Analyzing Casualty Risk using State Data on Police-Reported Crashes

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Project ID:
LM026

Overview

Timeline

- Start date: Mar 2010
- End date: Sep 2011
- 70% complete

Budget

- Total project funding
  - DOE share
  - Contractor share
- Funding received in FY10
  - $217K
- Funding for FY11
  - $217K

Barriers

- Barriers addressed
  - Fuel economy not top criterion for vehicle choice to purchase

Partners

- DOT National Highway Traffic Safety Administration
- EPA Office of Transportation and Air Quality

Relevance

- Objective: Estimate how changes in weight and size of contemporary vehicles would have affected historical casualty risk, holding footprint and other variables constant
- Results will enable NHTSA and EPA to set appropriate new vehicle standards that will encourage down-weighting of vehicles without affecting safety
- These standards will in turn encourage manufacturers to use advanced lightweight materials to reduce new vehicle weight without necessarily reducing size
- Standards will overcome some of the reluctance of consumers to purchase vehicles with high fuel economy

Strategy

- Replicate NHTSA 2011 regression analysis of US fatality risk
  - Advise NHTSA on data, variables, and methods
- Conduct separate regression analysis of casualty (fatality + serious injury) risk using data from 13 states
  - Provide another perspective from NHTSA analysis
- Results will be used in DOT Volpe model to forecast effect of MY2017 to 2025 fuel economy/CO_2 emission standards on fatalities and casualties
- Databases and programs will be made public, to allow replication of results

Two Analytical Approaches

- NHTSA analyses (1998, 2003, 2010, 2011)
  - Numerator: US fatalities, from FARS
  - Denominator: vehicle registration-years or miles
    - Uses detailed information on drivers and crashes from police-reported crashes in 13 states
    - Applies a weight to each vehicle in state crash data to scale up to national vehicle registrations (RL Polk®)
    - Applies an assumption of annual miles driven
  - Result: US fatalities per million vehicles or miles
- LBNL analysis (2010, 2011)
  - All data from police-reported crashes in 13 states
  - Numerator: fatalities or casualties (fatalities + serious injuries)
  - Denominator: all crash-involved vehicles in state crash data
    - Use Polk data to convert to risk per vehicle registrations
  - Result: State fatalities or casualties per crash-involved vehicle, or per million vehicles or miles

Similarities in Two Approaches

- Both use multiple logistic regression to estimate effect of reducing vehicle weight on risk, holding footprint constant
  - Model estimates likelihood that a specific crash resulted in fatality or casualty
  - Control for vehicle, driver (age, gender, etc.), and crash (urban/rural, night, wet, icy, speed limit, etc.) characteristics
- Both will use same database of vehicle characteristics
  - Make/model, body type, curb weight, footprint, airbags, ABS, ESC, etc.
- Both will estimate effect of weight on risk per vehicle or miles, to be input into Volpe model
- Both will estimate the recent historical relationship between vehicle weight and/or size and risk
- Neither can predict this relationship in the future, with new lightweight materials and vehicle redesign

Differences in Two Approaches

- Benefits of LBNL approach
  - All data from same source (13 states crash data)
  - Estimates effect of weight/size on serious injuries and fatalities
  - Risk per crash-involved vehicle focuses on vehicle crashworthiness (risk once a crash occurs), and eliminates effect of crash avoidance
- Drawbacks of LBNL approach
  - Limited to 13 states that provide Vehicle Identification Number (VIN)
    - Does relationship between weight/size and risk vary by state?
    - Are 13 states representative of national relationship?
  - May not be enough fatalities in 13 states to also get robust results for fatality risk

Technical Accomplishments and Progress

- Participating in ongoing multi-agency meetings to inform NHTSA's choice of data, variables, and methodology for 2011 regression analyses
- Assisted in compilation of vehicle attribute database
- Assembled dataset of police-reported crashes from 16 states, 1995 to 2008
- Collected odometer readings from 8 state I/M programs to derive miles traveled by vehicle make/model
- Used crash data from five states to compare four measures of risk: fatality v. casualty risk, per vehicle v. per crash

Conclusions from Comparison of Risks in 5 States

- Casualty risks per vehicle are similar to fatality risks per vehicle; however casualty risks are substantially lower than fatality risks for sports cars and pickups
- Vehicle types with high crash rates (subcompact and compact cars) have higher casualty risk per vehicle than per crash; vehicle types with low crash rates (large and import luxury cars, minivans, large SUVS, crossover SUVs, and pickups) have lower casualty risk per vehicle than per crash
- Accounting for miles driven by vehicle model has only a small effect on risk per vehicle, except for sports cars that are driven relatively few miles
- Regression models estimating casualty risk per crash must control for:
  - Sample bias in state data by including dummy variables for each state
  - Elderly and female drivers, but not young males
  - Crash location (urban v. rural)

Collaboration and Coordination with Other Institutions

- Working closely with NHTSA and EPA on data, variables, and methodology to be used in regression analyses
- All data and programs will be made public, to allow replication of results

Proposed Future Work

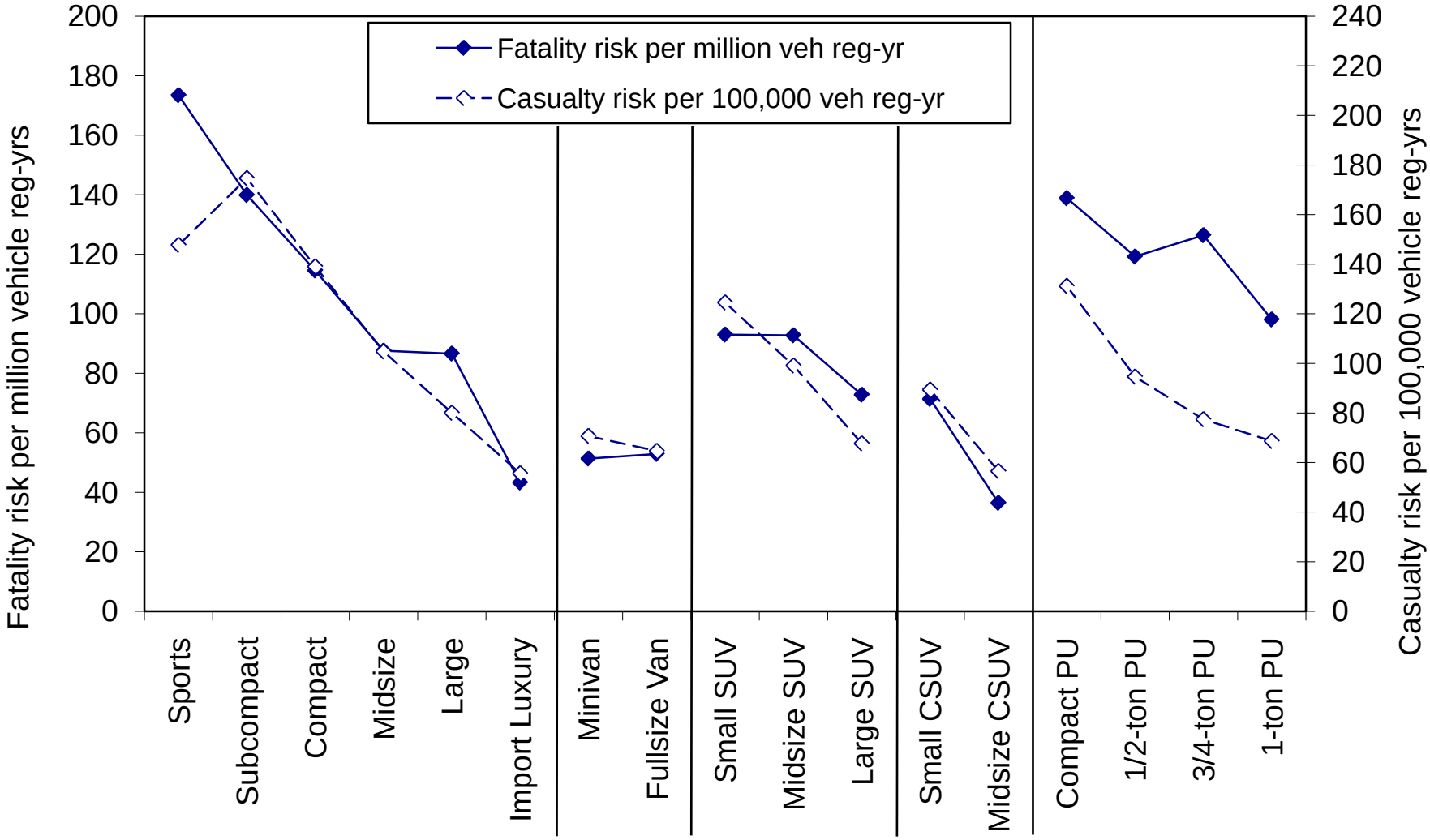
- Complete evaluation of NHTSA 2011 fatality risk regression analysis
- Complete casualty risk analysis
- Conduct additional research to identify causes of any discrepancies
- Conduct additional statistical analysis to further illuminate the relationship between vehicle weight and size, including the effect of new lightweight materials, on safety

Summary

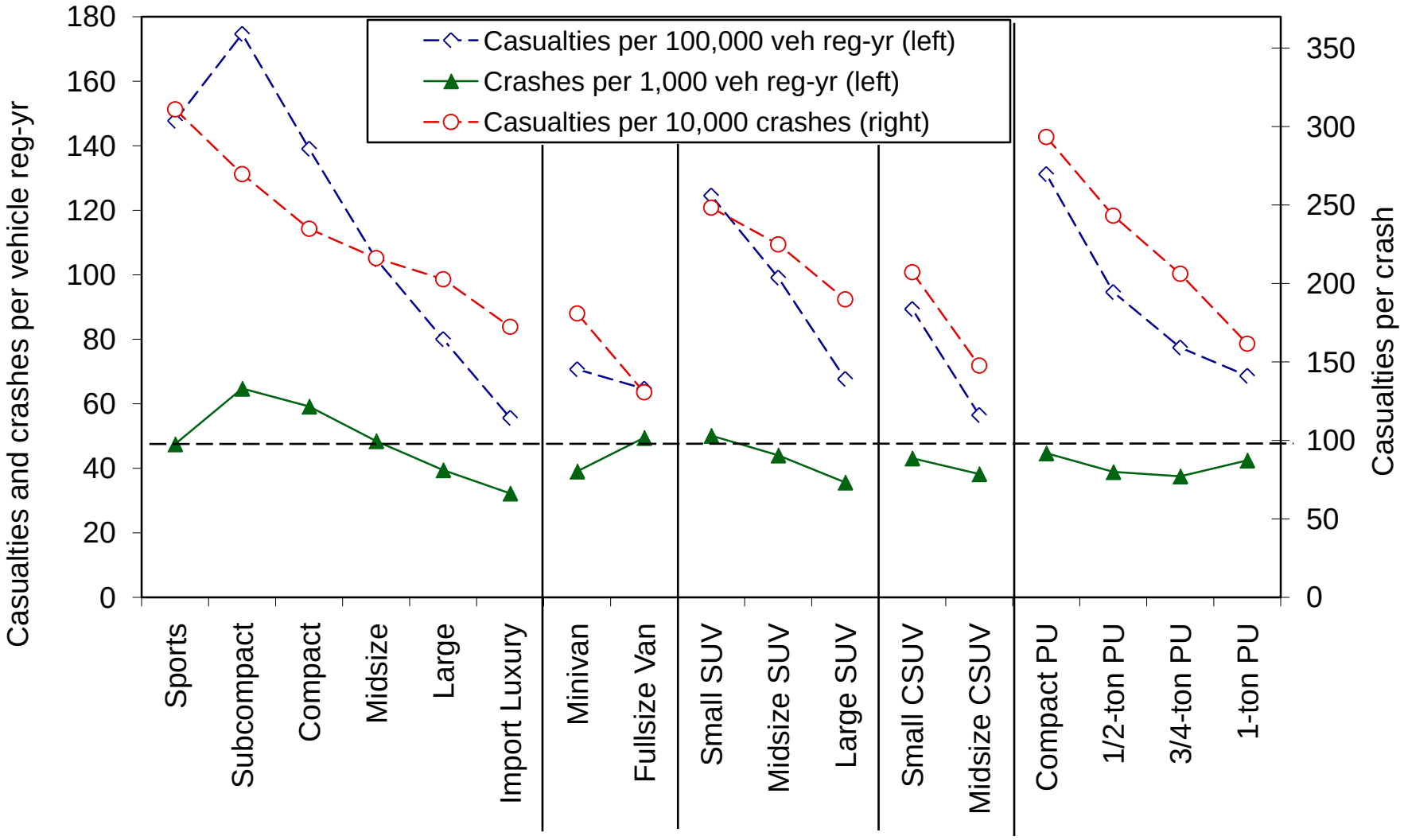
- Regression analyses can inform regulators on what effect standards may have on safety…
- … but cannot predict that effect, especially given extensive use of new materials that breaks historical relationships
- Casualty risk can be analyzed using state crash data
- LBNL regression analysis on casualty risk will enhance NHTSA regression analysis on fatality risk
- Analyses will indicate what level of vehicle weight reduction, and therefore fuel consumption/CO_2 reduction, can be achieved without sacrificing safety

Technical Back-Up Slides

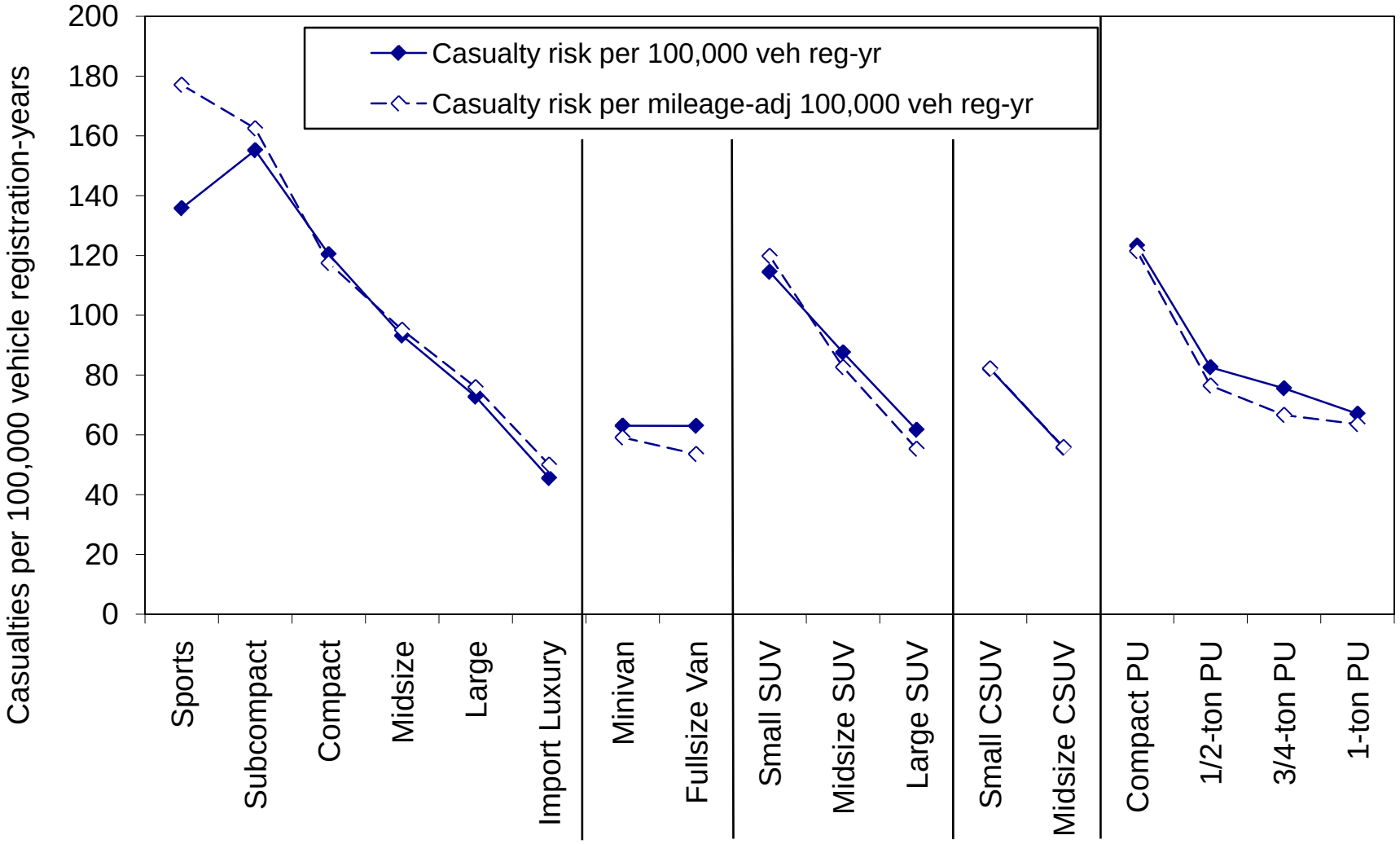
Fatality and casualty risks per vehicle are similar for most vehicle types, except sports cars and pickups



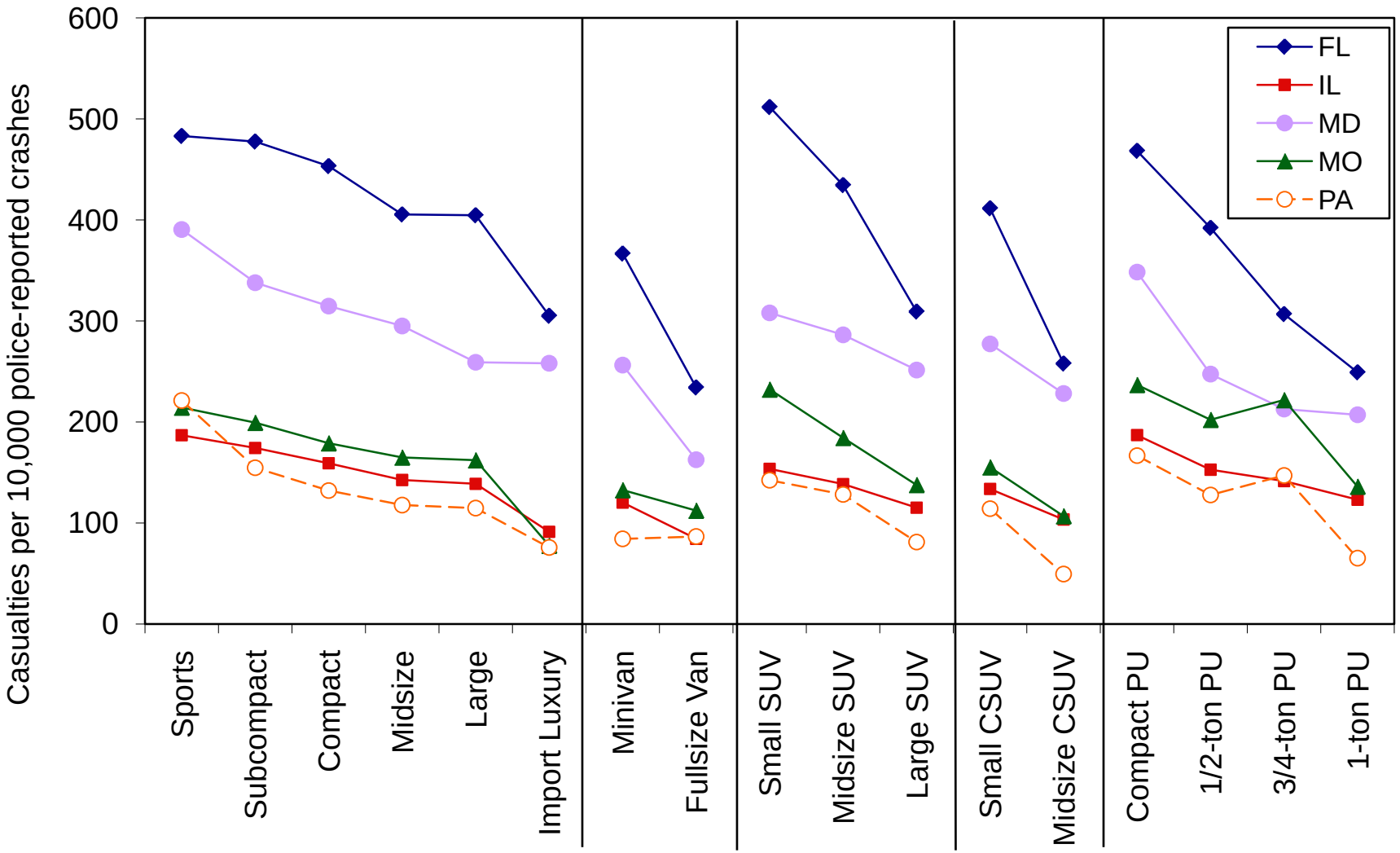
Vehicles with high crash rates (subcompact and compact cars) have higher casualty risk per vehicle than per crash



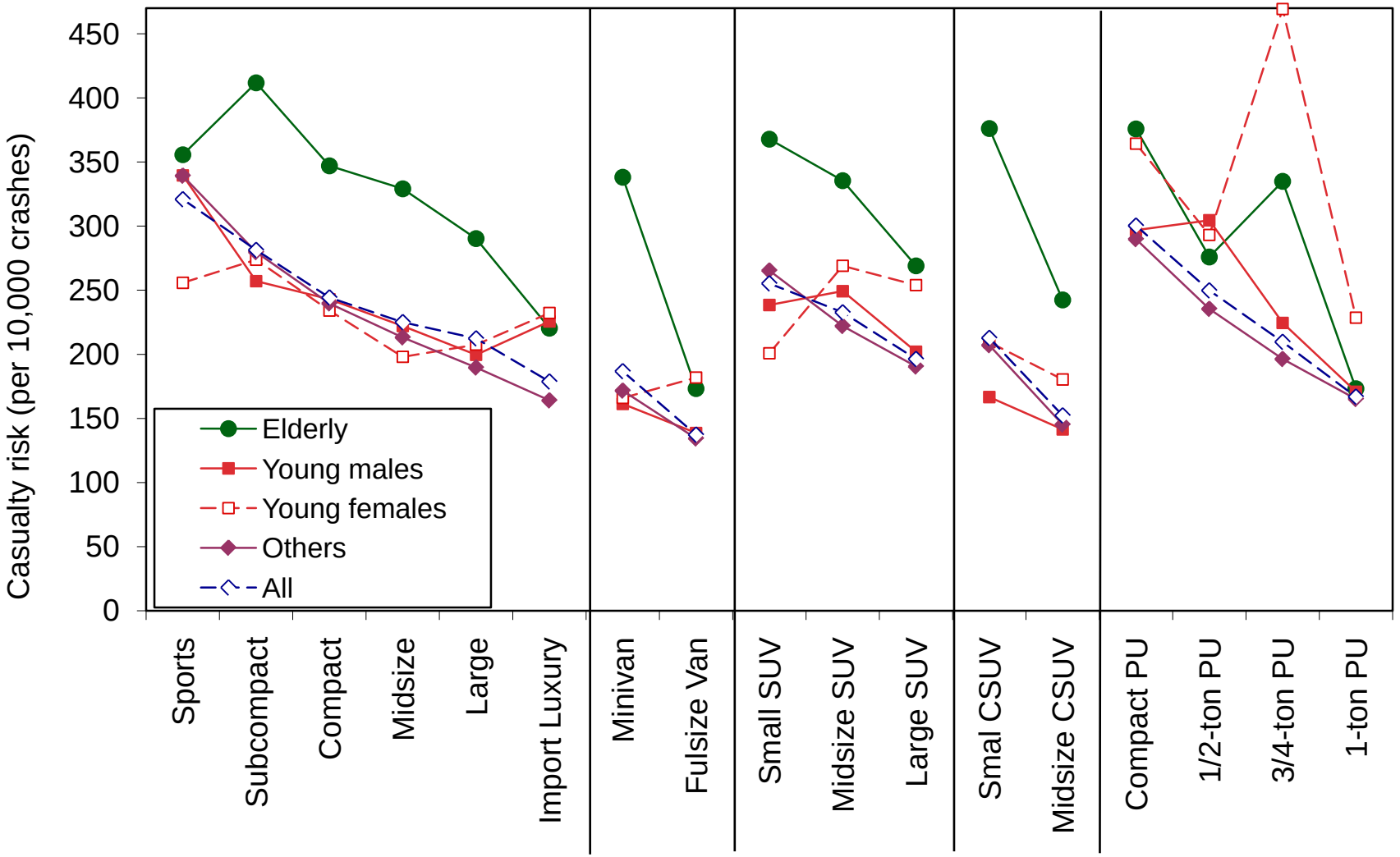
Accounting for vehicle mileage has little effect on casualty risk per vehicle



Casualty risk per crash is much higher in FL and MD, because fewer non-injury crashes are reported



Casualty risk per crash similar for all drivers except the elderly (and in some cases young women)



Casualty risks are highest in rural counties (with low population density)