Do Automobile Crash Tests Save Lives? An Impact Evaluation of the Insurance Institute for Highway Safety's Crash Testing Program

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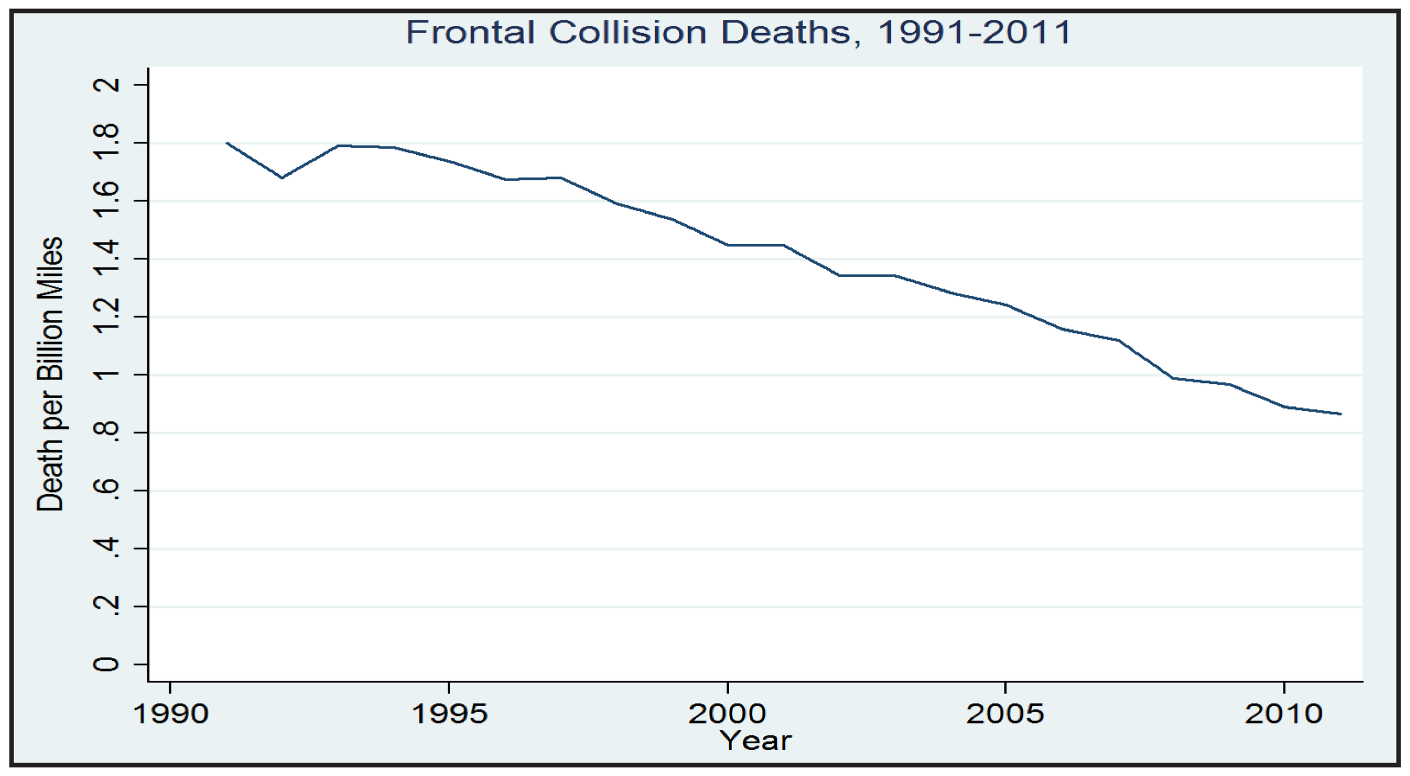
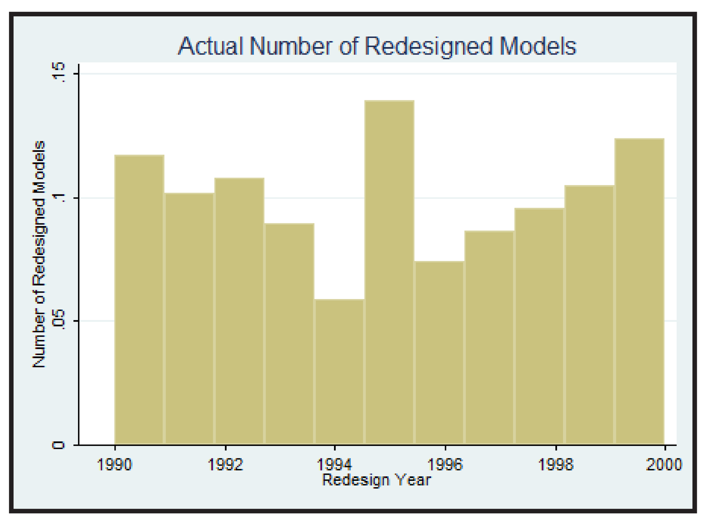
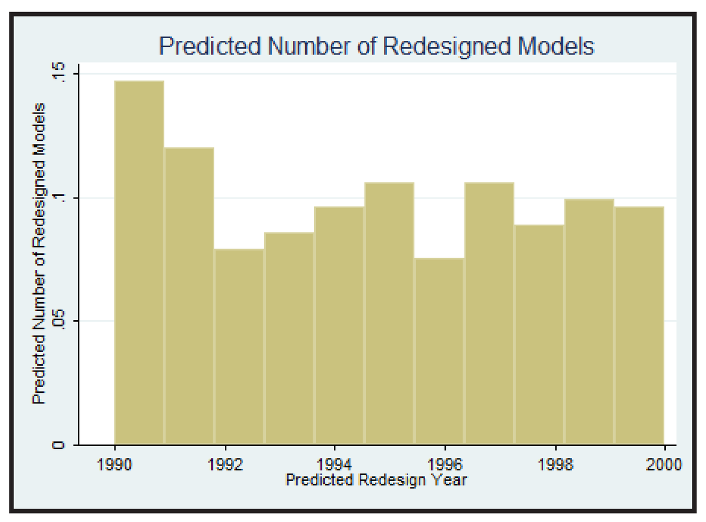
ABSTRACT:

The Insurance Institute for Highway Safety began performing frontal crash testing of vehicles in the US in 1995. Test scores demonstrate continuous improvement in models redesigned after 1995, with no evidence of earlier improvements. We analyze the relationship between year of vehicle redesign and the probability of driver death in severe head-on collisions. Redesign year is likely endogenous, so we instrument by predicting redesign year using typical time between redesigns. The instrument uncovers a pattern similar to the crash test results: fatality risk in frontal collisions was flat before 1995, but declining thereafter. The impact of these improvements is a 10% reduction in the probability of driver death in head-on collisions with a value of approximately $500 per vehicle.







METHODS:

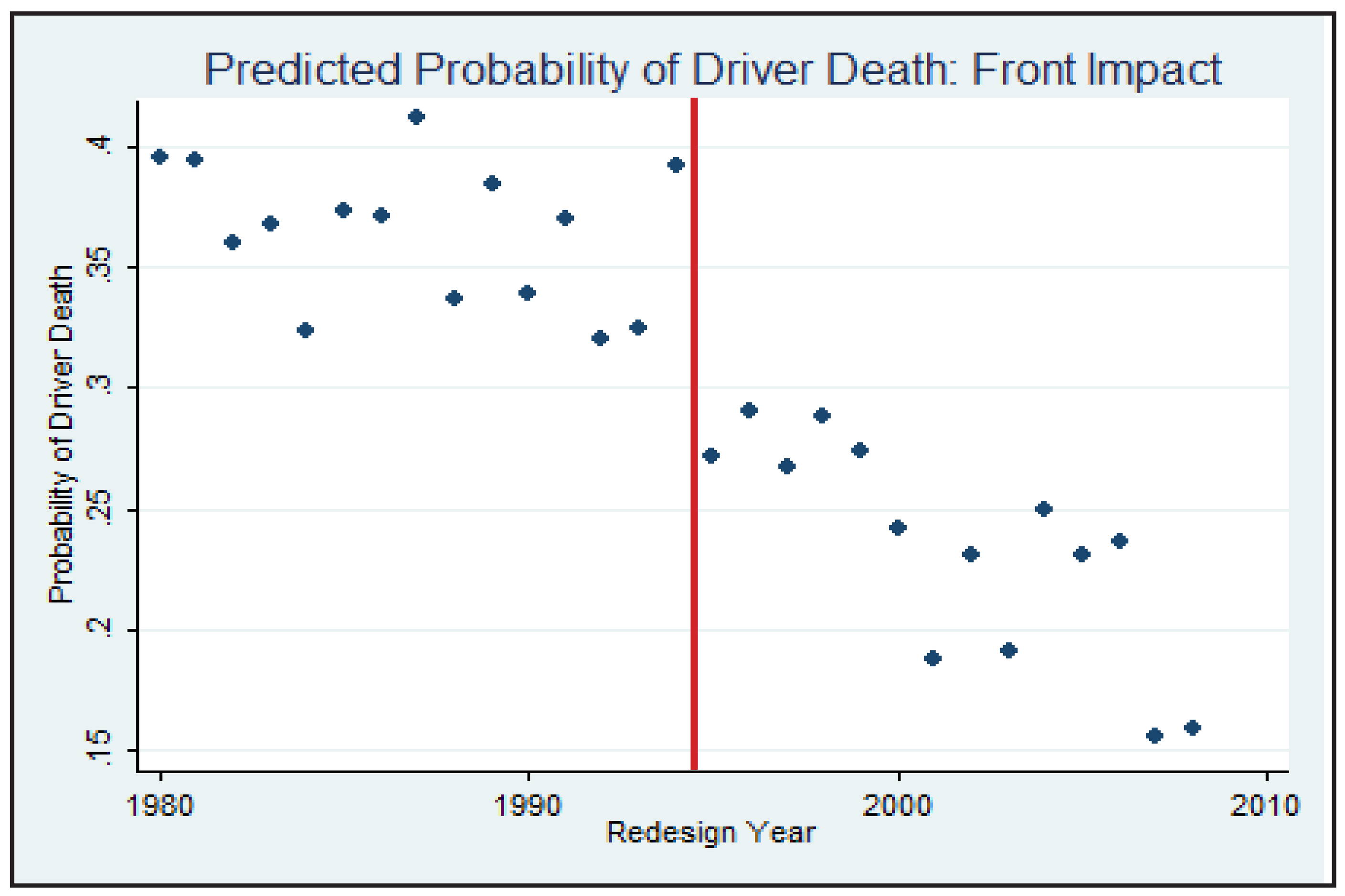
- The data used is the Fatality Analysis Reporting System (FARS)
  - Included all fatal accidents in US from 1991-2011
  - Restricted to 2 vehicle head-on collisions where both cars suffered severe damage and at least one of the two drivers died
- Label the two cars, i and j. The probability that the driver of each car died is written

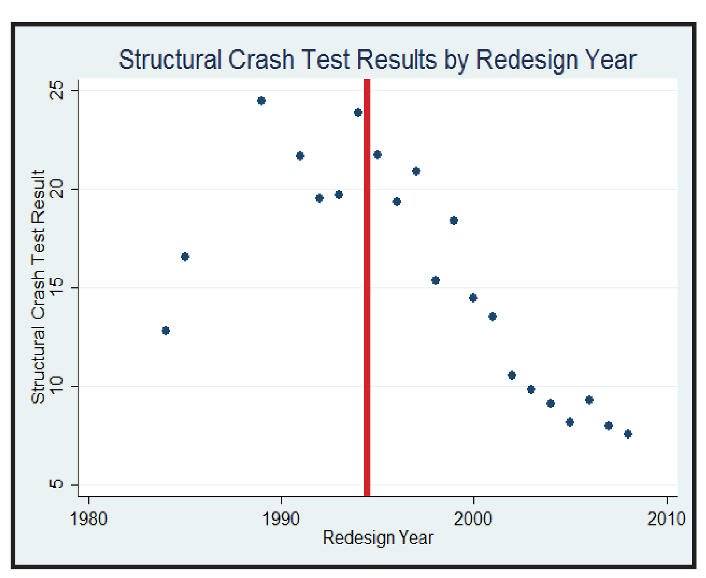
$$p_i = \Phi(X_i\alpha + Z_j\beta + A\gamma + \varepsilon)$$
$$p_j = \Phi(X_j\alpha + Z_i\beta + A\gamma + \varepsilon)$$

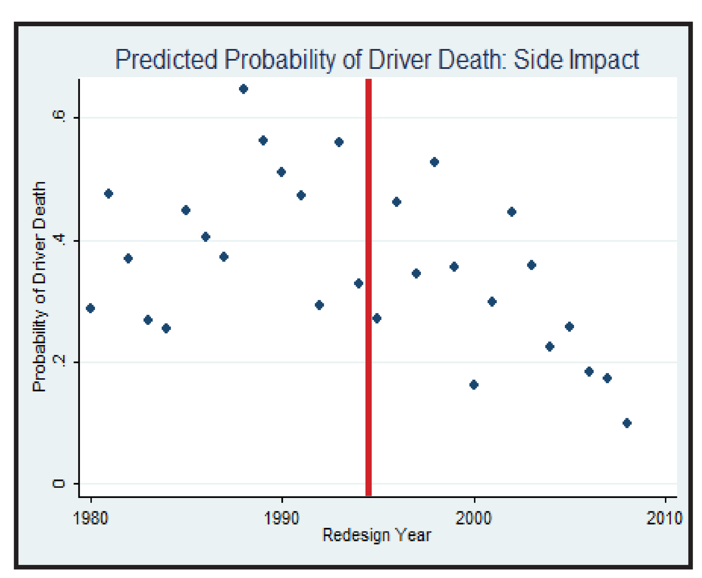
where:
  - X is a vector of "own car" characteristics
  - Z is a vector of "other car" characteristics
  - A is a vector of accident characteristics common to both cars
  - $\Phi(\cdot)$ is the cumulative standard normal distribution (to ensure predicted probabilities are between zero and one)
- For a given observed accident, the three possible outcomes with associated probabilities of observing them are:
  - Driver i dies; driver j does not die
  $$\frac{p_i(1-p_j)}{p_i + p_j - p_i p_j}$$
  - Driver i does not die; driver j dies
  $$\frac{(1-p_i)p_j}{p_i + p_j - p_i p_j}$$
  - Driver i dies; driver j dies
  $$\frac{p_i p_j}{p_i + p_j - p_i p_j}$$
- The likelihood of observing the complete dataset is simply the product of one term of the above type for each observation. The parameter vectors were estimated by maximizing the log likelihood function.
- The year in which cars are redesigned is likely endogenous. An instrument was constructed by estimating redesign year based on the usual interval between redesigns.

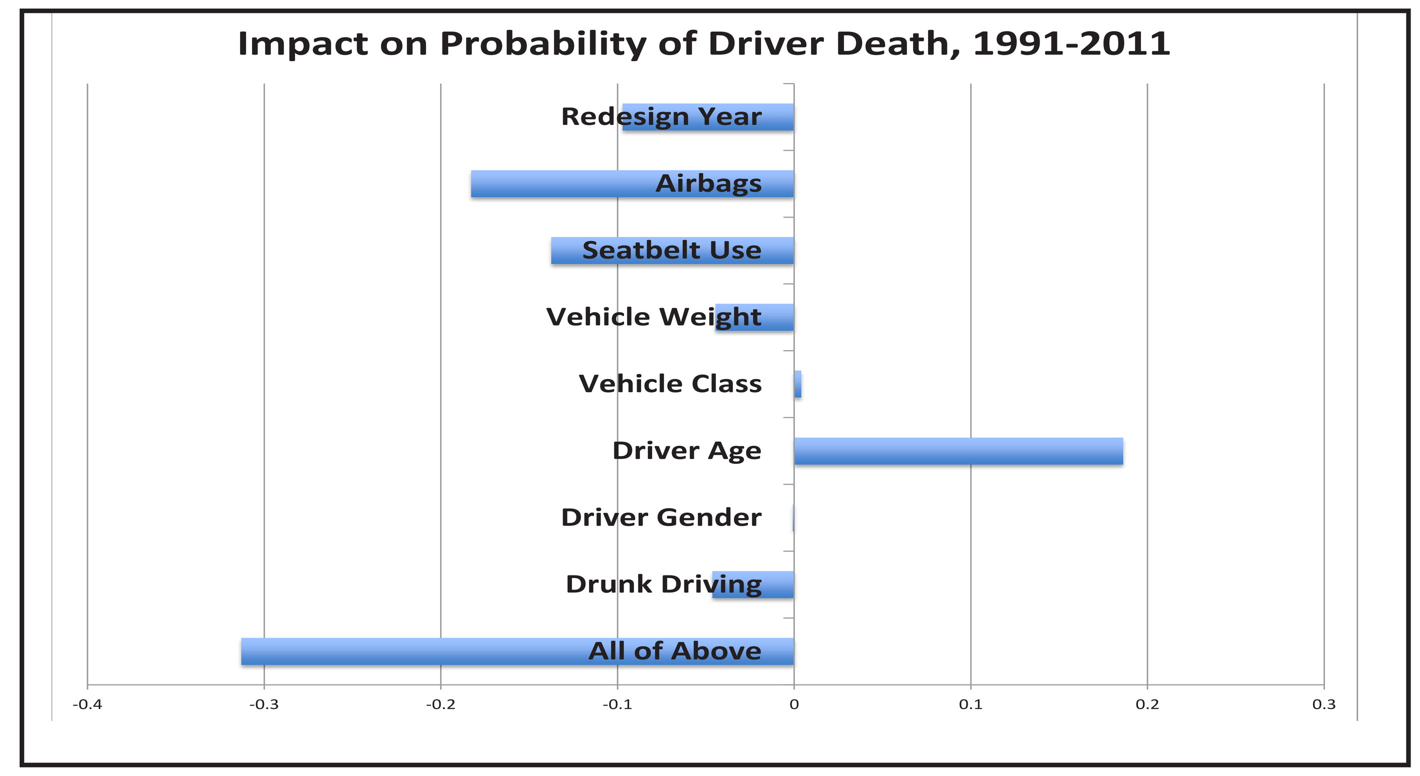
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ML	ML	ML	ML	IV1	IV2
Redesign Year	-0.0118***	-0.00483***	-0.00315***	-0.00193	0.000877	0.00214
	(0.00114)	(0.00122)	(0.00122)	(0.00141)	(0.00285)	(0.00244)
Red Yr > 1994	-0.0487***	-0.0540***	-0.0504***	-0.0352***	-0.000497	-0.0117
	(0.0108)	(0.0109)	(0.0110)	(0.0126)	(0.0129)	(0.0132)
Red Yr * (Red Yr > 94)	0.000621	-0.00368**	-0.00838***	-0.00584***	-0.00651**	-0.00844***
	(0.00177)	(0.00186)	(0.00186)	(0.00207)	(0.00325)	(0.00307)
Airbag Use		-0.0617***	-0.0732***	-0.0368***	-0.0590***	-0.0585***
		(0.00880)	(0.00874)	(0.00973)	(0.0127)	(0.0116)
Seatbelt Use		-0.209***	-0.214***	-0.202***	-0.204***	-0.204***
		(0.00729)	(0.00715)	(0.00744)	(0.00755)	(0.00753)
Driver Age			0.00550***	0.00717***	0.00709***	0.00712***
			(0.000154)	(0.000161)	(0.000161)	(0.000161)
Driver Female			0.0249***	0.0101	0.00833	0.00854
			(0.00587)	(0.00656)	(0.00659)	(0.00662)
Driver Drunk			0.122***	0.118***	0.120***	0.119***
			(0.0117)	(0.0115)	(0.0115)	(0.0116)
Other Driver Drunk			0.0548***	0.0585***	0.0586***	0.0591***
			(0.0109)	(0.0108)	(0.0108)	(0.0108)
Own Vehicle Wt				-0.343***	-0.359***	-0.361***
				(0.0503)	(0.0513)	(0.0512)
Own Vehicle Wt Sq				0.0291***	0.0305***	0.0307***
				(0.00746)	(0.00758)	(0.00759)
Other Vehicle Wt				0.406***	0.398***	0.397***
				(0.0523)	(0.0523)	(0.0523)
Other Vehicle Wt Sq				-0.0405***	-0.0393***	-0.0392***
				(0.00828)	(0.00829)	(0.00829)
Own Class: SUV				-0.0575***	-0.0591***	-0.0577***
				(0.0176)	(0.0176)	(0.0176)
Own Class: Minivan				-0.0275	-0.0243	-0.0240
				(0.0192)	(0.0192)	(0.0192)
Own Class: Pickup				-0.0785	-0.0718	-0.0680
				(0.103)	(0.105)	(0.105)
Other Class: SUV				0.0671***	0.0642***	0.0648***
				(0.0197)	(0.0198)	(0.0199)
Other Class: Minivan				0.0138	0.0149	0.0147
				(0.0202)	(0.0204)	(0.0204)
Other Class: Pickup				0.301**	0.304**	0.312**
				(0.146)	(0.144)	(0.145)
Year FE	yes	yes	yes	yes	yes	yes
Night/Weekend	yes	yes	yes	yes	yes	yes
Make FE	no	no	no	yes	yes	yes
Mean of p_i	0.256	0.27	0.288	0.356	0.356	0.356
1st Stage F	-	-	-	-	5322	7122
Observations	8,869	8,869	8,869	8,869	8,869	8,869

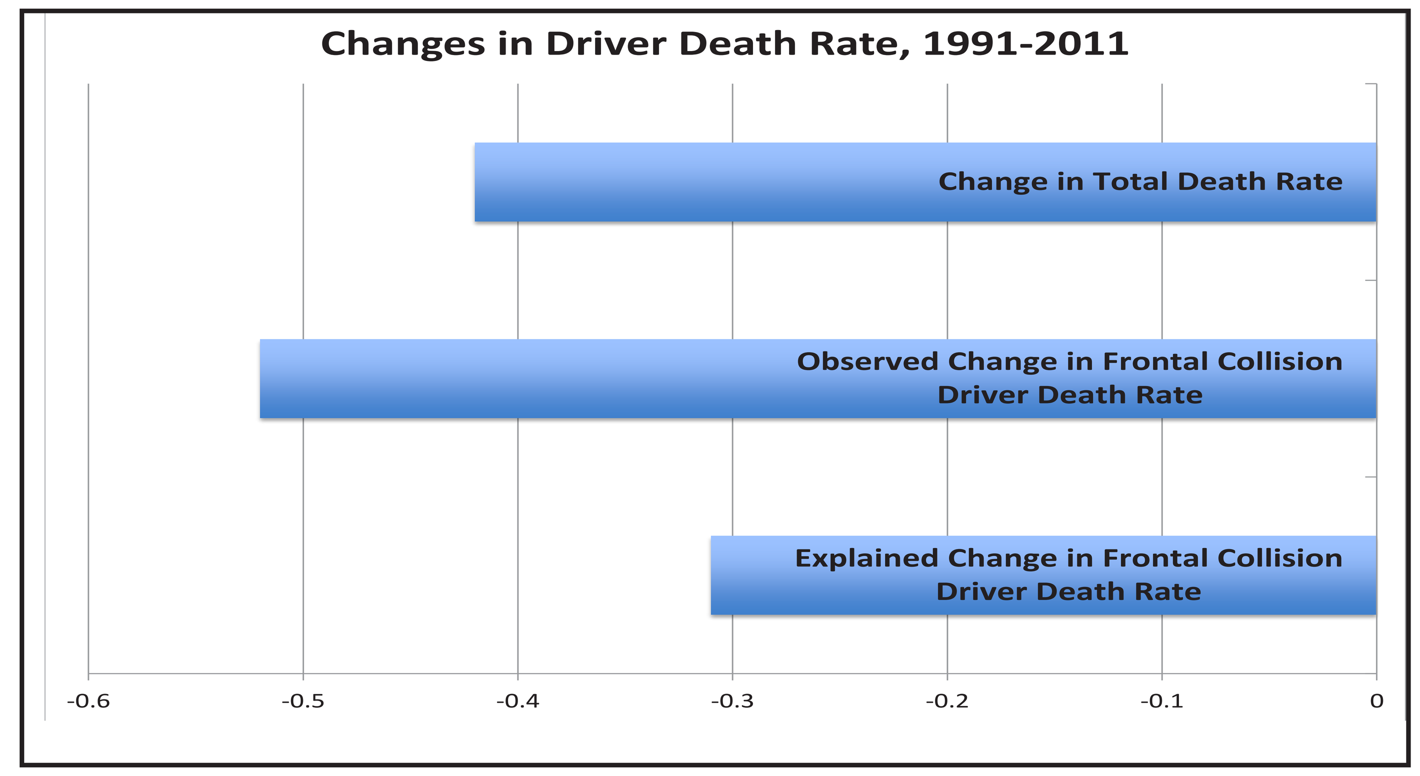
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1











DISCUSSION:

- The death rate for drivers in frontal collisions has declined more than the overall death rate.
- The variables in our model explain about 60% of the observed decrease in driver death rate in frontal collisions.
- The improved safety trend evident for cars with redesign years after 1995 is potentially attributable to an increased focus on frontal collision crashworthiness resulting in part from the IIHS crash testing program started that year.
- What is the value of the improved frontal collision safety? A back-of-the-envelope calculation:
  - Frontal Crash driver death rate: 1.4 deaths per 10^9 miles
  - Reduction in prob. of death: 10%
  - Total miles driven by a typical car: 150,000
  - Mean vehicle occupancy: 1.5
  - Value of statistical life: $8,500,000
  - Multiply all of above to get a value of $270 per vehicle
  - Benefits in single and >2 car crashes might double this to $540 per vehicle
- How much does improved frontal crashworthiness add to the cost of a car? We don't know, but stay tuned…

REFERENCES:

- IIHS crashworthiness evaluation programs and the U.S. vehicle fleet — Highway Loss Data Institute (HLDI) Bulletin Vol. 30, No. 7: April 2013.
- Sheehan-Connor, Damien, "Environmental Policy and Vehicle Safety: The Impacts of Gasoline Taxes and Fuel Economy Standards," Wesleyan University Department of Economics Working Paper.