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ON-ROAD FUEL ECONOMY OF VEHICLES IN THE UNITED STATES: 1923-2013

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16. Abstract

This report documents and analyzes the changes in fuel economy of vehicles on U.S. roads between 1923 and 2013. Information about distances driven and fuel consumed was used to calculate the actual, on-road fuel economy for the entire fleet of all vehicles and for different classes of vehicles, with primary interest in light-duty vehicles (cars, pickup trucks, vans, and SUVs).

As a sample from the results, the following are the main findings for the entire fleet of all vehicles. Fuel economy *decreased* from 14.0 mpg in 1923 to 11.9 mpg in 1973. Starting in 1974, fuel economy increased rapidly to 16.9 mpg in 1991. Thereafter, improvements have been small, with fuel economy in 2013 at 17.6 mpg.

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Introduction

This study is an update of the analysis in Sivak and Tsimhoni (2009). That study examined actual, on-road vehicle fuel economy in the United States from 1923 through 2006. The present study extends the data through 2013, and it also includes retroactive adjustments made to several values by the U.S. Department of Transportation.

Method

The data for this analysis consisted of estimated miles driven per gallon of fuel for each year from 1923 through 2013. For 1923 through 1935, fuel economy was calculated by dividing the estimated fuel consumption for highway use (U.S. Department of Commerce, 1957) by the estimated miles driven (National Safety Council, 2007). For 1936 through 1985, fuel economy was calculated from the information in U.S. Department of Transportation (1987). Finally, online versions of annual statistics (U.S. Department of Transportation, annual) were the sources of the information for 1986 through 2013.

For 1923 through 1935, fuel-economy information is available only for the entire 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 (U.S. Department of Transportation, annual).

Starting in 1966, the U.S. Department of Transportation divided the truck category into other two-axle, four-tire vehicles (labeled here "light trucks"), single-unit, two-axle, six-tire trucks ("medium-duty trucks"), and combination trucks ("heavy-duty trucks").[1] The light-truck category originally included only pickup trucks, but was expanded to include vans and SUVs when they were introduced.

[1] This classification of trucks by the number of axles and tires does not necessarily correspond to other classifications, such as a classification by gross vehicle weight rating (U.S. Department of Energy, 2015).

The analysis also examined the combined group of all light-duty vehicles. Prior to 2007, this group included cars and other two-axle, four-tire vehicles. Starting with 2007, the U.S. Department of Transportation changed the division of light-duty vehicles from cars and other two-axle, four-tire vehicles, to short-wheel-base light-duty vehicles and long-wheel-base light-duty vehicles. For simplicity, in the present report we will be referring to these two groups of vehicles as "cars" and "light trucks" throughout.

It is important to note that despite the change in 2007 in how all light-duty vehicles were subdivided, the overall classification of the combined group of all light-duty vehicles did not change in 2007.

Results

Figure 1 shows the changes in on-road vehicle fuel economy between 1923 and 2013.

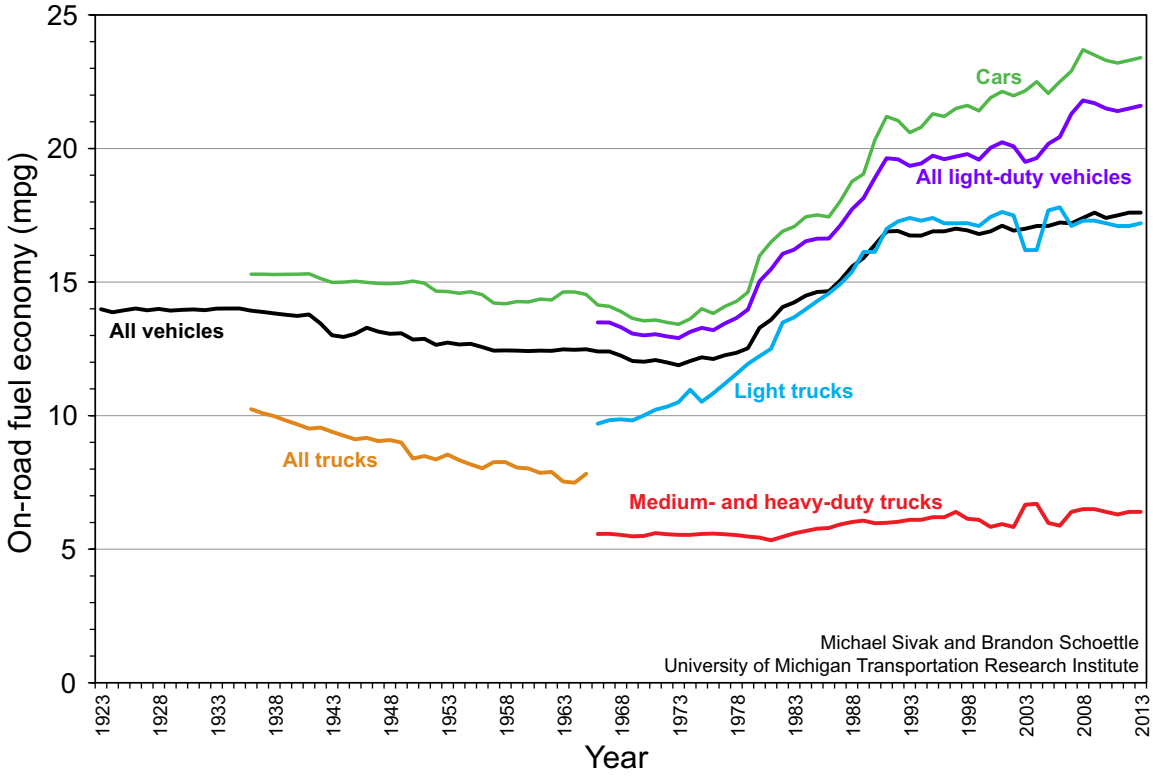

Figure 1. On-road fuel economy of vehicles from 1923 to 2013. (In 2007, there was a change in how light-duty vehicles were divided into cars and light trucks. See text.)

All vehicles (including cars, motorcycles, trucks, and buses).

From 1923 through 1935, on-road fuel economy stayed approximately constant at around 14 mpg. Starting in 1936, fuel economy gradually declined, falling to its lowest level, 11.9 mpg, in 1973—the year of the first oil embargo. Starting in 1974, fuel economy increased rapidly to 16.9 mpg in 1991. Thereafter, improvements have been small, with fuel economy at 17.6 mpg in 2013.

Cars

The data for cars follow a pattern similar to that of all vehicles. On-road fuel economy decreased from 1936 to 1973 (from 15.3 mpg to 13.4 mpg). This was followed by major improvements from 1973 to 1991 (from 13.4 mpg 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 since 1991 were small, with fuel economy at 23.4 mpg in 2013.

All trucks

For all trucks combined, the on-road fuel economy 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.)

Medium- and heavy-duty trucks

Since 1966 (when light trucks were split into a separate category), on-road fuel economy of medium- and heavy-duty trucks has improved from 5.6 mpg to 6.4 mpg in 2013.

Light trucks

On-road fuel economy of light trucks increased rapidly from 9.7 mpg in 1966 to 17.0 mpg in 1991. However, the improvements since 1991 were small, with fuel economy at 17.2 mpg in 2013.

All light-duty vehicles (cars and light trucks)

On-road fuel economy of the combined group of all light-duty vehicles decreased from 1966 to 1973 (from 13.5 mpg to 12.9 mpg). This was followed by a rapid improvement to 19.6 mpg in 1991. However, the improvements since 1991 were only modest, with fuel economy at 21.6 mpg in 2013.

Discussion

Changes in fuel economy from 1923 to 1935

From 1923 through 1935, fuel-economy information is available only for the entire fleet of all vehicles. During this period, fuel economy stayed approximately the same (at around 14 mpg).

Changes in fuel economy from 1935 to 1973

Fuel economy *decreased* from 1935 to 1973. This was the case for the entire fleet, as well as for cars and all light-duty vehicles. However, this does not imply that powertrains for vehicles have not improved during this period. Instead of focusing on fuel-economy improvements, engineers focused on increasing power and acceleration.

Changes in fuel economy from 1973 to 2013

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. For example, from 1973 to 1991, fuel economy of all light-duty vehicles improved by 51.9% (from 12.9 mpg to 19.6 mpg). This represents a compound rate of improvement of 2.4% per year. On the other hand, from 1991 to 2013, fuel economy improved by only 10.2% (from 19.6 mpg to 21.6 mpg), representing a compound rate of improvement of 0.8% per year.

Turning over the fleet

One fundamental problem with improving the fuel economy of the entire on-road fleet is that improvements in fuel economy of new vehicles take a long time to substantially influence the fuel economy of the entire fleet. This is the case because it takes many years to turn over the fleet. For example, the 16.5 million light-duty vehicles sold in the United States in 2014 (New York Times, 2015) accounted for only about 6.5% of the entire fleet of 252.7 million light-duty vehicles in operation (IHS, 2015), and the average age of light-duty vehicle on the road is currently 11.4 years (IHS, 2015).

Where do improvements matter most?

As has been argued eloquently by Larrick and Soll (2008), equal absolute increases in miles per gallon result in greater fuel savings as the initial fuel economy of a vehicle 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 about 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 economy, such as medium- and heavy-duty trucks, and buses. For medium- and heavy-duty trucks, the relevant societal measure is not miles per gallon but ton-miles of freight per gallon. Alternatively, the relevant measure for buses is passenger-miles per gallon.

The above observations suggest that our focus should be on the lower tails of the distributions of fuel economy in each vehicle class. In other words, society has much more to gain from improving a car from 15 mpg to 16 mpg than from improving a car from 40 mpg to 41 mpg. Similarly, the benefits to society are greater from improving a truck from 4 mpg to 4.5 mpg than from improving a truck from 7 mpg to 7.5 mpg (while keeping the load-carrying capacity the same).

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