The effect of fuel economy on automobile safety: a reexamination

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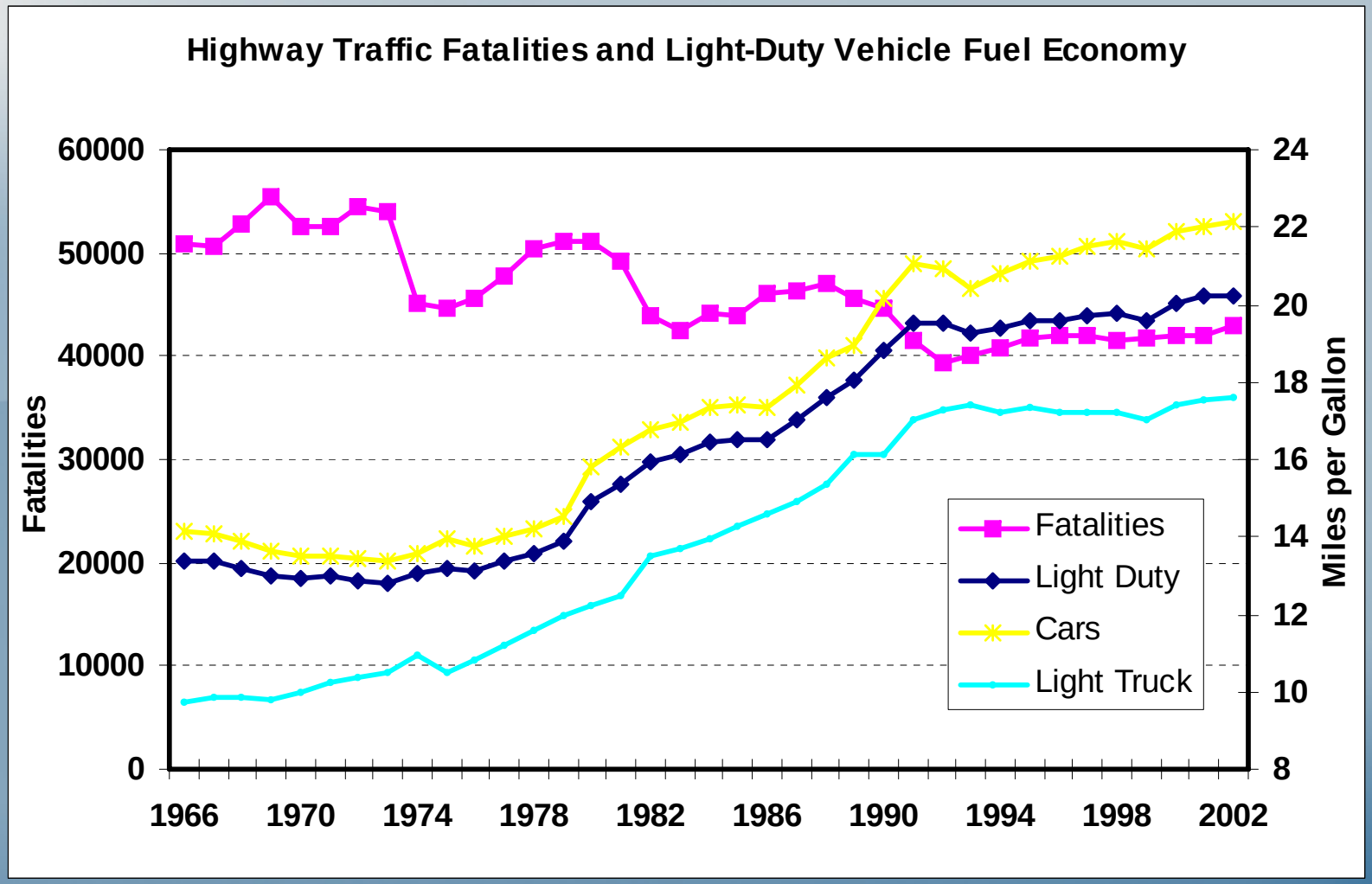
Higher MPG means less weight means more traffic fatalities?

- Seminal 1989 paper by Crandall and Graham said so.
- But included data only through 1981 for fuel economy standards that began in 1978.
- Did not consider other potentially intervening variables (e.g., horsepower).
- Subsequent studies have both challenged (e.g., Noland, 2004) and supported (e.g., Kahane, 2003) the MPG:weight:safety linkage.

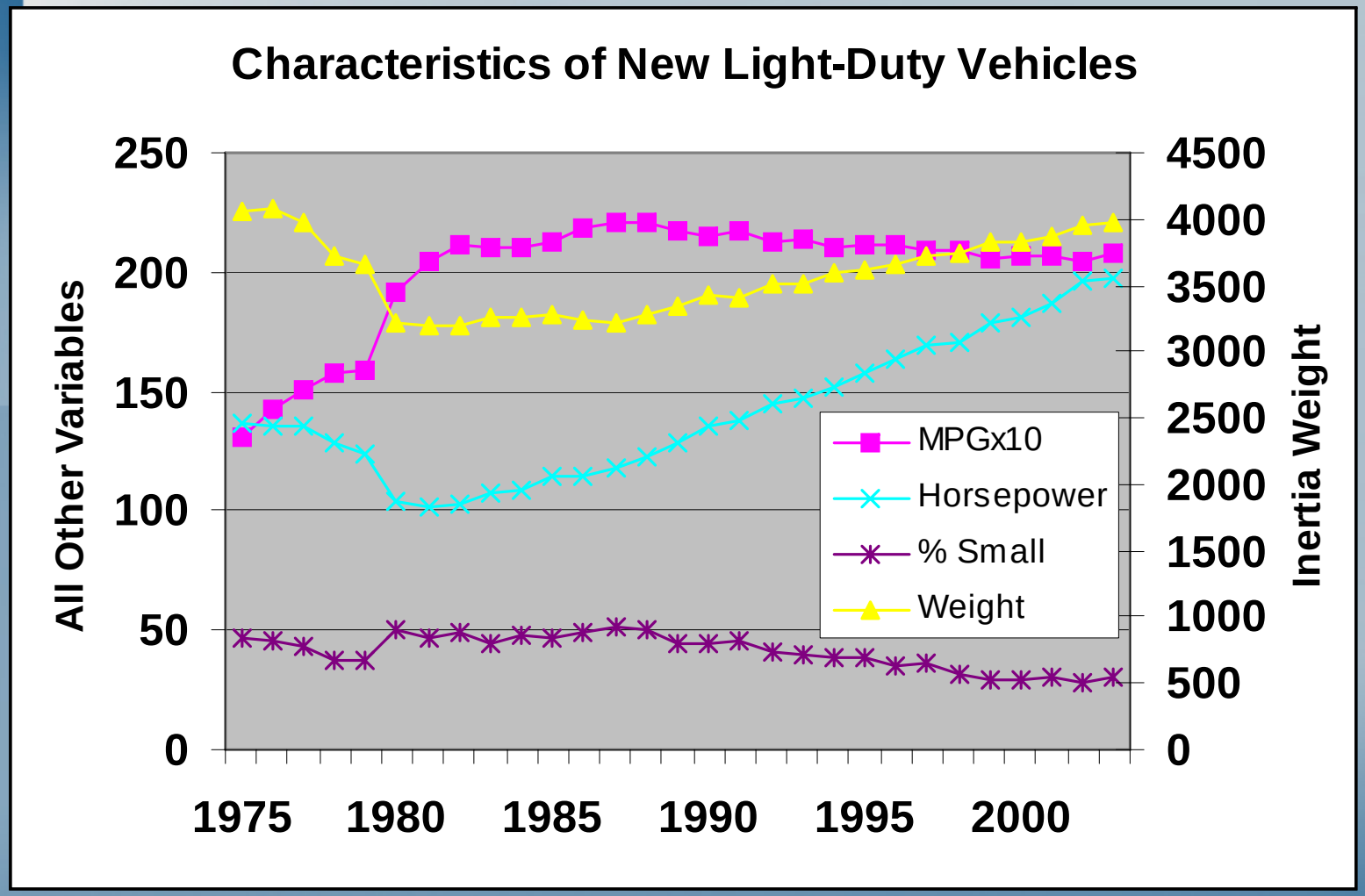
Recent studies provide support for and against a fuel economy ⇨ safety link.

- Kahane/NHTSA (1997, 2003): weight helps safety
- Van Auken & Zellner (2002, 2003): size helps, weight not significant or harmful given constant size
- Noland (2004): mixed results, fuel economy no longer significantly related to safety
- Ross and Wenzel (2003): weight helps some, harms others, design key
- Lund et al. (2000): weight protects

The premise of this study is to search for a stable relationship between light-duty vehicle fuel economy and total highway traffic fatalities.



From 1975-1980, MPG increased and weight decreased; relations changed after 1980.



Cointegration analysis looks for stable (stationary) relationships between variables.

- When dependent and explanatory variables have trends (non-stationarity of degree 1) spurious correlations are common.
- Differencing may remove the long-term relationship of interest.
- If the residuals = Y-(a+bX) are not stationary, the correlations are spurious.
- Also test for residuals for heteroskedasticity, autocorrelation, and normality.

Do highway traffic fatalities increase with increased fuel economy?

- **Total Traffic Fatalities**
- **Scale and Trends:** VMT, Population, GDP, Drivers, Vehicle Registrations, Time Trend
- **Contributing Factors:** Passenger car & (single unit 2-axle 4-tire) light truck MPG, Price of Gasoline, Seat Belt Use, Alcohol Consumption per capita
- **Dummy variables:** National Speed Limit changes, 1974 Gas Shortage, Drinking Age to 18

4 kinds of models were estimated.

- Linear regression including all explanatory variables (most satisfactory results)
- “Parsimonious” linear regression including only statistically significant variables
- Log-log models including all
- Log-log models in first differences

Full model linear regressions

- Without time trend
  - MPG: coefficient = -3642, t = -3.0
  - Other significant variables:
    - Reduced speed limit: coeff = -7192, t = -3.6
    - Price of gasoline: coeff = +6952, t = 2.3
    - Constant: t = 2.3
- With time trend
  - MPG: coeff = -3212, t = -2.6
  - Other significant variables:
    - Reduced speed limit: coeff = -5390, t = -2.3
    - Price of gasoline: coeff = 7134, t = 2.4

Full linear models with first order autoregressive correction.

- Durbin-Watson test inconclusive in linear models.
- AR1 w/o trend:
  - MPG insignificant, negative coefficient
  - Only reduced speed limit significant (-)
- AR1 with trend
  - MPG: coeff = +401, t = 0.22 (nonsignif.)
  - Rho = 0.71 +/- 0.36
  - Like a first difference model may be reflecting short-term relationships (e.g., GDP significant and positive effect on fatalities).

Parsimonious linear models

- Without time trend:
  - MPG: coeff = -1703, t = -12.8
    - Speed: coeff = -5388, t = -5.0
    - Price of gasoline: coeff = 4635, t = 2.5
    - Constant: t = 23.8
- With time trend:
  - MPG: coeff = -2521, t = -4.8
- The parsimonious models **failed** the heteroskedasticity tests and the autocorrelation tests at the 5% level.

Log-log models

- Only MPG significant at 0.05 level
  - MPG: coeff = -0.96 , t = -2.50
  - GDP and constant significant at 6%
  - Results similar if trend included
- Parsimonious log-log model has serious nonstationarity and autocorrelation problems.
- Applying AR1 correction led to no variables significant.
- First differences models showed MPG not significant but GDP with a significant positive coefficient.
  - MPG has long-term but no short-term impact
  - GDP has short-term but no long-term impact

The national fatality and light-duty vehicle fuel economy data do not support a positive correlation between MPG and fatalities.

- In cointegrated models not failing tests for heteroskedasticity and autocorrelation, fuel economy was statistically significantly ***negatively*** related to total traffic fatalities.
- Log-log models and autoregressive models failed one or more tests.
- In all models tested, fuel economy was either significantly ***negatively*** correlated with fatalities or statistically insignificant.
- ***The data are consistent with the hypothesis that increasing fuel economy reduces traffic fatalities*** and inconsistent with the hypothesis that increasing fuel economy increases traffic fatalities.

How could increased fuel economy *not* increase fatalities?

- Reducing the weight of both vehicles in a collision may not increase risk. Fleet average fuel economy may have a different relationship to safety than individual vehicle fuel economy.
- Initially, increased fuel economy was associated with reduced weight; over the longer run technology was used to increase fuel economy.
- Variables other than weight (horsepower, front wheel drive, unibody construction, etc.) may have had important effects.
- Safety depends primarily on driver behavior, environmental factors, and vehicle engineering and design. In comparison to these factors, fuel economy *per se* is relatively unimportant.

Thank you for your interest.

Paper available at:
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