Policy Brief

Science and Government

US Fuel Economy and Safety: Second-Hand Crash Deaths
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For years, many researchers, including the National Highway Traffic Safety Administration (NHSTA) and the Insurance Institute for Highway Safety (IIHS), have argued that low-mass vehicles pose a safety risk for their occupants [1,7,10]. This argument has long inhibited regulations to improve fuel economy. But the implication that low mass and likewise fuel efficient vehicles are less safe does not hold up under scrutiny of real world crash data [2,3,5,6,9]. Furthermore, safety is usually defined exclusively in terms of the risk to the occupants of the vehicle (“personal-risk”), ignoring the risk posed to occupants of a vehicle it may collide with (“societal-risk”). In this article, we argue: (1) vehicle safety (whether or not it includes societal-risk) is not correlated with fuel economy and (2) analysis of vehicle safety should include risk to others on the road.

The exposure of non-smokers to “second hand smoke” has been studied in depth [12] and is now a serious policy issue (e.g. banning smoking in public places). Similarly “second-hand crash deaths” or exposure to dangerously designed vehicles on public roadways must be addressed for other drivers. Focusing only on the risk a vehicle model poses to its own occupants is as socially irresponsible as considering only deaths of smokers.

“Combined-risk” imposed by a particular vehicle model is defined here as the number of driver-deaths in vehicles of that model plus the driver-deaths in opposing vehicles it crashed with, divided by million registered vehicles of that model. We concentrate on drivers because the exposure is known, i.e. every vehicle has a driver. A more complete definition would include other occupants, as well as pedestrians and bicyclists; but while all fatalities are known, the exposure is tenuous. Therefore we use driver deaths as a proxy. For the purposes of this article we mainly focus on two-vehicle crashes. In the first figure, the combined-risk is shown for the more popular vehicle models. One sees no correlation with fuel economy. We also break this down into “personal-risk” (driver-deaths in the vehicle model, divided by million registered vehicles) and “societal-risk” (driver-deaths in opposing vehicles, divided by million registered vehicles). The second graph shows “personal-risk” and “societal-risk” vs. fuel economy for those same models. Again, we see no statistical correlation of personal-risk with fuel economy ($R^2=0.17$) nor societal-risk with fuel economy ($R^2=0.21$). Note that the risks shown here do not account for differences among vehicle models in miles traveled, driver behavior, or driving location; these factors likely influence risks to some extent in certain cases, but do not explain the large differences shown in risk by vehicle model [7,9].

The Ford Explorer, a truck-based SUV, was remodeled for the 2002 model-year and consequently showed a remarkable improvement in safety. For model years 1997 to 2001, Explorer’s personal-risk in all types of crashes was 105 fatalities/million registrations; whereas, from 2002 to 2006, personal-risk dropped to 67. These improvements have already saved several hundred lives! The 2002 Explorer got “a wider stance, longer wheelbase and independent rear suspension” that inhibited rollovers and “starting in late MY02 optional curtain side air bags went in” [13]. These modifications decreased personal-risk, particularly in rollover crashes. Another factor is likely the discontinued use of Firestone tires, which may have led to an increase in fatal Explorer rollover crashes in the late 1990s [15]. While personal-risk in the Explorer decreased substantially, its societal-risk was unchanged, at about 75 fatalities/million registrations. If the same regulatory focus on personal-risk was also placed on societal-risk, manufacturers would be motivated to reduce their vehicles’ aggressivity to others.

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Cars have low societal-risk, while personal-risk ranges from 10 to over 100 fatalities/million registrations, depending on the model. In general, inexpensive subcompact cars tend to be riskier than larger cars; however, some of today’s subcompacts are as safe for their occupants as heavier pickups and SUVs. For example, the Honda Civic and Volkswagen Jetta have good to excellent safety records on the road. The Jetta’s personal-risk in two-vehicle crashes was 28 (for 2002-2006), among the lowest for all Light-Duty Vehicles (LDVs). Jetta and Civic are highlighted because the average drivers of these models are among the most aggressive (excluding sports car drivers), with a high fraction of young male drivers and traffic violations, such as for speeding and alcohol [6]. For these cars, safe drivers do not explain their low risks; good vehicle design is the likely explanation. Moreover, it is well known that Volkswagen and Honda have taken a special interest in structural safety, or “passive safety”. Similarly, import luxury cars have among the lowest personal-risks despite often having unsafe drivers. In contrast the cars with high personal-risk tend to be the bottom-of-the-line, inexpensive cars such as the Neon and Cavalier; both displaying personal-risk of over 100 fatalities/million registrations.

The models with high societal-risk tend to be the large pickup trucks and truck-based SUVs (see figure 2), which, in addition to low fuel economy and high mass, have very stiff and high front ends [10]. For example, the vehicles with the highest risk are the ¾ and 1 ton Ford, GMC and GM pickups. They are so heavy that they fall outside EPA regulation and their fuel economy is not measured, let alone regulated. We had to model their fuel economy based on publicly available data [17]. All of the pickup trucks and truck-based SUVs design characteristics make them especially detrimental to occupants of other vehicles with which they collide. This is especially true in the case of side impacts, where they are two to six times more deadly to car drivers in left side crashes than other vehicles [5]. Crossover SUVs tend to be less aggressive towards others on the road; they are built on a car platform which has better crash absorption and lower frontal height than the truck-based designs. This makes them much more crash-compatible with other vehicles on the road.

Mass reduction is critical to major improvement of fuel economy and decreasing gasoline consumption. In the late 1970s and early 1980s, gasoline shortages led to the virtual elimination of the heaviest cars being manufactured. This sensitivity of fuel economy to mass still applies. If the mass of today’s status-quo new vehicle were reduced 10%, its fuel economy would increase 7%, assuming adoption of smaller engines in the new lighter vehicle to match the lower weight [17]. The main safety and fuel economy argument during this time period was influential [1], but naïve - lower mass vehicles are not inherently less safe; they can be, and have been, designed to be just as safe as heavier vehicles [3-6].

When safety is only defined in terms of personal-risk, then policy can be misguided [7-11]. An example is the recent size-based fuel economy standards for light trucks, which discouraged the down-sizing of light trucks’ “footprint” (essentially length times width) in order to minimize rollover crashes. This regulation focused on the lives that could be saved by reducing rollovers (even though height is as, if not more, important than size in vehicle stability), and essentially ignored the lives that could be saved by making trucks smaller, lower, and therefore more compatible with cars. Structural compatibility (bumper heights, how stiff structures interact, etc.) is what primarily determines the overall risk in vehicle-to-vehicle collisions, and not strictly the weight or footprint of the vehicles involved. Although there has been research on vehicle compatibility (especially in Europe [14]), there currently is no regulatory test program specifically addressing it. While US manufacturers have entered into voluntarily, nonbinding agreements aimed at improving the frontal compatibility of light trucks with cars [16], they need to be given stronger incentives and/or regulations to consider the safety of other vehicles on the road. Regulators need to consider crash compatibility in vehicle safety, and fuel economy regulations, so that “second-hand” deaths from vehicle crashes are treated with as much importance as deaths from second-hand smoking.

Trucks and SUVs have a much higher societal-risk (squares over 75), but their personal risk (circles) is similar to other vehicle models (circles below 50). An interactive time-series graph of the data from 1973-2007 is available at http://empowerdesign.org/safetyandfueleconomy/ for further investigation. Specific vehicle models can be tracked overtime in terms of fuel economy, weight, personal-risk, societal-risk, combined-risk, etc.
References and Notes