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Insuring The Future of Mobility
How self-driving vehicles and the way we use them will impact the insurance industry

Peter Tomopoulos, ACAS, MAAA
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CAS Annual Meeting
Orlando, FL
November 14-16, 2016

CAS Anti-Trust Slide

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The Future of Mobility™

Autonomous Vehicles in the News

Driverless Cars Threaten to Crash Insurers' Earnings

Technology may be decades away, but firms are already scrambling to figure out how to deal with expected decline in premiums as autos become safer

Tesla car mangled in fatal crash was on Autopilot and speeding, NTSB says



PHOTO COURTESY OF NTSB

Uber's First Self-Driving Fleet Arrives in Pittsburgh This Month

The autonomous cars, launching this summer, are custom Volvo XC90s, supervised by humans in the driver's seat.

Autoblog.com

"Driverless Cars Threaten to Crash Insurers' Earnings", Wall Street Journal, July 26, 2016
 "Uber's First Self-Driving Fleet Arrives in Pittsburgh This Month" Bloomberg, August 18, 2016
 "Tesla Car Mangled in Fatal Crash was on Autopilot and Speeding, NTSB Says", Los Angeles Times, July 26, 2016
 "Lyft Says Robots will Drive Most of its Cars in Five Years", NBC, Sept. 18, 2016

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.

According to the handbook, by 2021, Lyft intends to have a majority of its fleet be driverless. Titled "The Third Transportation Revolution: Lyft's Vision for the Next Ten Years and Beyond," Zimmer's mission statement predicts that by 2025, the idea of individual car ownership will be a thing of the past and the automotive industry will undergo a huge transition.

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US DOT releases initial framework for driverless cars

The White House
Office of the Press Secretary
For Immediate Release September 19, 2016

FACT SHEET: Encouraging the Safe and Responsible Deployment of Automated Vehicles

POTENTIAL BENEFITS OF HIGHLY AUTOMATED VEHICLES

- Safety.** Helping prevent the vast majority of car crashes that result from human error or judgment and possibly saving tens of thousands of lives in the United States.
- Mobility.** Transforming personal mobility for millions of Americans who lack it today, including the elderly and those with disabilities.
- Productivity.** Reducing the cost of transportation for families, communities, and businesses, while giving working people back hours spent driving every day.
- Sustainability.** Improving the efficiency of vehicles and reducing road congestion, which can help decrease carbon emissions.


FEDERAL RECOMMENDATIONS

- Vehicle performance guidance for automated vehicles.** These guidelines will serve as a set of leading practices for automakers to follow when designing, testing, and building self-driving vehicles. They will evolve as the technology does, according to the DOT.
- Model state policy.** This is designed to help ensure that the road regulations that states currently control will not be any different with autonomous vehicles.
- NHTSA's current regulatory tools.** The NHTSA has the authority to recall any vehicle or piece of automotive equipment in the US that it deems to be unsafe.
- New tools and authorities.** As the notion of a car changes, so too may the ways the US regulates them. The DOT has not committed to any new ways of working yet, but said it may look at how other government agencies handle complicated technological regulation.

"Encouraging the Safe and Responsible Deployment of Automated Vehicles", White House, Office of the Press Secretary, September 19, 2016


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Converging forces are transforming the automotive industry's longstanding structure and dynamics




Maturing powertrain technologies

Battery and fuel-cell electric vehicles offer higher energy efficiency, lower emissions, greater energy diversity, and new vehicle designs




Lightweight materials

Stronger and lighter materials are helping reduce vehicle weight without sacrificing passenger safety




Rapid advances in connected vehicles

New vehicles are being outfitted with vehicle-to-infrastructure (V2I), vehicle-to-vehicle (V2V), and communications technologies, so every car can know precisely where every other car is on the road



Shifts in mobility preferences

Younger generations are leading the way toward pay-per-use mobility in place of owning a car; nearly 50% of Gen Y consumers like using a smartphone app for transport and plan travel so they can multitask!



Emergence of autonomous vehicles

Autonomous-drive technology is no longer a case of science fiction; the question is when and how will it become more mainstream and widely adopted?

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There are two profoundly different visions about how the future could evolve

Insider view

The industry will **evolve naturally and incrementally** toward a future mobility system that **retains its roots** in what exists today

The key players, major assets, and overall structure of the **current ecosystem can remain intact** while change progresses in an **orderly, linear fashion**

Disrupter view

A **whole new age** is dawning featuring **fully autonomous cars** accessible on demand

Before long, a **tipping point** will occur, after which the **momentum of change will become unstoppable**

New entrants, from Silicon Valley, are **catalysts** for transformation

Which side are you on?

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Live Polling

QUESTION #1 – What side are you on?

- Insider View
- Disrupter View

QUESTION #2 – What year to you expect driverless vehicles to make up 50% of the cars on the road?

- 2021-2030
- 2031-2035
- 2036-2040
- After 2040

QUESTION #3 – What year do you think you'll give up personally driving a car?

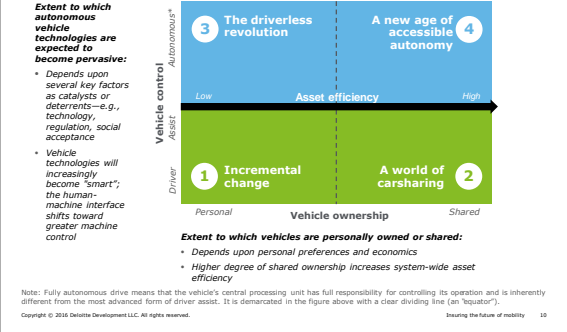
- 2021-2030
- 2031-2035
- 2036-2040
- After 2040

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Stakes are high – with **~\$2 trillion** in revenues collected annually by the current extended auto industry

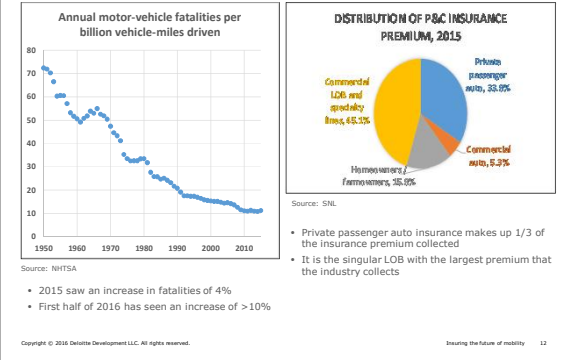
¹Total revenue is \$1,997.
 Source: Deloitte analysis based on JBDWorld Industry Reports, BHS, DOT, US Census, EIA, Auto News, TechCrunch. Current revenue represents 2014 figures (or earlier if 2014 data not available) in the United States.
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The converging forces will likely give rise to the emergence of four future states of mobility, which exist in parallel



The impact on insurance

A snapshot of personal auto insurance today



Driverless cars threaten personal auto insurers' earnings

Expectations are that "industry pure premiums" will drop 20 percent under their 2015 levels by 2035, even if the technology is adopted at just a moderate pace, one insurance broker said. Assuming the same moderate trajectory, those premiums could plunge by more than 40 percent if full adoption of autonomous vehicles takes place, as expected, by 2050.
--Insurance Journal, 9/12/16

In a report last year, one actuarial consulting firm estimated an 80% drop in the U.S. accident-frequency rate by 2040. Among its assumptions: By 2020, some fully autonomous cars will be available and authorities will be experimenting with upgrades to road infrastructure to help driverless cars navigate.
--WSJ, 7/26/16

One reinsurer reckons that such systems will reduce accidents on motorways by 16% by 2020, and on other roads by 12%. The reinsurer expects these more advanced systems will lead to a fall of 45% in accidents on motorways and of 28% on other roads.
--Financial Times, 6/28/16

Premiums consumers pay could drop as much as 60 percent in 15 years as self-driving cars hit the roads, according to one boutique research firm. The message for insurers: "You have to be prepared to see that part of your business shrink, probably considerably."
--Bloomberg, 7/30/15

*Autonomous Cars to Cut U.S. Auto Premiums by 20% in 20 Years", Insurance Journal, September 19, 2016
 "Driverless Cars Threaten to Crash Insurers' Earnings", Wall Street Journal, July 26, 2016
 "Cost of car insurance to plunge with rise of driverless vehicles", Financial Times, June 28, 2016
 "Can the Insurance Industry Survive Driverless Cars?", Bloomberg, July 30, 2015
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The auto insurance sector is on the verge of major change, which will likely lead to the following

- 1 New insurance models will likely emerge** to meet the needs of FOM ecosystem stakeholders
- 2 Premiums will likely shift substantially** due to shared and autonomous vehicles
- 3 New entrants will likely threaten legacy players'** ability to capture market share
- 4 Operational complexity will likely increase** due to new segments and coverages
- 5 Insurers need to act now** to effectively position themselves for the future

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Each future state of mobility corresponds to a specific owner / operator model

3 Personal Autonomous

- Personally-owned, fully-autonomous vehicles

4 Shared Autonomous

- Includes shared autonomous vehicles primarily owned and operated by fleets

Future states of mobility

1 Driver-Driven, Personally-Owned

- Driver-driven vehicles similar to those of today, though with increasing driver assist features

2 Driver-Driven, Shared

- Includes all driver-driven shared vehicles such as taxis, ride sharing and rental car companies

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New insurance models are expected to emerge based on unique stakeholder needs in each future state

Future State	Model	Stakeholders	Coverage Model	
1 Incremental Change	Traditional Personal Auto Insurance	Vehicle Owner Individual	<ul style="list-style-type: none"> Remains similar to today, though likely with more usage-based elements as telematics adoption grows 	MOSTLY SIMILAR
2	Fleet (e.g., yellow cab, limo)	Vehicle Owner Commercial	<ul style="list-style-type: none"> Remains similar to today 	
	Rental Cars	Vehicle Owner Commercial Vehicle Driver Individual	<ul style="list-style-type: none"> The growing sophistication of telematics devices, specifically mobile devices, may enable driver-centric liability policies 	
3 Shareholder Revolution	Owner / Operator (e.g., Uber, black car)	Vehicle Owner Individual / Commercial	<ul style="list-style-type: none"> Coverage packages configured for ride sharing services may greatly expand 	MOSTLY NEW
4 Accessible Autonomy	Personal Autonomous Vehicle Insurance	Vehicle Owner Individual AV System Manufacturer Commercial	<ul style="list-style-type: none"> Liability is likely to shift to the autonomous vehicle system manufacturer, while the owner remains responsible for comprehensive coverage 	
	Commercial Autonomous Vehicle Insurance	Vehicle Owner Commercial AV System Manufacturer Commercial	<ul style="list-style-type: none"> Commercial fleet owners will require comprehensive policies, while the AV manufacturer will be responsible for liability 	

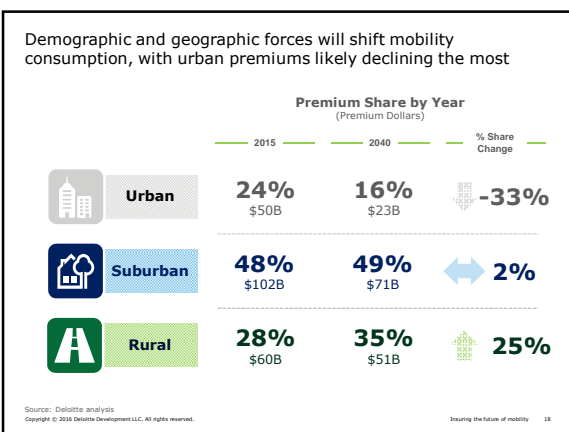
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Premiums will likely shift substantially due to shared and autonomous vehicles

Key Drivers of Change in Premiums

- Advanced vehicle technology** can help reduce loss frequency and severity
- The premium mix** will likely move away from traditional auto policies and decline overall
- Demographic and geographic forces** will shift mobility consumption, with urban premiums expected to decline the most

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Alternatives to traditional policies and coverages may create barriers for insurers

Self-Insurance

- Autonomous vehicle manufacturers and commercial fleet operators may reach a scale that allows them to self-insure, similar to what large transportation and logistics companies do today
- Premiums for car & ride sharing, personal autonomous, and shared autonomous vehicles are particularly vulnerable

Bundled Coverages

- Insurance coverage may be bundled with products or services, such as autonomous vehicle leases or car and ride sharing fees
- Insurers may face challenges reaching end users due to the positioning and product bundles offered by mobility providers and other intermediaries

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Operational complexity will likely increase due to the need to serve new segments and provide new coverages

Channels

- An increased focus on commercial lines sales and relationships for shared vehicles and product liability-related coverage is anticipated
- Partnerships with intermediaries (e.g., car sharing services, AV manufacturers) may be advantageous

Underwriting

- New classes of data and technologies with varying safety implications are expected to increase the complexity of underwriting
- Insurers that can better understand the implications of these data and technologies on risk will likely have a distinct competitive advantage

Claims

- Significantly more data will be collected and available for analysis when a claim is filed
- Autonomous and connected vehicles' "black boxes" can help make the determination of fault easier
- Fraudulent claims will likely be substantially reduced

Increasing operational complexity, when paired with falling premiums, could result in a wave of consolidation among auto insurers

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Quantifying an uncertain future: Insurance in the new mobility ecosystem

Key Highlights of Our Actuarial Model

- Rooted in an actuarial model that projects annual auto insurance premiums through 2040 related to the transportation of people using passenger vehicles
 - Personal (driving a vehicle you own)
 - Commercial (taxi, ride-sharing, car-sharing, rental car, autonomous vehicle ownership of entities)
- Our model did not consider commercial trucking or delivery services, or account for the potential effects of self-insurance or other alternative forms of coverage
- Our projections relied upon:
 - Publicly available insurance industry data (e.g. SNL)
 - Third-party projections
 - Our own research and assumptions
- Quantified the changes that we believe will be realized by the auto insurance industry as a result of the four future states of mobility that we identified

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Actuarial Model

Our approach starts with the fundamental insurance equation

$$\text{Premium} = \text{Losses} + \text{Loss Adjustment Expenses} + \text{Underwriting Expenses} + \text{Profit}^1$$

- 1. Baseline assumptions**
 - Estimate baseline assumptions:
 - Pure premiums (the average loss per exposure unit)
 - LAE to loss ratios
 - Underwriting expense ratios
 - Underwriting profit provision
- 2. Pure premium modifiers**
 - Identify and quantify what will affect future pure premiums. Examples include:
 - Advances in vehicle safety and autonomous driving technology
 - Shifts in mobility preferences
- 3. Autonomous vehicle product liability**
 - Estimate the size of the market for the new class of coverage to insure the software and sensors enabling autonomous vehicles.
- 4. Future premiums through 2040**
 - Multiply modified pure premiums by estimated miles driven in each future state
 - Apply LAE, underwriting expense, and underwriting profit percentages
 - Add the autonomous vehicle product liability load to arrive at future premium by each future state

Source: ¹Geoff Werner and Claudine Modlin, Basic Rate-making, 4th edition (Casualty Actuarial Society, 2010)
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We developed baseline assumptions using our own research and US P&C industry information

Premium =	Losses	<ul style="list-style-type: none"> Liability: Property, Collision, Comprehensive Auto Physical Damage: Collision, Comprehensive 	<ul style="list-style-type: none"> Assumption Source: Schedule P, Miles Driven Schedule P
	Loss Adjustment Expenses (LAE)	LAE to Loss Ratio	Schedule P
	Underwriting Expenses	<ul style="list-style-type: none"> WP Expense Taxes / Licenses / Fees General Other Acquisition 	Insurance Expense Exhibit
	Underwriting Profit	Underwriting Profit	Rate filing sample review

Source: Deloitte analysis
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We looked at the components for each future state of mobility, as each has specific coverage implications

- 3 Personal Autonomous**
 - Personal lines
 - AV product liability
 - Primarily comprehensive APD
- 4 Shared Autonomous**
 - Commercial lines
 - AV product liability
 - Primarily comprehensive APD
- 1 Driver-Driven, Personally-Owned**
 - Personal lines
 - Traditional liability and physical damage
- 2 Shared-Driven, Personally-Owned**
 - Commercial lines
 - Traditional liability and physical damage

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The insurance coverages needed are expected to expand as shared and autonomous vehicles become more widely adopted

Coverage Type	Description
Traditional Comprehensive	Protection for the policyholder's vehicle for damages that are not related to a collision (e.g., natural disasters, falling objects, vandalism, theft).
Collision	Protection for the policyholder's vehicle for damages arising from a collision. Examples of covered incidents include hitting another car or hitting a stationary object.
Traditional Liability	Protection for the driver against the damages caused to another person's body (bodily injury liability) or property (property damage liability) because of the negligent operation of the vehicle.
Other Coverages	Other traditional automobile insurance coverages include medical payments, underinsured / un-insured, and personal injury protection, among others.
New Product Liability for AV	The entities responsible for designing, building, and maintaining the hardware and software comprising an autonomous vehicle operating system may seek protection against catastrophic losses resulting from some or all of these components malfunctioning, resulting in a loss.

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We researched what might affect loss costs throughout each future state of mobility

Frequency

- Human Error**
Semi and fully AV technology could reduce the human error contribution to accidents.
 - NHTSA estimates **94% of accidents are caused by human error**¹.
 - IHS estimates that **13% of all police-reported crashes could be avoided** if all vehicles were equipped with advanced driver-assist technologies².
- Fraud Reduction**
Expansion of vehicle connectivity and the data available to claims handlers could reduce fraud.
 - The Insurance Research Council estimates that **13-17% of auto claim payments are either excessive or fraudulent**³.
 - With the additional data expected to be available, claims personnel could be able to **identify fraud much earlier in the claims process**, resulting in fewer fraudulent payments.

Source:
¹NHTSA, "Traffic Safety Facts", February 2015
²Susanna Götsch, "2016 CCC Crash Course", CCC Information Services
³Insurance Research Council, February 3, 2015, "Insurance Research Council Finds That Fraud and Buildup Add Up to \$7.7 Billion in Excess Payments for Auto Injury Claims"
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We researched what might affect loss costs throughout each future state of mobility

Severity

Accident Intensity
Advanced driver-assist technology could reduce bodily injury severity over time

Auto Repair Costs
Advanced driver-assist technology increases vehicle complexity

Shared AV Costs
Large fleets of AVs could benefit from economies of scale

- Ex: A vehicle equipped with automatic emergency braking could reduce the speed at impact to the point where lives could be saved and injuries reduced, despite the collision occurring.
- Over time as more vehicles on the road are equipped with advanced driver-assist technology, the benefits could have an impact on losses.
- Research conducted by CCC Information Services indicates that average auto repair costs have increased by about 3% annually since 2011¹, driven largely by growth in the average number of parts replaced per claim, as well as more labor hours per claim.
- Production costs of the autonomous "pods" underlying large fleets could be significantly lower than vehicle costs today.
- Our view is that these pods could cost between \$10,000 to \$15,000 per vehicle².

We also incorporated a general inflation assumption based on the historical trends within the industry data

Source:
¹Suzanna Gotsch, "2016 CCC Crash Course", CCC Information Services
²Deloitte analysis
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Autonomous vehicle product liability will have new implications beyond existing auto liability

Current Perils

- AVs will not be able to avoid ALL accidents.
- There will still be the potential for random, unforeseen events that result in an AV accident, similar to an accident of today
 - Ex: AV is unable to identify a parked car and rear ends it
 - Ex: AV swerves to avoid an obstacle, but causes an accident in the process.

Future Likely Perils

- There is likely a new exposure related to the hyper-connected nature of AVs
 - Ex: A systemic programming flaw could cause a large number of accidents in a short period of time
 - Ex: Malicious programs could be deployed by hackers to cause widespread damage to individual vehicles, or the integrity of the AV network.
 - Ex: Hackers could steal personal information through the AV network

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Model outputs
 Mobility preferences will shift significantly over the next 25 years

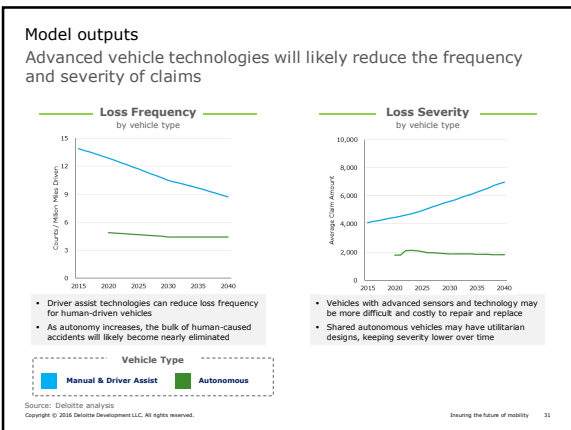
Future States

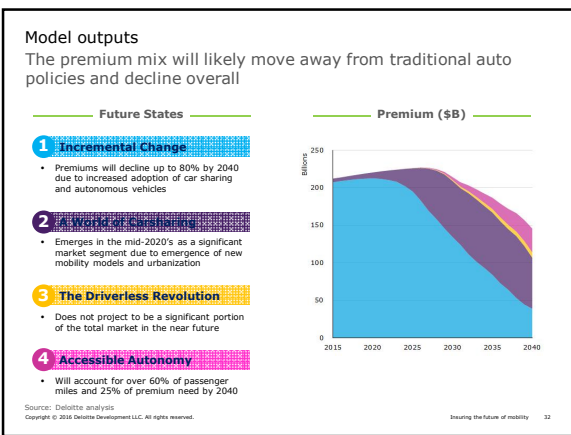
- Incremental Change**
 - Miles driven declines over time as mobility preferences shift towards future states 2 through 4
- The World of Connected Mobility**
 - Steadily increases until the late 2020s, then plateaus as autonomous vehicles proliferate
- The Driverless Revolution**
 - Does not project to be a significant portion of the total market in the near future
- Accessible Autonomy**
 - Grows exponentially because of demonstrated high efficiency and low costs to consumers

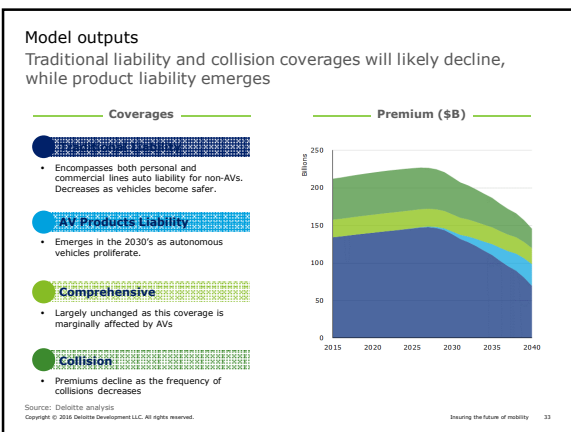
Miles Driven

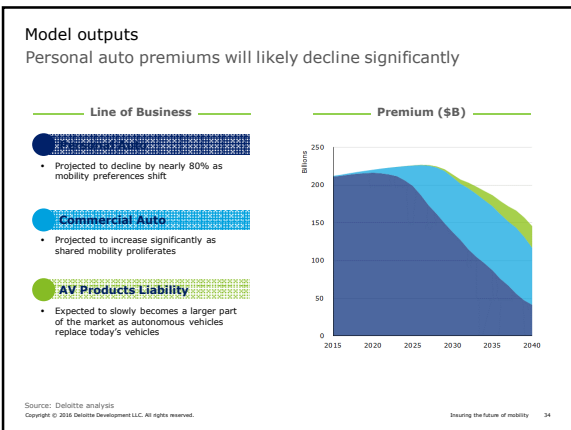
Source: Deloitte analysis
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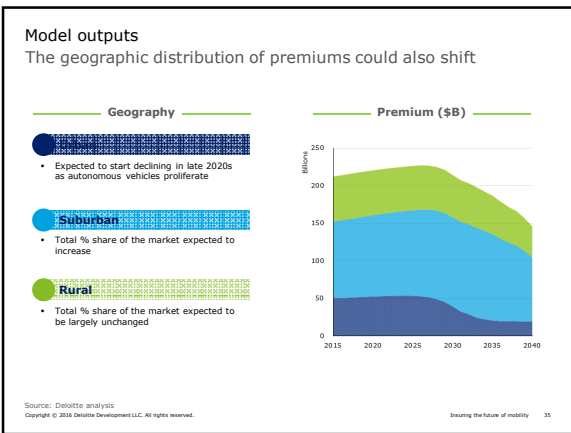
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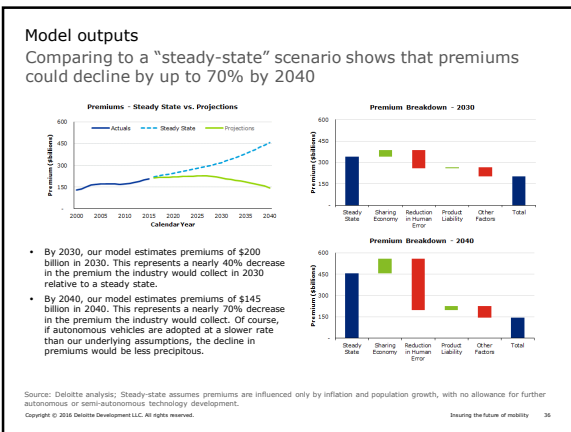












Beyond the potential for lower premiums, there are multiple other considerations insurers should address


 Expenses	 Pricing	 Reserving
---	--	--

- | | | |
|---|--|--|
| <ul style="list-style-type: none"> • Loss adjustment expenses <ul style="list-style-type: none"> - Claims department may downsize with fewer claims - Claims will likely become more complex because of the advanced electronics and new types of data available, driving increased specialization • Underwriting expenses <ul style="list-style-type: none"> - Disruption to the agency channel could be significant, as shrinking premiums would lead to lower commissions - Insurers could increasingly rely on the direct-to-consumer channel | <ul style="list-style-type: none"> • Rating algorithms will likely need to be modified or overhauled as shared mobility and autonomous vehicles proliferate. • New rating variables may need to be incorporated to accurately segregate risks (e.g. between autonomous and non-autonomous vehicles). • Miles driven could become the exposure base of choice, as consumers become more comfortable with usage-based insurance | <ul style="list-style-type: none"> • Reserving actuaries might consider revising their segmentations to group autonomous, semi-autonomous, and non-autonomous risks separately in order to effectively monitor each class accordingly |
|---|--|--|



Conclusions

Insurers should act now to effectively position themselves for the future

- Evaluate the potential impact** of the Future of Mobility across their businesses
- Engage with new classes of data near-term**, such as the connected car or AV pilots
- Build cross-sector relationships** across the new mobility ecosystem
- Embrace innovation** to establish a lasting competitive advantage
- Think differently** (try not to be an insurance company)



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