Fuel Economy and Safety

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October 26, 2011

Motivation

- Long engineering and physics literature suggests that heavier vehicles are safer (Kahane 1997, 2005)
- Recent literature (much of it in economics) instead highlights the externality that weight imposes on others (White 2004, Gayer 2004, Anderson and Auffhammer working paper)
- Fuel economy standards change the mix of the whole fleet, meaning both effects enter at the same time
  - A unified model is needed

Economic Significance

- Auto accidents represent a large cost to society (fatalities alone represent $250 billion/year at typical VSL)
  - Small relative changes can profoundly alter the costs of saving gasoline
- NRC (2002), 2,000 deaths/year due to the 300-700 pound decline in fleet weight resulting from CAFE
  - Out of about 40,000 total
- Back-of-the-envelope calculation:

  $1.55 / gallon saved (cost of change in accident fatalities only)

The Arms Race

- Size and weight decreases in isolation capture single-car accidents reasonably well
  - These are 60% of fatalities inside passenger vehicles
- **But,** the same decreases have both a positive and a negative effect on the 40% of crashes that involve multiple cars
  - Negative effect on own safety
  - Positive effect on the safety of others drivers
- An arms race means the current fleet will be inefficiently large and heavy

Positioning

- The arms race gives an effect that looks like positioning
  - But here it comes from actual safety risks: Being safer in accidents with other cars in the fleet
- A "positional treadmill" along the dimensions of size, power, towing capacity, etc. will exacerbate the arms race in safety

Empirical Model of Total Fleet Fatalities

Light and heavy (L and H) => 6 types of fatal accidents

Single-Car

L $n_L\beta_L$	H $n_H\beta_H$

2-Car

LL $n_{LL}\beta_{LL}$	LH $n_{LH}\beta_{LH}$
HL $n_{HL}\beta_{HL}$	HH $n_{HH}\beta_{HH}$

To count total fatalities, need both accident rates (n) and fatality risk given an accident (β) in each cell

Data – Per Billion Miles Traveled

Class	2-Car Accident Fatality Rate		Single-Car Fatality Rate	Crash Test Fatality Risk
	Own Vehicle	Other Vehicle		
Compact	11.4	4.3	14.3	1.00
Midsize	8.6	5.1	11.3	0.93
Fullsize	8.8	6.1	10.2	0.67
Small Luxury	5.8	4.3	13.5	0.80
Large Luxury	7.2	6.0	11.9	0.89
Small SUV	3.3	5.2	9.4	1.18
Large SUV	3.2	9.3	12.8	1.00
Small Pickup	6.8	7.2	15.9	1.26
Large Pickup	4.5	14.4	18.2	1.11
Minivan	3.7	4.2	4.9	1.09

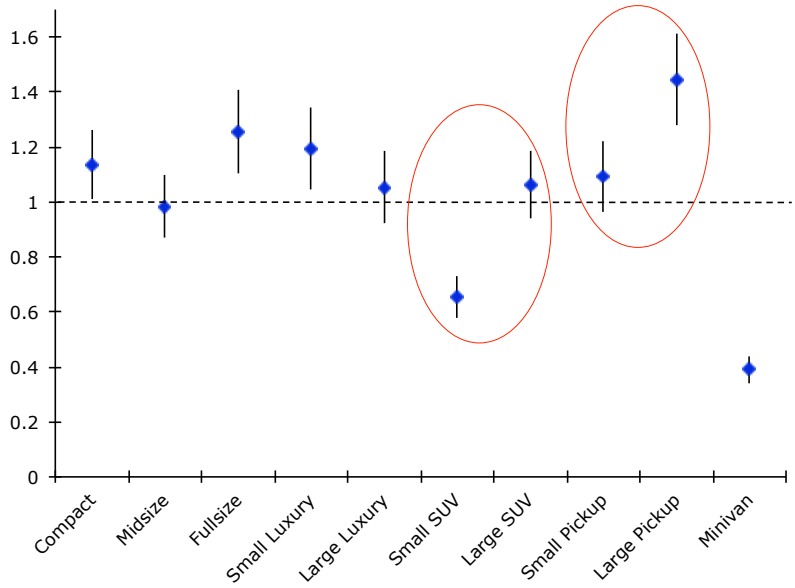
Estimation Results

- Two types of results:
  - Driver effects
  - Engineering safety (assuming a standardized driver)

- The raw data on accident rates is biased by behavior
  - Minivans look incredibly safe (age, income, etc.)
  - Small cars can look safer than large ones (urban/rural split)

Driver Effects

- Summary statistic for average driver effects by class (higher values indicate more dangerous driving behavior **or** conditions)



Intrinsic "Engineering" Safety

- For average drivers in accidents involving a compact and large pickup the fatality risk is 8 times larger in the compact
- The safest vehicle in a single-car crash is a full-size sedan
  - Small pickups are worst, carrying 1.9 times the risk
- Risk to other drivers rises by ≈40% per 1000 pounds (also varies with class)
  - 25th to 75th percentile in SUV's is 1100 pounds differential

Policy Implications

Two key factors appear:

1. Larger vehicles do better in single-car accidents (more spacing and mass to absorb energy from barriers or commercial vehicles)

2. Uniformity is essential (for example, to avoid the 8-fold risk increase in compact to pickup accidents)

A fleet of all compacts is slightly better on safety than today's fleet
- Meaning that uniformity trumps size at least to a point

Key Intuition for CAFE

	Small Car	Large Car	Small SUV	Large SUV
Initial fleet	2	2	2	2
CAFE, cars and trucks separate	3	1	3	1
CAFE, single standard	4	3	1	0

Full Simulation: Incorporating Driver Behavior

Full policy simulations include driver behavior, keeping track of how people substitute under CAFE

Keeping cars and trucks separate keeps the severe risks in unevenly matched accidents

- Safety (in single-car accidents) cost is 30 cents per gallon saved

Fuel economy policies that encourage switching between cars and trucks would slightly **improve** safety

-The reduction in the number of SUV to car collisions more than offsets the 30 cent cost from single-car accidents