Automated Vehicles: An overview of CAS Taskforce Research

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CAS Automated Vehicle Task Force

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The Automated Vehicle Task Force (AVTF) believes collaborative research is the most efficient way to safely bring AV's to the market

Why Actuaries:

Only through proper assessment of risk can certain critical decisions be responsibly made:

- When AV technology is ready for deployment
- How risk should be priced and managed
- What is the optimal public policy approach to take toward resolving potential future liabilities associated with the technology

Why multidisciplinary cooperation:

1. Identification and specification of consistent data formatting and collection processes:
   - Clean/consistent data for analytical evaluation to quantify the risks associated with AVs
2. Creation of risk minimizing AV rollout strategy
3. Optimal Liability system

A multidisciplinary approach, across functions and industries, will help ensure that all perspectives are considered and included

Agenda

1. Insurance Premiums (Credibility Models)
2. Liability Systems
3. Automated Vehicle Risks

1

Properly matching price with risk will help AVs come to market

Question	***Response***
How will insurance industry premiums change?	Little interest from the public
How much of a discount will the vehicle I purchase receive?	High interest from the public

- In the long-run, insurers will price automated vehicles appropriately (premiums will follow costs)
- Long run does **not** tell us about actual premium discount the technology will receive when first introduced

Inaccurate pricing will also come with societal harms

Pricing error	***Response***
Overpricing Automated Vehicles	Make a life saving technology unaffordable to some customers
Underpricing Automated Vehicles	Insureds in other, less-safe vehicles will subsidize the insurance of insureds with safer vehicles

Accurate pricing of these risks is necessary to avoid cross subsidies

Further, there are multiple issues that still need to be solved…

#	*Issues*
1	Data Availability
	• Cannot ID which vehicles have the AV tech
2	Pricing Models
	• What is the quality of our models to price these new vehicles?

… and some intricacies that will arise due to automated vehicles…

Lower frequency ≠ lower losses

- Higher severity can offset any frequency reduction
- Pricing cares about loss reduction

Lower frequency risk ≠ fewer accidents

- Increase miles driven may offset lower risk

Safer cars ≠ safer drivers

- Drivers may adjust habits (e.g. cell phone usage)

1

So the CAS partnered with a large USA national personal auto carrier to dig into Credibility methods with Automated Vehicles

Goal: To understand the discount that current credibility methods will provide insureds who purchase automated vehicles

Analysis

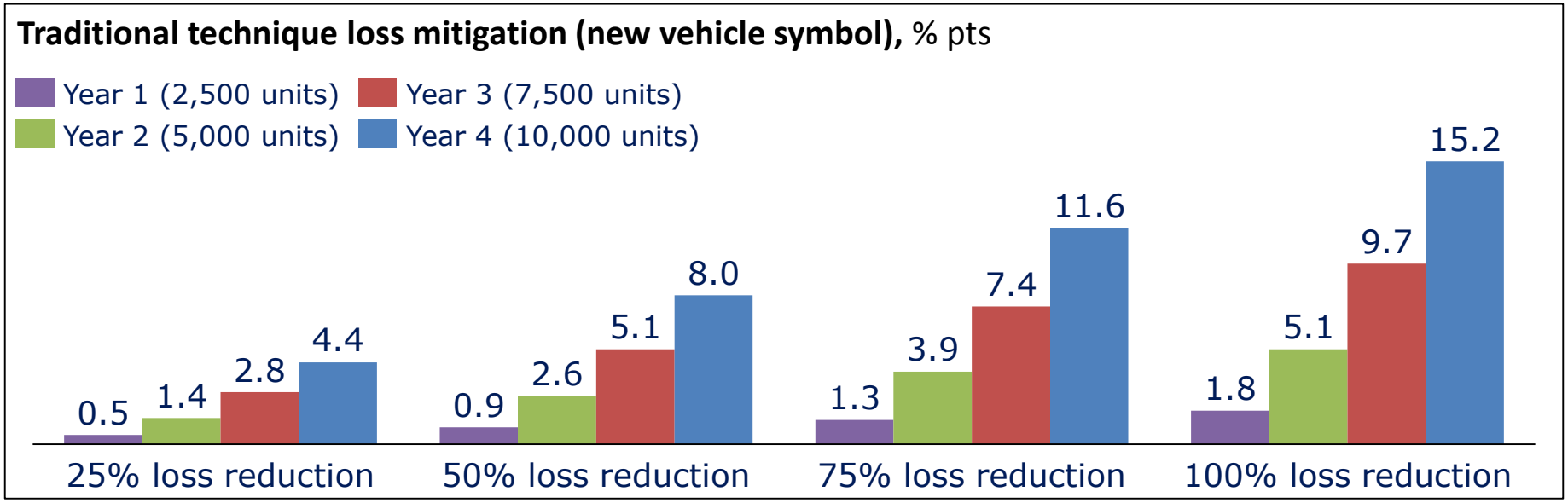
Vehicle symbol: option 1

- **Assume a brand new vehicle**
  - No initial prior year factor, growth trend impacts credibility

Vehicle symbol: option 2

- **Assume update to a current vehicle**

Using traditional techniques, insurers' pricing models could take too long to recognize improved risk performance…

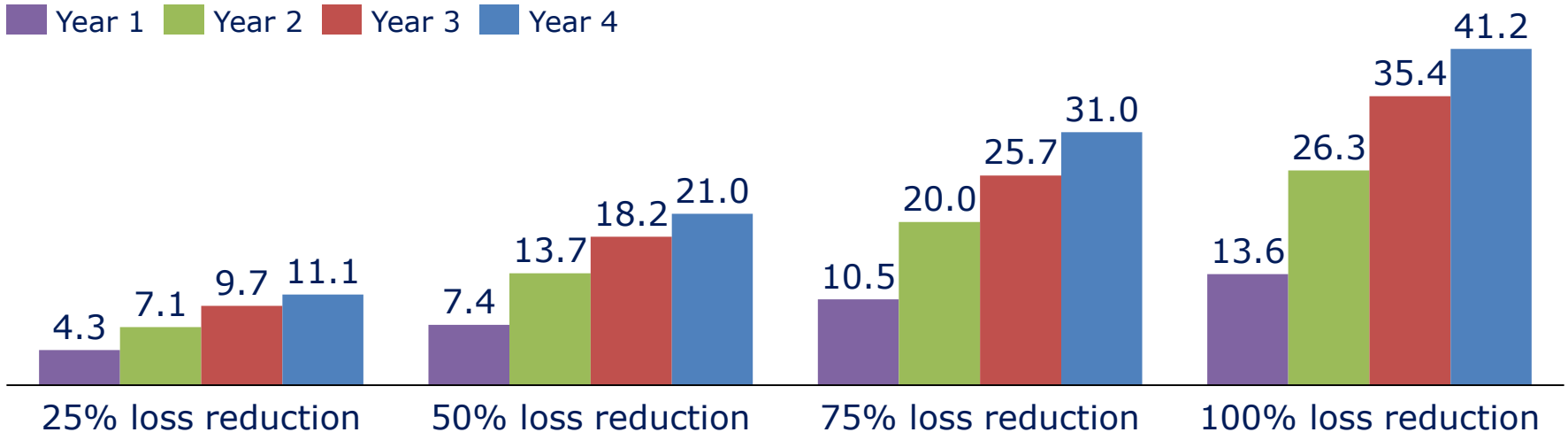


Comments

- Assumes a new vehicle symbol with no prior rating history
- Results meant to be illustrative, per insurer CAS partnered with
  - Results dependent on the technology's introduction, the number of vehicles with the technology, and insurer's view of the risk

However, when varying certain assumptions, a completely cashless car could achieve a larger discount (1/2)

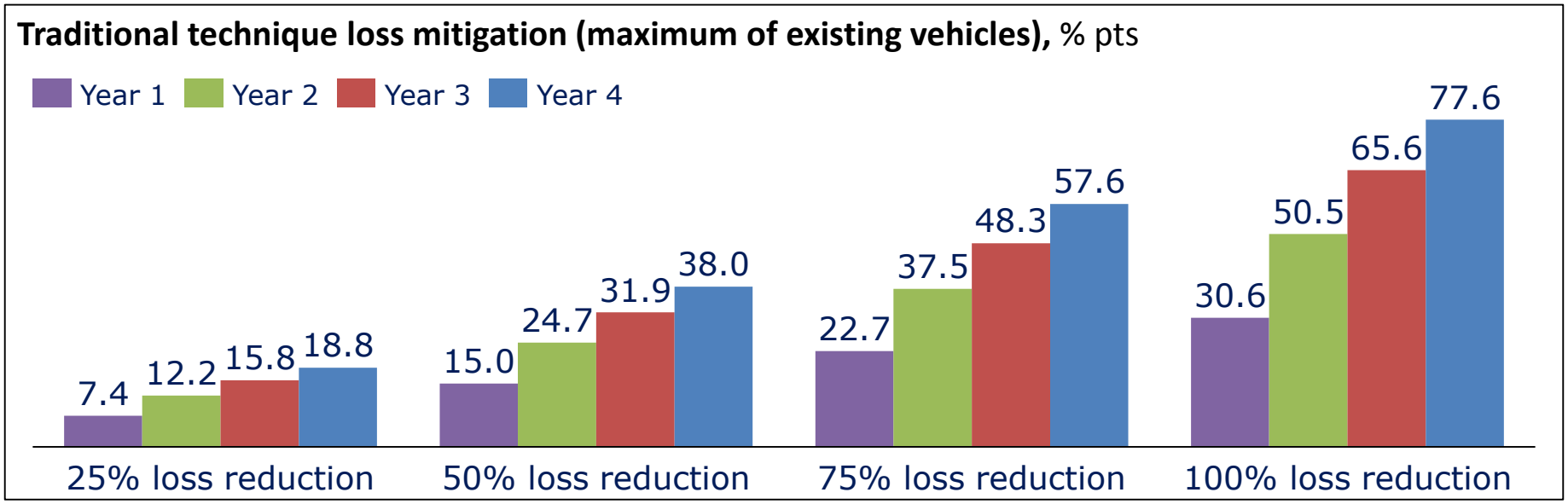
Traditional technique loss mitigation (average of existing vehicles), % pts



Comments

- Steady state, assumes an existing vehicle symbol with all autos of this sort now AVs
- This is the average discount this carrier would provide, based on their actual insureds

However, when varying certain assumptions, a completely cashless car could achieve a larger discount (2/2)



Comments

- Steady state, assumes an existing vehicle symbol with all autos of this sort now AVs
- This is the maximum discount this carrier would provide, based on their actual insureds
  - This is the discount for the most popular vehicle they insure, assuming x% loss mitigation

Implications of the study (1/2)

#	*Implications*
1	Long run: the Vehicles will be priced accurately
2	Short run: vehicles that increase or decrease loss costs will be mispriced

Implications of the study (2/2)

Conclusion

Insurers & manufacturers need a more direct and transparent collaboration to ensure the technology is clearly identifiable in the insurer's datasets to properly quantify using current credibility methods

Comments: More data is needed

- Which vehicles have the technology
- What is the technology's expected impact on frequency and severity
- What / how are the vehicles operated
- What is the driver interface

Agenda

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2

An efficiently liability system is the first step to compensating claimants

Question	***Response***
Who will be liable for automated vehicle accidents?	Narrow focus
What is the optimal liability system?	Efficiency will hasten claims handling

2

There are four main goals for a liability system

1. Align accountability & responsibility
2. Compensate claimants fairly & efficiently
3. Encourage product development & safety
4. Perform these tasks at the lowest possible cost

To insure risks associated with AVs, policymakers may consider shifting from a negligence based personal auto liability system, to a strict products liability setting – but such decisions should contemplate all potential system costs, not just claims

Auto liability and products liability will differ in costs due to:

1. Operating expenses
2. Claim settlement strategy and expenses
3. Capital allocation and profit targets
4. Coverage triggers
5. Coverage limits

To compare ultimate costs, we utilized multiple industry resources and made the following assumptions:

1. Number of vehicles is unchanged & every vehicle owned by manufacturer
2. Every vehicle is fully autonomous
3. Mfg purchase 1st dollar products liability, self insure physical damage
4. Severity remains unchanged from today; vehicles carry $1M/$1M/$1M*
5. End state claim frequency will vary in claim reduction
6. Impact on health insurance is outside of scope
7. “Premium” = cost to pay liability claims and physical damage repairs

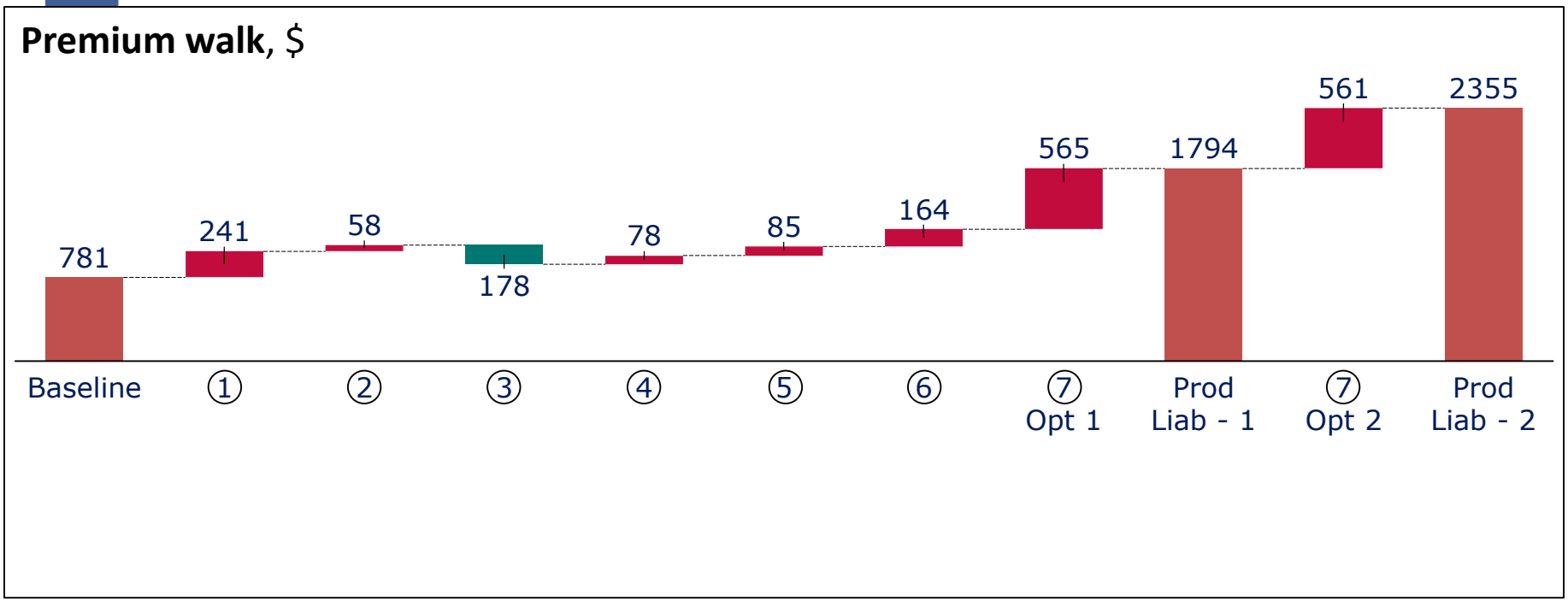
* In the USA auto liability system A/B/C represents a per person bodily injury, per accident bodily injury and per accident property damage. There is no simple way to move to unlimited caps using industry personal auto ILFs, so moved to $1M caps

We also need to level set some basic formulas

	Formula
Premium	= Expected Claim Payments + Expenses + profit
Expected Claim Payment	= Exposure x Frequency x Severity • Exposure = Earned vehicle year • Frequency = Number of claims per vehicle year • Severity = Loss dollars per claim
Expenses	= Loss adjustment expense + Acquisition expenses + General & other expenses + Taxes/licenses/fees • Loss adjustment expenses = Defense costs + Other adjustment expenses

2

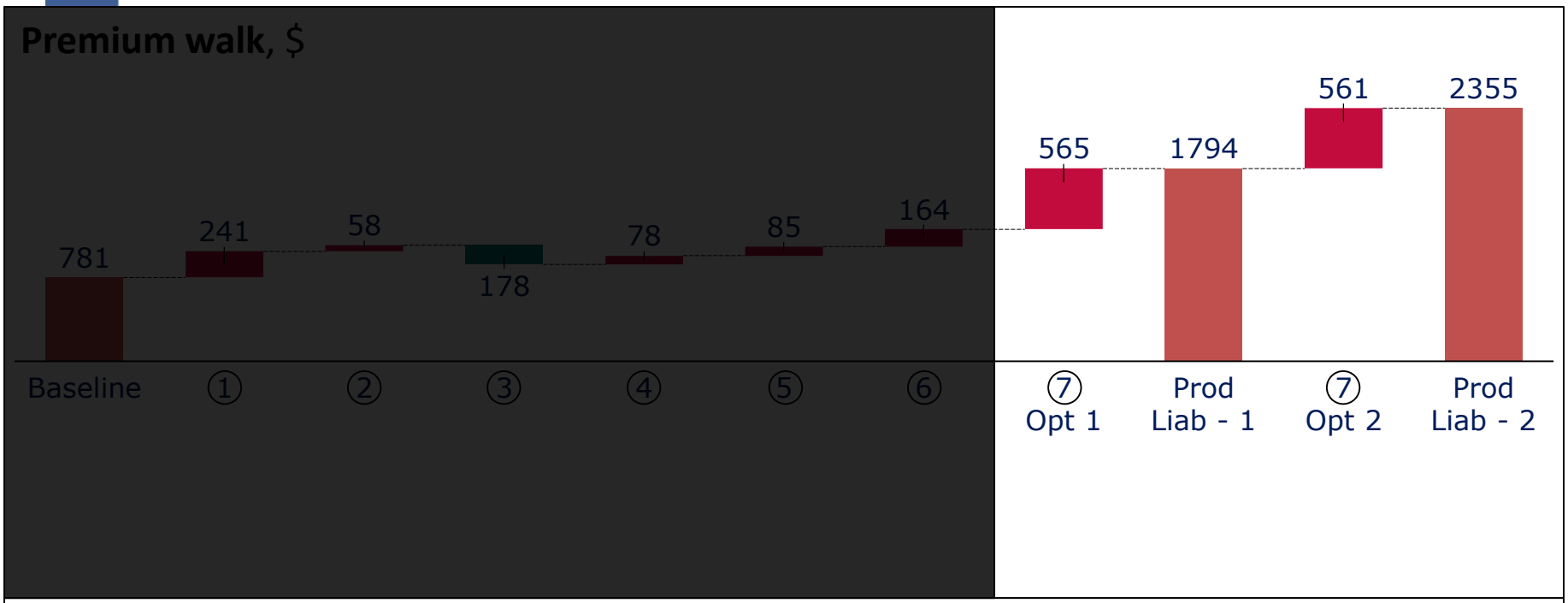
To walk the premium, we broke the calculation to seven steps…



Steps

1. 100% of vehicles receive full insurance coverage
2. Provide voluntary market liability limit coverage to every vehicle
3. Pass physical damage coverage to manufacturer
4. Redefine claim coverage based on manufacturer ownership liability
5. Eliminate physical damage deductibles
6. Replace personal auto expenses and profit provisions with commercial insurance assumptions
7. Increase limits to $1M

… with step 7 having two potential options simulated, depending on the future liability system

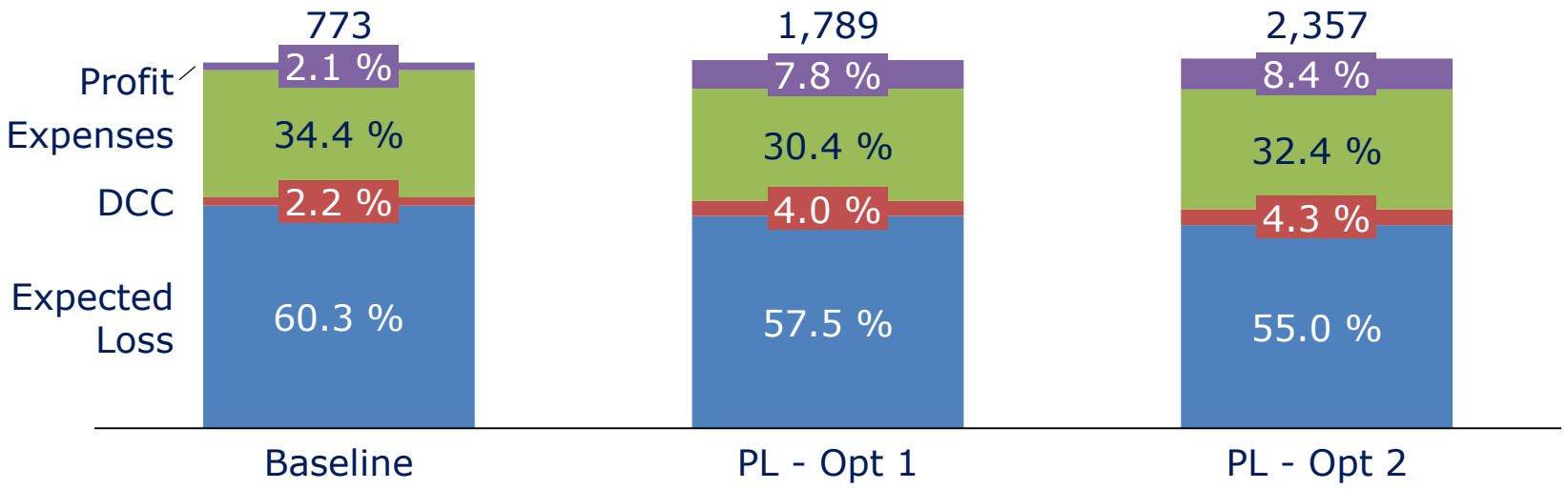


7 – option 1: Split coverage, apply new increased limit factors to the bodily injury and property damage premiums, medical and personal injury protection payments are added on top

7 – option 2: Rolling coverages together into a single liability coverage (potentially more reflective of the future state, however makes assumption that it is ok to apply ILFs to current liability and medical payments

This will impact how premium dollars are distributed

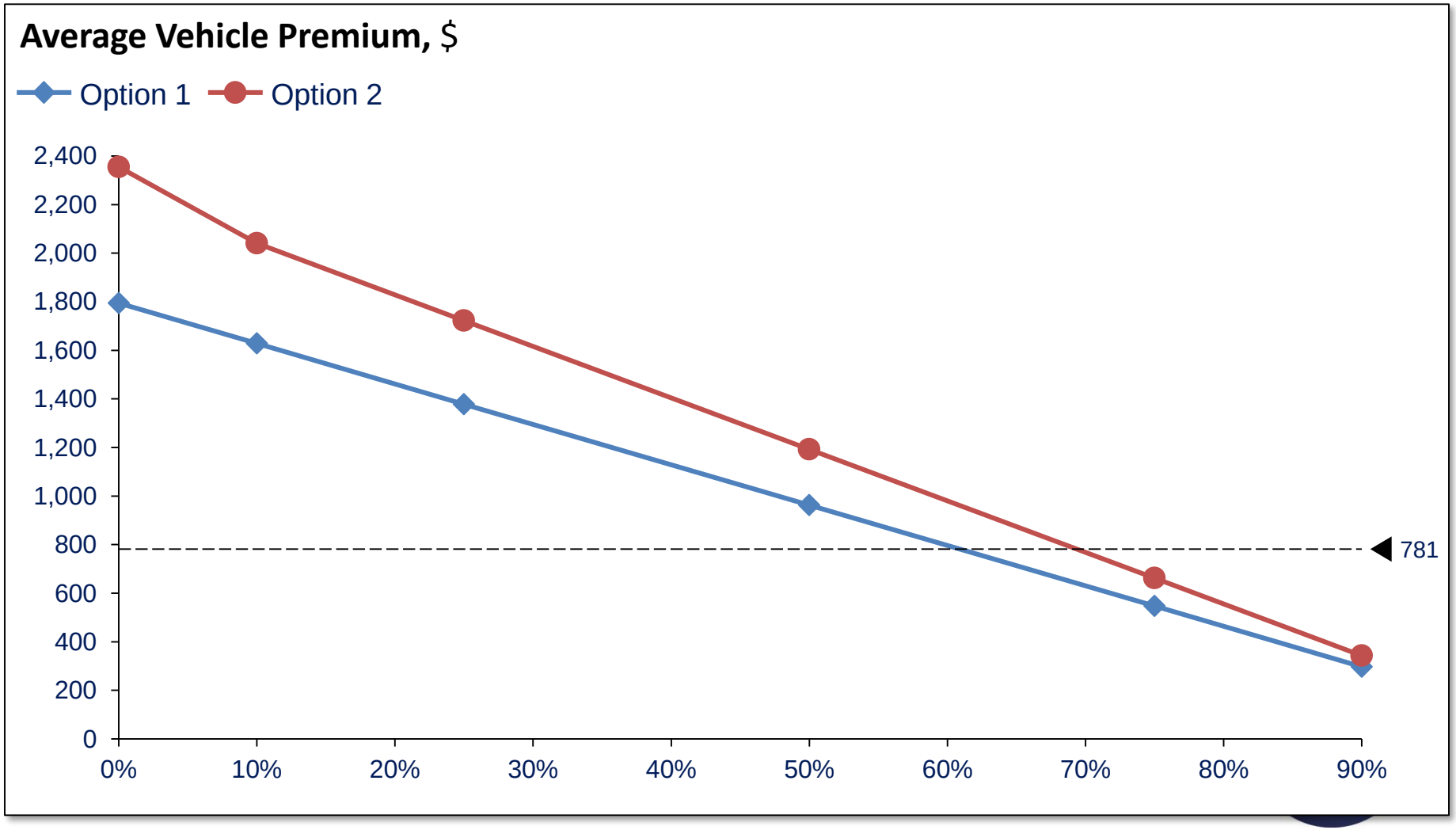
Premium dollar distribution, % pts



Comments

- Increase driven by expanding the vehicles coverage
- Does not take into account mitigation of losses from Automated Vehicles into account (frequency)

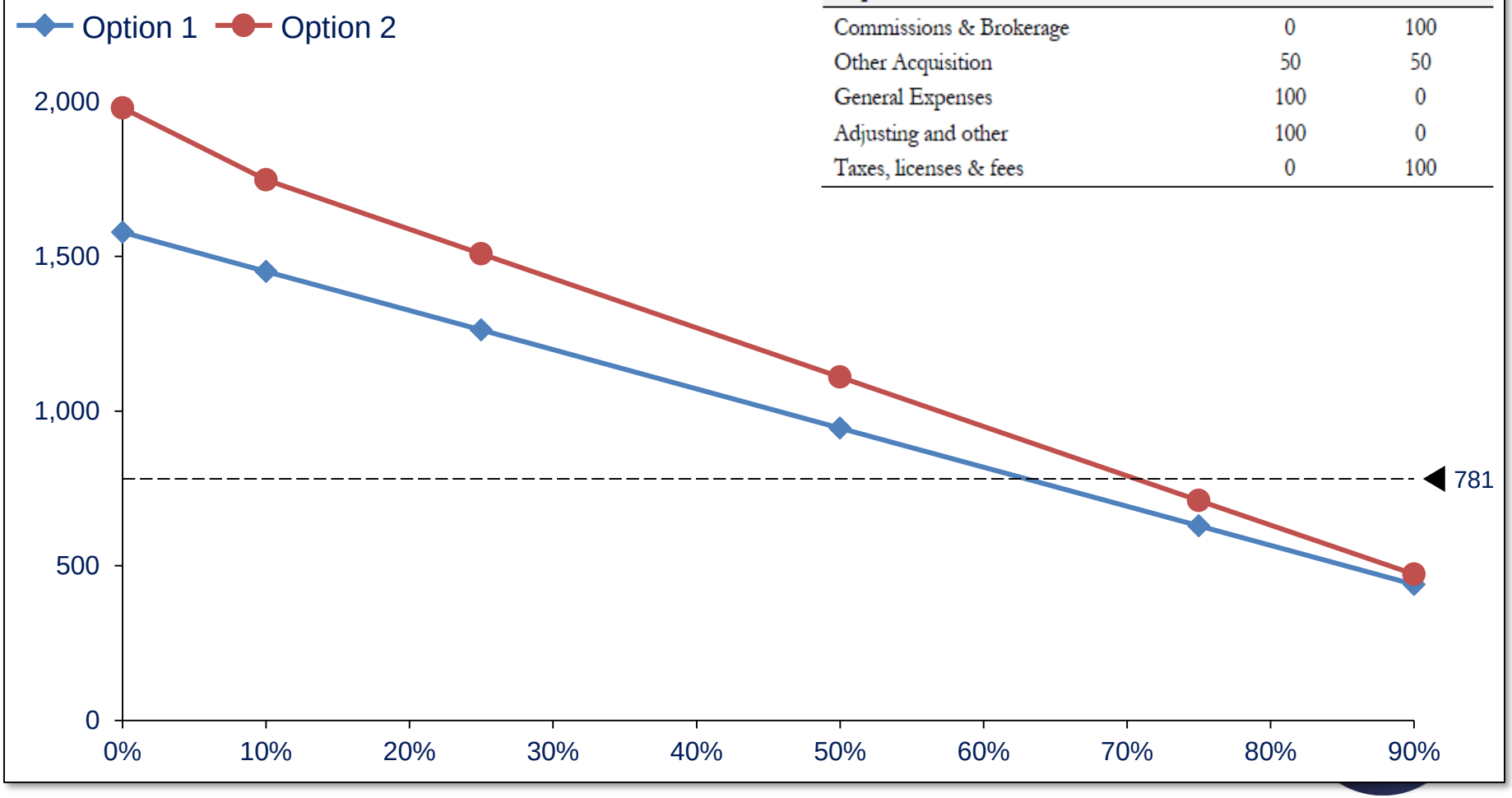
Significant loss mitigation is necessary for Products Liability premium close gap to personal auto rates



2

Adjusting expenses to their fix and variable components will slightly adjust the products liability premiums and mitigation implications

Average Vehicle Premium, $



Expense Ratio	% Fixed	% Variable
Commissions & Brokerage	0	100
Other Acquisition	50	50
General Expenses	100	0
Adjusting and other	100	0
Taxes, licenses & fees	0	100

Implications of the study

Premium Analysis

- Calculating liability costs is extremely complex
- Products liability offers much greater coverage
- Greater coverage also entails greater frictional costs

Liability System

- Accident reporting data should be determined, in part, by insurance industry's needs

Liability system is not a problem but an opportunity for involvement

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The goal of introducing any new product is to maximize profits

Profits = Revenue - Cost

Cost = Cost of goods sold + Liability cost

$$\text{Liability cost} = \sum_{i=1}^{n} \text{Incident exposure}_i \times \text{Incident frequency}_i \times \text{Average incident severity}_i$$

Minimizing loss potential will help maximize profits

3

A risk (cost) minimization strategy will involve the following three steps

1. Change the paradigm / adjust how we look at the problem
2. Identify & quantify all risks
3. Develop a comprehensive introduction strategy that minimizes cost

3

And we will make the following two assumptions

Assumption	*Requirement*
Technology assumptions	• Technology will not operate in inclement weather (e.g. weather systems where LiDAR and other technology will not operate at full capacity) • Accurate up to date maps of surrounding environment • All other errors will be random & error rate lower than human → more technology would equal less loss
Manufacturer assumptions	• Primary goal is to minimize frequency – Product liability costs: 60% to claimants vs. 40% to lawyers • Secondary goal is to minimize severity

Restating NHTSA's NMVCCS will help us improve our understanding of AVs

NHTSA - Disabling Factors	
Risk	**Size**
Weather	12.2%
Vehicle Issue	11.6%
Infrastructure	0.4%
Total Tech	**21.3%**
Distraction	16.7%
Drugs	11.0%
Sleeping	2.9%
Driver Disables	3.1%
Physical impairment	2.3%
Total Behavioral	**32.4%**

Comments

- Data
  - Source: 2008 National Motor Vehicle Crash Causation Study
  - Data is old & insufficient
- Identify & quantify all risks
- Quantify risks & correlations
- Supplement data with judgment

Source: http://www.casact.org/pubs/forum/14fforum/CAS%20AVTF_Restated_NMVCCS.pdf

3

One approach for AV introduction could be…

Introduction strategy

- Company owned public transportation service – human cannot take control
- Operates in small location (major city; favorable climate; lots of hospitals)
  - Conduct trials prior to broad introduction in city
  - Fleet size large enough for scale, but will not drown out other options

Vehicle Design

- Includes an emergency response button
- Designed to minimize risk to pedestrians and passengers
- Eliminate unnecessary features

Operation Details

- Fleet will not run in inclement weather
- Service regularly
- Expansion to new cities will be dependent on results on preceding cities

3

Which would help minimize the following risks (1/2)

Item	*Description*
Behavioral / skill deterioration	• Avoid: risk eliminated, no pass off
Infrastructure	• Minimize: defined operating area
Weather	• Avoid: operating area & shutdown protocol
Vehicle issues	• Company ownership reduces frequency • Restricting area reduces costs
Other driver interactions	• Minimize: pre-testing fleets and defined operating area
Physical Impairment	• Operating area to reduce severity with proximity to hospitals

3

Which would help minimize the following risks (2/2)

Item	*Description*
Animal	• Operating in a city reduces interactions
Hacking	• Removing driver may increase risk • Restricted area impact unknown
Random Errors	• Removing driver may increase risk • Restricting area and speed reduces severity • Success measured in errors per trip
Unknowns	• Restricting area reduces number of unknowns
Severity	• City imposes natural speed limits and minimizes distance to hospital • City increases pedestrian interactions

3

Implications of potential introduction strategy

1. Introduction will be locally rapid, globally disjointed
2. Technology will follow parallel development paths
3. Liability may initially reside with the manufacturer
4. More data is required to help refine analysis

Thank you

Appendix

AV ownership may change household car ownership patterns

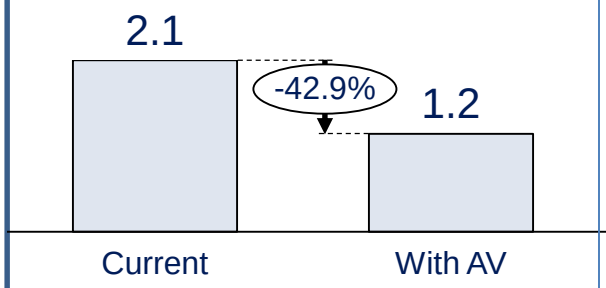
University of Michigan:
2009 National Household Travel Survey from U.S. DOT

- 84% of U.S. household trips today do not overlap with other trips
- Only 16% of households require 2+ cars

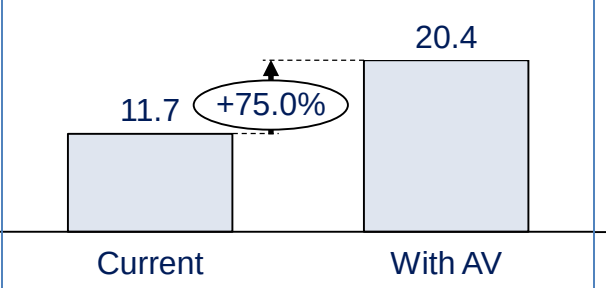
<u>Does not contemplate</u>

- Additional miles from 'return to home' feature
- Additional miles if 'non-drivers' can operate vehicle for transportation
- Many commuters do not want to share vehicle

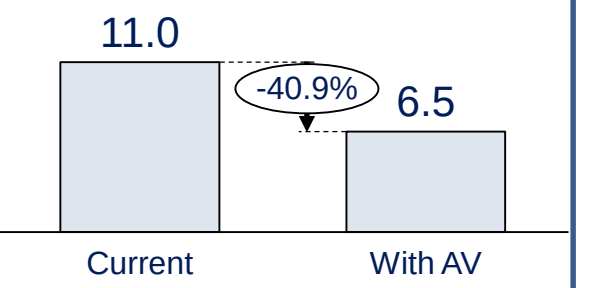
Household Car Ownership



Annual miles driven, (000s)

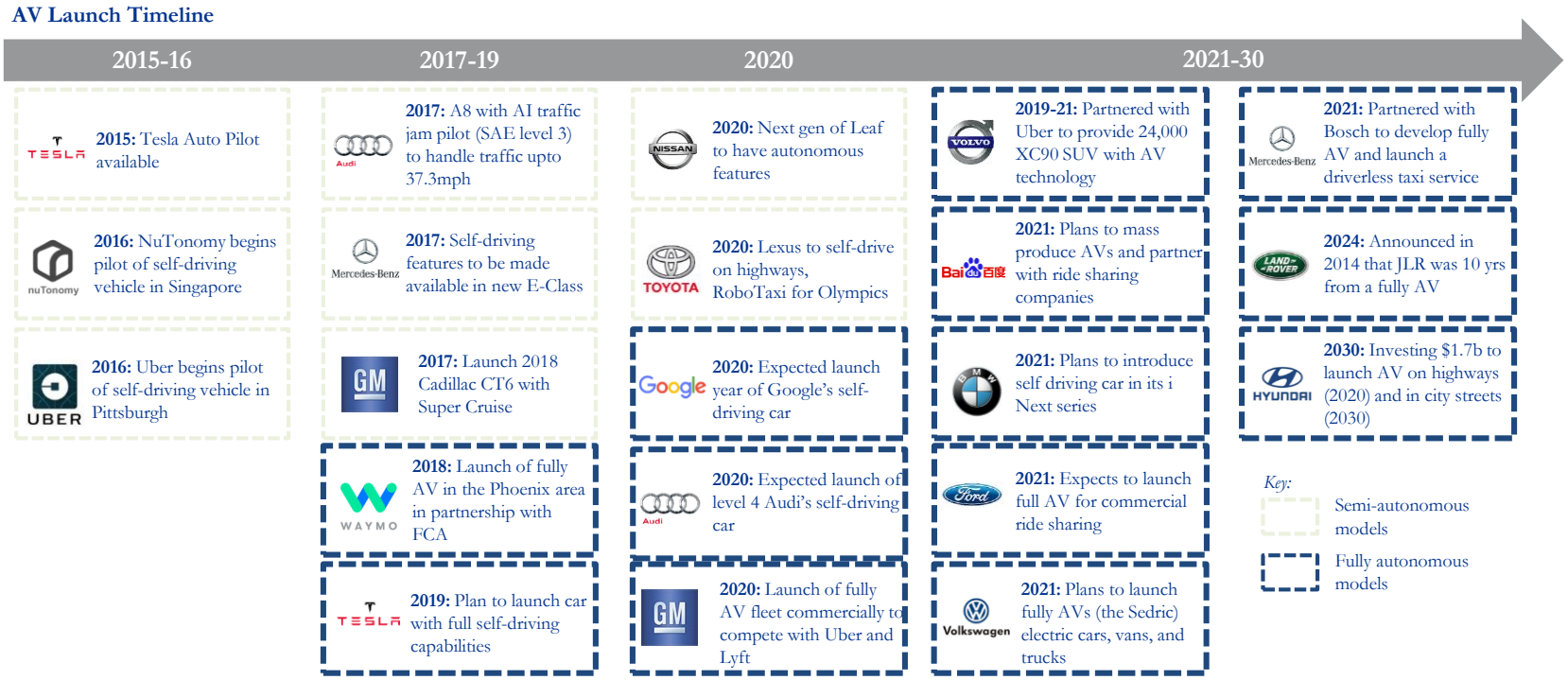


Car lifespan



http://www.umich.edu/~umtriswt/PDF/UMTRI-2015-3_Abstract_English.pdf

Company announcements to date indicate that autonomous vehicles being developed aggressively with plans to launch post-2020



Source KPMG LLP Actuarial Analysis

Source(s): CB Insights, The WSJ, Autonews.com, Topgear.com, Driverlessfuture.com, Business Insider, Wired, The Guardian, Slashgear, Drive, Huffington Post, Motoring.com, The Verge, IEEE, CNBC

Current Impact - ADAS efficacy from various sources

				Testing Method Assessment				Test Parameter Assessment		
ADAS Technology	Collision Type	Source	Reduction Estimate	Estimate Method	Weather	Geography	Speed	Sample Size	OEM Diversity	Publication Date
Rear Camera	Rear	IIHS	17%	✓	✓	✓	✓		✓	
	Rear	AAA	30%	✓			✓		✗	✗
Lane Detection Warning System	All	IIHS	11%	✓	✓	✓	✓		✓	
	All	NCBI	23%	✓			✓	✓		
	All	EUROPA	33%	✓				✗		
	All	AAA	3%	✓						✗
Blind Spot Detection	Side	IIHS	14%	✓	✓	✓	✓			
	Side	EUROPA	33%	✓						
Cross Traffic Alert	Side	IIHS	13%	✓			✓		✗	✓
	Side	Consumer Reports	31%	✗						
	Side	SAE	39%	✓	✗	✗				✗
	Side	IIHS	2%	✗			✗		✗	✗

Legend

Estimate Method: ✓ Collision Data ✓ Simulation ✗ Survey / Other

Other: ✓ Inclusive / Favorable ✗ Limited / Unfavorable

Source KPMG LLP Actuarial Analysis

Note(s): Missing assessment indicates no information was provided. Assumes collision data assessment of random sample incorporates weather, geography and OEMs

Current Impact - ADAS efficacy from various sources

				Testing Method Assessment				Test Parameter Assessment		
ADAS Technology	Collision Type	Source	Reduction Estimate	Estimate Method	Weather	Geography	Speed	Sample Size	OEM Diversity	Publication Date
Forward Collision Warning	Rear	IIHS	27%	✓	✓	✓	✗		✓	✓
	Rear	DOT	27%	✓	✓	✓	✓			✓
	Rear	IIHS	23%	✓		✓			✓	
	All	NCBI	67%	✗			✗	✓		
	Rear	AAA	10%	✓				✗		✗
Automatic Emergency Braking	Rear	IIHS	50%	✓	✓	✓	✗		✓	✓
	Rear	DOT	43%	✓	✓	✓	✓			✓
	Rear	IIHS	40%	✓		✓			✓	
	All	IIHS	17%	✓	✓	✓	✗			
	Rear	EU NCAP	38%	✓	✓	✓	✗			✗
Adaptive Cruise Control	Rear	Academic	10%	✓						✗
	Rear	AAA	17%	✗					✗	✗

Legend

Estimate Method	✓ Collision Data	✓ Simulation	✗ Survey / Other

Other	✓ Inclusive / Favorable	✗ Limited / Unfavorable

Source KPMG LLP Actuarial Analysis

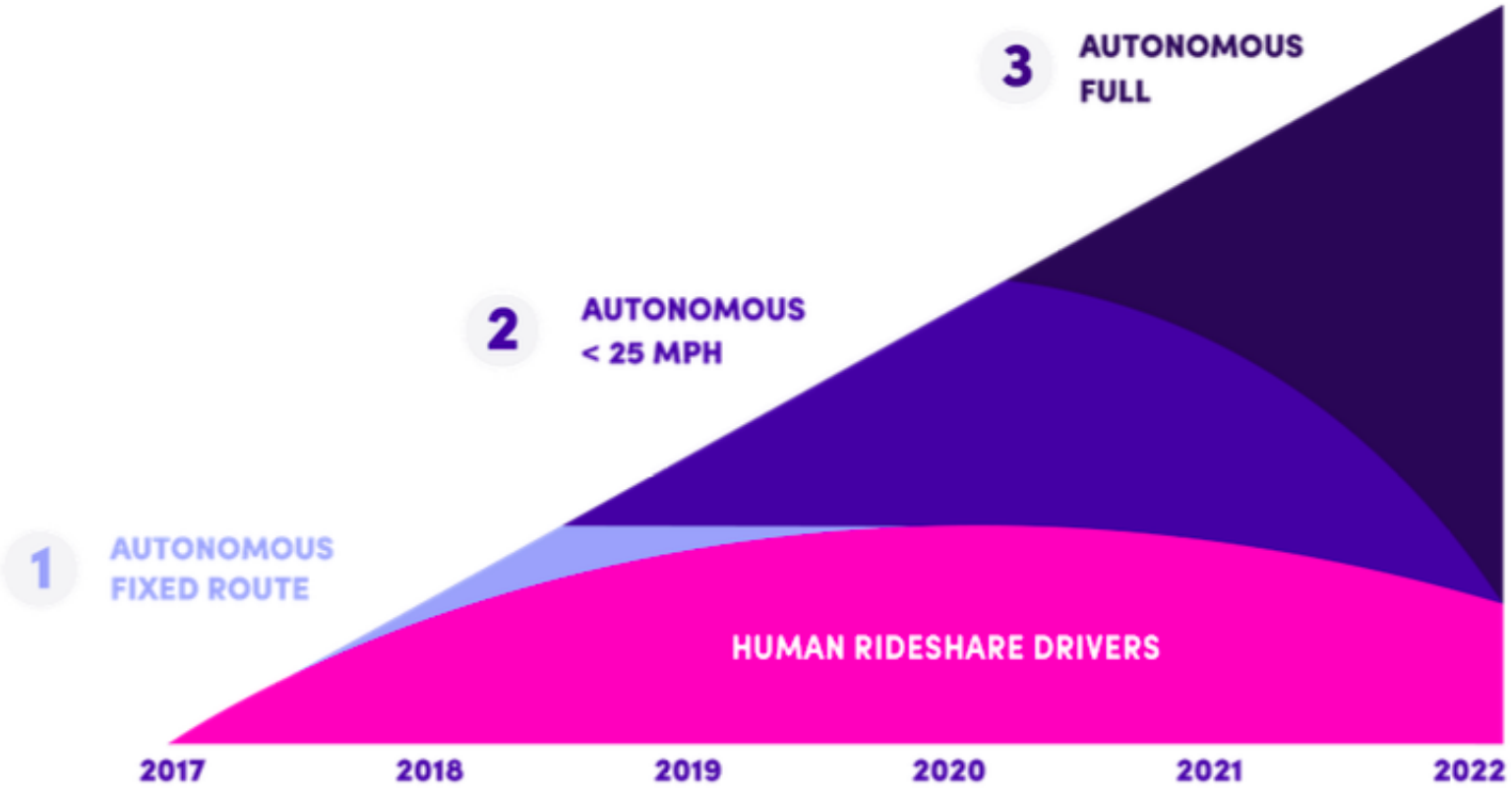
Note(s): Missing assessment indicates no information was provided. Assumes collision data assessment of random sample incorporates weather, geography and OEMs, select sources / studies shown for AEB

Lyft's Point of View on Autonomous Technology Roll Out

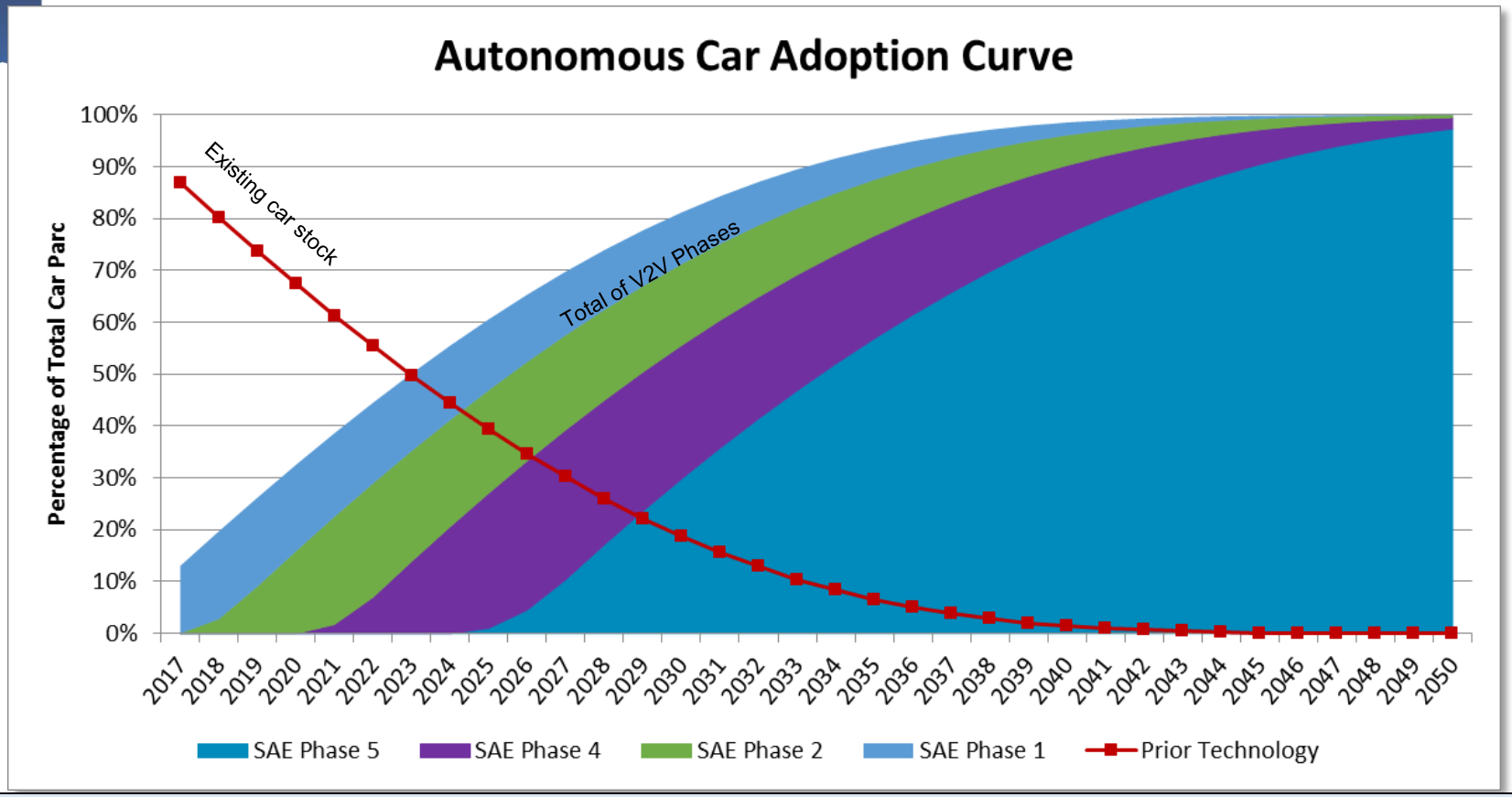
Lyft says robots will drive most of its cars in five years

Expect to see semi-autonomous vehicles driving on fixed routes by 2017 in a subscription model.

BY JOHANA BHUIYAN · @JMBOOYAH · SEP 18, 2016, 9:15A



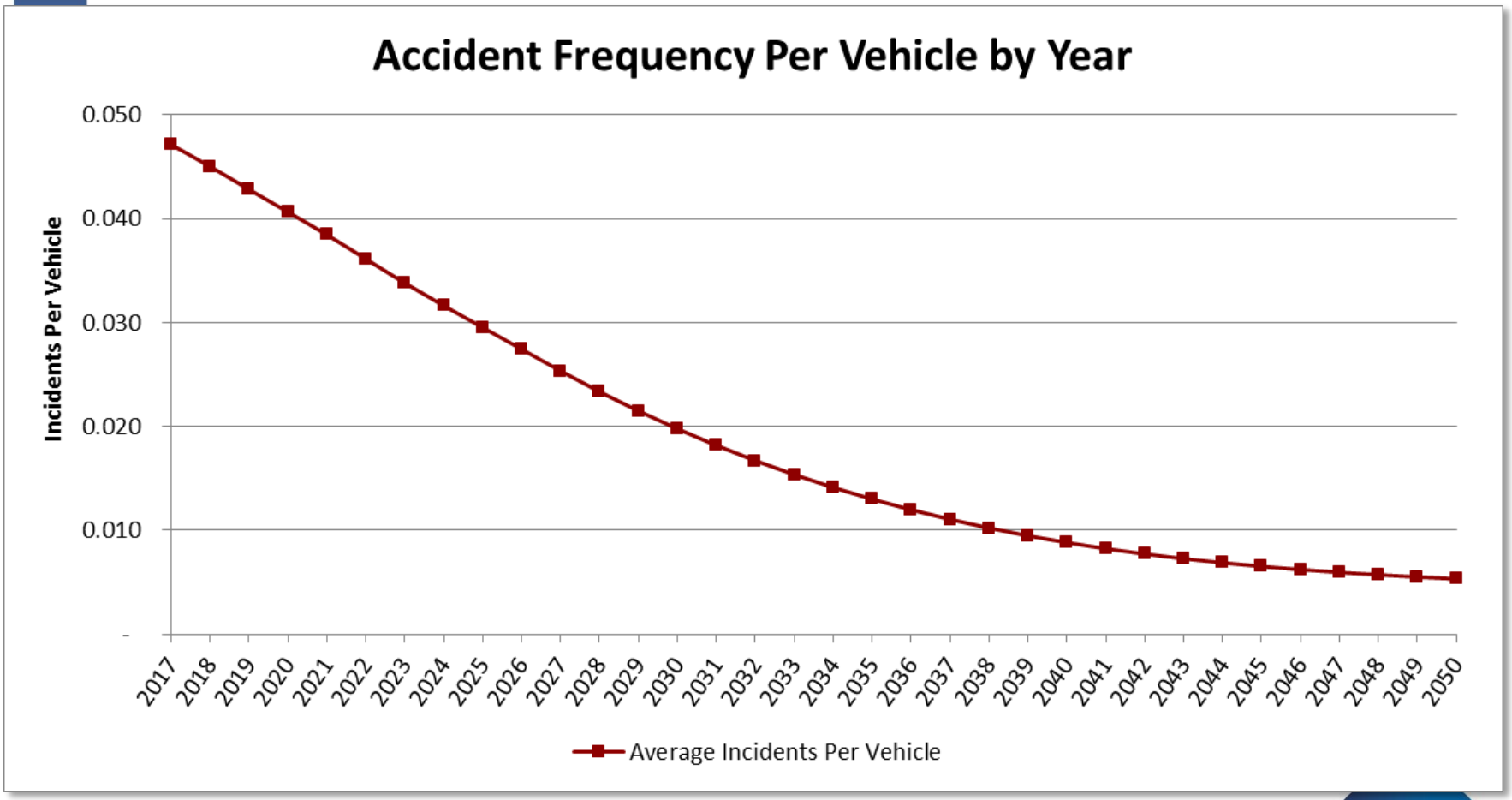
Adoption Assumptions



- KPMG developed a model to test the potential effects of Autonomous vehicles on the auto insurance marketplace
- The first assumption of the model mapped the cumulative effect of the four phases of advancing technology (per the baseline scenario) on the stock of total cars
- By 2028, cars with some degree of automated controls could account for over half of those in use and nearly all vehicles by 2050

Source: KPMG LLP actuarial analysis

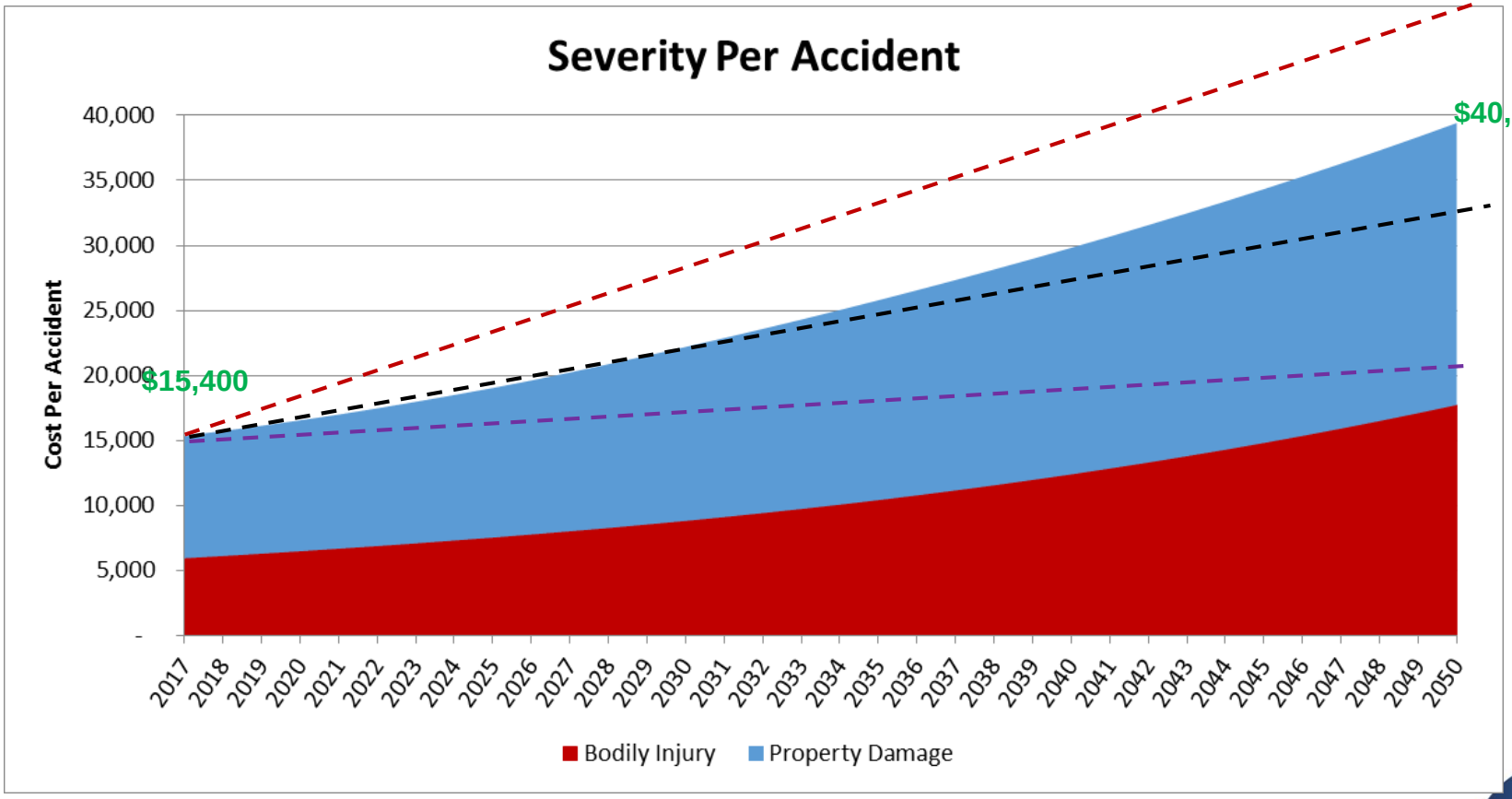
Accident Frequency



Given the new safety technology in autonomous vehicles, the KPMG Actuarial Team predicts a potential 90% reduction in accident frequency by 2050, which is the largest driver of loss reduction

Source: KPMG LLP actuarial analysis

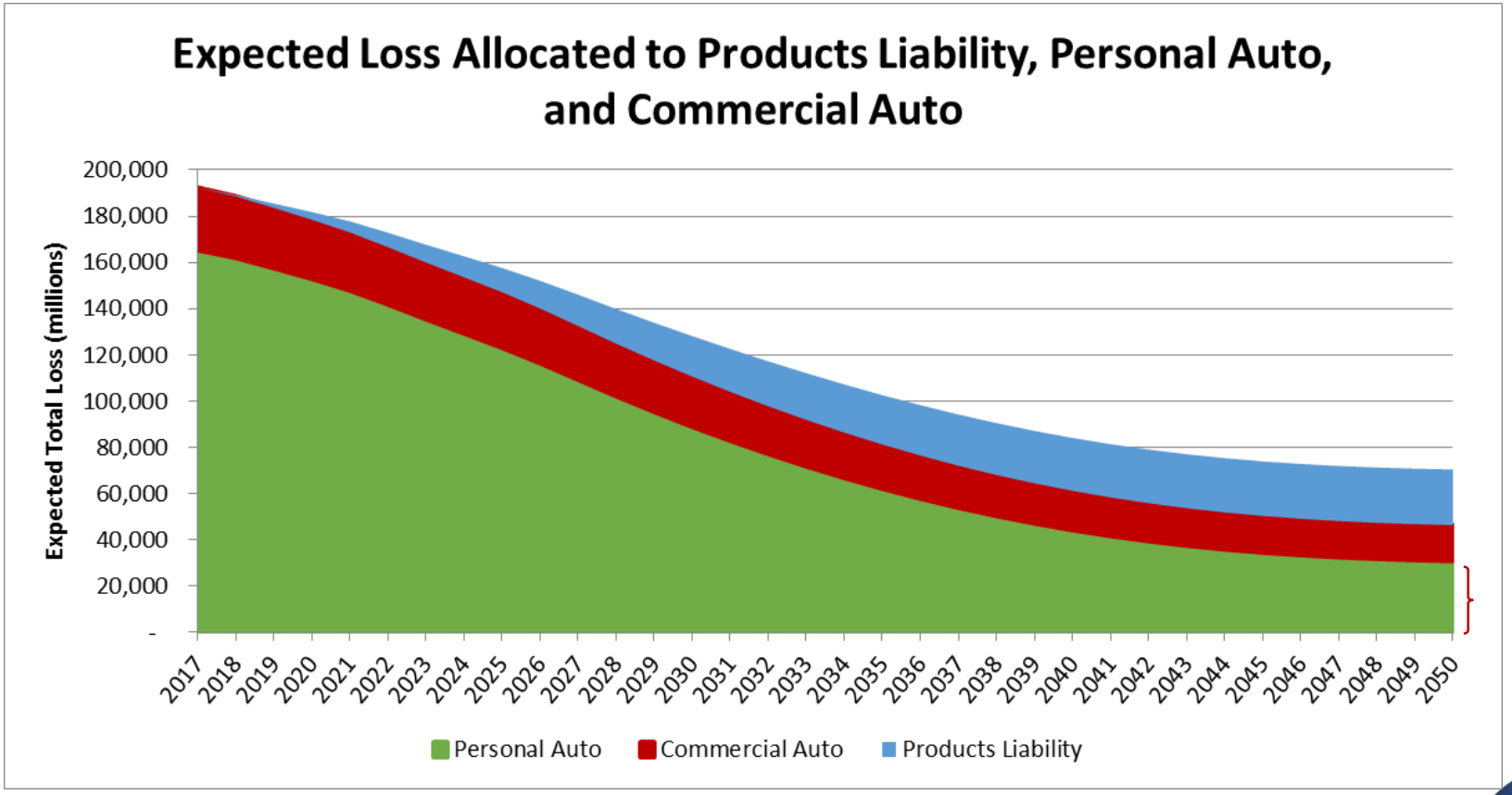
Loss Severity



The KPMG Actuarial Team modeled severity broadly in line with inflationary trends. There are, however, a variety of different potential scenarios that could have a significant impact on severity over time

Source: KPMG LLP actuarial analysis

Industry Loss Costs



80% decrease in personal auto losses

Safer vehicles could result in total auto insurance industry losses decreasing by 60% by 2050 with commercial and product liability accounting for a larger portion of the loss pie

Source: KPMG LLP actuarial analysis