Session 090: Applications of Vehicle History in Auto Insurance Rating and Underwriting

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

INSURING THE MODERN VEHICLE

Applications of vehicle-specific attributes in auto insurance rating and underwriting

Don Hendriks, **ASA, ACAS, FCA, MAAA**
Actuary and Data Scientist

Society of Actuaries Annual Meeting & Exhibit
Tuesday, October 29
Toronto, Ontario

The power of segmentation

- Insurers discriminate between risks to determine the costs associated with providing insurance coverage.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Effective segmentation

Lift

- Members of segments must be effectively identified.
- There must significant differences between the segments

Performance

- Between – Average frequency or severity must be different for different segments
- Among – Variance between members of the same segment should be random and low.

Increasing Segmentation

LESS SEGMENTED

Driver Classification

- Age, gender, marital status
- Driving records

Territory Classification

- Urbanity
- Population density

Vehicle Classification

- Year, make and model
- Cost new (Symbol)

MORE SEGMENTED

Driver-Specific Data

- Credit history
- Driving behavior (UBI)

Location-Specific Data

- Weather models
- Commute and traffic data

Vehicle-Specific Data

- Advanced safety features
- Vehicle history

Vehicle-level rate adjustments

MORE COMMON

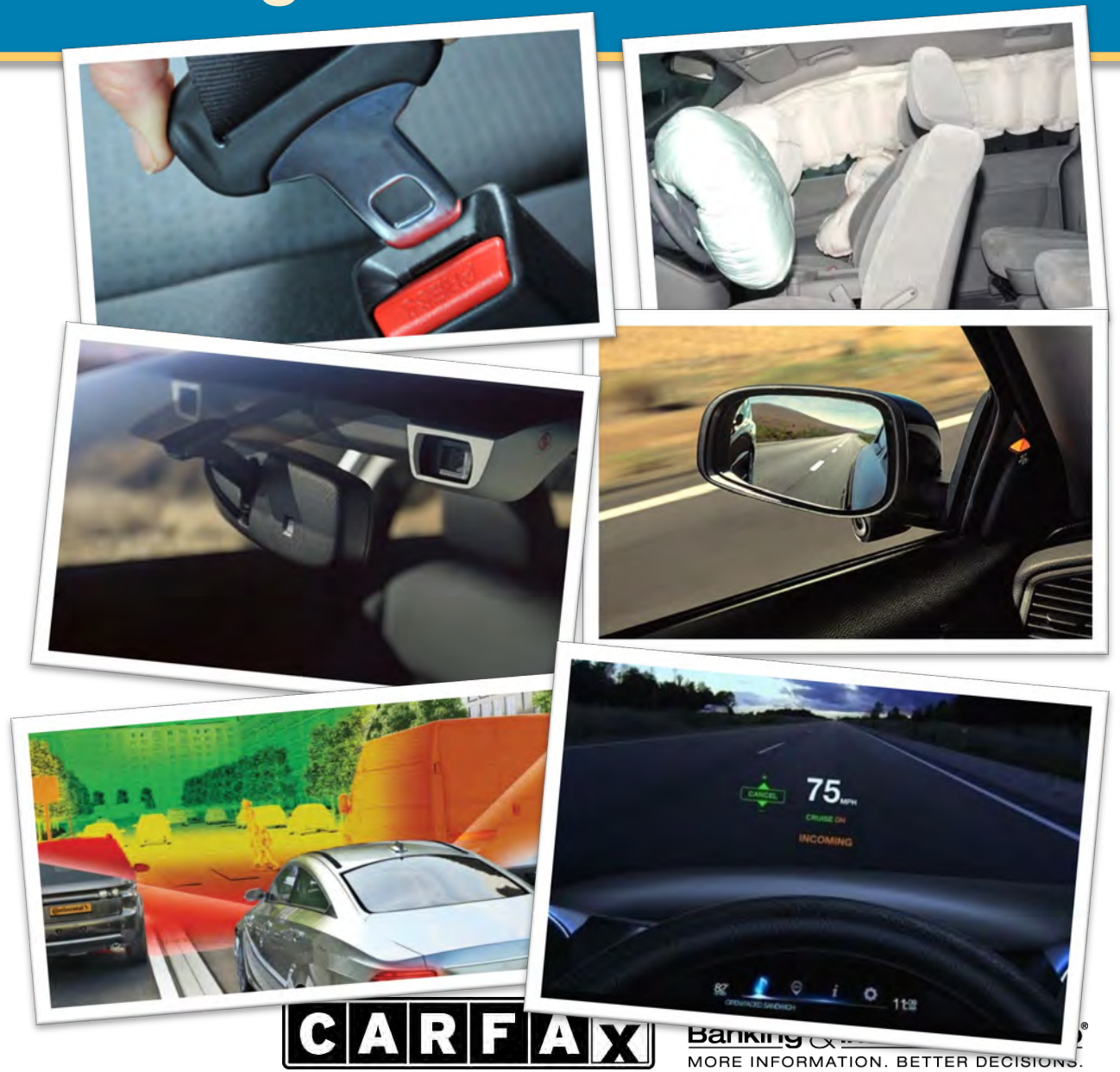
- Passive Restraint Systems
  - Automatic seat belts.
  - Driver-side and passenger-side airbags.
- Anti-Lock Brakes
- Daytime Running Lights
- Anti-Theft Systems
- Stolen Vehicle Recovery Systems

LESS COMMON

- Rearview Cameras
- Front Collision Avoidance
- Blind Spot Detection
- Lane-Departure Warning Systems
- Tire-Pressure Monitoring Systems
- Emergency Response Systems

Vehicle attributes in underwriting

- Companies are offering discounts on safety features that provide very little effective segmentation.
- Many advancements in vehicle safety are ignored in underwriting and rating.
- Safety features are evolving at a breakneck pace.



Automatic Seat Belts

Raise your hand if you have ever ridden in a car with one of these:

Automatic Seat Belts

Raise your hand if you have ever ridden in a car with one of these:

Now put it down if you have ever watched a broadcast of this show:

CARFAX
Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

ADAS: ADVANCED DRIVER ASSISTANCE SYSTEMS

The low-hanging fruit of auto segmentation

Vehicle Safety Features

2016 Buick Envision
MSRP $42,380

Forward-Collision Warning
Low Speed Auto-braking
High Speed Auto-braking
Lane Departure Warning
Lane Keeping Assist
Blind-Spot Warning
Rear Cross Traffic Warning
Rearview Camera

2016 IIHS TOP SAFETY PICK+

2016 BMW X3
MSRP $39,650

Forward-Collision Warning
Low Speed Auto-braking
High Speed Auto-braking

Blind-Spot Warning

Rearview Camera

2016 Ford Escape
MSRP $31,745

Blind-Spot Warning
Rear Cross Traffic Warning
Rearview Camera

2016 VW Tiguan
MSRP $30,645

Rearview Camera

Advanced Vehicle Safety Features – Prior to 2006

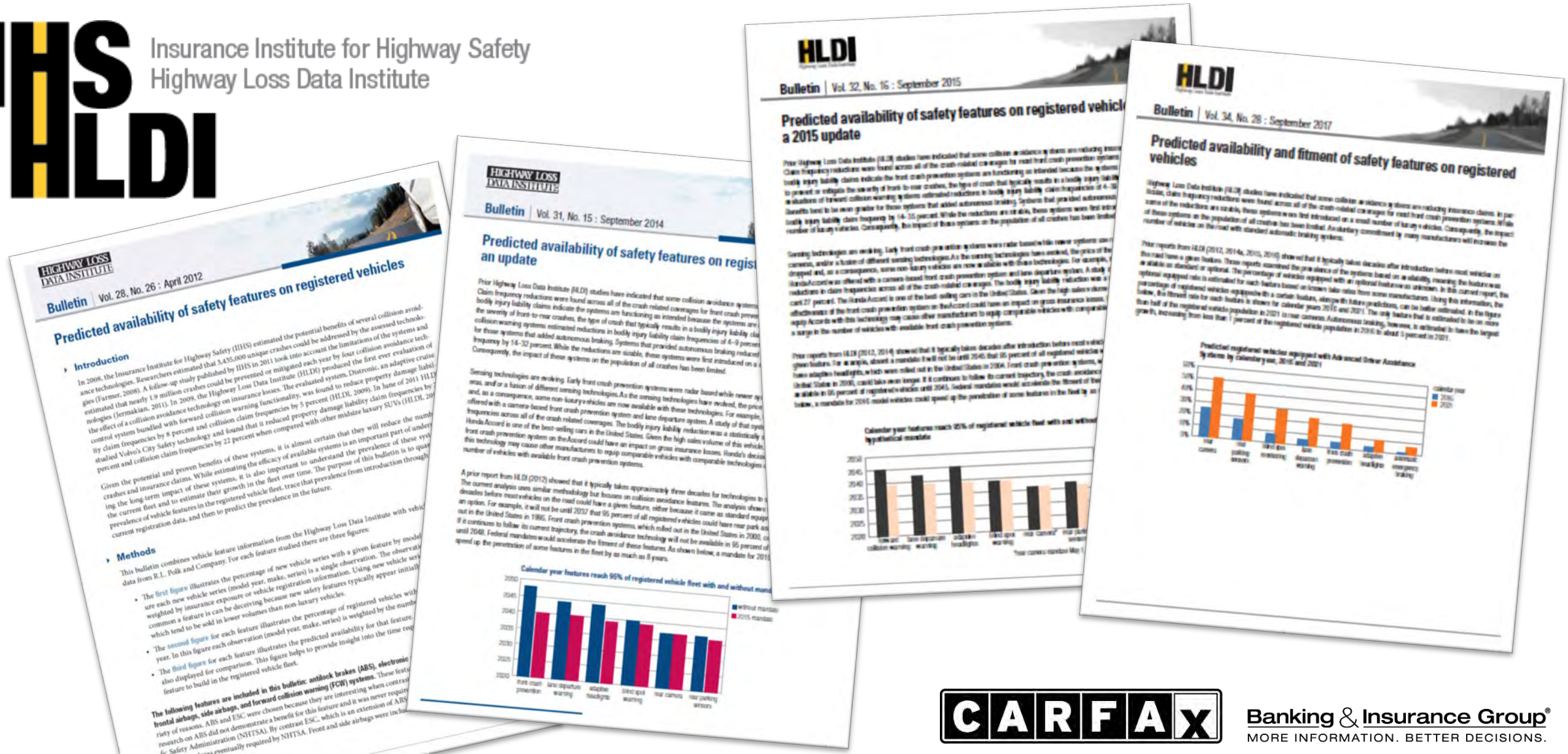
- All-wheel drive systems
- Safety belt pretensioners
- Safety belt load limiters
- Active head restraints
- Advanced airbag deployment systems
- Tire pressure monitoring systems
- Side-impact airbags
- Automatic door locks
- Antilock brakes
- Electronic brake assist
- Electronic stability control
- Traction control
- Sturdy body cell
- Crumple zones
- Cargo barriers
- LATCH

Advanced Vehicle Safety Features – Since 2006

- Visualization and augmented reality
  - Rear-view camera
  - Heads-up display
  - Infrared night vision
  - 360° Overhead View
  - Adaptive headlamps
  - Automatic high beams
  - HID and LED headlights
  - Matrix headlights
  - Traffic monitoring and warning
  - Congestion avoidance GPS
- Adaptive cruise control
- Collision avoidance and mitigation systems
  - Forward automatic emergency braking
  - Rear automatic emergency braking
  - Lane-keeping assist
  - Lane-centering assist
  - Automatic parking
- Collision warning systems
  - Forward-collision warning
  - Blind-spot warning
  - Rear cross-traffic warning
  - Lane-departure warning
  - Driver alertness detection

Safety Equipment Fitment

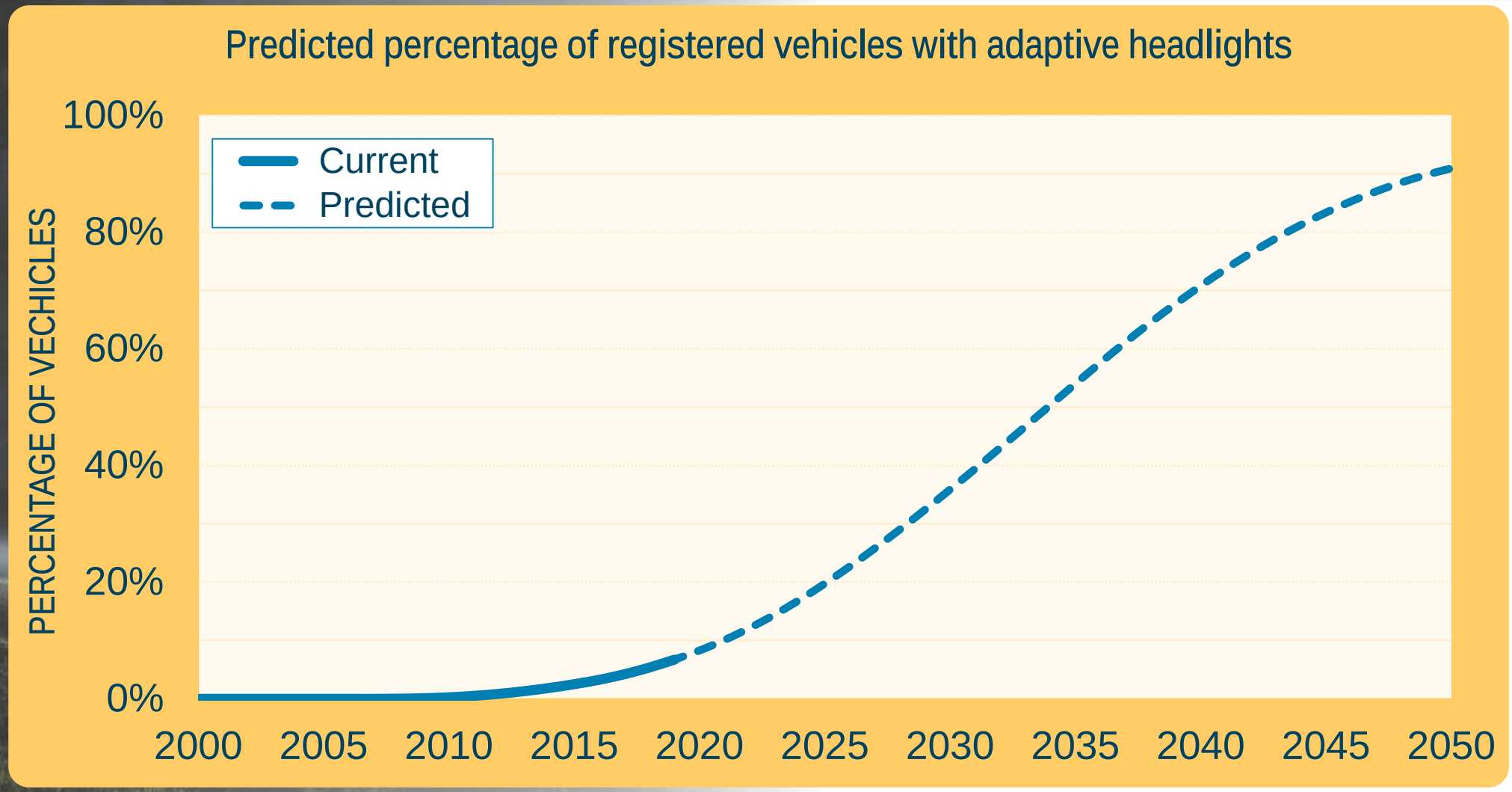
Insurance Institute for Highway Safety
Highway Loss Data Institute



CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Curve-Adaptive Headlights



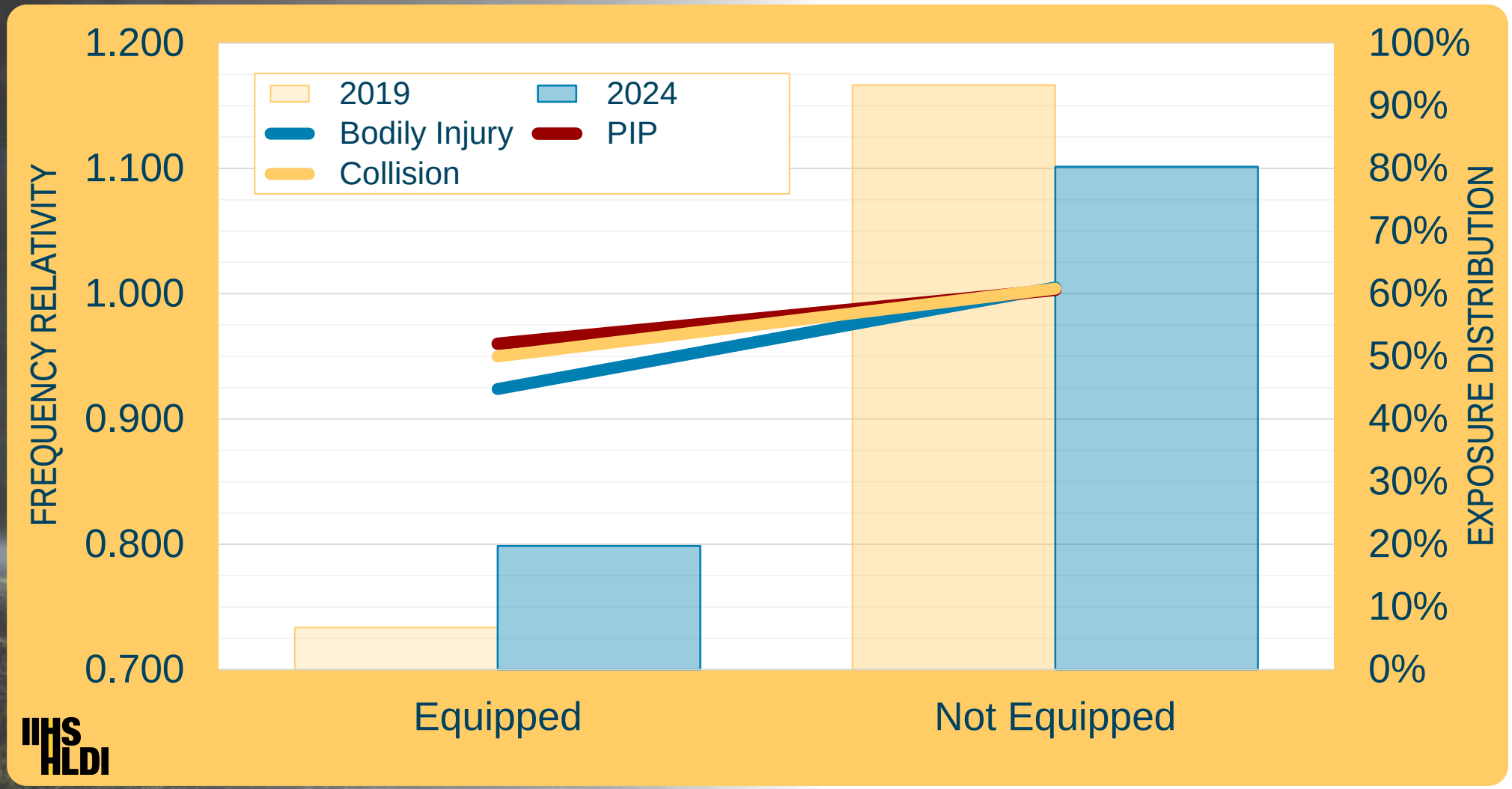
Highway Loss Data Institute. Sep 2017. Predicted availability and fitment of safety features on registered vehicles. *Loss Bulletin*. Vol. 34, No. 28. Arlington, Virginia.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

FREQUENCY LIFT

Curve-Adaptive Headlights



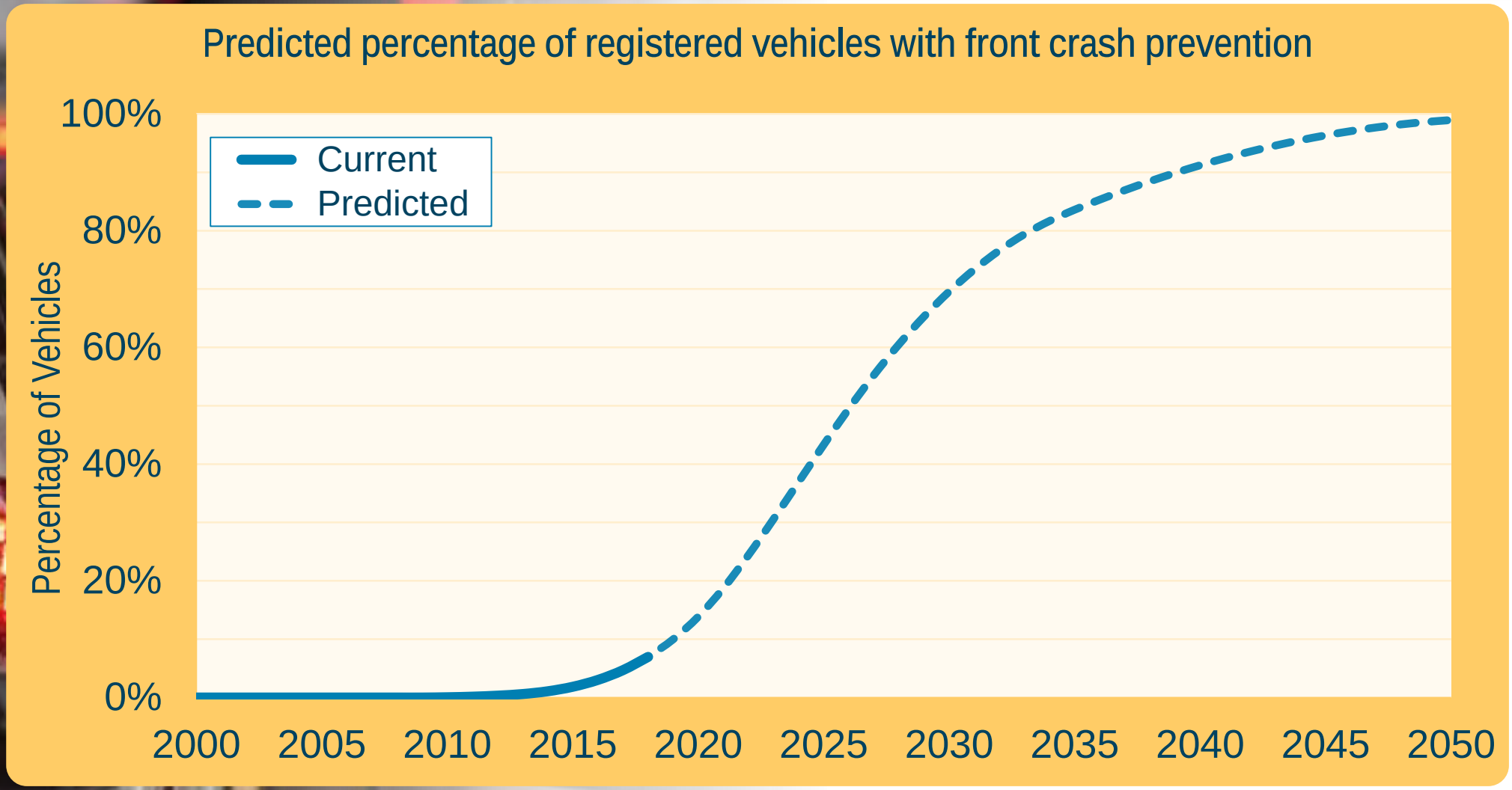
IIHS HLDI

CARFAX

Banking & Insurance Group®

MORE INFORMATION. BETTER DECISIONS.

Front Collision Warning



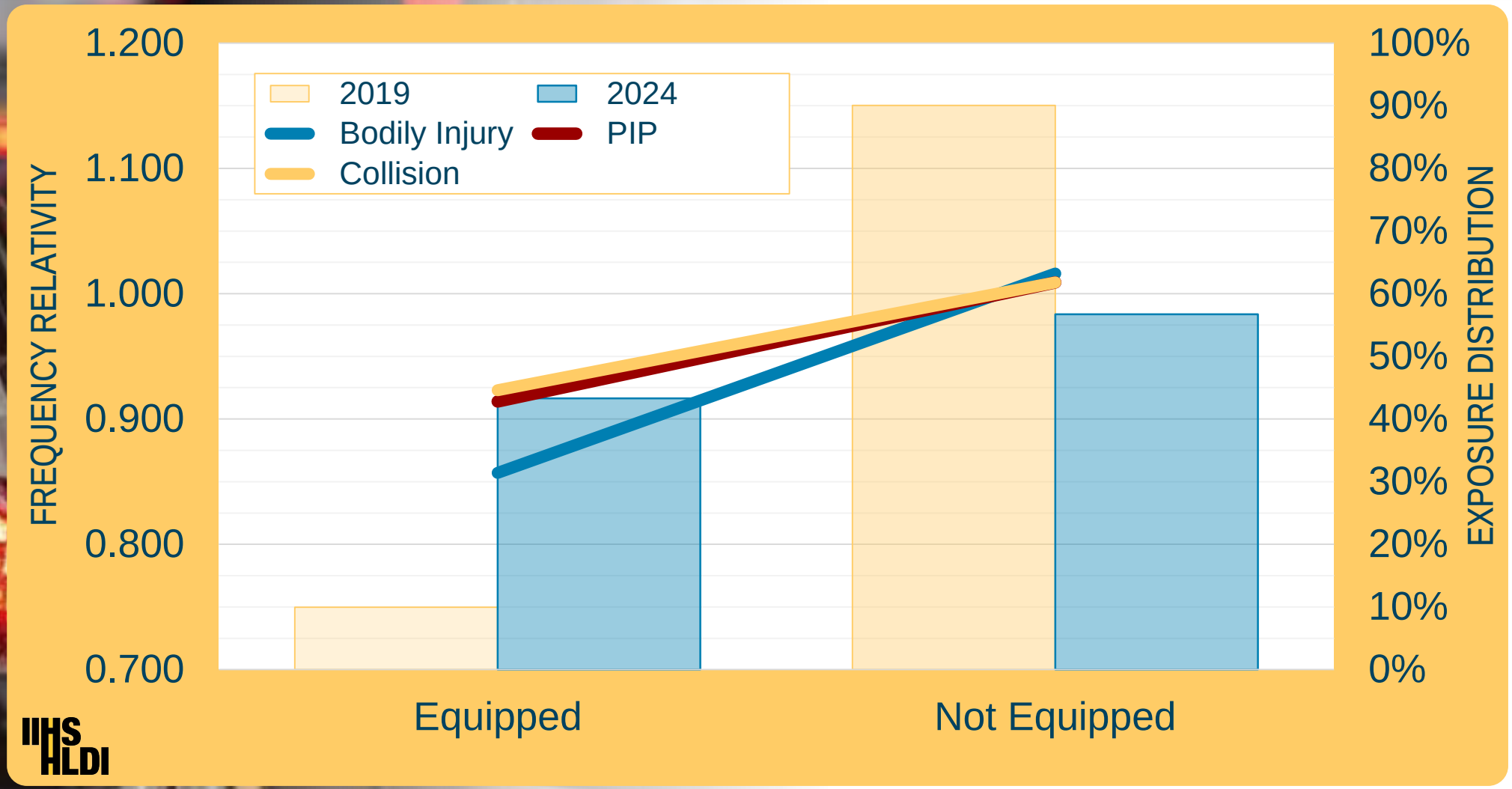
Highway Loss Data Institute. Sep 2017. Predicted availability and fitment of safety features on registered vehicles. *Loss Bulletin*. Vol. 34, No. 28. Arlington, Virginia.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

FREQUENCY LIFT

Front Collision Warning

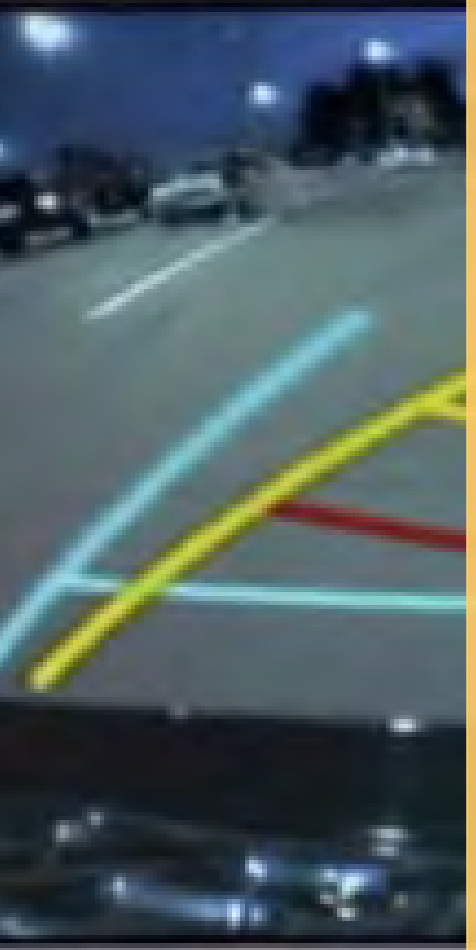


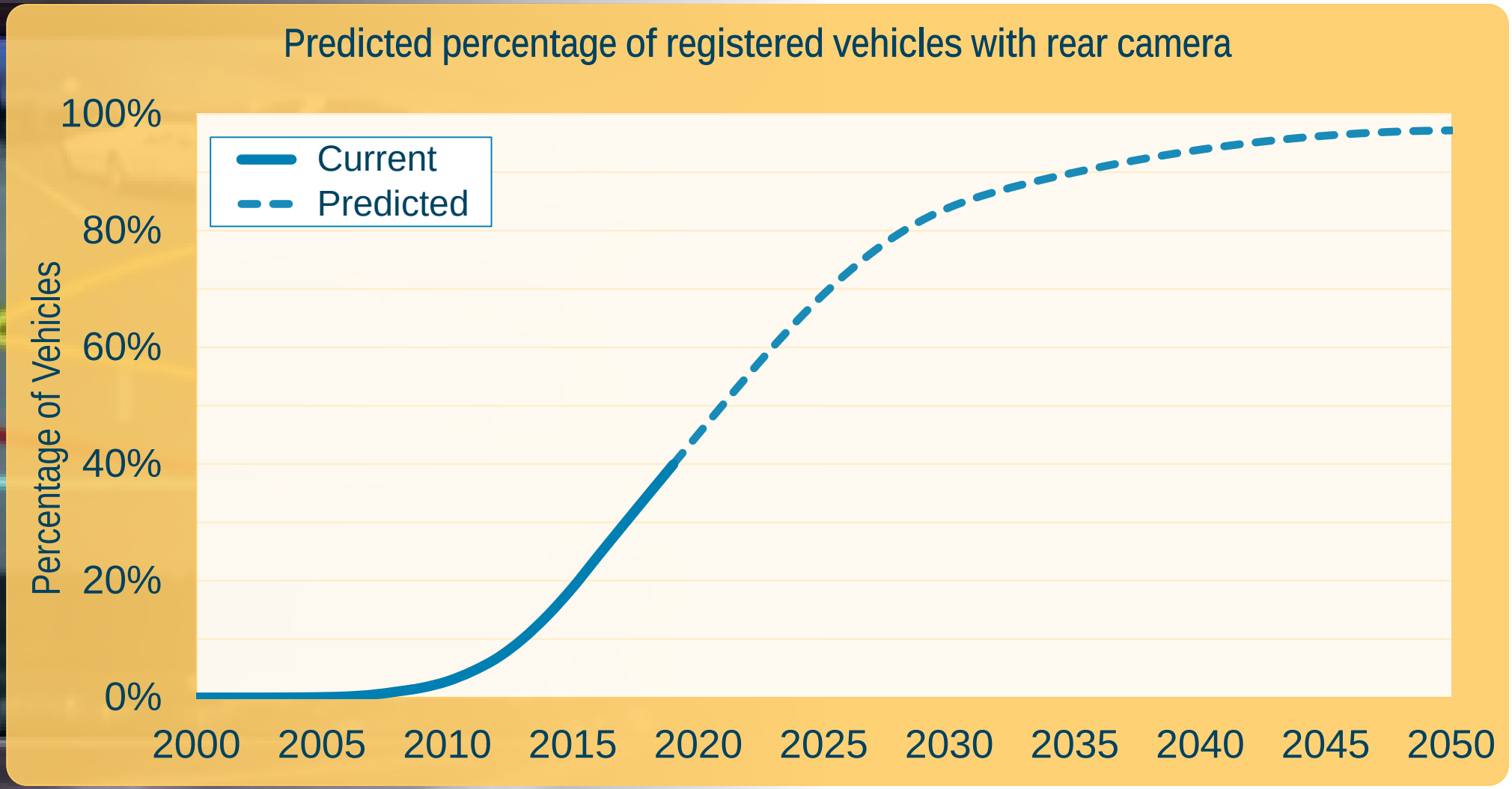
IIHS HLDI

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Back-up Camera



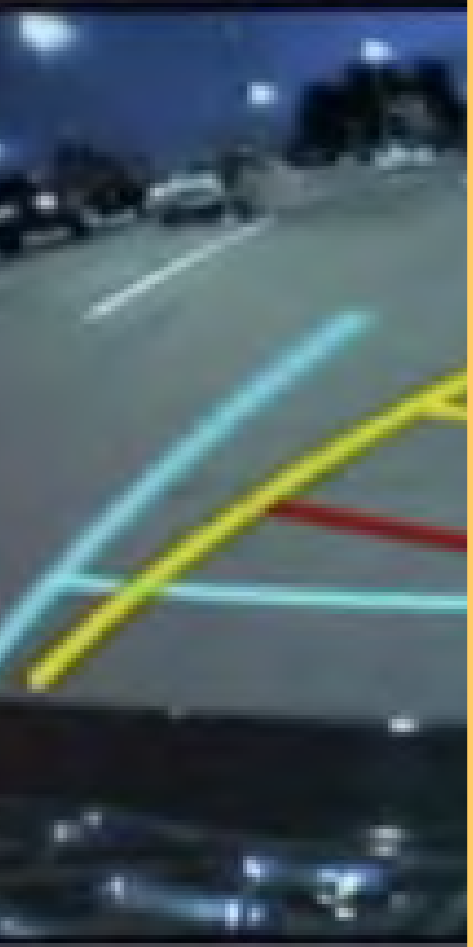


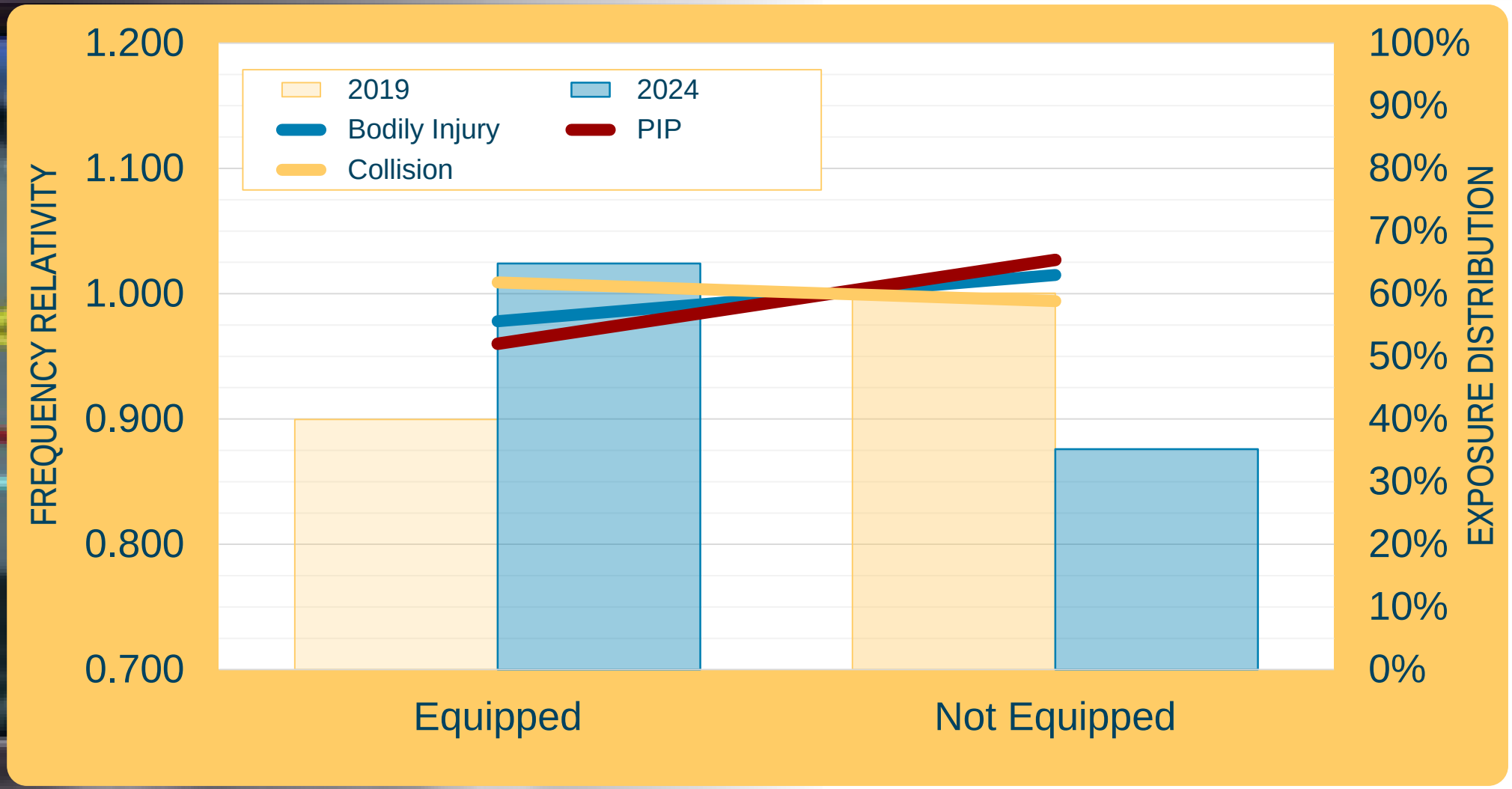
Highway Loss Data Institute. Sep 2017. Predicted availability and fitment of safety features on registered vehicles. *Loss Bulletin*. Vol. 34, No. 28. Arlington, Virginia.

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

FREQUENCY LIFT

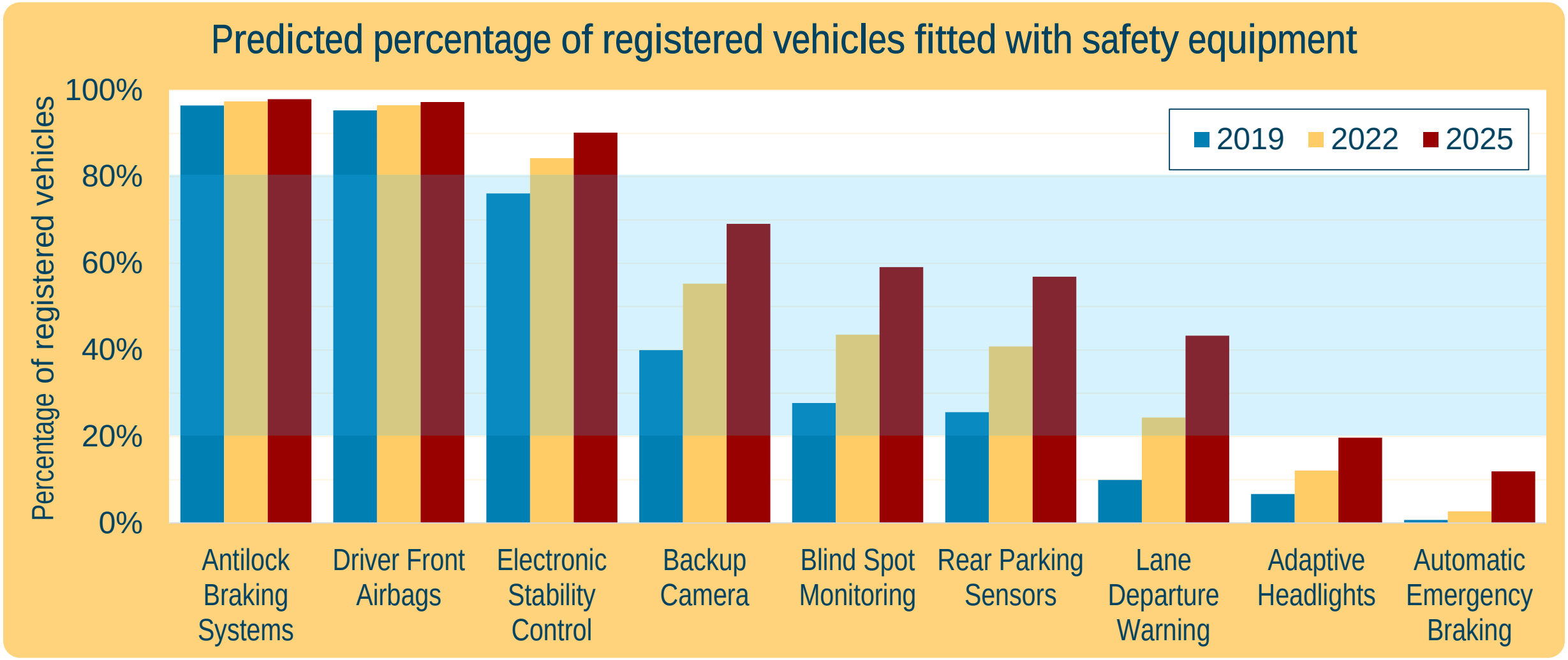
Back-up Camera





CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Vehicle Safety Equipment – The next 6 years



Highway Loss Data Institute. 2012, 2015, and 2017. Data compiled from various reports. *Loss Bulletin*. Vol. 28, No 26; Vol 32.16; Vol. 34, No. 28. Arlington, Virginia.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Advanced Safety Features and Insurance Pricing

Consumer Expectations[1]

46.1%

of auto insurance customer believe that safety technology like blind spot warning or a rear-view cameras affect their insurance rates.

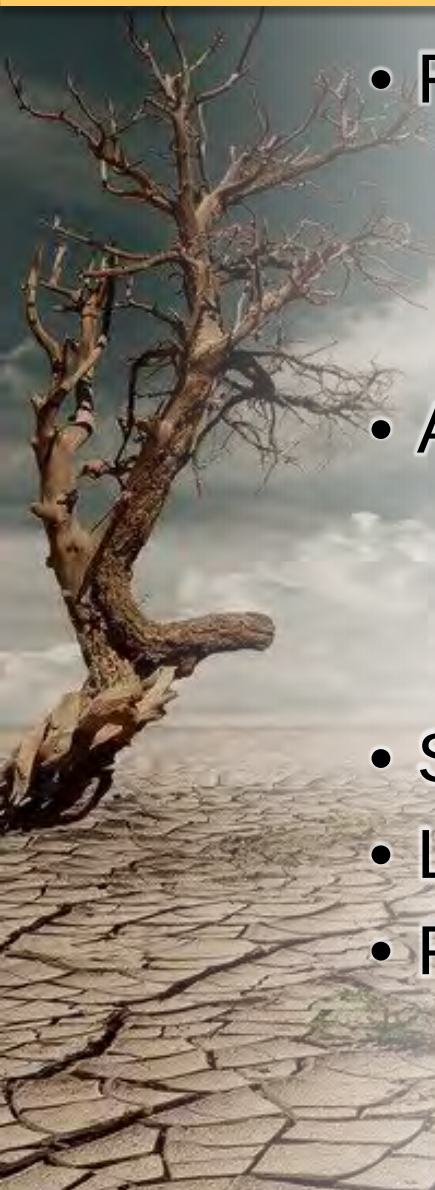
Average Insurance Rating[2]

Original Premium	$1,434	
Electronic Stability Control	- 7	- 0.49%
Electronic Stability Control	0	0.00%
Collision Preparation System	0	0.00%
Blind Spot Monitoring	0	0.00%
Driver Alertness Monitoring	0	0.00%
Lane Departure Warning	0	0.00%
Rear-View Camera	0	0.00%
Heads-Up Display	0	0.00%
Night Vision	0	0.00%
Discounted Premium	**$1,427**	

1. The Zebra. *Auto Insurance Awareness* Survey. October, 2017. Austin, TX.
2. The Zebra. *Why Car Technology That Makes You Safer Won't Lower Your Insurance Rates.* https://www.thezebra.com/research/new-car-tech-wont-lower-insurance-rates/#key-findings

CARFAX Banking & Insurance Group® MORE INFORMATION. BETTER DECISIONS.

Challenges



- Fitment data is difficult to get.
  - OEMs limit data based on contractual obligations or competitive concerns.
  - Branding and packaging make identification difficult.
  - Available data is incomplete or contradictory.
- ADAS features are often optional equipment.
  - Insurers are reluctant to trust car buyers to correctly identify what technology their vehicle has on board.
  - Difficult to validate which features are fitted.
- Some features may be turned off by the vehicle owner.
- Limited claims data to accurately determine pricing.
- Performance differences between and even among manufacturers.

The Morale Hazard of ADAS

2018 Survey by the AAA Foundation for Traffic Safety

- About 75% of owners find ADAS useful and trust it.
- About 70% of owners want their next car to be equipped with ADAS.
- 30% feel comfortable looking away from the road to engage in other activities while using adaptive cruise control.
- 55% use the blind spot monitor for lane changes without visual confirmation.
- 33% feel comfortable looking away from the road, making a phone call or sending a text while using lake keeping assist.
- 45% utilize the rear cross traffic feature without a visual check.

McDonald, A. , Carney, C. & McGehee, D.V. (2018). Vehicle Owners' Experiences with and Reactions to Advanced Driver Assistance Systems. *AAA Foundation for Traffic Safety.*

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

INFOTAINMENT AND CONVENIENCE

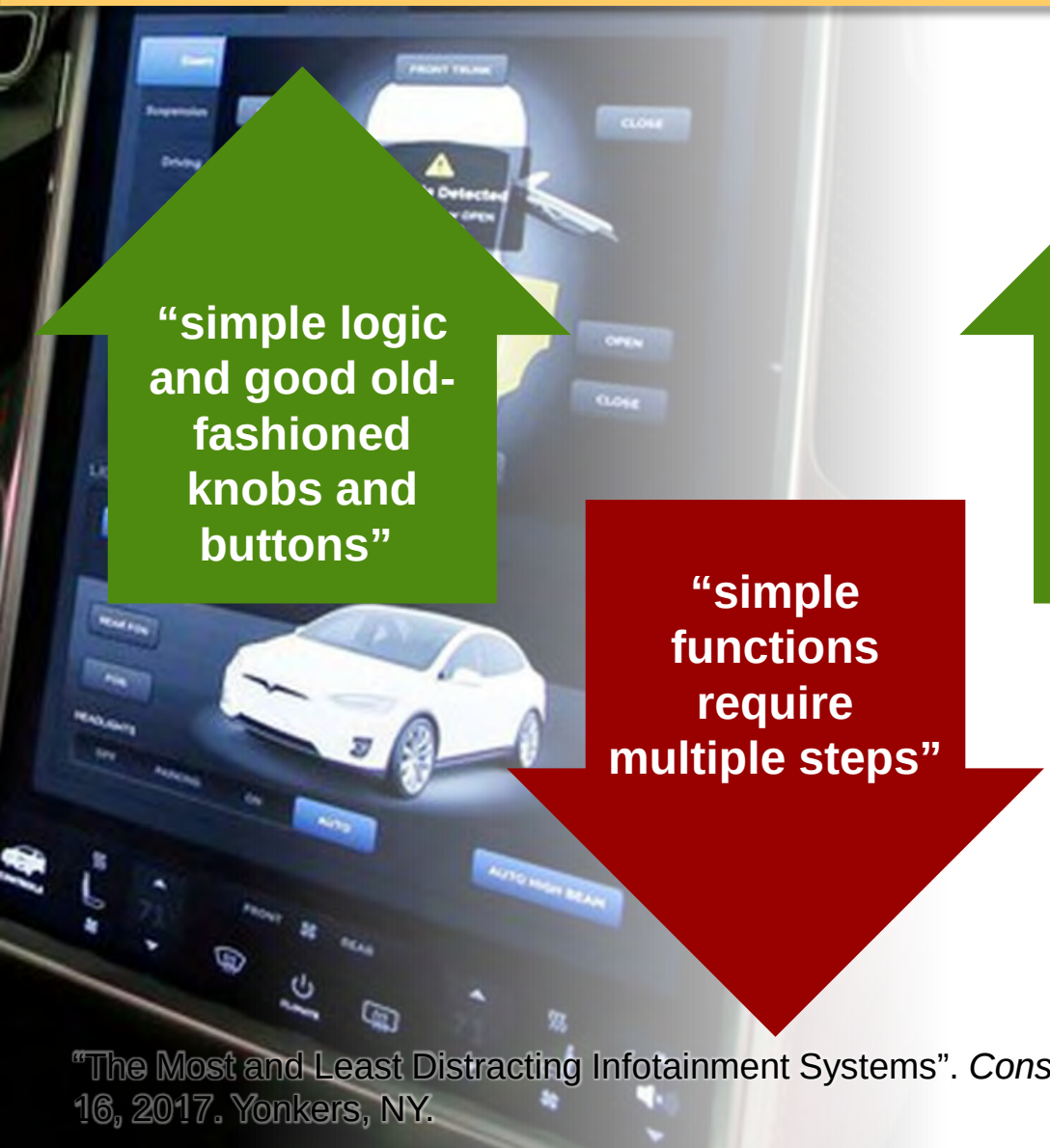
Other vehicle attributes that impact insurability

Push Button Start

- Convenience feature becoming ubiquitous
- Eliminates automatic safety interlock
  - Combined with auto-start, people leave vehicles on but unattended
  - Often no audible warning if vehicle is left running
- Vehicles restart and move on their own with no driver
- Carbon monoxide poisoning*
  - 28 deaths
  - 45 others suffered injuries

“Deadly Convenience: Keyless cars and their carbon monoxide toll”. *The New York Times*. May 13, 2018. New York, NY.

Infotainment Systems



"simple logic and good old-fashioned knobs and buttons"

"simple functions require multiple steps"

"easy-to-read screen and text"

"finicky voice-command system"

"well-designed steering-wheel controls"

"The Most and Least Distracting Infotainment Systems". *Consumer Reports*. November 16, 2017. Yonkers, NY.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Infotainment Systems – The best and worst

Least Distracting

- Fiat Chrysler
- Ford/Lincoln
- GM (except Cadillac)
- Hyundai/Kia
- Nissan
- Subaru
- Toyota
- Volkswagen

Moderately Distracting

- Audi
- BMW
- Honda (except Accord)
- Infiniti Q50
- Mazda
- Mini

Most Distracting

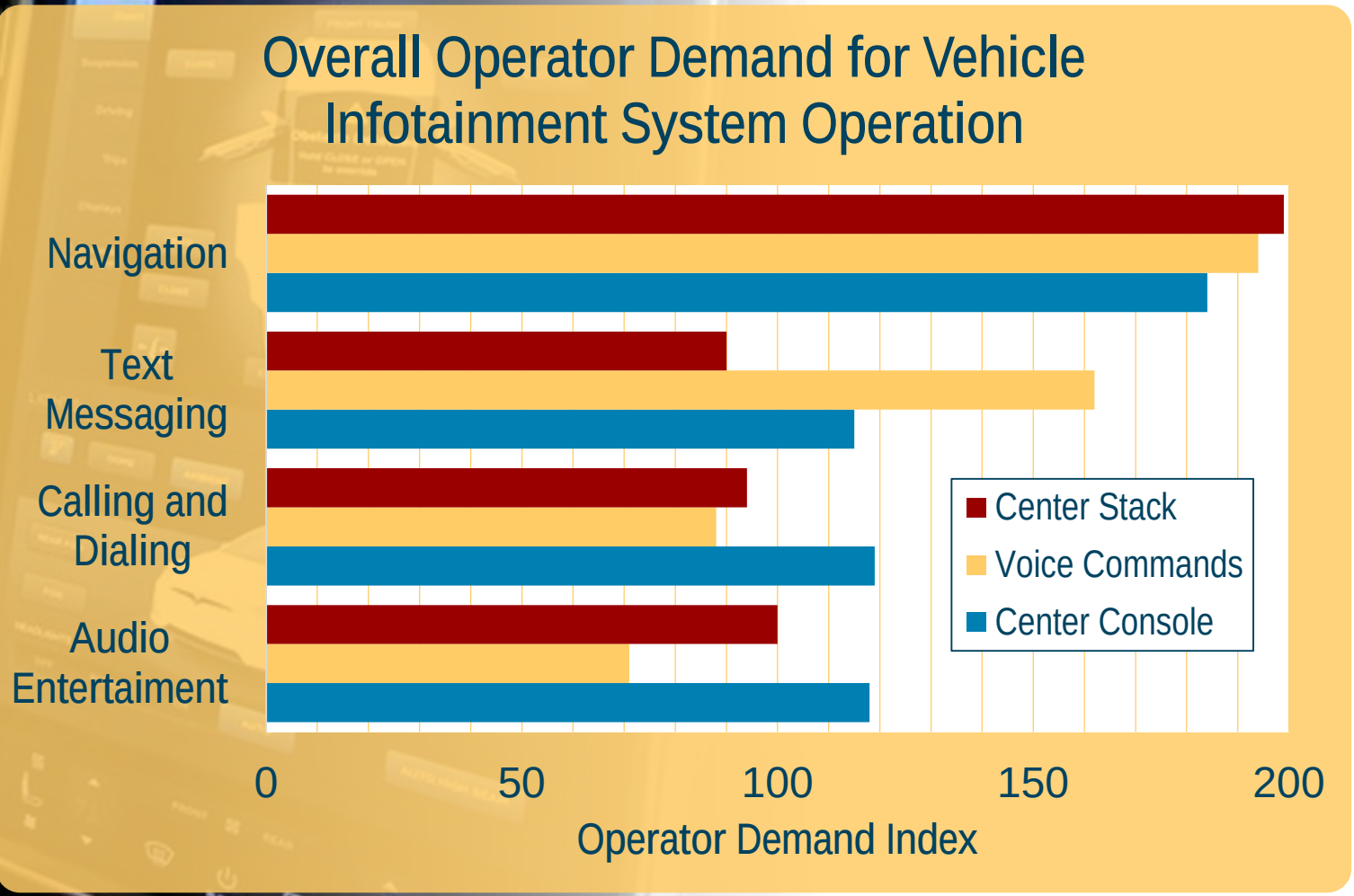
- Acura
- Cadillac Cue
- Lexus NX, RX, GS, LS, and LC
- Mercedes-Benz
- Tesla Models S and X
- Volvo XC60, XC90, S90, and V90

"The Most and Least Distracting Infotainment Systems". *Consumer Reports*. November 16, 2017. Yonkers, NY.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

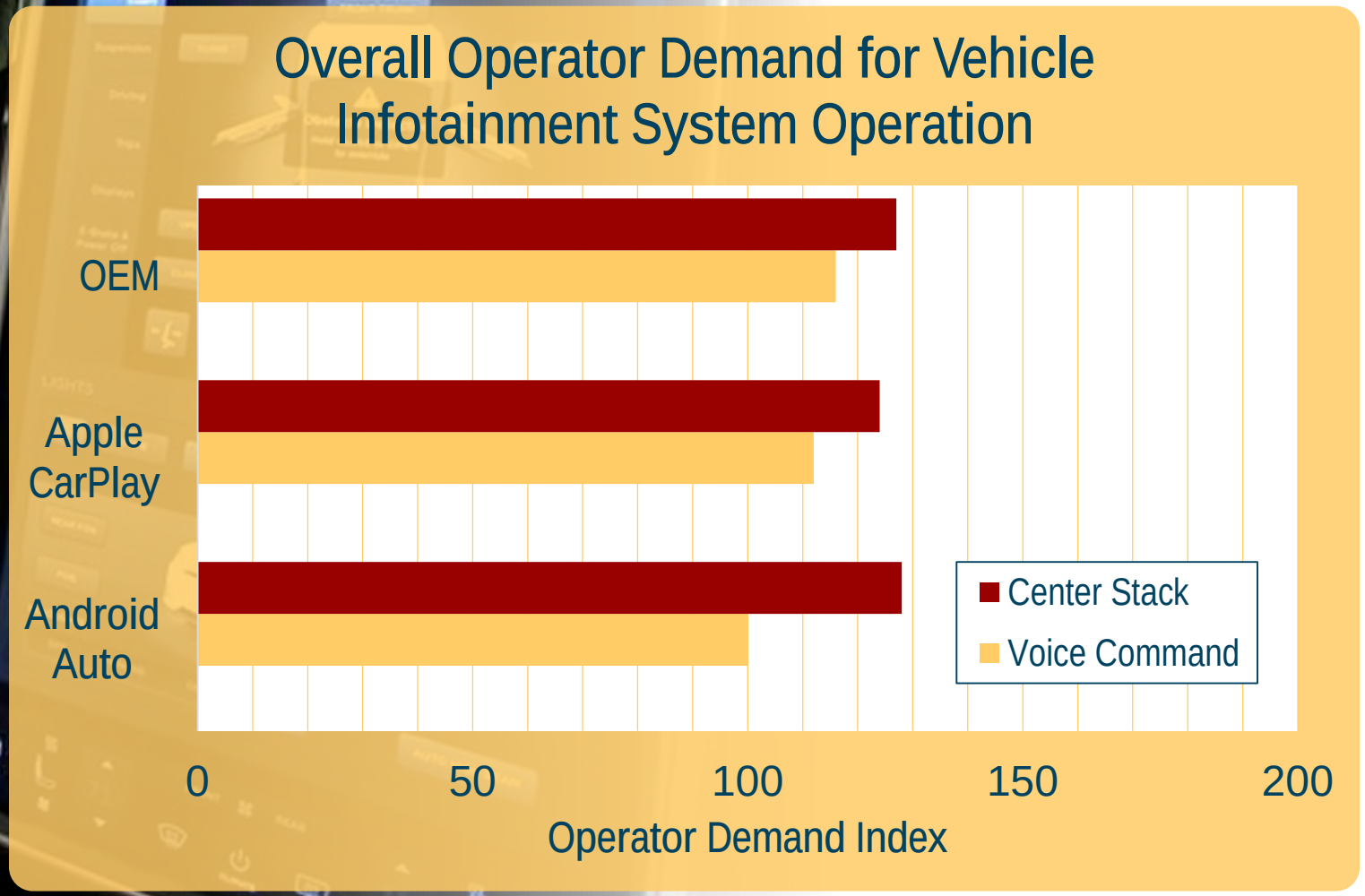
Infotainment Systems



- Infotainment system designs contribute to distracted driving.
- Navigation is more distracting than texting or calling.
- Newer systems are more distracting.
- Results vary by manufacturer and trim.

Strayer, D.L. Cooper, J.M., Goethe, R.M., McCarty, M.M., Getty, D. & Biondi, F. Visual and Cognitive Demands of Using In-Vehicle Information Systems. *AAA Foundation for Traffic Safety.* 2017.

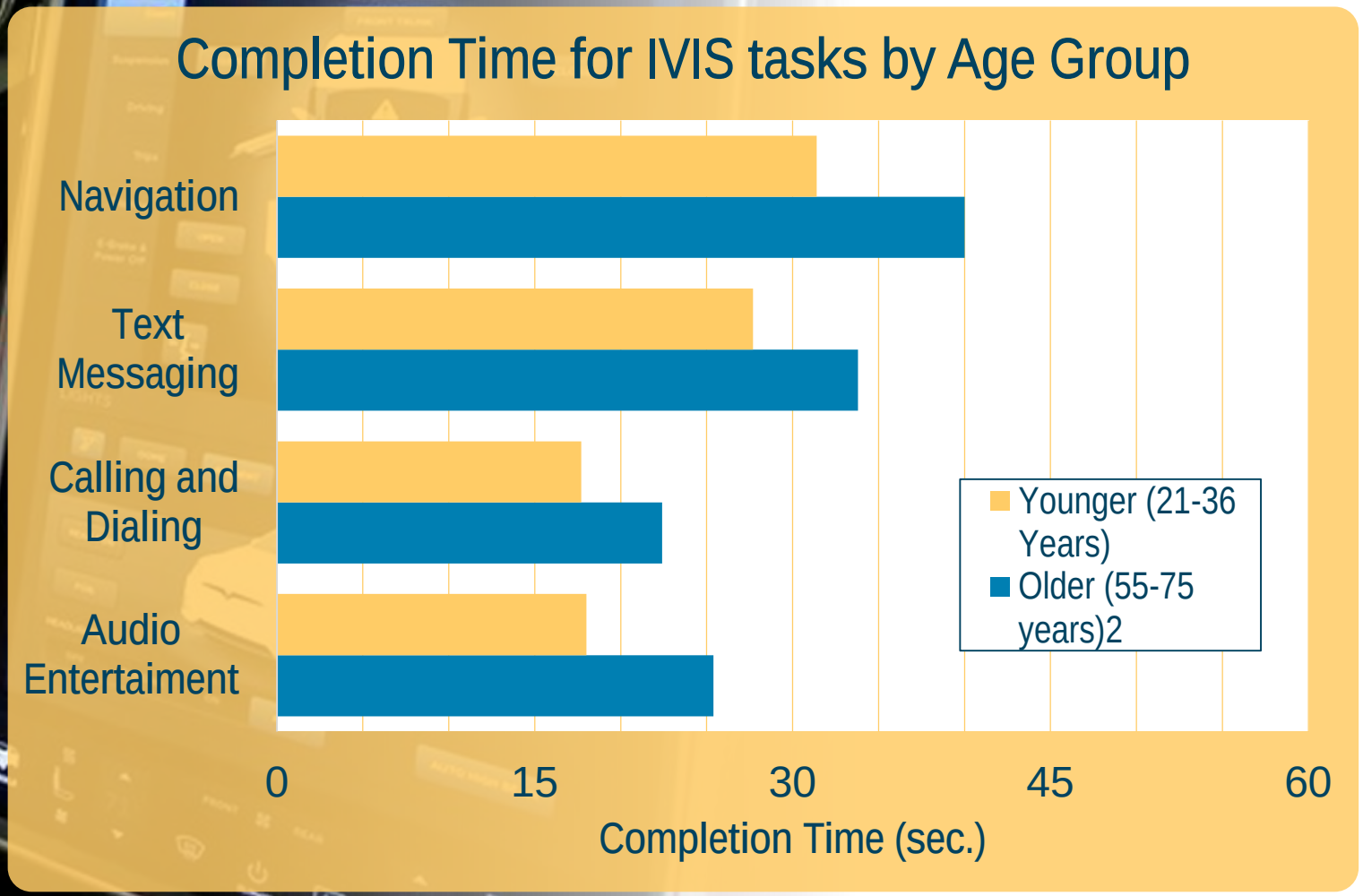
Infotainment Systems – OEM vs Phone-based



- Not all created equal
- Voice commands beat center stack
- Android Auto is significantly less distracting in Voice Mode
- Standardized platforms may improve Apple and Android results over time.

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Infotainment Systems – Older drivers



- Take longer to complete in-vehicle information system tasks
- Experienced higher levels of cognitive and visual demand
- Effect apparent across all modes of interaction

Cooper, J.M., Wheatley, C.L., McCarty, M.M., Motzkus, C.J., Lopes, C.L., Erickson, G.G., Baucom, B.R.W. & Strayer, D.L. (2019). Age-Related Differences in the Cognitive, Visual and Temporal Demands of In-Vehicle Information Systems. AAA Foundation for Traffic Safety.

CARFAX
Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

VEHICLE HISTORY

Insurance scoring for your car

What is *vehicle history*?

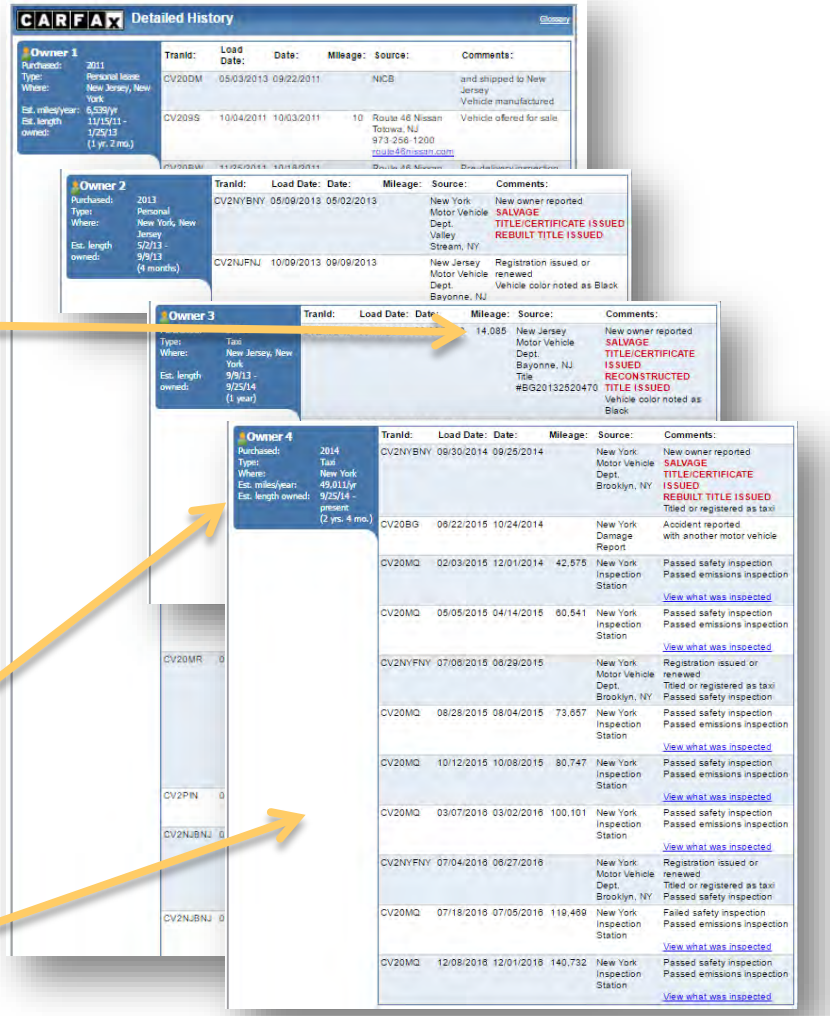
Damage information

Mileage data

Ownership data

Title information

Detailed service history



CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

What is *vehicle history*?

OWNERSHIP

- Number of owners
- Length of ownership
- Leased vs. owned
- Registration gaps
- Lien
- Repossession

USE

- Total miles
- Average annual miles
- Changes in annual miles
- Registration type
- Historical use
- Gaps in coverage

CONDITION

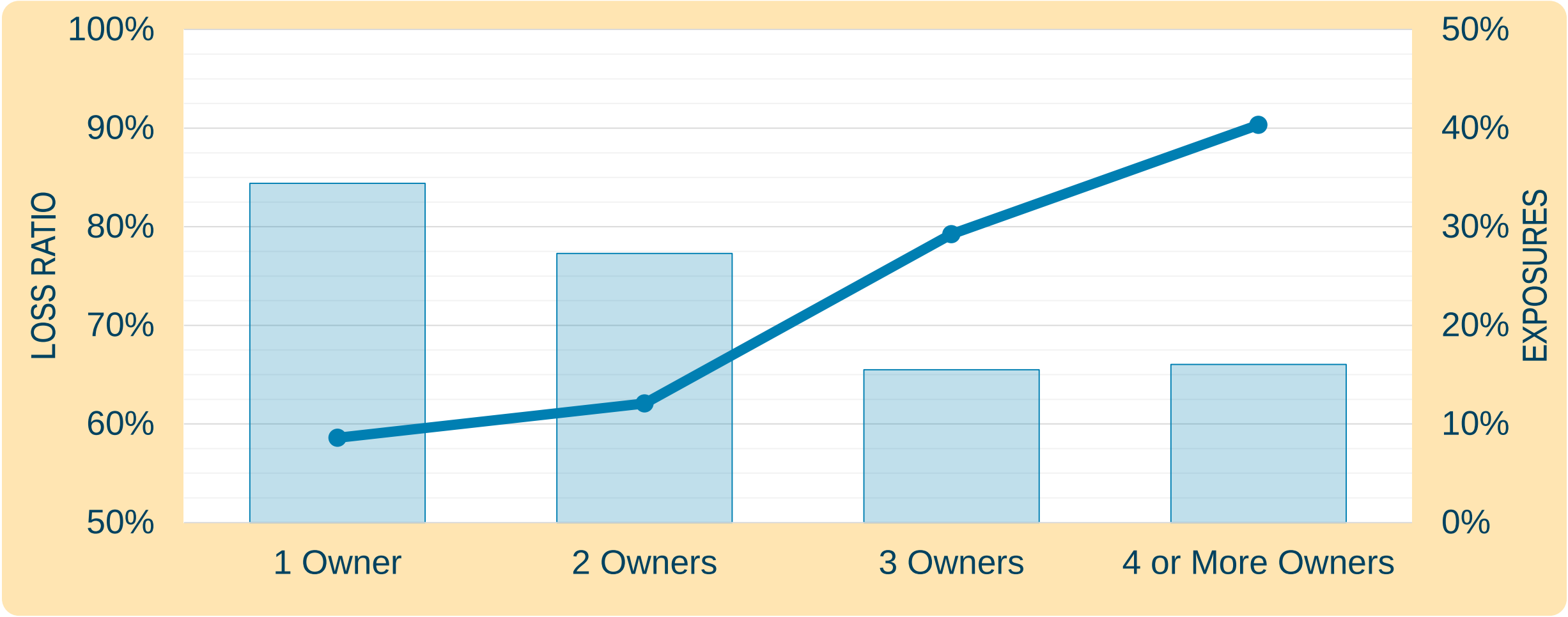
- Maintenance
  - Scheduled
  - Unscheduled repairs
- Damage
  - Accidents
  - Structural damage
  - Flood, Fire or Hail
  - Thefts
- Open recalls

Ownership History
Number of Owners

- One-owner cars are more valuable in the used-car marketplace.
- Fewer owners means fewer opportunities for neglect.
- Earlier owners tend to have to follow maintenance schedules more closely.
- Cars needing frequent or major repairs may be replaced rather than repaired
- Lemons tend to change hands more often.

Lift from Number of Owners

Univariate Analysis



CARFAX Univariate Data Analysis, 2006-2015.

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Ownership History

Certified Pre-Owned Vehicles

- Tend to be newer, lower-mileage, second-owner vehicles
- Undergo thorough inspection from manufacturer
  - Meet strict criteria for condition
  - Consistent maintenance history
- Vehicles reconditioned by factory-trained technicians
- Covered under extended warranties
  - Minor repairs are not skipped
  - Repairs done at dealerships

CERTIFIED PRE-OWNED

GMC

HONDA

Certified Pre-Owned

SUBARU CERTIFIED PRE-OWNED

FORD CERTIFIED PRE-OWNED

Backed by Ford Motor Company

Certified Pre-Owned by BMW

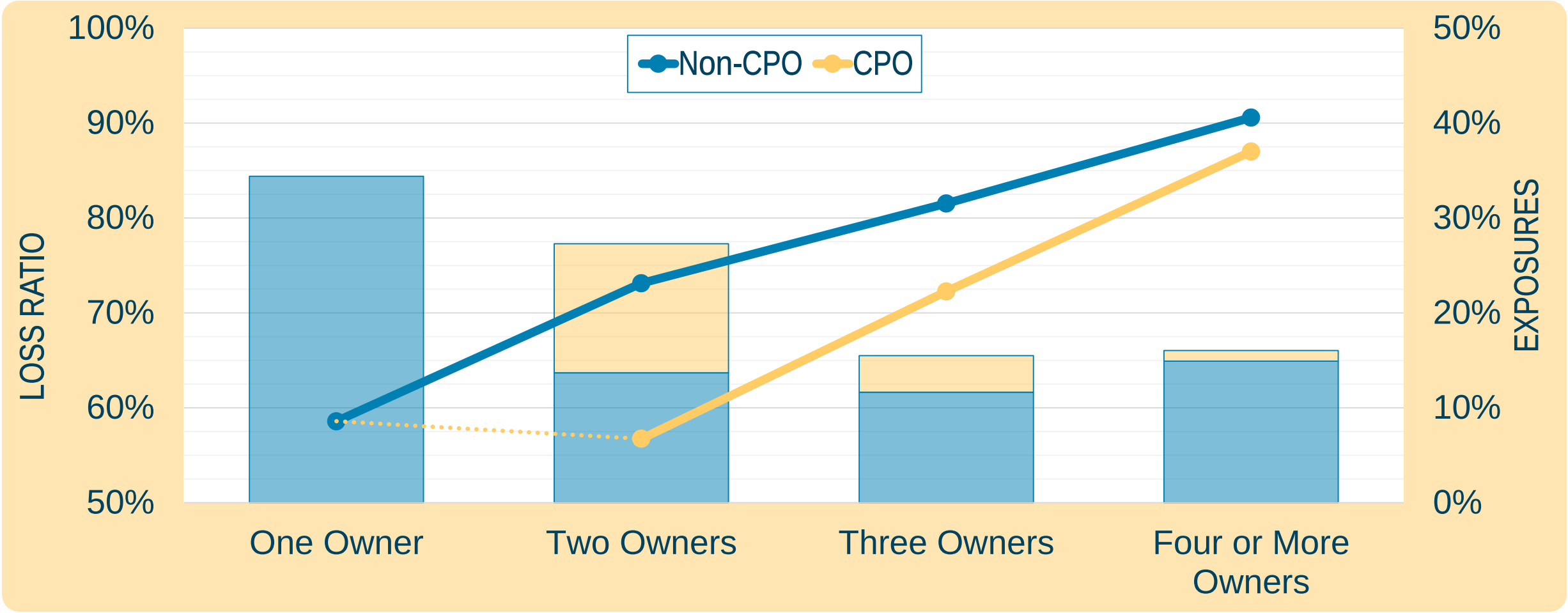
CARFAX

Banking & Insurance Group®

MORE INFORMATION. BETTER DECISIONS.

Lift from Number of Owners with CPO

Univariate Analysis



CARFAX Univariate Data Analysis, 2006-2015.

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Ownership History

Current Owner Length of Ownership

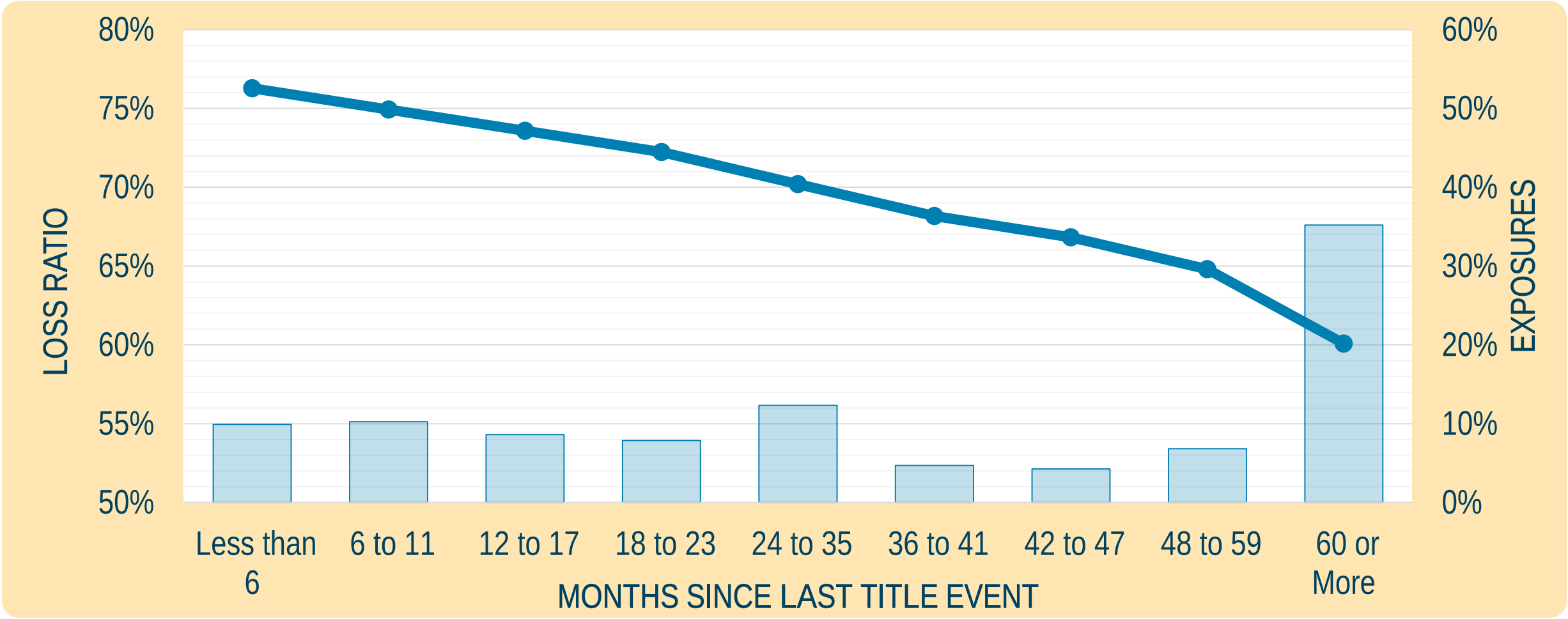
CARFAX studies show that the longer a car is owned, the better the risk becomes.

- Newer cars are less familiar.
- Newer cars are used on longer drives.
- Minor damage is more likely to be reported on newer cars.
- Lemons get moved on to new owners.

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Lift from Length of Ownership

Univariate Analysis



CARFAX Univariate Data Analysis, 2006-2015.

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Ownership History
Average Length of Ownership

Owners tend to hold on to “good” vehicles

- Repair savings outweigh replacement costs, even when opportunity cost of driving older vehicle is considered
- Problem vehicles change hands often

PROBLEM VEHICLES ARE MORE LIKELY TO HAVE SAFETY ISSUES

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Vehicle Use Components

TYPE OF USE

- Personal
- Commercial
- Government
- Police
- Farm
- Seasonal
- Show cars

FREQUENCY AND AREA OF USE

- Mileage
- Registration vs garage ZIP
- Out-of-area service

Vehicle Use

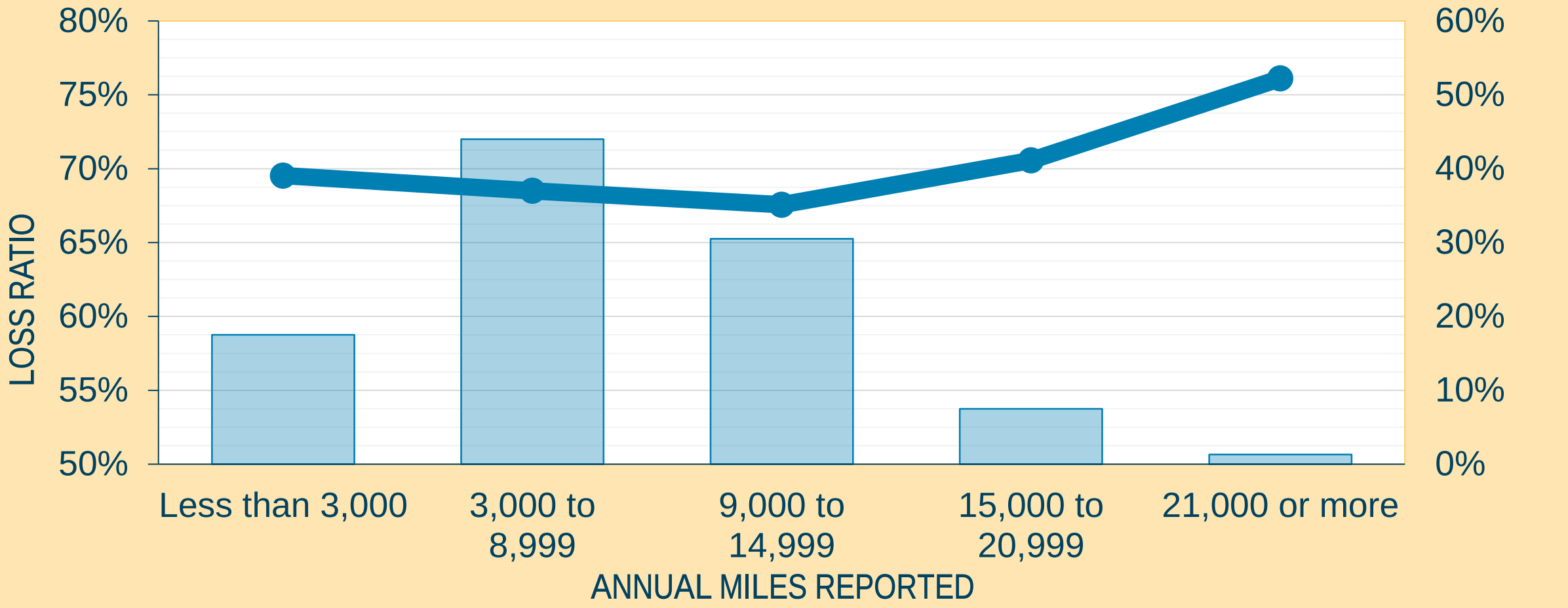
Current Registration Type

- Less likely to be fraudulently reported than self-reported use
  - Tax incentives for commercial registrations
  - Significant penalties for misreporting
- Used in underwriting to match customers to most appropriate coverage

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Vehicle Use

Lift from Self-Reported Mileage



Source: TransUnion Performance Analytics Database, 2006-2010

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

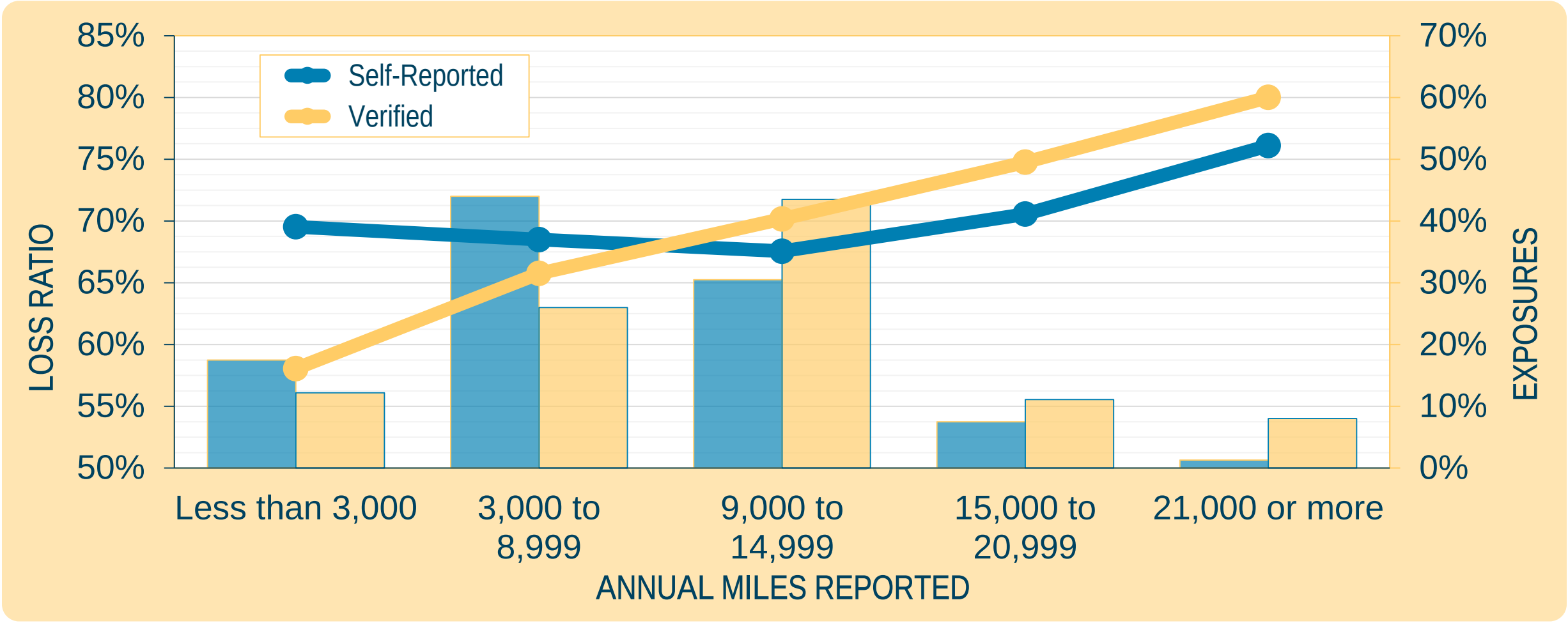
Self-Reported Mileage

- Often Inaccurate
  - Customers may not know how much they drive
  - Significant cost incentive to underreport
  - Agents underreport to save time
- Can change over time
- Difficult for insurers to verify

Source: TransUnion Performance Analytics Database, 2006-2010

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Lift from Annual Mileage
Univariate Analysis



Source: TransUnion Performance Analytics Database, 2006-2010

CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Vehicle Condition Components

KNOWN DAMAGE

- Severe accidents
- Minor accidents
- Title brands
- Flood and water damage
- Fire damage
- Hail damage
- Airbag deployment

PROBLEM CONDITIONS

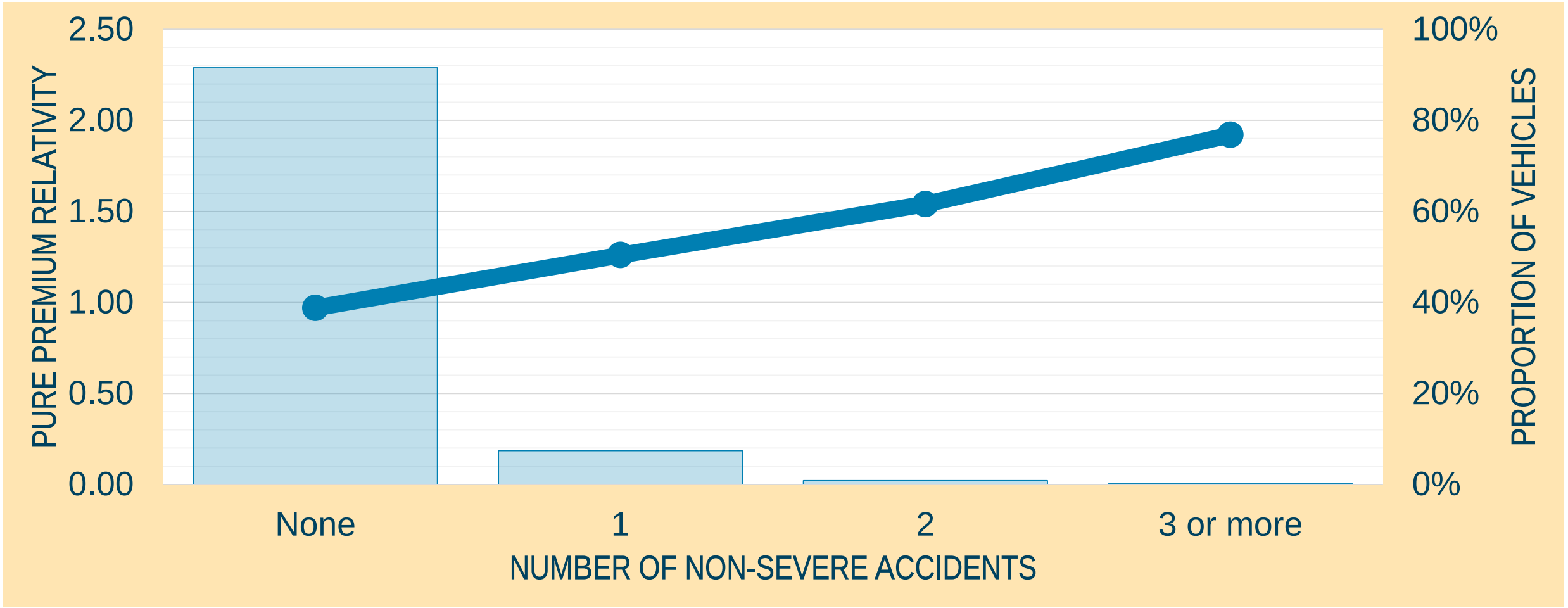
- Service history
- Collision repair records
- Claims history
- Failed safety inspections
- Open recall
- Stolen and recovered
- Repossessed vehicles

Vehicle Condition
Accident Damage

- Structural integrity is compromised
- Repairs may be improperly or incompletely done
  - May cause sensitive electronics to fail
  - Damage to critical structural components may be missed
- Low-quality aftermarket safety components may fail

Lift from Non-Severe Accidents

Univariate Analysis



Source: TransUnion Performance Analytics Database, 2006-2010

CARFAX

Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Vehicle Condition

Flood Vehicles

Flood water can damage several components of vehicle

- Antilock braking systems.
- Electronic safety system sensors.
- Passive and active restraint systems.
- Rusted structural components.
- Water damage inside engine, transmission and other components.

"When a car's electrical systems have been compromised, it may no longer be safe or roadworthy."

- U.S. Department of Justice

U.S. Department of Justice Bureau of Justice Affairs. "Buyer Beware: Safety Hazards of Flood-Damaged Vehicles" Web. www.bja.gov/programs/flooddamagedvehicles_nmvtis.pdf

Vehicle Condition
Branded Titles

Salvage Titles

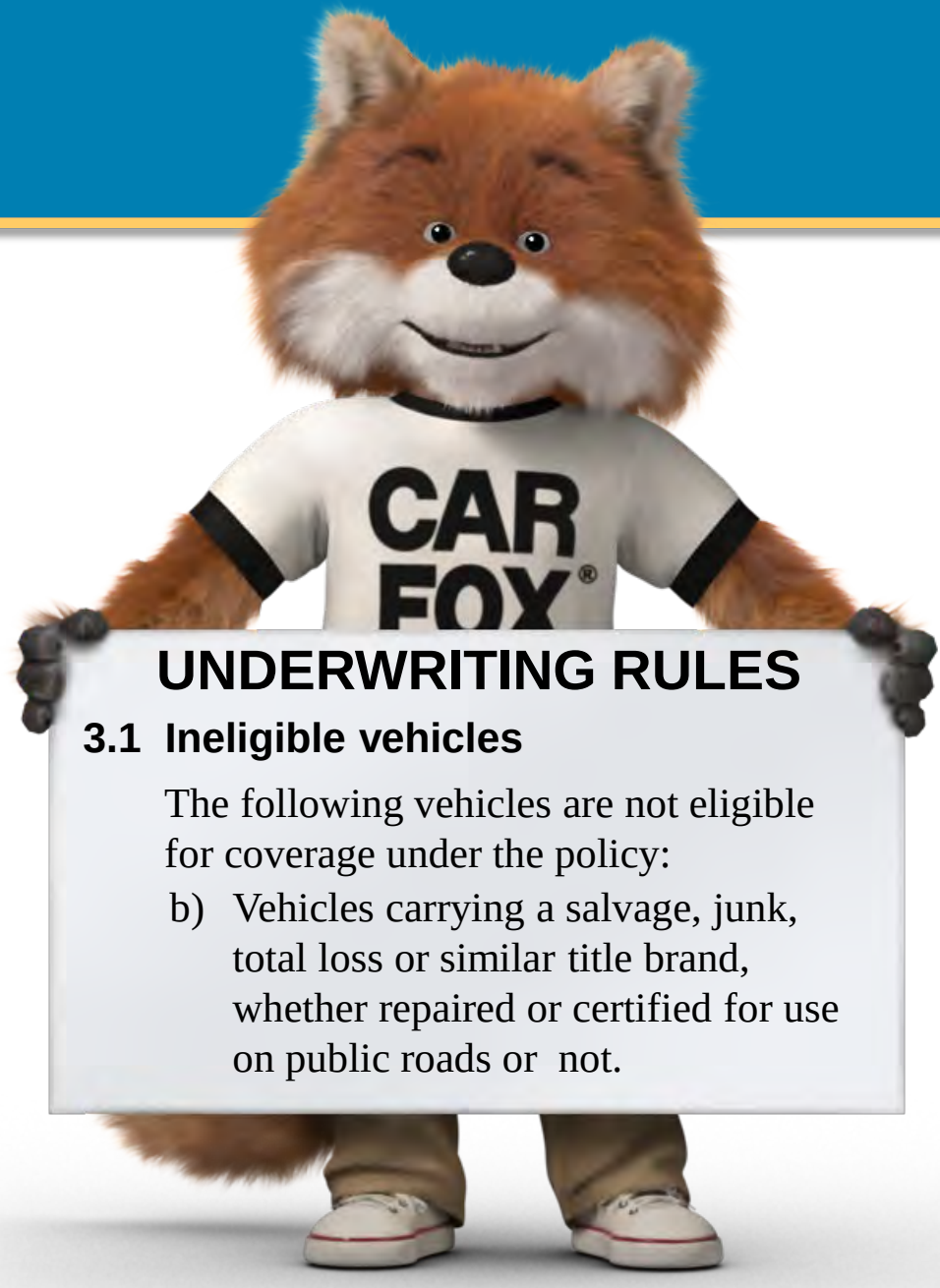
- Precluded by many underwriting plans
- Need copy of title

Rebuilt Titles

- Repairs may not meet standards
- Often incomplete or improper repair

Fire and Flood Titles

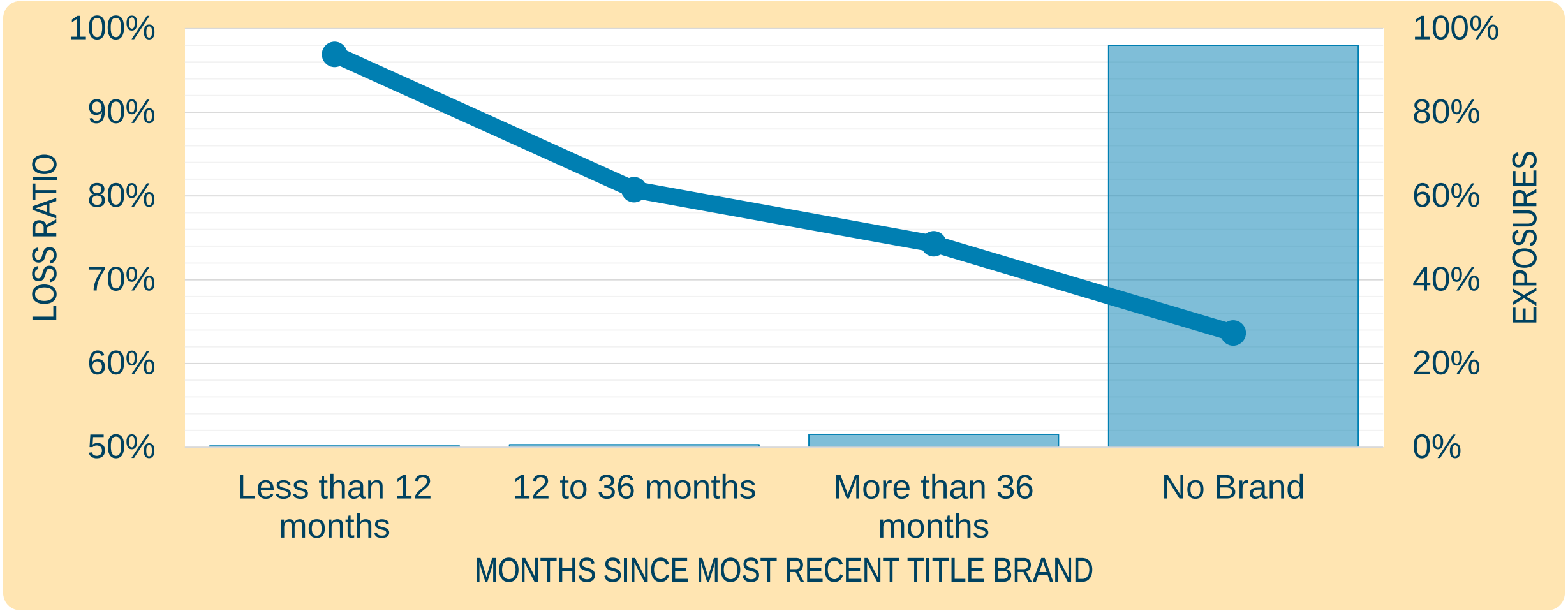
- Possible damage to sensitive electronic or critical structural components



CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Lift from Branded Titles over Time

Univariate Analysis



Source: TransUnion Performance Analytics Database, 2006-2010

CARFAX

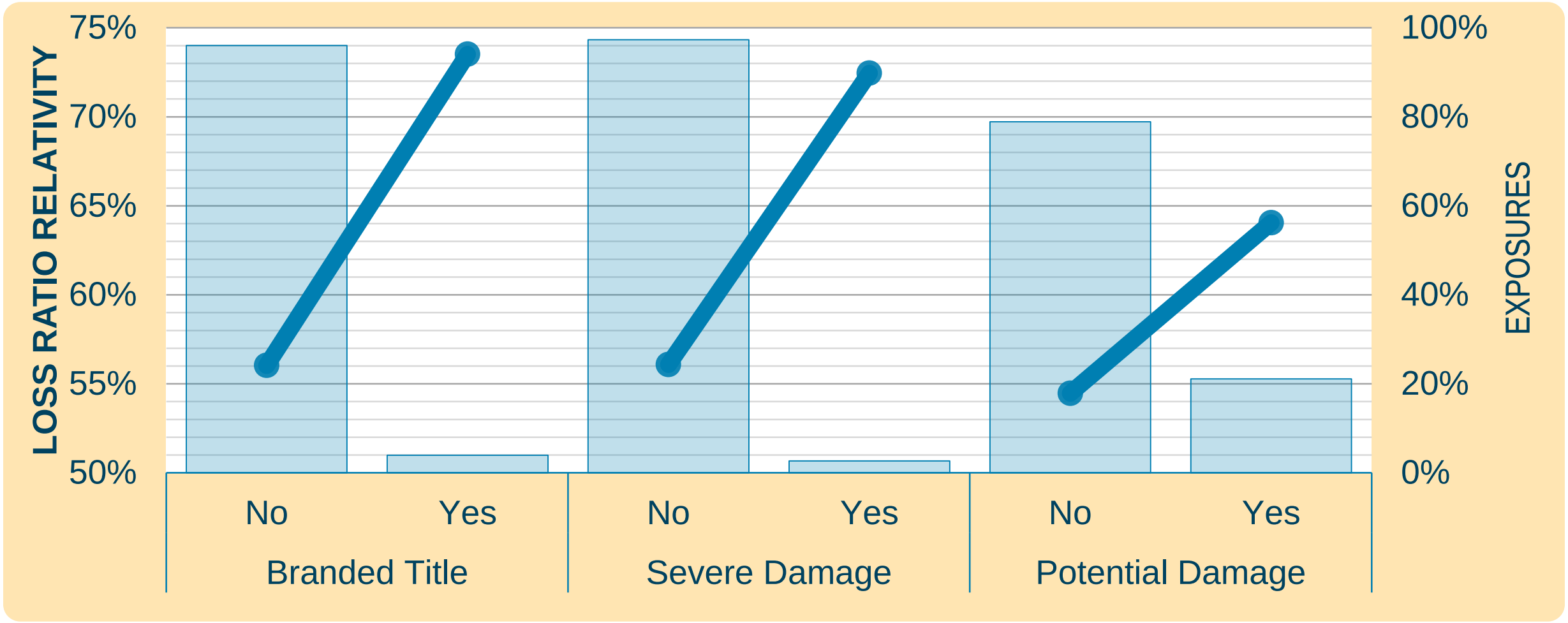
Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

Vehicle Condition
Potential Damage

Indications of damage that is likely to affect insurability

- Frame inspected
- Police accident report
- Collision repair facility records
- Failed inspections
- Auction damage disclosure

Lift from Vehicle Damage
Univariate Analysis



Source: TransUnion Performance Analytics Database, 2006-2010

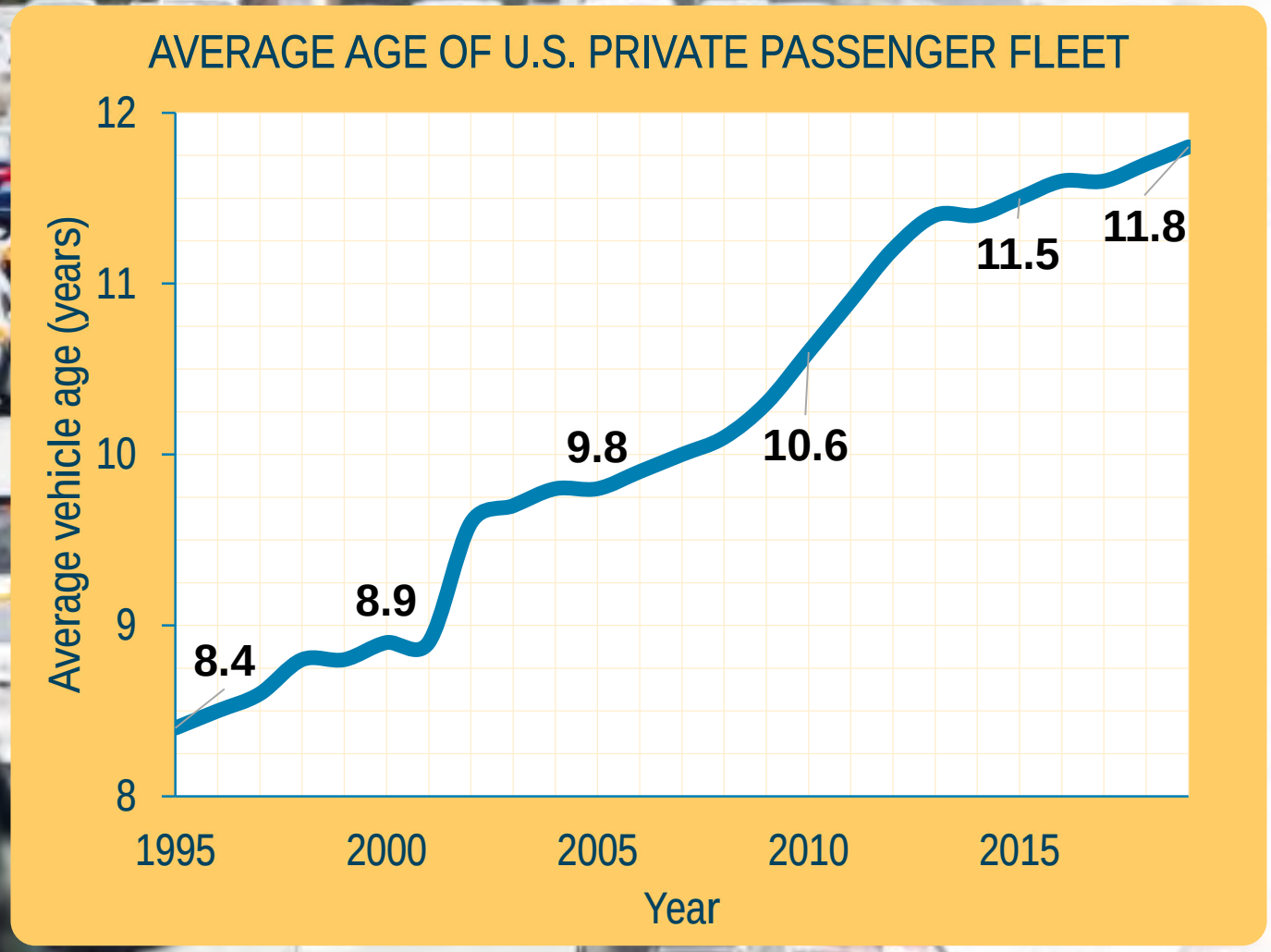
CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

CARFAX
Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

IMPLEMENTATION

Pulling it all together

Vehicle-based underwriting matters more than ever

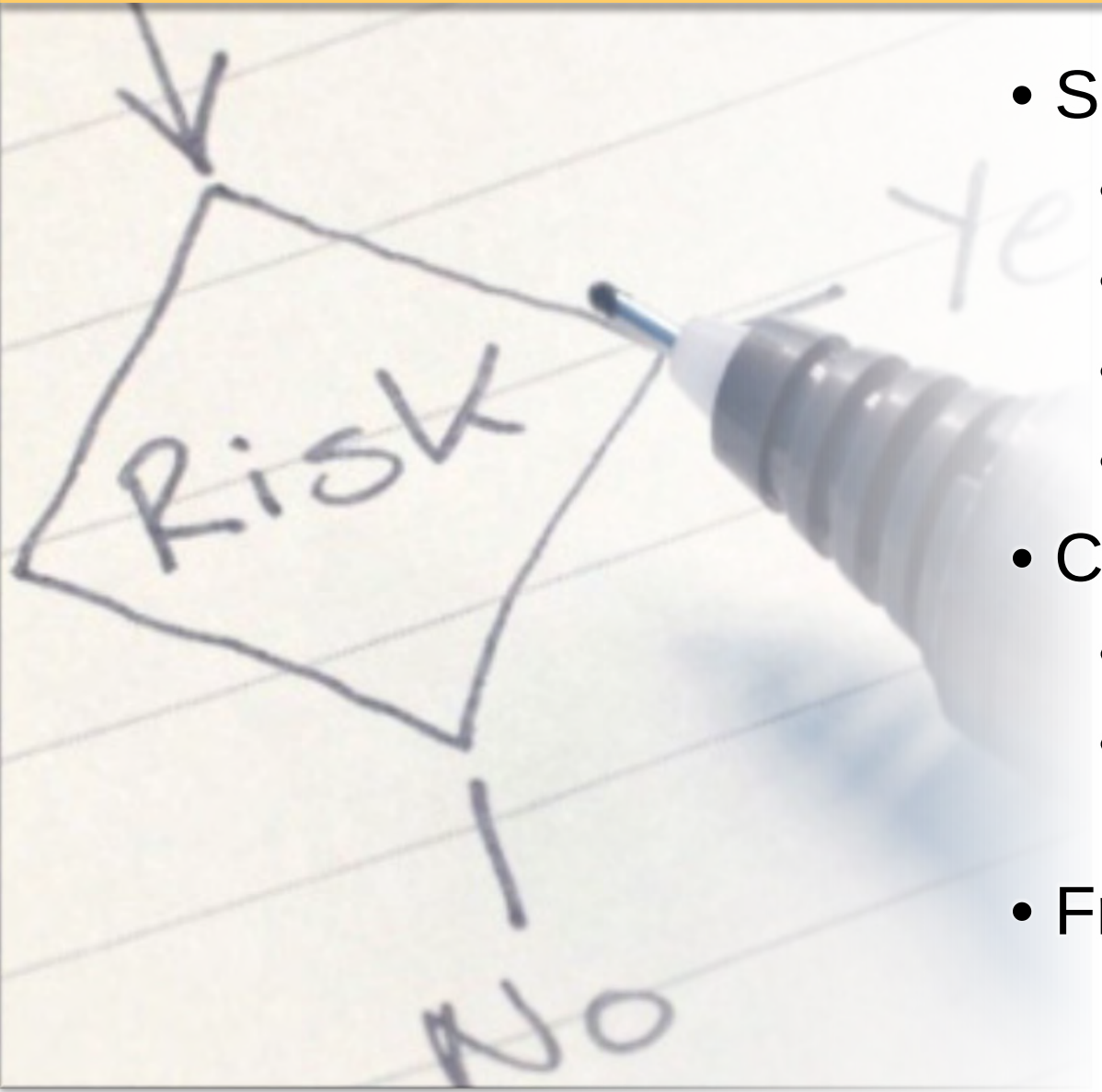


- Vehicles are lasting longer
  - Average age in 2019: 11.8 years
  - More differences as new technologies come to the road
  - More variance in drivability among vehicles of similar ages
  - More history per vehicle
- Model year and symbol don't describe older vehicles well

IHS Automotive. June 2019. ***Average Age of Cars and Light Trucks in U.S. Rises Again in 2019 to 11.8 Years.*** IHSMarkit Online Newsroom. Southfiled, MI

CARFAX Banking & Insurance Group® MORE INFORMATION. BETTER DECISIONS.

Use in Underwriting



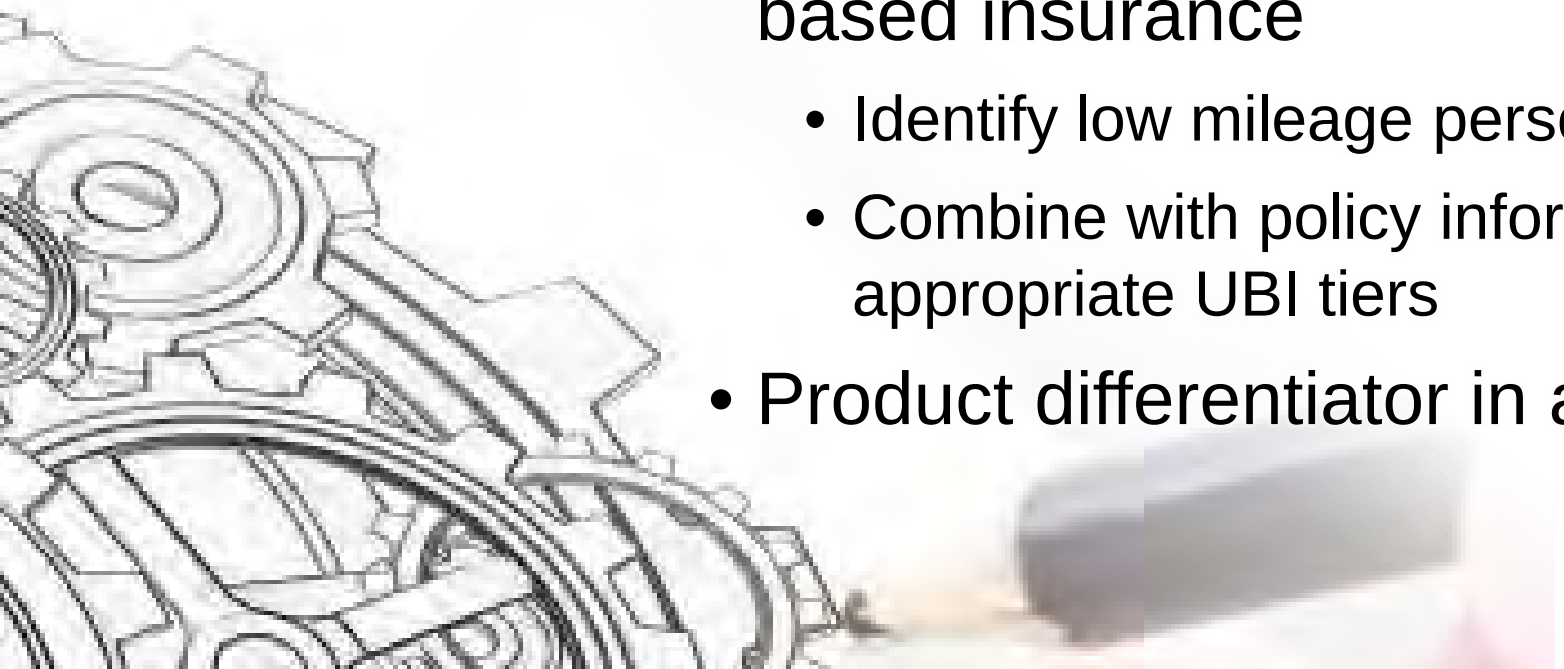
- Some attributes are already in use
  - Salvage titles not eligible for coverage
  - Mileage verification
  - Commercial use
  - Government or Non-Profit use
- Customer service
  - Establishes a touch-point
  - Helps find the best coverage for hard-to-cover risks
- Front-end flags for fraud detection

Use in Rating

- Many interactions between variables
  - Carefully consider impact on other variables
  - Multivariate analysis is needed to get the most out of the data
  - May result in replacement of some proxy variables
- Good candidate for a scoring or tiering model
- Fits well as a modification to symbols
- Can be “averaged” across the policy

Use in Product Development

- Opportunities for new product innovation
  - Advanced safety feature discounts
  - Product enhancements for older one-owner cars or CPO cars
- Can be used as a lead-in for usage based insurance
  - Identify low mileage personal use vehicles
  - Combine with policy information to ‘slot’ customers into appropriate UBI tiers
- Product differentiator in a commodity market



CARFAX Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

CARFAX
Banking & Insurance Group®
MORE INFORMATION. BETTER DECISIONS.

QUESTIONS

Vehicle Attributes in Auto Insurance Rating and Underwriting