This trend likely reflects, in part, the increases in vehicle size and load being carried.

3.4. Medium and heavy trucks

Since 1966 (when light trucks were split into a separate category), the efficiency of medium and heavy trucks has improved only modestly, from 5.6 mpg in 1966 to 5.9 mpg in 2006. (There are no fuel-efficiency standards for these classes of vehicles.)

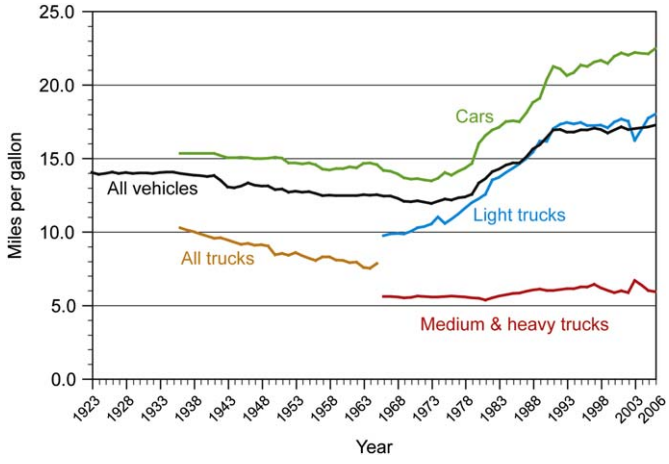

Fig. 1. Fuel efficiency of vehicles from 1923 to 2006.

3.5. Light trucks

The changes in fuel efficiency tended to parallel those for cars. Specifically, there was a rapid improvement from 1966 to 1991 (from 9.7 to 17.0 mpg). The changes since 1991 were modest, with the efficiency reaching 18.0 mpg in 2006. (The CAFE standard for 2006 model-year light trucks was 21.6 mpg.)

3.6. Potential for fuel savings

The following analysis evaluates the improvements in fuel efficiency of current vehicles of different classes that would be needed for an equivalent total reduction in fuel consumption. These calculations are based on the assumption that the distances driven by the respective classes of vehicles would remain the same as they were in 2006. (It is likely, however, that distance traveled will change as a result of natural growth and variation in economic conditions. For example, recent data show year-to-year monthly *reductions* in distances driven (Sivak, 2008). Furthermore, a rebound effect—increased travel as a consequence of improved fuel efficiency (e.g., Small and Van Dender, 2007)—needs to be considered as well.)

Table 1 presents the calculated improvements in fuel efficiency needed for a 10% reduction in the total fuel consumption for two conditions: (1) an equal percentage reduction in fuel consumption by all vehicle classes, and (2) a reduction in fuel consumption by only one class of vehicles. (The calculations are based on the mileage and fuel-consumption data in Department of Transportation, annual.)

4. Discussion

4.1. 1923 through 2006

After the 1973 oil embargo, vehicle manufacturers achieved major improvements in the on-road fuel economy of vehicles. However, the slope of the improvement has decreased substantially since 1991. Specifically, from 1973 to 1991, the efficiency of the total fleet of vehicles has improved by 42% (from 11.9 to 16.9 mpg). This represents a compound rate of improvement of 2.0% per year. On the other hand, from 1991 to 2006, the efficiency has improved by only 1.8% (from 16.9 to 17.2 mpg), representing a compound rate of improvement of 0.1% per year.

Table 1
Improvements in miles per gallon needed for a 10% reduction in the total consumption of highway fuel of all vehicles.

Vehicle class	Distance traveled, 2006 (millions of miles)	Fuel consumed, 2006 (millions of gallons)	Miles per gallon		
			Actual in 2006	Total fuel consumption in 2006 minus 10%	
				Fuel efficiency needed for across the board reduction of 10% in fuel consumption	Fuel efficiency needed if only one vehicle class were to make improvements
Cars	1,682,671	74,983	22.4	24.9	29.3
Light trucks	1,089,013	60,662	18.0	19.9	25.2
Medium and heavy trucks	223,037	37,918	5.9	6.5	10.9
All vehicles[a]	3,014,116	174,930	17.2	19.1	19.1

[a] Includes motorcycles and buses.

4.2. Future challenges

Future improvements in fuel economy of vehicles are needed across the board, for both passenger and commercial vehicles. Some of the improvements in effective fuel efficiency will come from the ongoing partial shift (due to the increased cost of fuel) from using light trucks to cars for personal transportation. Given the differences in the fuel efficiency of light trucks and cars (18.0 vs. 22.4 mpg in 2006), a complete shift would result in a 6.9% reduction in the total consumption of fuel for all vehicles. (A shift of 25% would lead to a reduction of 1.7% in fuel consumed.)

As has been argued eloquently by Larrick and Soll (2008), equal absolute increases in miles per gallon result in larger amounts of fuel saved as the initial fuel efficiency decreases (despite what most of us intuitively believe). Consider the following two scenarios, each involving 12,000 miles of driving per year. In the first scenario, an improvement from 40 to 41 mpg yields a reduction of 7 gallons of fuel per year. In the second scenario, an improvement from 15 to 16 mpg yields a reduction of 50 gallons of fuel per year.

This observation, however, does not necessarily argue that we should focus our efforts on those classes of vehicles that currently have the lowest fuel efficiency, such as heavy trucks and buses. For heavy trucks, the relevant societal measure might not be miles per gallon but miles per pound of freight. Alternatively, the relevant measure for buses is passenger (and not vehicle) miles per gallon.

The above observation suggests that our focus should be on the lower tails of the distributions of fuel efficiency in each vehicle class. In other words, society has much more to gain from improving a car from 15 to 16 mpg than from improving a car from 40 to 41 mpg. Similarly, the benefits to the society are greater from improving a truck from 4 to 4.5 mpg than from improving a truck from 7 to 7.5 mpg. Such improvements could be fostered by tax policies that assist the development and introduction of new relevant technologies and encourage scrapping older vehicles.

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