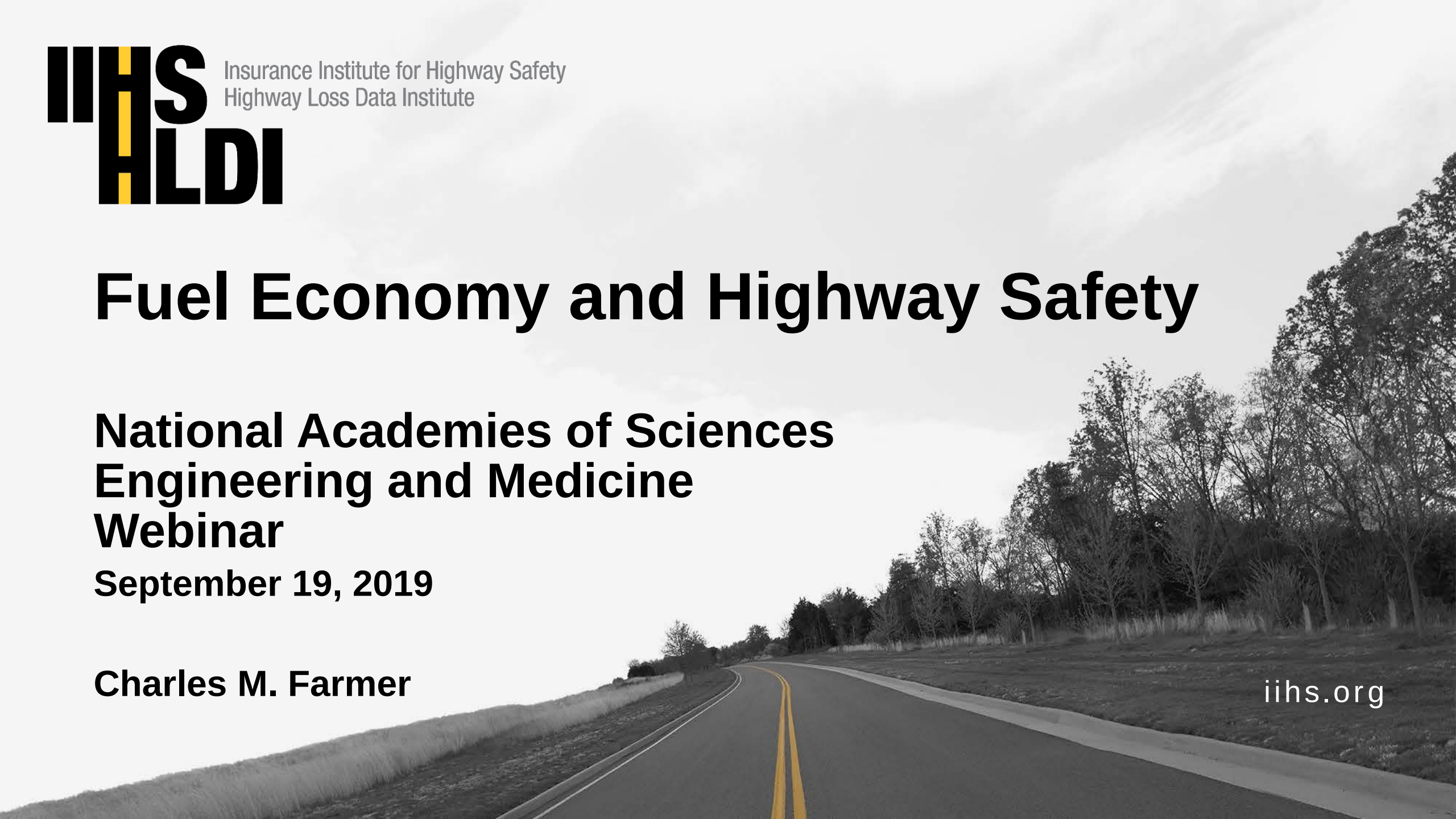
Insurance Institute for Highway Safety
Highway Loss Data Institute

Fuel Economy and Highway Safety

National Academies of Sciences Engineering and Medicine Webinar

September 19, 2019

Charles M. Farmer

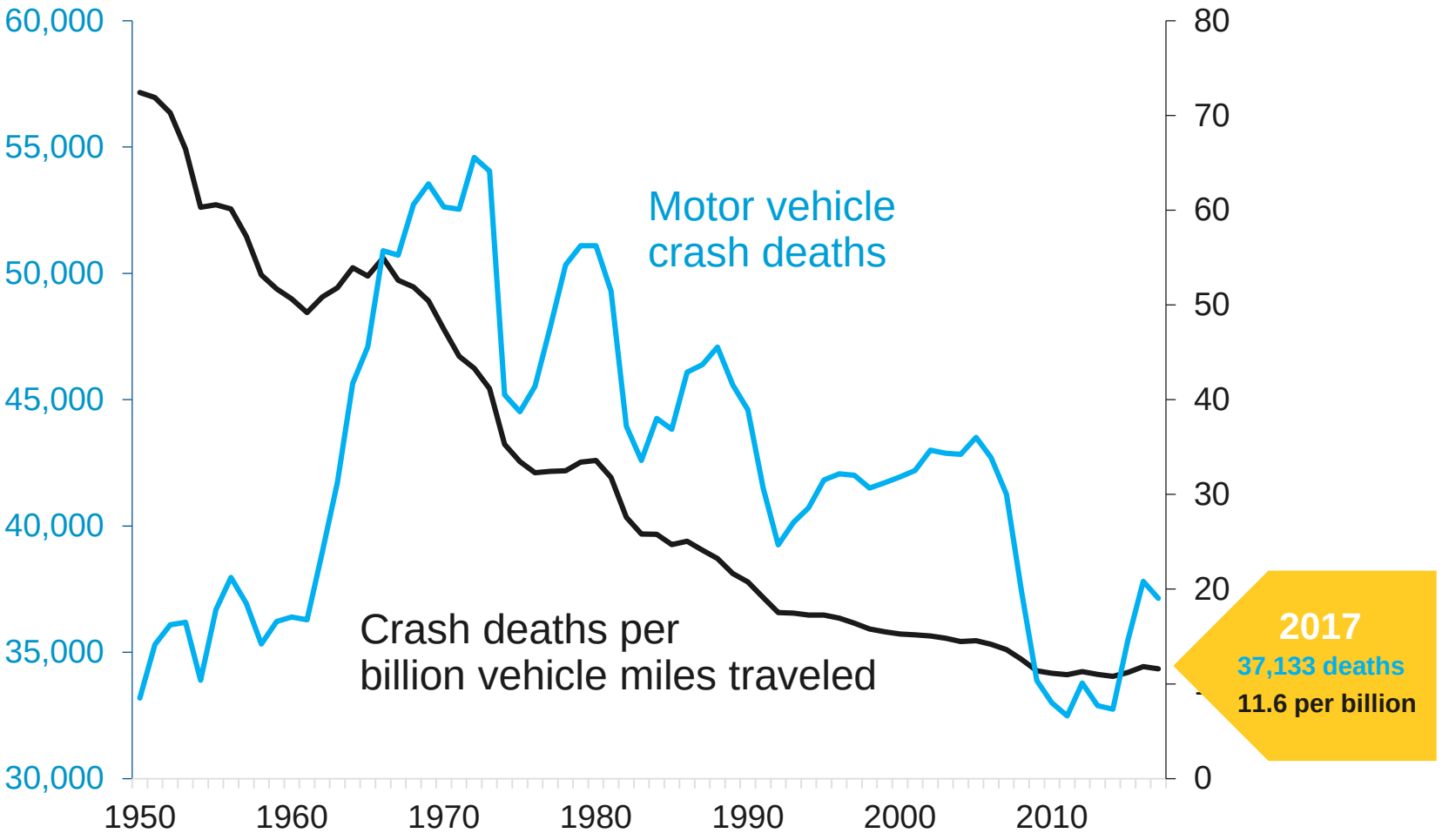


iihs.org

Historical trends

U.S. motor vehicle crash deaths and deaths per billion miles of travel

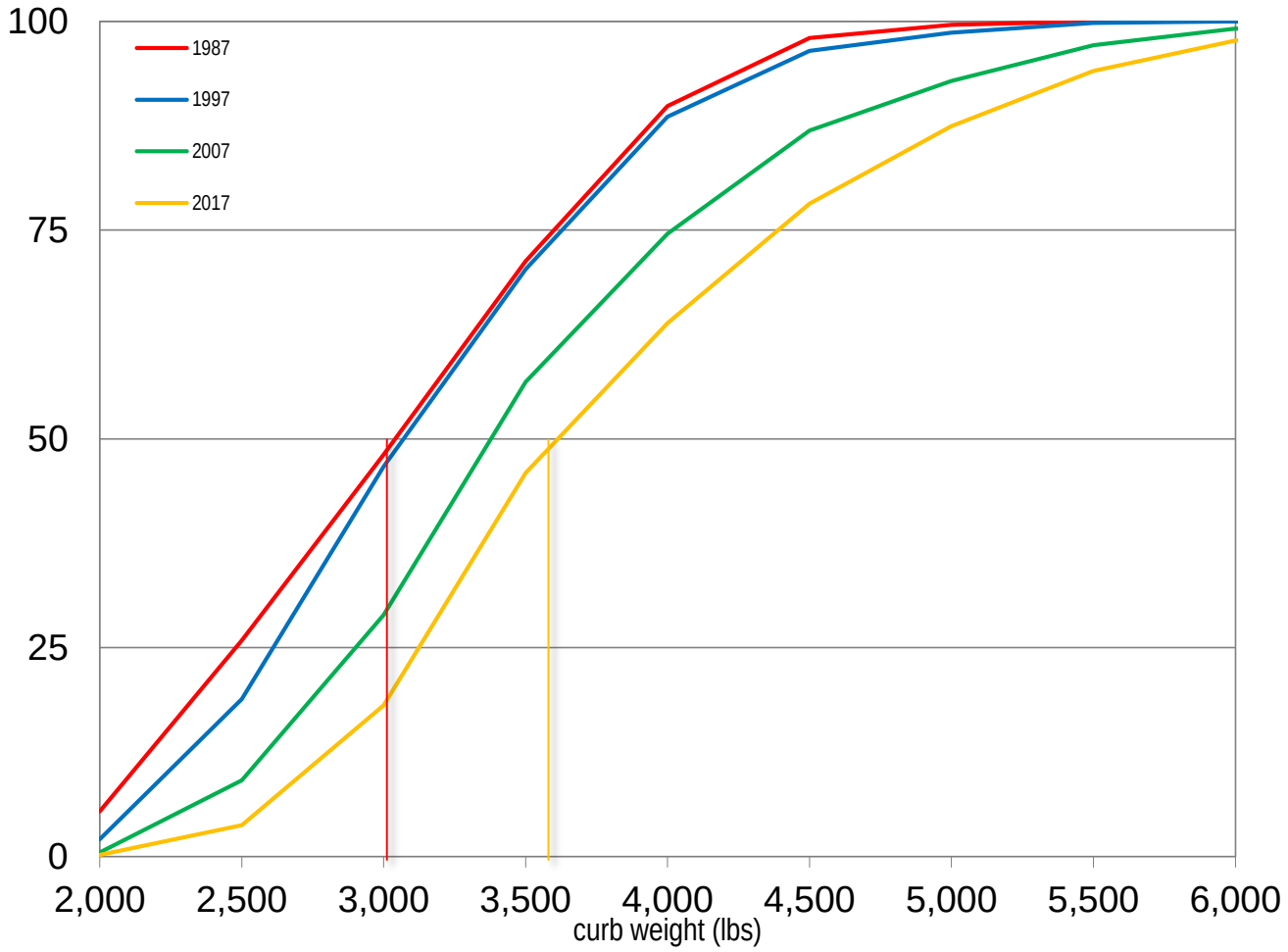
1950-2017



Motor vehicle crash deaths have declined significantly in the U.S. during the past 50+ years

Trends in vehicle weight

Cumulative percent of passenger vehicle registrations by weight

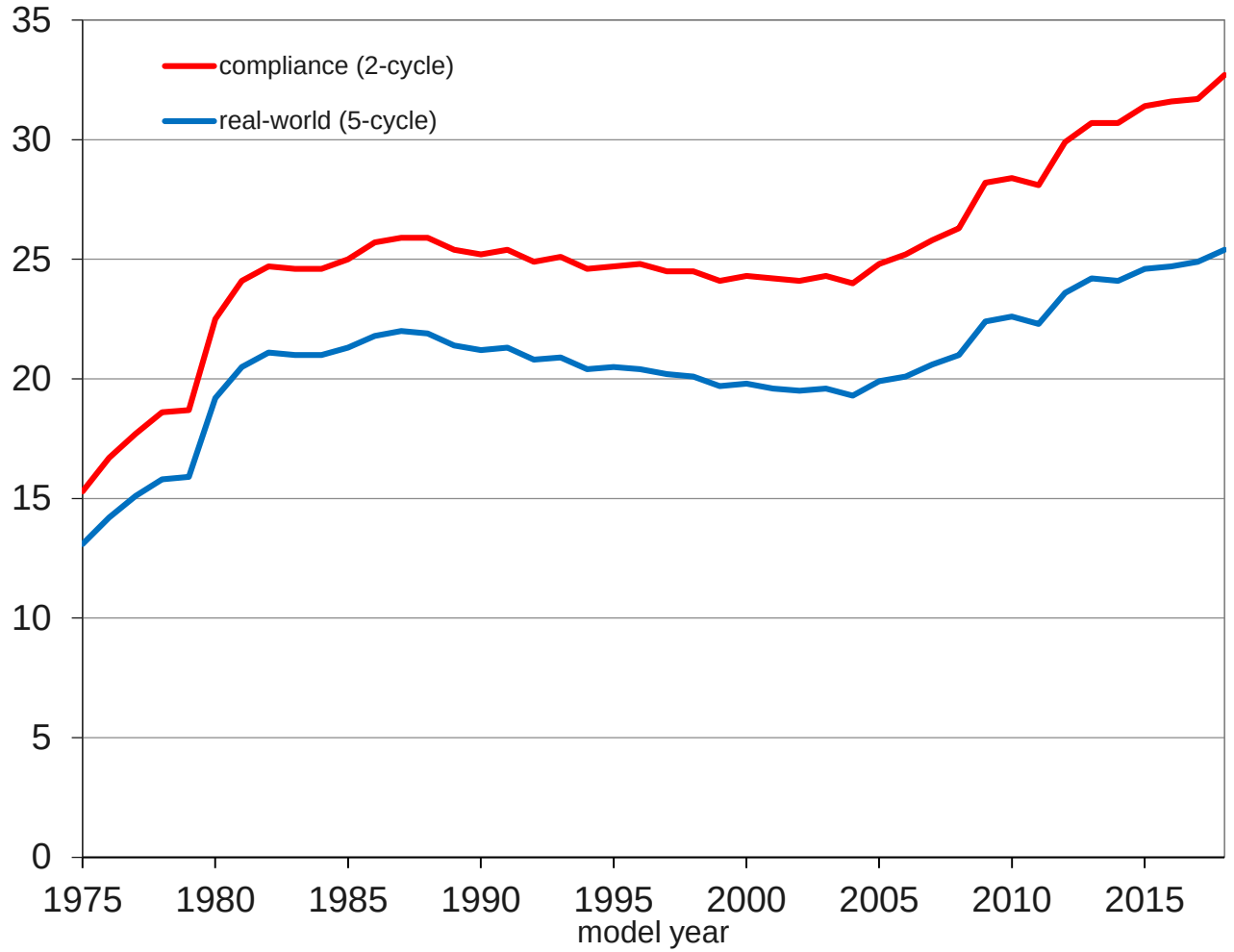


Passenger vehicles have gotten heavier over time

The median weight of the passenger vehicle fleet has increased from 3,047 pounds in 1987 to 3,585 pounds in 2017

Estimated fuel economy (mpg) of light-duty vehicles (EPA, 2019)

By model year



New vehicles have become much more fuel-efficient – with the average miles per gallon rising by more than 30% in the past 15 years

Can we improve fuel efficiency without reducing safety?

Fuel efficiency can be improved with alternative fuels

While maintaining good crash test performance

"Vehicles with alternative powertrains have come into their own," IIHS Chief Research Officer David Zuby says. "There's no need to trade away safety for a lower carbon footprint when choosing a vehicle."

IIHS/HLDI crashworthiness ratings of vehicles with alternative powertrains

Model	Front	Side	Roof
2019 Tesla Model 3	G	G	G
2019 Audi e-tron	G	G	G
2019 Chevrolet Bolt	G	G	G
2019 Hyundai Nexo	G	G	G
2019 Kia Niro	G	G	G
2019 Honda Insight	G	G	G
2019 Toyota Prius	G	G	G
2019 Hyundai Ioniq	G	G	G
2019 Chevrolet Volt	G	G	G
2019 Nissan Leaf	G	G	NOT TESTED

Fuel efficiency can be improved with alternative fuels

While occupant injury rates are lowered

Hybrids on average are 10 percent heavier than their standard counterparts. Also, the odds of being injured in a crash are 25 percent lower for occupants of hybrids compared with occupants of nonhybrid models.

IIHS/HLDI analysis of hybrids and their twins

	Collision Claims	Injury Claims	Percent With Injury
Hybrids	40,120	3,416	8.5
Twins	280,125	31,640	11.3

Fuel efficiency can be improved with alternative materials

While crash test performance is unchanged

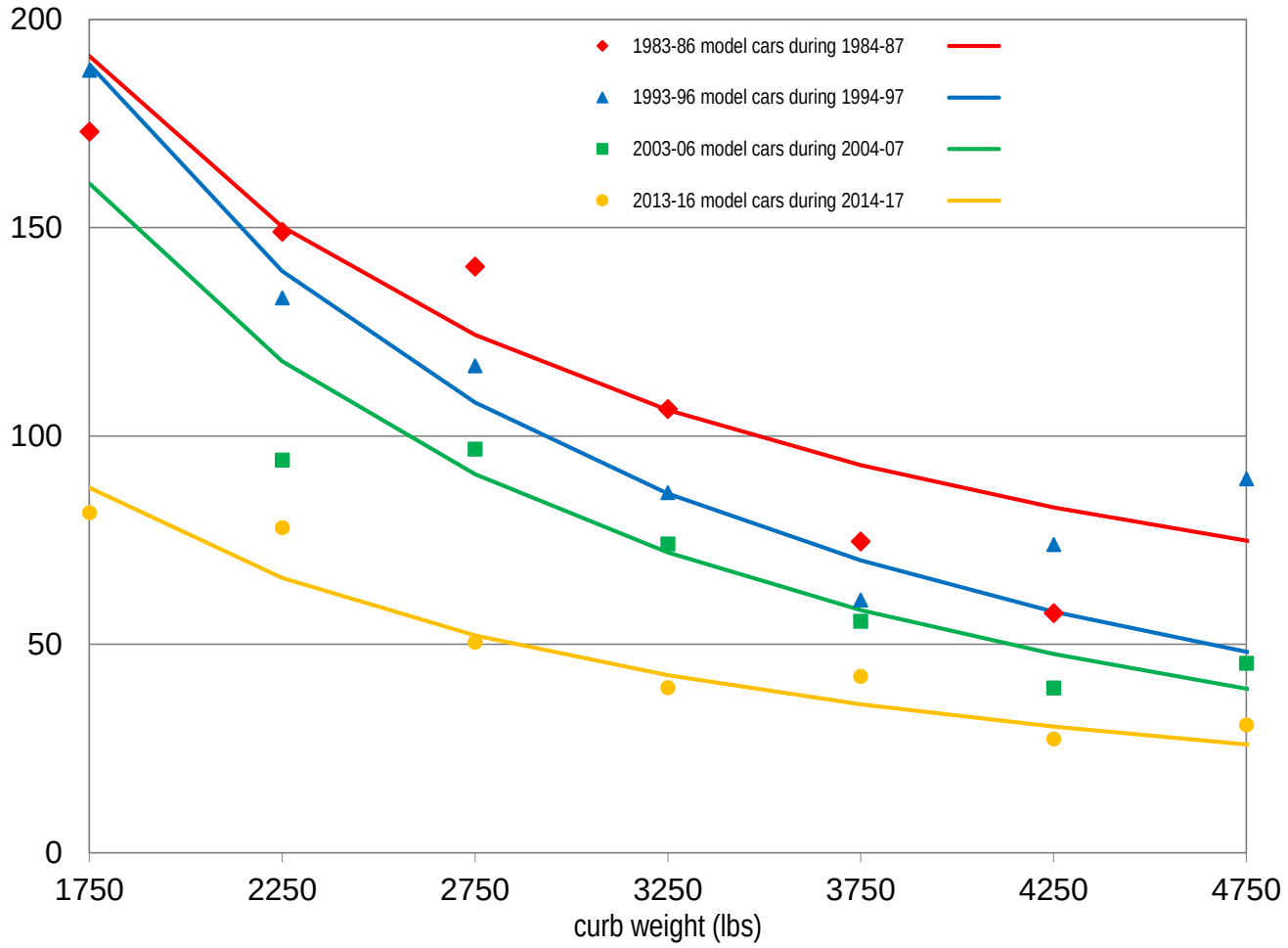
The 2015 Ford F-150 was the first mass-market vehicle with an all-aluminum body. It is 500 pounds lighter than the 2014 model, but there was no significant change in performance in IIHS crash tests.

IIHS/HLDI crashworthiness ratings of Ford F-150

Model Year	Front	Side	Roof
2014	G	G	G
2015	G	G	G

Driver deaths per million vehicle registrations

1-4 year-old cars, by weight class

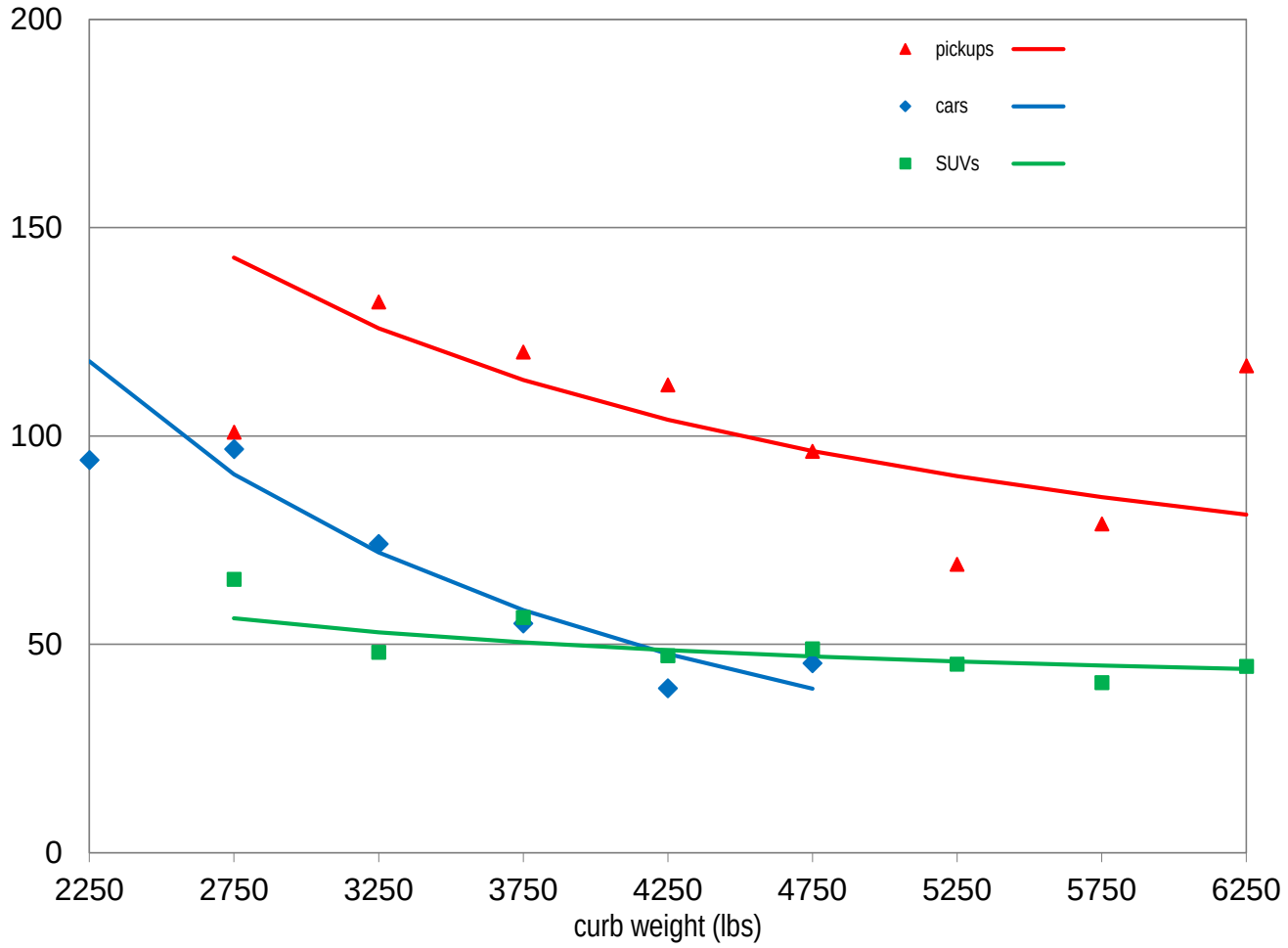


Driver death rates have gone down over the past 4 decades for all weight classes

But heavier vehicles still have lower driver death rates compared with lighter vehicles

Driver deaths per million vehicle registrations

2003-06 passenger vehicles during 2004-07, by weight class

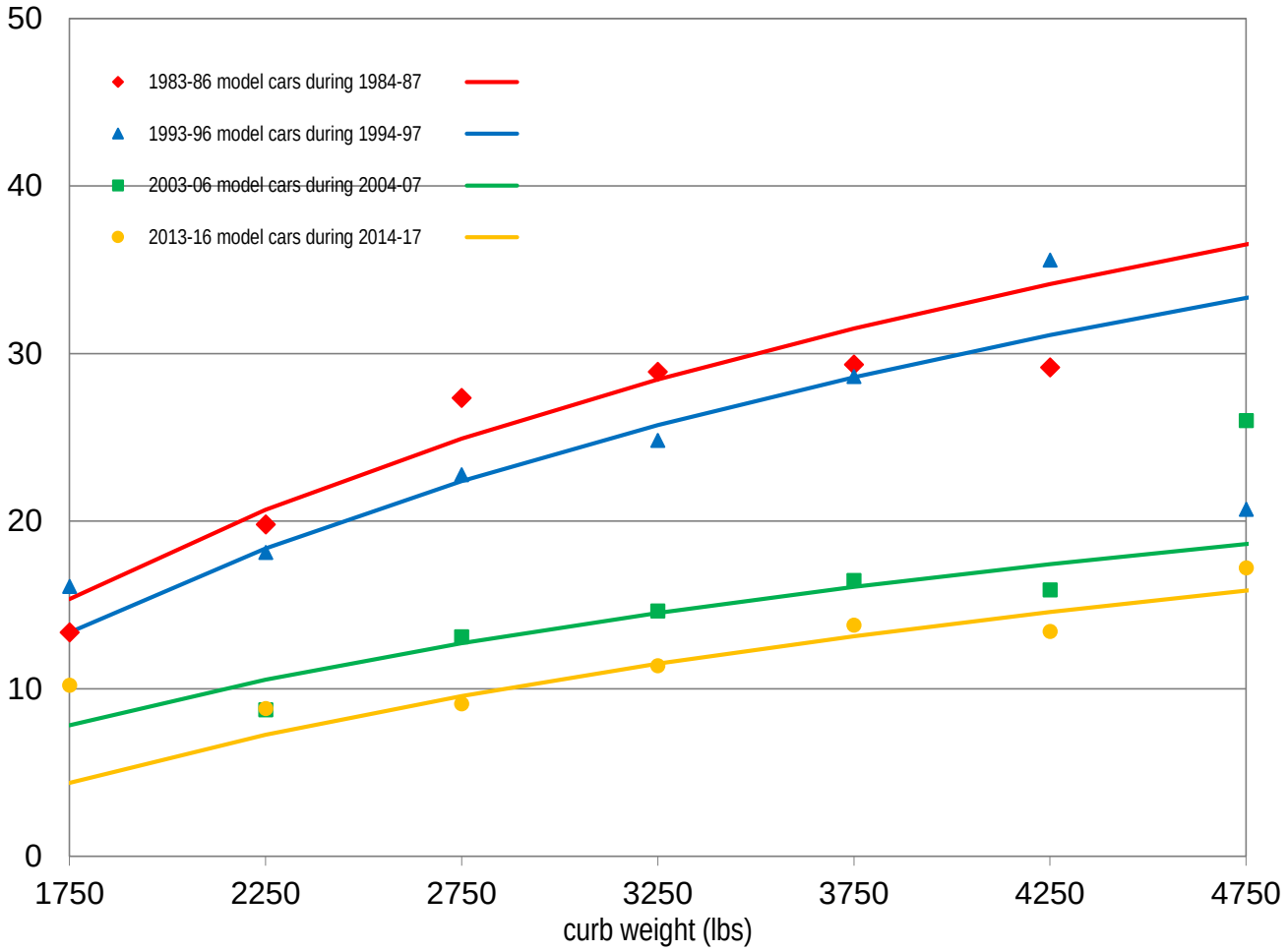


When weights are comparable, SUVs have lower driver death rates compared with cars

And pickups have the highest driver death rates

Other car driver deaths per million vehicle registrations

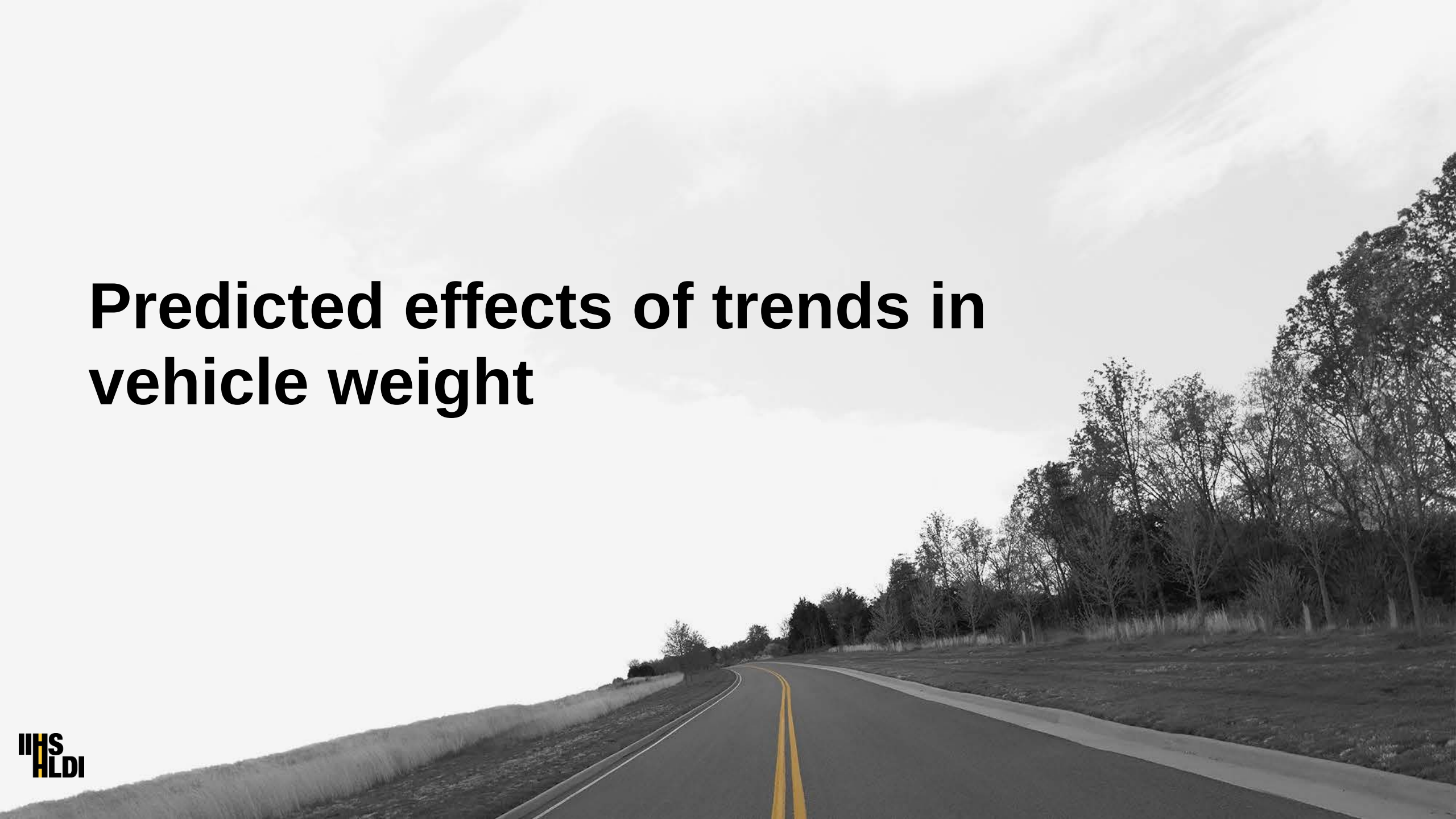
1-4 year-old cars, by weight class



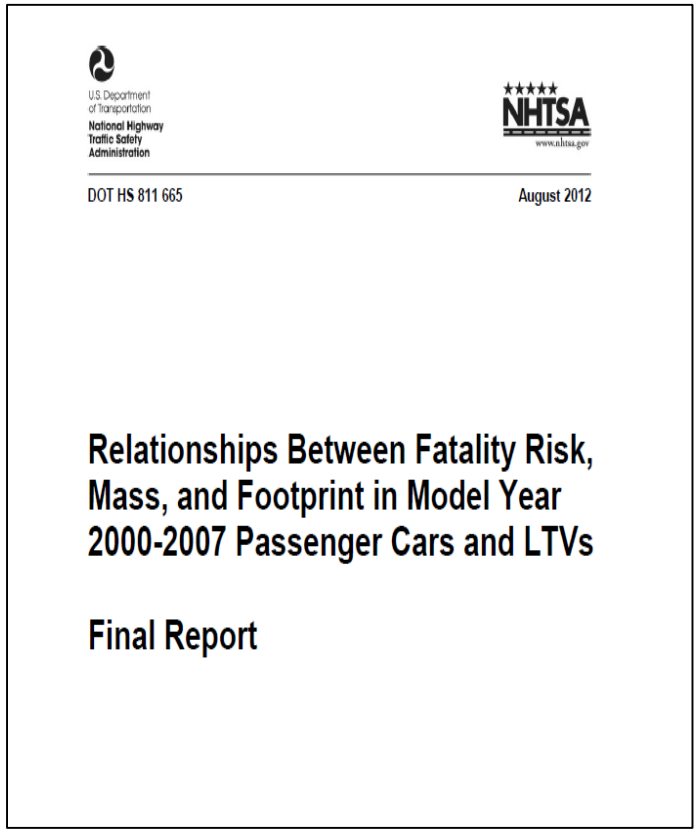
Bigger, heavier cars are more aggressive toward other cars

But the effect of weight on aggressivity has lessened over the past 4 decades

Predicted effects of trends in vehicle weight



Kahane (2012) predicted a 0.56% increase in deaths if all vehicles were 100 pounds lighter (all else being unchanged)



U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
www.nhtsa.gov

DOT HS 811 665

August 2012

Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000-2007 Passenger Cars and LTVs

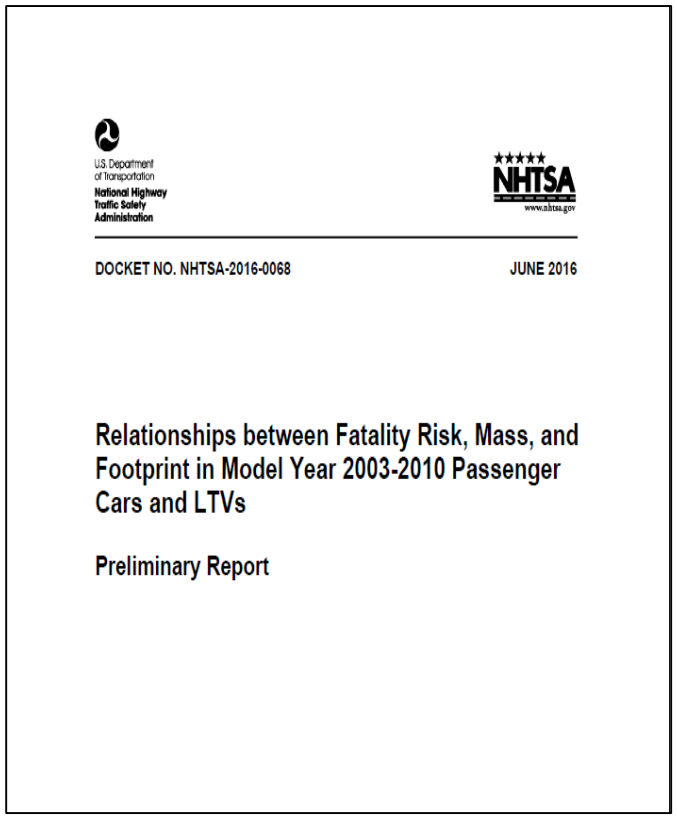
Final Report

So a 500-pound INCREASE in weight should lead to a 2.77% reduction in deaths

Fatality change (%) per 100-pound mass reduction while holding footprint constant

	Estimate
Cars < 3,106 pounds	1.56
Cars ≥ 3,106 pounds	0.51
CUVs and minivans	-0.37
Truck-based LTVs < 4,594 pounds	0.52
Truck-based LTVs ≥ 4,594 pounds	-0.34
Total	0.56

Puckett & Kindelberger (2016) predicted a 0.37% increase in deaths if all vehicles were 100 pounds lighter (all else being unchanged)



U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA

DOCKET NO. NHTSA-2016-0068 JUNE 2016

Relationships between Fatality Risk, Mass, and Footprint in Model Year 2003-2010 Passenger Cars and LTVs

Preliminary Report

So a 500-pound INCREASE in weight should lead to a 1.84% reduction in deaths

Fatality change (%) per 100-pound mass reduction while holding footprint constant

	Estimate
Cars < 3,197 pounds	1.49
Cars ≥ 3,197 pounds	0.50
CUVs and minivans	-0.99
Truck-based LTVs < 4,947 pounds	-0.10
Truck-based LTVs ≥ 4,947 pounds	-0.72
Total	0.37

But, although the fleet average increased 500 pounds during 1987-2017

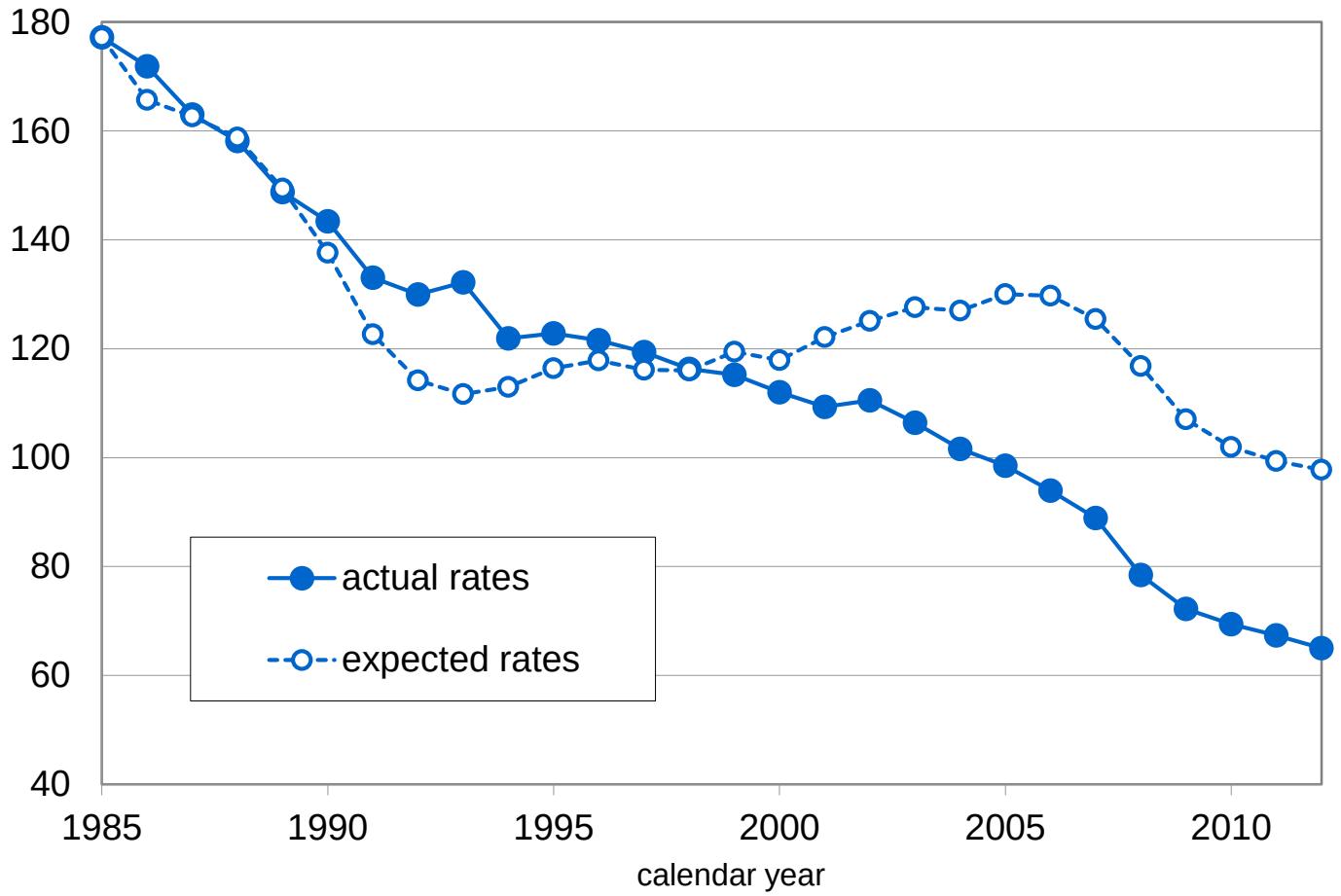
All else was NOT unchanged

- Frontal airbags
  - In all new passenger vehicles since 1999
  - Reduce occupant fatality risk by 29-32%
- Side airbags
  - In all new passenger vehicles since 2014
  - Reduce occupant fatality risk by 37-52%
- Electronic stability control
  - In all new passenger vehicles since 2012
  - Reduce occupant fatality risk by 38-56%

Advances in vehicle technology have reduced the risk of a crash fatality

Vehicles have become much safer

Driver deaths per million passenger vehicles and expected rates if vehicle designs did not change



The reduction in driver death rates since the mid-1990s has been driven primarily by changes in vehicle design (including weight)

Driver deaths in 2012 were 35% lower than would have been expected without vehicle design changes (Farmer & Lund, 2015)

Percentage of crashes relevant to four Advanced Driver Assistance Systems (ADAS)

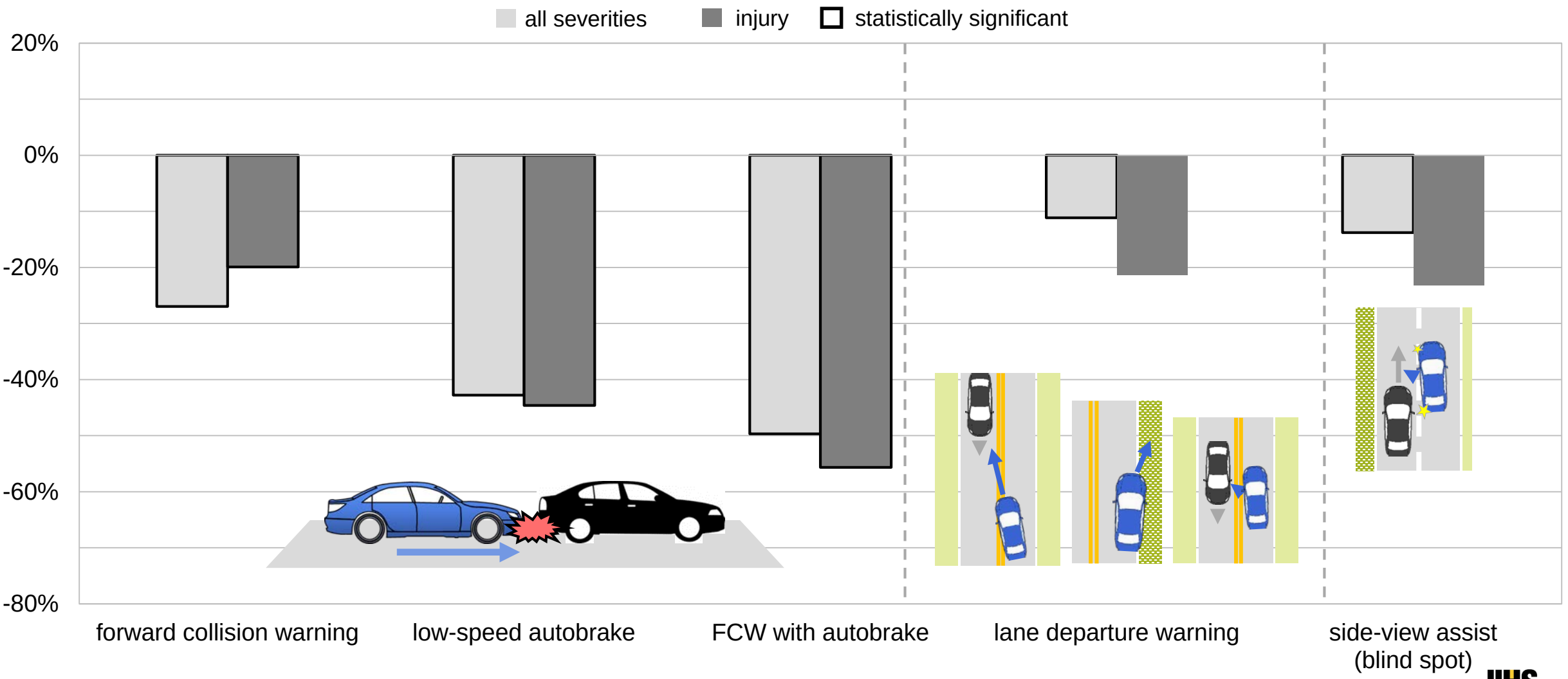
Driver assistance system	All crashes	Nonfatal injury crashes	Fatal crashes
Forward collision warning	20	9	3
Lane departure warning	3	5	23
Blind spot warning	7	3	1
Adaptive headlights	2	4	8
All four systems	32	21	31

And technology continues to advance

Technology now common in new vehicles has the potential to cut crashes by a third

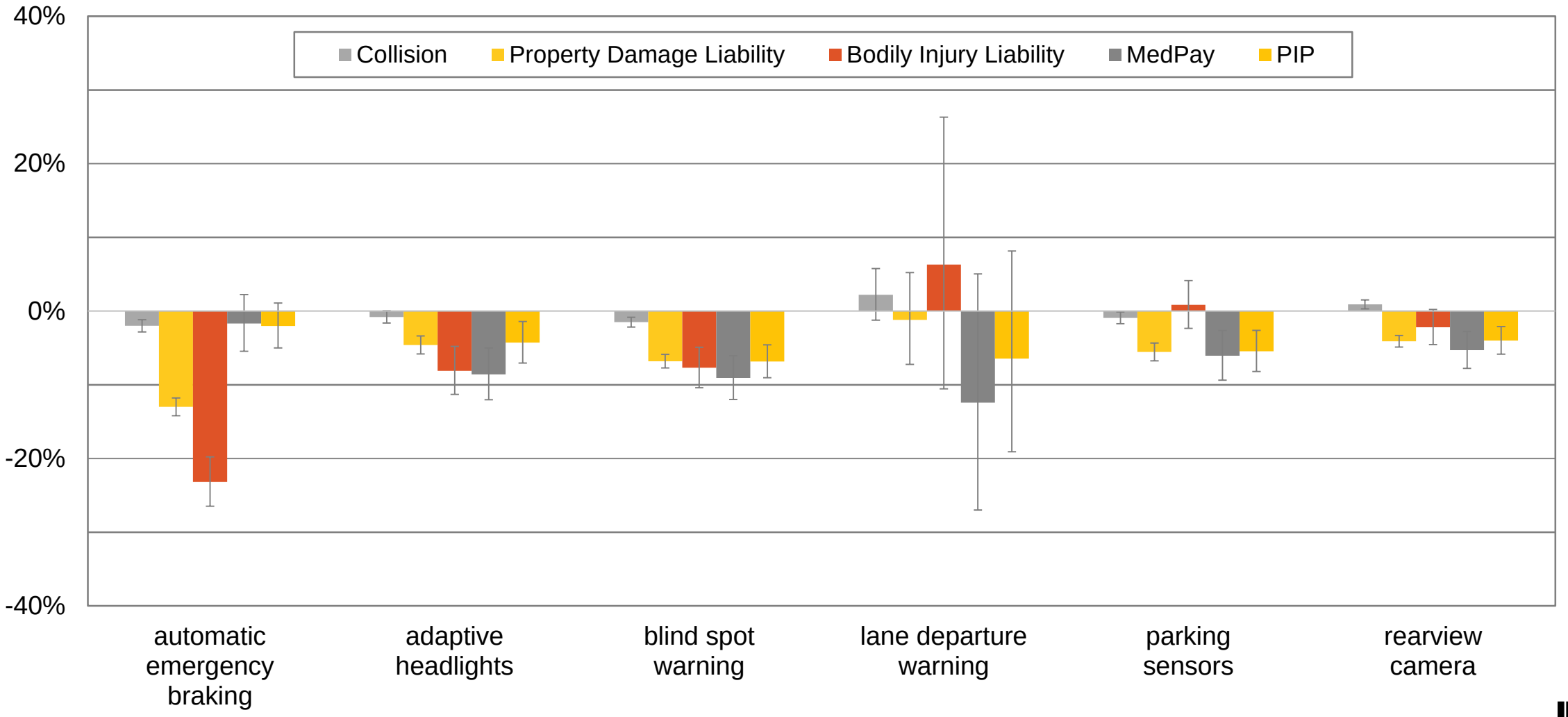
Most crash avoidance technologies are living up to expectations

They are reducing relevant types of police-reported crashes



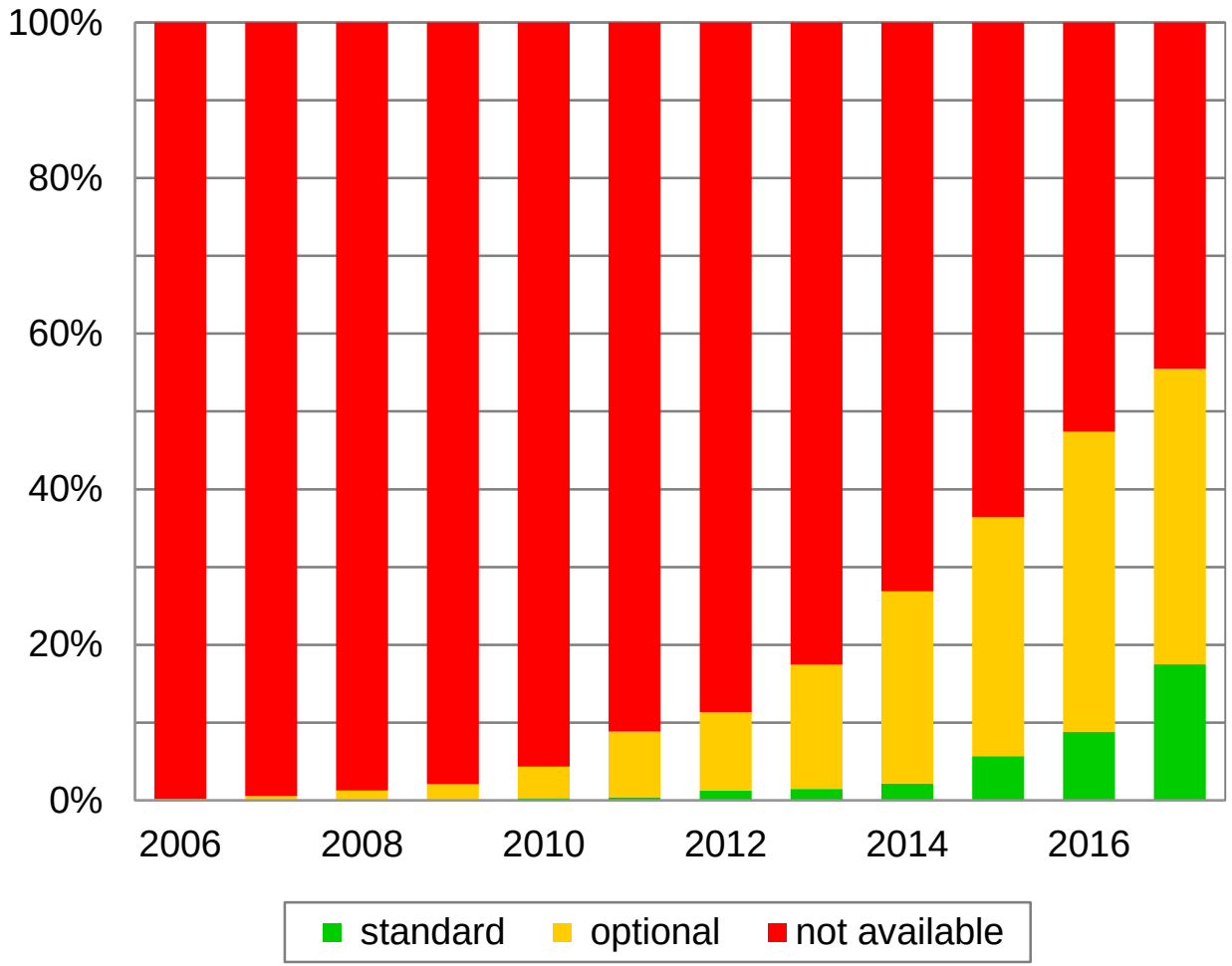
Most crash avoidance technologies are living up to expectations

They are reducing insurance claims



New vehicle series with automatic emergency braking

By model year

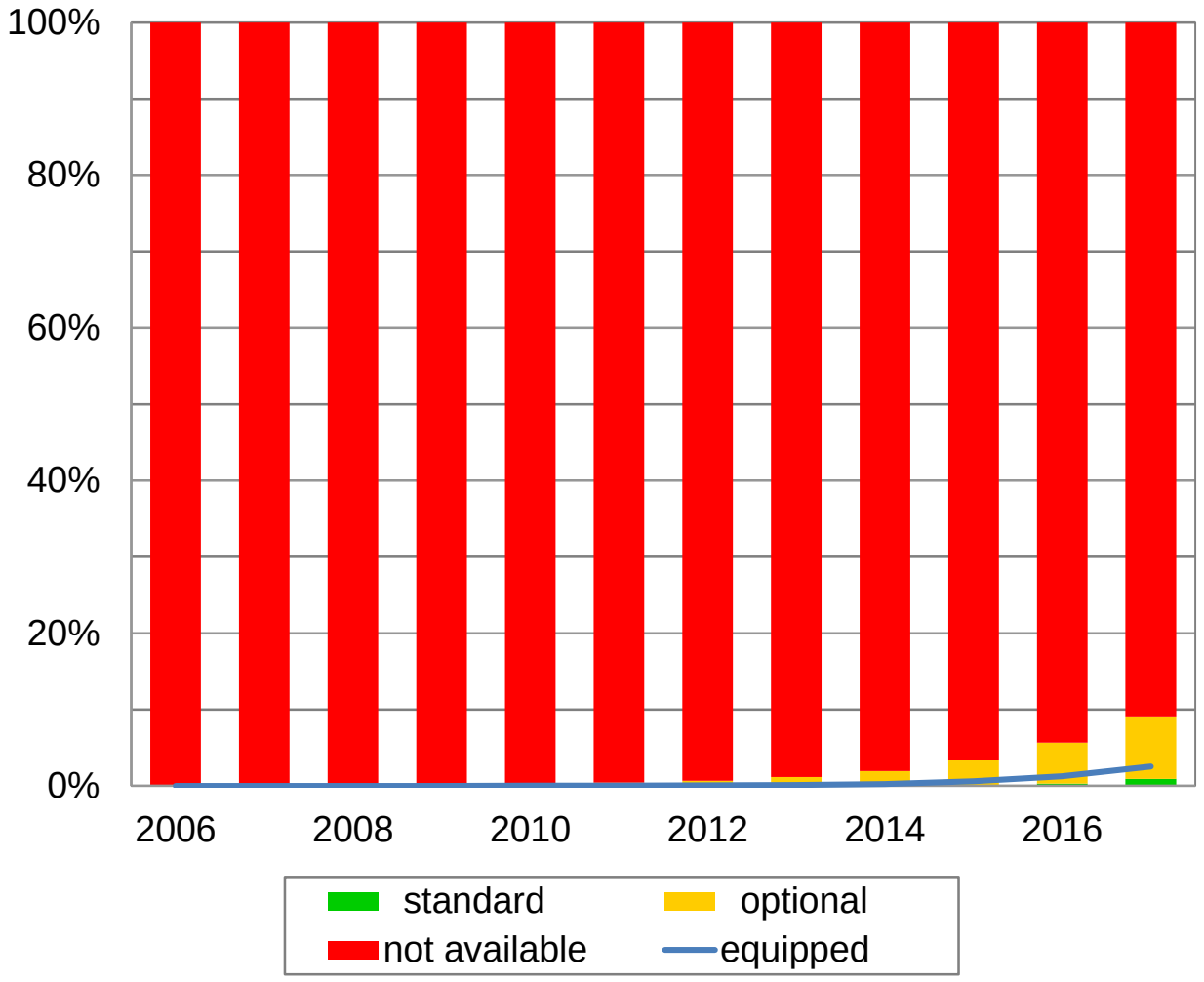


Automatic emergency braking (AEB) is becoming more and more common in new vehicles

And many manufacturers have committed to making AEB standard equipment by model year 2023

Registered vehicles with automatic emergency braking

By calendar year

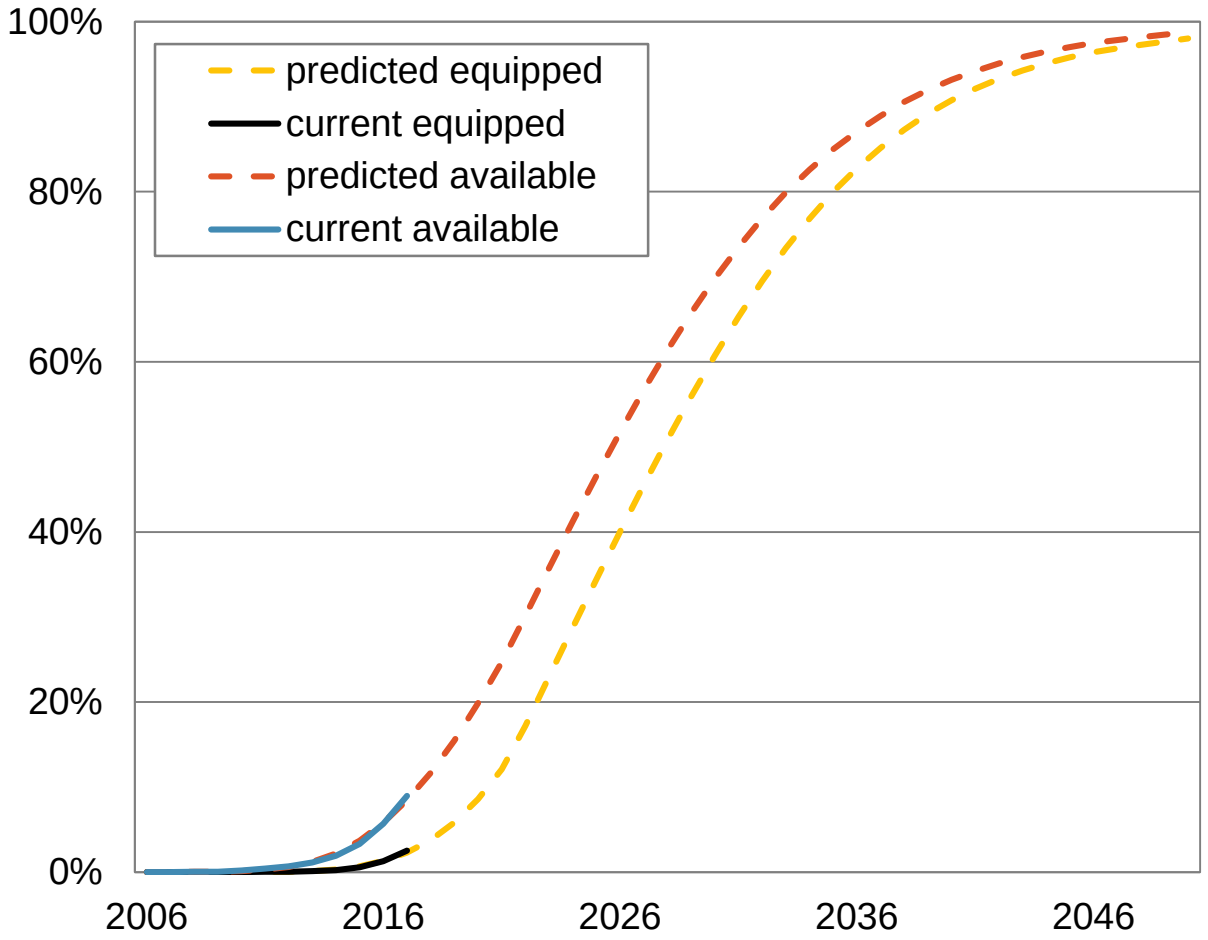


But AEB still exists in less than 10% of vehicles on the road

It takes many years for new vehicle features to become common on the road, especially when these features are only offered as optional equipment

Predicted registered vehicles with automatic emergency braking

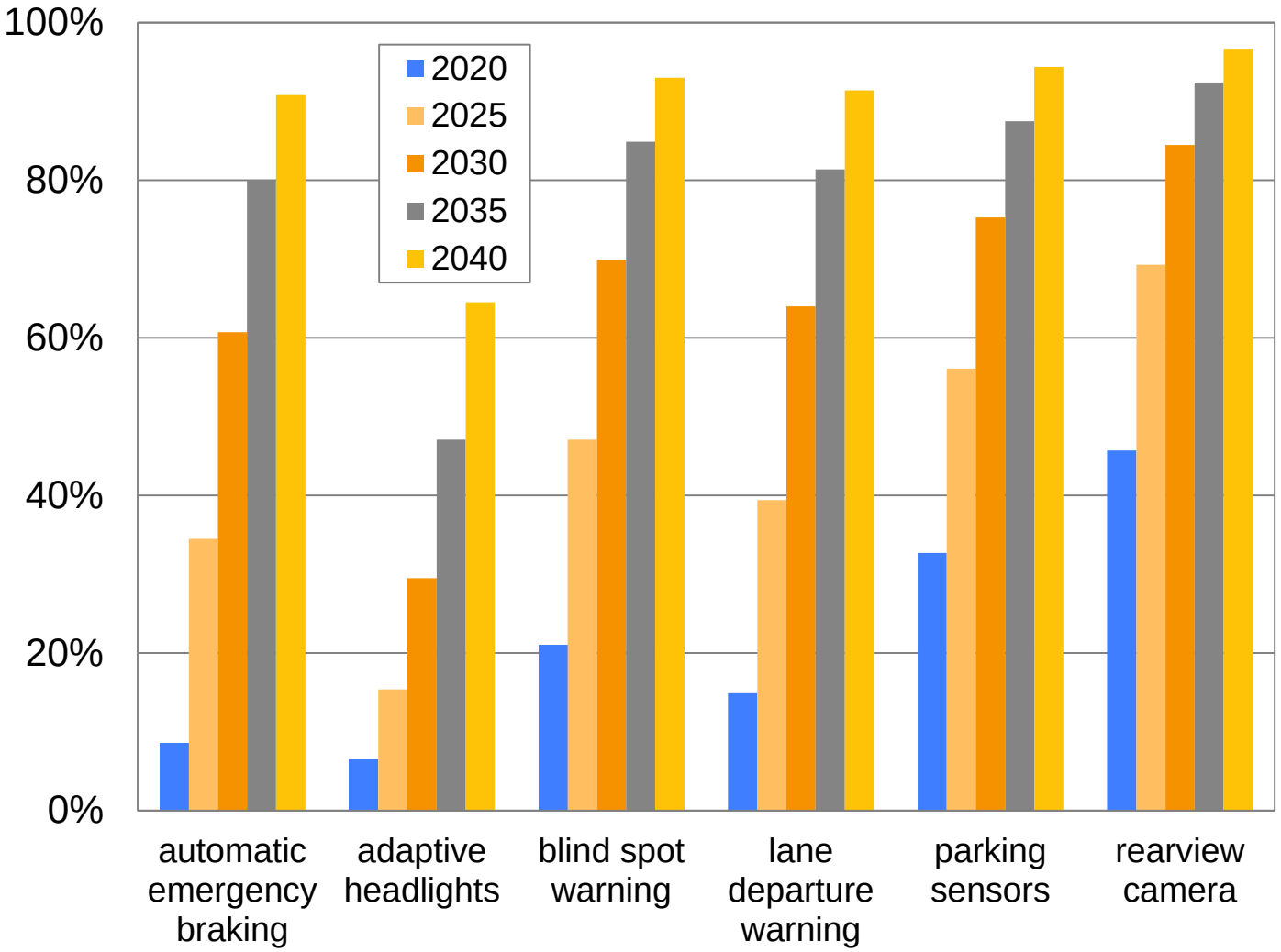
By calendar year



Based on past trends, we project that around 34% of vehicles on the road will be equipped with AEB in 2025

This should rise to 80% by 2035

Predicted registered vehicles by feature and calendar year



Rear cameras and parking sensors are estimated to be on more than half of the registered vehicles in 2025, while AEB, blind spot warning, and lane departure warning will make up 34-47%

By 2035, all of these features will be relatively common

Expected injury crash reduction in calendar year 2025 due to advanced driver assistance systems

Driver assistance system	Prevalence in 2025 (%)	Relevant injury crash types	Crash risk reduction (%)	Fewer injury crashes (%)
Automatic emergency braking	34	Front-to-rear	56	19
Bind spot warning	47	Lane-change	23	11
Lane departure warning	39	Single-vehicle, Head-on, Sideswipe	21	8

So, there should be fewer injury crashes than otherwise expected in 2025

For example, the prevalence of lane departure warning should reduce single-vehicle, head-on, and sideswipe injury crashes by 8%

In summary,
the relationship between vehicle mass and fatality risk is changing

With changes in vehicle design

- Disparate size and weight will always exist in the fleet
- Smaller and lighter vehicles will always be at a disadvantage

BUT,

- Advanced structural engineering and technology innovations have improved the fleet compatibility and occupant protection across all vehicle sizes
- Advanced crash avoidance and mitigation helps, especially when fitted to the most vulnerable vehicles
  - Counter to historical trend of fitting expensive technologies to larger (and more expensive) vehicles first

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Charles M. Farmer
Vice President, Research and Statistical Services
cfarmer@iihs.org
+1 434 985 9260