THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF RISK MANAGEMENT

IMPACT OF AUTONOMOUS VEHICLES ON AUTOMOBILE INSURANCE

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SPRING 2017

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Risk Management
with honors in Risk Management

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ABSTRACT

As technology revolutionizes the way cars are being built and driven, the fully autonomous-vehicle is born, an automobile that can sense traffic and environmental conditions and operate without human assistance. This will transform the automobile industry, and more specifically the automobile insurance industry. With the introduction of self-driving cars on the road, there are potential risk factors that need to be addressed and safety measures that need to be implemented before these vehicles can be sold to consumers and businesses in the market.

This paper focuses on the impact of autonomous vehicles on automobile insurance for consumers, insurers, and manufacturers. As autonomous vehicles are introduced, personal cars will transform into a creative space for consumers that offer more options for customization. Ridesharing is also gaining increasing popularity in cities where personal vehicles are the primary mode of transportation. Autonomous ridesharing offers accessibility and convenience for customers and long term economical savings for businesses.

The transition to fully autonomous vehicles on the road will take time, so the goal is to develop affordable insurance for consumers and businesses. These policies will aim to estimate losses and claims for insurers, set reasonable premiums, and evaluate potential changes in underwriting in order to assess the ultimate impact on the insurance industry.

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ACKNOWLEDGEMENTS

I would like to thank Ron Gebhardtsbauer for meeting with me through the process of writing my thesis and providing insight and advice where needed. You have been an extremely encouraging and helpful mentor for the last four years.

I would like to thank Lisa Posey for taking the time to provide critique and advice throughout my thesis.

I would also like to thank Gina Badowski for answering my questions and helping me along every step of the way. You have provided me valuable resources and were extremely willing to address all my concerns.

I would lastly like to thank my mentor at my internship, Sarah Manuel, for driving my interest in this topic in the first place and pointing me in the right direction and starting me off with the many useful assets I used while writing this paper.

Chapter 1

Introduction

Companies such as Tesla and Google are currently testing their self-driving cars on the road, which will be available for sale to consumers and businesses in just a few years. This is a new industry with limited data and statistics that can be analyzed to create the framework for insurance for autonomous vehicles. With the arrival of self-driving cars, there are new possibilities for auto accidents, which will introduce a new batch of risk factors that could significantly alter costs of claims and premiums. With these technological advancements, self-driving cars are predicted to have higher claim costs initially but overall reduced frequency of accidents, which may ultimately reduce the overall cost of automobile insurance (Matley et al.).

Chapter 2 classifies and describes the four future states of mobility and explains the evolution from driver-driven vehicles to fully autonomous vehicles.

Chapter 3 examines three potential risk factors that are taken into account when pricing insurance. Concerns about regulations, cybersecurity, and changing role of stakeholders are addressed to determine how the automobile industry will need to transform to accommodate impending changes.

Chapter 4 focuses on the three basic types of coverage for automobile insurance which are utilized by insurers currently. More specific types of coverages are then evaluated to assess effects to personal and commercial lines of automobile insurance.

Chapter 5 discusses how insurers will need to set premiums in the future. Factors utilized in pricing insurance are examined and ranked based on importance and applicability to self-driving cars. The premium formula is then evaluated to form predictions for future premium levels based on the most profitable venue for insurers.

Chapter 6 assesses claim costs in accordance to claim trends with respect to physical damages and medical costs. Generalized Linear Modeling is then utilized to estimate claims costs based on different characteristics of the policyholders for autonomous vehicles.

Chapter 7 evaluates changes to the underwriting system as new expenditures arise for insurers, and different methods of filing claims being to emerge.

Chapter 8 focuses on the overall impact on the automobile insurance industry, and the growing popularity of ride-sharing services in cities. This sections scrutinizes how insurers and manufacturers can continue to innovate to establish a competitive advantage over their peers.

Chapter 2

Four Future States of Mobility

Four future states of mobility are expected to coexist in the near future as technology rapidly advances. These four states include personal manual vehicles, personal autonomous vehicles, ridesharing for manual vehicles, and ridesharing for autonomous vehicles (Corwin et al., 2015). Each state of mobility is classified according to the type of vehicle ownership, personal or shared, and the type of vehicle control, driver or assist as shown in Figure 1.

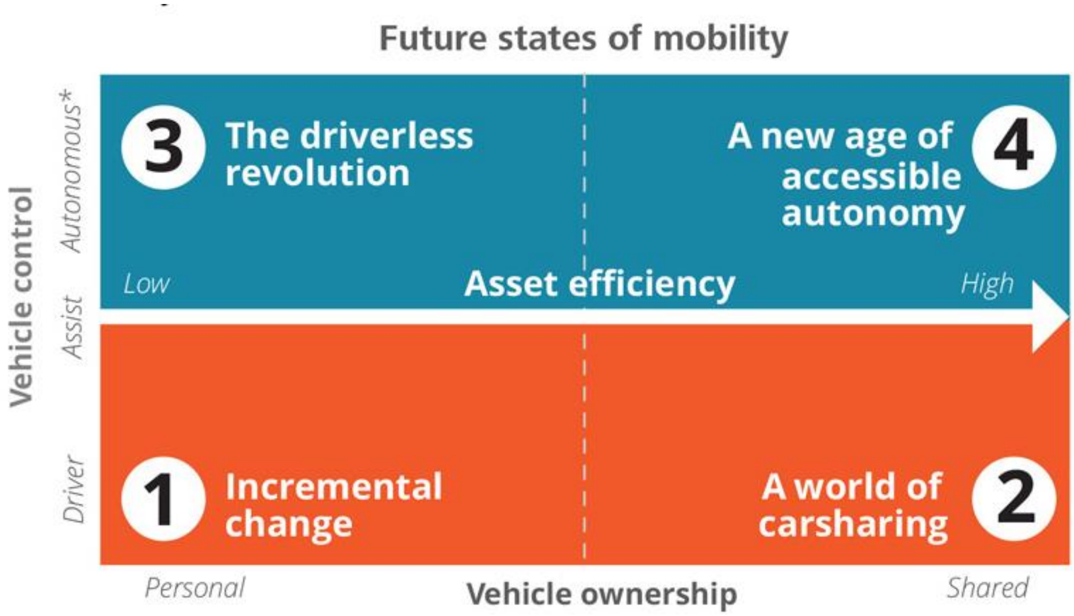

Figure 1 Future States of Mobility (Source: Corwin et al., 2016)

The first state of future mobility is the driver-driven personal vehicle, which is the most common form that exists today. This state is known as the "state of incremental change" because these consumers are often hesitant to give up their own vehicle to invest in driverless cars (Corwin et al., 2015). They enjoy the private ownership of their vehicle, which can offer convenience, safety, and privacy for the driver and passengers of the vehicle. These consumers often see autonomous vehicles as a development of the future, an invention that will not be accessible to consumers anytime soon. Since these customers align to a more conventional form of transportation, manufacturers will need to continue to produce vehicles with innovative technologies to improve overall customer experience and satisfy the needs and wants of this group (Corwin et al., 2015)

The second state of future mobility is ridesharing for driver-driven vehicles, which is becoming extremely popular in urban environments. Ride-sharing services such as Uber and Lyft focus on point to point transportation through a mobile app in which customers can order a vehicle to pick them up from a specific location at a specific time. This has proven extremely successful in urban settings, so individuals can avoid driving in congested traffic and trying to find parking. This can reduce the number of vehicles needed in a household, in turn, reducing the financial expenditures associated with owning a vehicle. Ridesharing can also provide services to people without licenses, people with disabilities, the elderly, and people who cannot afford cars, something personal vehicles have been unable to accomplish (Corwin et al., 2015).

The third future state consists of personal autonomous vehicles, which are currently being tested and may be available to consumers in the near future. Customers in this state still prefer the privacy of their own vehicle, but unlike consumers who prefer driver-driven vehicles, they are more open to the freedom autonomous vehicles can offer. These individuals may prefer to multi-task or utilize this time for themselves to accomplish other tasks rather than using that time to drive. A key focus for these types of vehicles is to customize to a setting that is suitable for the driver. The idea is that these vehicles will be similar to driver-driven personal vehicles with the driver seat in the front-left side of the car and steering wheel reality so it mimics the experience of driving one’s own vehicle. With these features, there are more opportunities for customization so the owner can still enjoy a personalized experience and still possess their own vehicle (Corwin et al., 2015).

The fourth and last state is ridesharing for autonomous vehicles. This state is designed to target the urban community that utilizes ride-sharing services the most frequently. These vehicles aim to find the quickest and shortest route based on traffic conditions to ensure that the customer arrives at the destination in a timely manner (Corwin et al., 2015). Inside the vehicle, there are sensors that can perceive a driver's drowsiness and assess stress level based on skin sensors. Outside, cameras and scanners can evaluate conditions of the road and respond accordingly (Claudel and Ratti). Beginning in August, Uber has commenced the testing self-driving vehicles in Pittsburgh, the first ride-sharing service to take on the road. These vehicles utilize different features such as radars, cameras, and GPS receivers to sense various traffic and environmental conditions. Currently, these vehicles are overseen by a driver in the front seat of a Volvo XC90 in the instance there is a technological failure or error (Chafkin).

The transition to fully autonomous vehicles on the road will not be immediate as many are hesitant to switch to this new type of technology. However, the transition towards autonomous vehicles is beginning now. This change is often classified into three eras of transformation: the current state, the changing state, the ultimate state.

Era 1 represents the current state of the automobile industry, the commencement of testing different models of autonomous vehicles. In the short term, 2015-2020, autonomous vehicles will be unavailable for sale for consumers, so this state focuses on enhancing and improving features for preexisting vehicles. Manufacturers will work to improve vehicle structures and designs and implement innovative features (Bertoncello and Wee). Many vehicles incorporate semi-autonomous features such as collision warnings and cruise control, which has foreshadowed a gradual transition towards fully autonomous features (Claudel and Ratti). Pioneer manufacturers have already begun to refine features of driver-controlled vehicles and conduct research on autonomous technology. However, late entrants may not adopt autonomous technologies until costs drop (Bertoncello and Wee).

During this time, ride-sharing services have been gaining popularity, and there is a notable transition from future state one, the driver-driven personal vehicle, to future state two, ridesharing for driver-driven vehicles. With observations and customer feedback, ride-sharing services are continuing to improve experiences for both drivers and customers, which has led to the increased popularity of such services. For instance, Uber provided 140 million rides worldwide in 2014 and is adding 50,000 drivers a month to match increasing demand (Corwin et al., 2015). This era primarily showcases the development of the ride-sharing services as competition to provide affordable and quality services increases.

Era 2 characterizes the entrance of autonomous vehicles into the market, an episode that will likely occur following 2020-2025. There is a change in insurance models as priorities shift from protecting consumers to protecting automobile manufacturers. With the advancement of technology, the likelihood of accidents resulting from human error will decline significantly, reducing the need to protect consumers. Instead, there will be an increased liability for manufactures who produce and design autonomous vehicles. Rather than insuring millions of consumers, insurers will need to cover manufacturers, who have primarily taken on the burden of risk and responsibility for accidents since manufacturers will also be responsible for servicing and maintaining these vehicles (Bertoncello and Wee). However, it is also possible that consumers and manufacturers will both need to purchase insurance in the case they could both be at fault.

In Era 3, autonomous vehicles are expected to completely dominate the automobile industry and become the conventional form of automobile transportation. This is the long-term outlook on transportation, which is not expected to transpire until three decades from now. With the convenience of autonomous vehicles, drivers could save 50 minutes a day on commute. There will also be a reduced need for parking as self-parking vehicles require less open-door space when dropping off passengers, which can reduce parking spaces by 15%. The principal advantage of such technology is the reduced fatalities associated with auto accidents. It is expected that accidents rates will decrease by 90%, dropping from 2^{nd} to 9^{th} in terms of lethality (Bertoncello and Wee).

This three step transformation represents the expected timeline of the entrance of autonomous vehicles into the market. As shown in Figure 2, the preferred mode of automobile transportation currently is the personal driver-driven vehicle. In the next decade or so, ridesharing for manual and autonomous vehicles is expected to skyrocket in popularity as consumers begin to accept and embrace the accessibility and convenience of such modes of transportation. However, some consumers will still refuse to accept autonomous vehicles as they prefer the freedom and safety associated with driver-driven vehicles, features that have existed for decades. By 2040, however, it is expected that shared autonomous vehicles will become the primary mode of automobile transportation, capturing around 70% of the automobile market (Corwin et al., 2016).

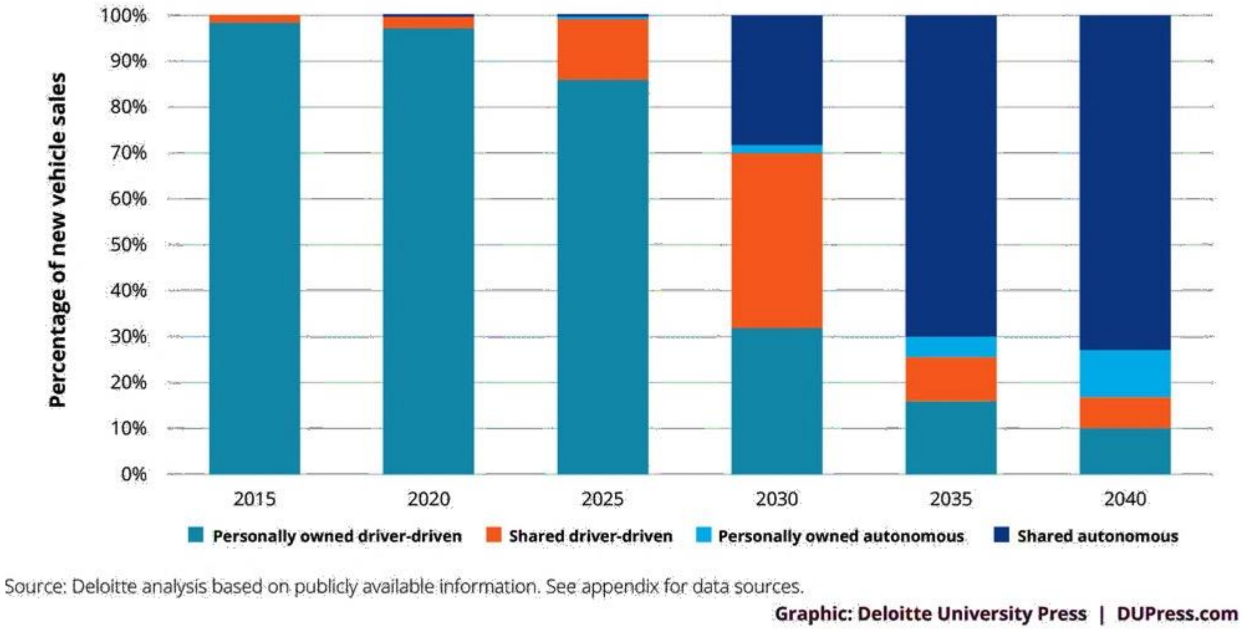

Figure 2 Forecast of New Vehicle Sales Distribution In Urban Areas in the U.S. (Source: Corwin et al., 2016)

Chapter 3

Potential Risks

Cybersecurity

Despite the predicted popularity of autonomous vehicles, there are some concerns regarding privacy and safety of autonomous vehicles, which may impede the ability of autonomous vehicles to grow in the market. The success in sales of automobiles is reliant on consumers' willingness to buy products that satisfy their needs and wants (Corwin et al., 2015). However, with a vehicle that is completely built around technology, hacking is a viable threat, and many see this as an invasion of personal space and privacy.

Cybersecurity is one of the major concerns of consumers. Despite cutting edge technology, computer systems are never completely safe because existing threats can be secured, but it is almost impossible to predict emerging and evolving threats. A hacker can gain access to an individual's personal identification information, license plate and registration, vehicle location, insurance and tax information and other information that is connected electronically through mobile devices or tablets. With such dangers, it is reasonable that consumers are cautious to own a driverless vehicle while their personal information is at stake ("Automotive Cyber Security"). Many consumers do not trust computer systems, which are vulnerable to hacking and malfunctions for that reason. On the other hand, some simply prefer the actual act of driving their own vehicle. Rather than having a robot control their vehicle, they prefer the freedom and control that driving can offer. They may also develop a false sense of security because they are controlling the vehicle and are less likely to get into an accident.

Legislation

Only 20 states have introduced legislation pertaining to autonomous vehicles on the road. Beginning January 2016, the NHTSA, National Highway and Transportation Safety Administration, has begun to establish standards and guidelines to guarantee safe operation of driverless vehicles (“Autonomous Vehicles"). The U.S. Department of Transportation is also focusing on “laying a path for the safe testing and deployment of new auto technologies” ("U.S. DOT"). A 15-point safety assessment is used to set guidelines for manufacturers for the production of safe driverless vehicles. ("U.S. DOT"). However, these standards that oversee crashworthiness and cybersecurity, just to name a few, are somewhat ambiguous. With such complex technology, it is difficult to align and classify all autonomous vehicles to these guidelines and must be evaluated on a case by case basis (McFarland).

Despite the government’s promise of “aggressive oversight,”, many of these regulations are up to the discretion of manufacturers (McFarland). The government is trusting automakers to release transparent and accurate safety assessments to guarantee a safe experience for consumers (McFarland). Ultimately, it comes down to the automakers and manufacturers to perfect the technology to successfully reduce the casualties from automobile accidents. The government plays an important role in ensuring the safety for all individuals on the road but adhering to such strict expectations may prove difficult for manufacturers.

There are also many nonparticipating states who have not yet implemented any regulations pertaining to autonomous vehicles. The government is agreeing to fund $4 billion for the research and development of driverless technology to drive the arrival of autonomous vehicles on the market. However, only a dozen states have even initiated legislation that allows the testing of autonomous vehicles. Despite overarching federal regulations, it may be difficult to generate consistent regulations across the board since different states are at different stages of testing driverless cars. There are concerns that government regulation may ultimately lead to weaker state laws if there is improper oversight. With stricter government enforcement, however, it is the hope that states will also enforce stricter rules as well (Kang).

Stakeholders

There are several key stakeholders whose positions may be threatened as business models begin to shift to accommodate the entrance of driverless vehicles. Manufacturers and automotive suppliers will need to create more flexible and customized vehicle systems tailored to consumer needs. Cutting-edge technology requires a highly technical and specific skillset in order to create and maintain these vehicles. Technology firms could actually take over this role due to the expertise in this area. However, this could be detrimental for dealers, repairmen, and unions who often do not have this background and knowledge. This could cause high unemployment for the blue-collar group but give rise to plenty of employment opportunities as well. The entire business structure and employment model will have to transform to accommodate these changes, so it is unclear where this industry will be headed (Corwin et al. 2015). The role of stakeholders will be discussed more in the next chapter.

Chapter 4

Coverage and Products

The purpose of automobile insurance is to protect the driver and passengers in the vehicle in the case of an accident or vehicle-related incident such as theft. Automobile insurance includes three general different types of coverage: property coverage, which covers damage or theft of the vehicle, liability coverage, which covers injury and/or property damage to others' vehicles, and medical coverage, which covers the cost of treatment for injuries, lost wages, and funeral expenses. Most states mandate some sort of auto liability insurance in order to drive a car, but all states require that an individual must have the minimum insurance required or financial means to cover the liability in case of an accident due to the fault of that individual ("Auto Insurance Basics").

The $205 billion automobile industry is beginning to transform as future states of mobility shift to include autonomous vehicles. The predicted trend is the decline of frequency of accidents over time with the advancement of technology. The direction of this change depends on a variety of elements such as social attitude, technological advancement, and stakeholders' acceptance of autonomous vehicles. These are all important factors that need to be considered as insurers begin to modify business models to satisfy consumer needs and the changing marketplace.

The self-insurance industry is beginning to flourish as large shared fleet companies want to choose an alternative that can provide stop loss and coverage for catastrophes and correlated loss events. Commercial buyers will begin to filter into the insurance industry as individual buyers begin to phase out (Matley et al.). This marks a major milestone for the fluctuating insurance industry as businesses will need to adapt to remain competitive and economical in the industry.

Products

Generally, an auto insurance policy includes six basic types of coverage. Bodily injury liability covers all injuries caused to other individuals from individuals under the policy. Medical Payments covers injuries or medical fees of the driver and passengers under the policy. Property Damage Liability pays for damage to another individual's property by someone on the policyholder's insurance. Collision insurance covers damage to the vehicle of the policyholder in the case of a collision with another vehicle or object. Comprehensive insurance compensates for theft or damage unrelated to a collision with another vehicle. Lastly, Uninsured and Underinsured Motorist Coverage seeks to reimburse individuals under a policy if hit by a hit and run driver or uninsured person ("Auto Insurance Basics"). Many policyholders purchase some form of automobile insurance to ensure they have coverage as costs for damages or injuries without insurance is extremely expensive. Even with autonomous vehicles, these types of coverage will continue to exist in some form. However, some types of coverage may no longer be applicable or necessary for policyholders, and other types of coverage will need to be modified to accommodate self-driving car.

With shifting demand, new insurance products and lines of business will begin to emerge to satisfy stakeholders in the four separate states of mobility. In future state one, which represents the current status of the auto insurance industry, vehicle owners are considered the primary stakeholders. Individuals will need to purchase insurance to protect themselves and their vehicles through all-inclusive coverage. With the growing employment of semi-autonomous technology within driver-driven vehicles, the frequency of accidents will decline. However, with the introduction of driverless vehicles, collision coverage may become more expensive initially. If a driver hits a driverless car due to human error, the cost of replacing parts and repairing the vehicle will increase significantly. Overall, these products should remain relatively comparable in the future with little variation as drivers will still continue to purchase such policies (Matley et al.).

In future state two, there are three primary stakeholders: fleet, rental, and ride-sharing companies. The primary difference between future state two and one is that future state two requires coverage for both the owner and operator of the vehicles since these two individuals can be different. All-inclusive coverage is still necessary for these companies in the case of an accident or vehicle-related incident. For the drivers, only collision and liability coverage is needed since the company will cover the rest (Matley et al.).

It is a different scenario for some ride-sharing services since the owner of the vehicle is also the operator of the vehicle. For example, Uber provides partial insurance when the driver has accepted a ride, and there is a customer is in the vehicle as shown in Figure 3.

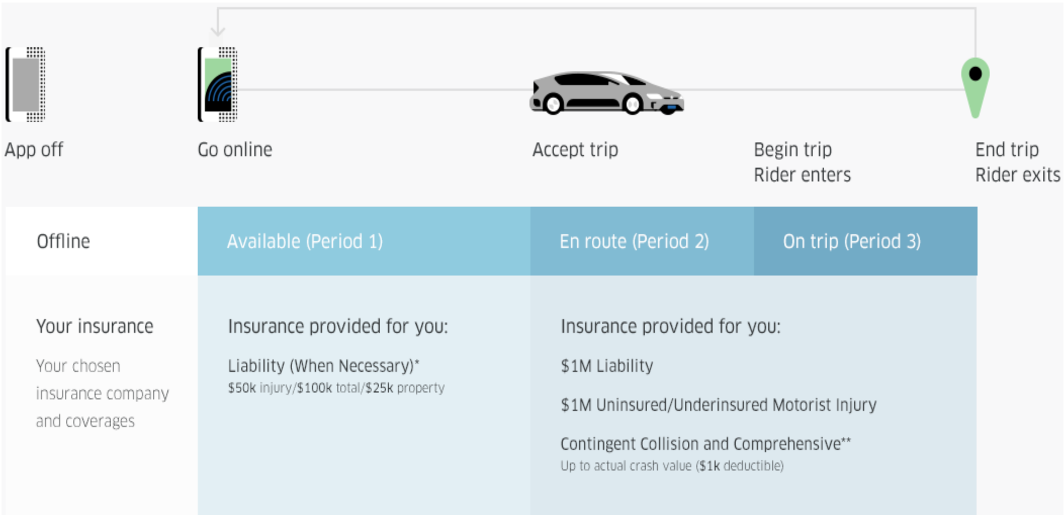

Figure 3. Uber's Insurance Policy (Source: Uber)

If the app is on, but the driver is not serving a customer, partial coverage via liability insurance is provided for the driver with a cap on the amount of liability payment. Once the driver has accepted the ride, the liability is covered under Uber's $1 million insurance policy, which includes liability insurance, uninsured/underinsured motorist injury insurance, and collision and comprehensive insurance. This provides more coverage for the driver and passengers over the driver's insurance policy (Uber).

Manufacturers, vehicle owners, and businesses responsible for constructing, designing, and maintaining autonomous vehicles all hold significant roles in future state three. These are similar to the stakeholders in future state four, except in future state four, the ride-sharing service may provide partial insurance as described previously. With driverless vehicles, new risks will emerge, and some risks may become irrelevant. Vehicle owners will still need comprehensive coverage in the case of a vehicle-related incident or collision. Manufacturers will also require coverage in the case of malfunctioning software and vehicle parts. Cyber insurance will also be needed to protect against hacking and security breaches (Matley et al.).

As the frequency of accidents continues to decline with advanced technology, collision insurance may become cheaper, but comprehensive coverage will still remain in place for non-accident related incidents. New policies may emerge to accommodate changing needs and unfamiliar risks.

Commercial vs. Personal Automobile Insurance

One primary difference between driver-driven vehicles and ridesharing for policyholders is the type of insurance required. Generally, personal driver-driven vehicles require personal automobile insurance, while ride-sharing businesses require commercial automobile insurance. I expect that commercial automobile insurance will become a more popular option with the growing popularity of ride-sharing services. Businesses who begin utilizing self-driving vehicles to transport their products to warehouses and customers will need commercial insurance to prevent against the possibility of large losses. Premiums for personal lines of automobile insurance will decline with the transition from less vehicles per household to more uses of public transportation and ride-sharing services. If vehicles ever become fully and completely autonomous, which means no steering wheel and no pedals, the responsibility will lay entirely on the manufacturers and software developers. Therefore, customers may no longer need to purchase insurance for their vehicles, but manufacturers and software developers will need to purchase insurance instead.

The majority of loss today for an insurer comes from personal automobile insurance. However, as shown in Figure 4, there will be a 60% decrease in personal auto losses by 2040. This is a significant decline for insurers since the primary share of business for them comes from personal automobile insurance. The convenience and affordability of ride-sharing services in urban environments has prompted the rapid growth of customer base, leading to an increase in expected losses for commercial automobile insurance. With more consumers and more trips, the need for commercial insurance is growing. Expected losses for commercial automobile insurance is also increasing as personal automobile insurance is decreasing, leading to an overall decrease in expected losses for car insurers. Since insurers are expected to receive less premiums and face increasing losses, the next step is to determine how automobile insurers will continue to generate a consistent profit margin. Insurers may need to cover manufacturers, software developers, and other companies involved with the production of self-driving cars. This will provide insurers with an extensive customer base they can profit from. They can also form partnerships or create their own lines of businesses that contract with cyber insurance and reinsurance, which will be discussed in a later section.

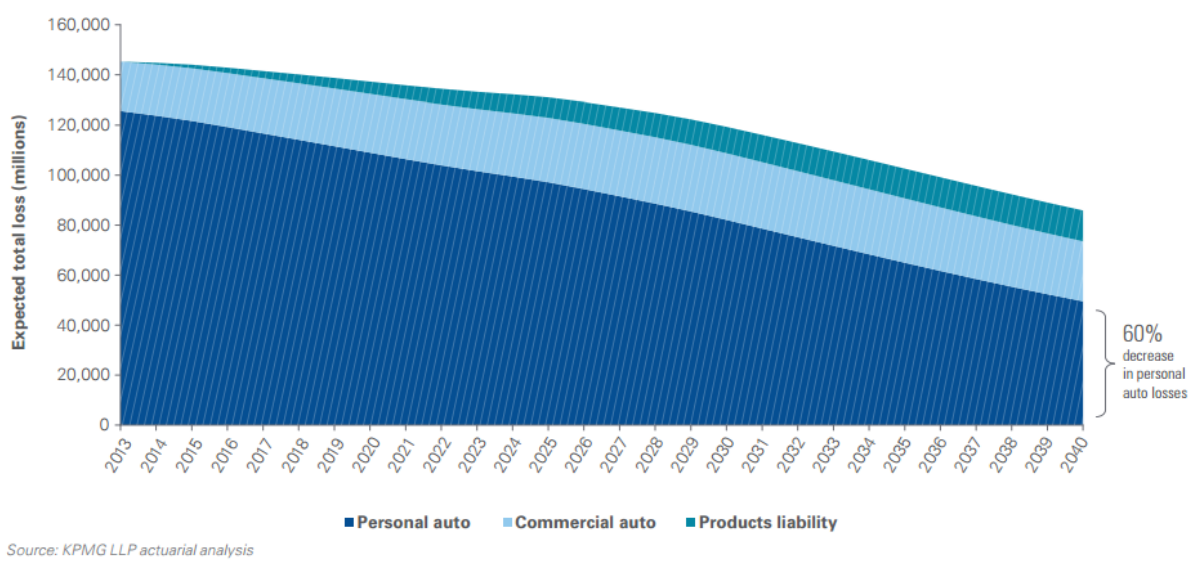

Figure 4 Expected Loss Allocated to Different lines of Automobile Insurance (Source: Bin-Nun et al)

Chapter 5

Premiums

Factors Influencing Premium Levels

When determining the price of an individual's automobile insurance, the insurance company takes into account a variety of factors. These factors aid insurers in determining the likelihood of an individual having an accident. Insurance companies utilize different measures in setting the premium of a policy, but there are a few characteristics that insurers generally use. Factors such as driving record, age, gender, the type of car, and even credit score can vary premiums significantly. For instance, if a driver has more accidents or violations than the average driver in a certain age group, that individual will have to pay higher premiums to account for the increased risk for insurers. Less experienced drivers, typically younger drivers, are more likely to get into accidents, and women are proven to have fewer driving under the influence charges and fewer accidents overall. An approach that some automobile insurance companies use to price insurance is to evaluate an individual's credit score. Individuals with good credit history tend to have safer driving habits and will get into less accidents. As a result, insurance companies will charge individuals a higher premium if they have consistent late credit payments or a low credit score ("What Determines The Price Of My Auto Insurance Policy?").

The factors that I deem most important are age, driving record, credit score, and make and model of car. Age, credit score, and driving record mark the characteristics of an individual which will vary from person to person. However, the make and model of the car pertain to the vehicle and will become an important consideration with autonomous vehicles. If vehicles have the option for individuals to drive when needed, factors such as age, credit score, and driving record will still be necessary and relevant when pricing insurance. But in the case of a technological malfunction, the make and model of the car is essential as this can significantly vary the value of the claim. The role of these factors will be utilized in Generalized Linear Modeling, which is explained in Chapter 6.

Premium Calculations

For an automobile insurance policy, the policyholder must pay premiums to the insurance companies to guarantee coverage for the vehicle if an accident or vehicle-related incident. Based on a series of factors discussed in the previous section, insurance companies must set a premium for a policyholder to guarantee they will have the financial means of covering the cost of claims and generate a profit. The commonly predicted trend is a decrease in frequency and increase in severity of accidents. With the introduction of self-driving cars and advanced technology, frequency of accidents is predicted to decline by 80% (Bin-Nun et al.). But severity will increase as parts, software, and hardware will become more expensive to replace and repair, and specialized expertise is needed. Frequency and severity are calculated by the equations shown below:

Equation 1 Frequemcy Formula (Source: Werner et al.)

$$Frequency = \frac{Number\ of\ Claims}{Number\ of\ Exposures}$$

Equation 2 Severity Formula (Source: Werner et al.)

$$Severity = \frac{Losses}{Number\ of\ Claims}$$

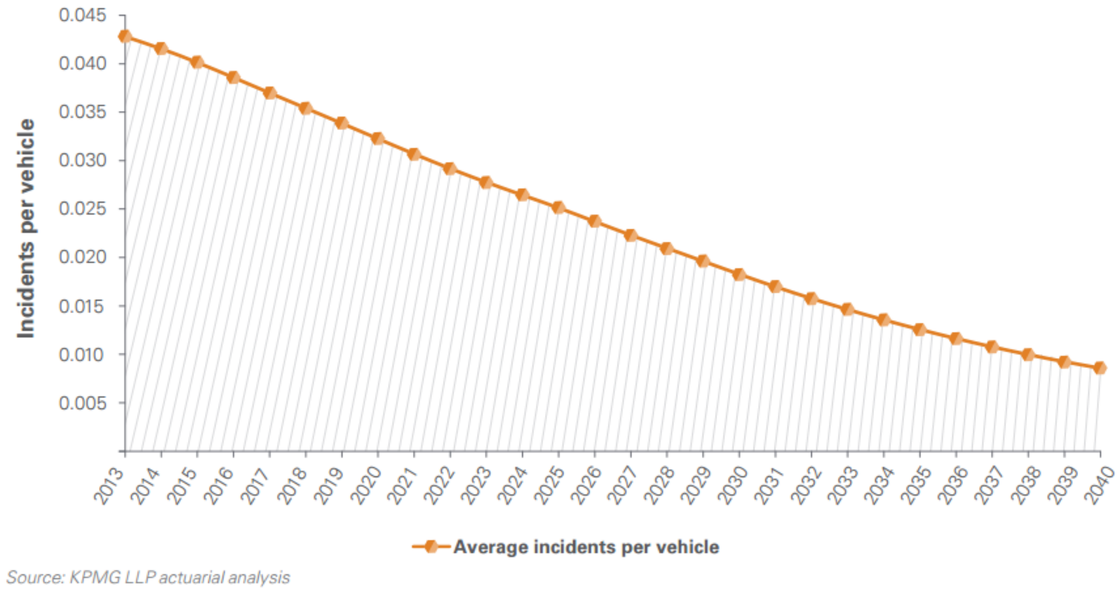

Figure 5 Accident Frquency per vehicle per year (Source: Bin-Nun et al.)

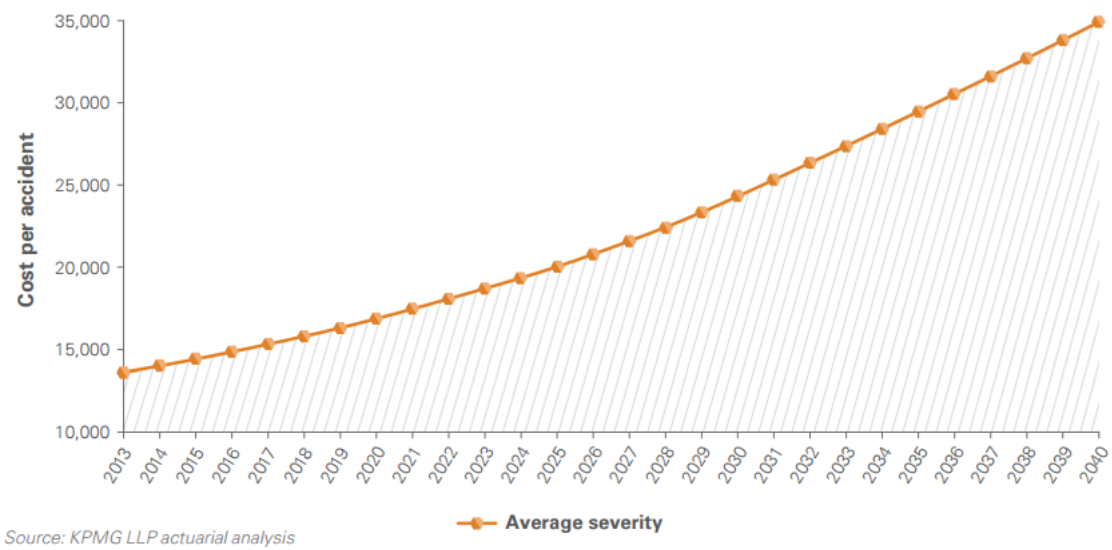

Figure 6 Severity per accident (Source: Bin-Nun et al.)

These formulas and future trends for frequency and severity make sense intuitively. The number of claims will decrease with the reduced likelihood of accidents with little to no change in the number of exposures. Therefore, frequency will continue to exponentially decrease as shown in Figure 5. The average size of losses will continue to increase regardless of the number of claims that are filed. With costlier losses, severity will steadily increase as shown in Figure 6.

Traditionally, insurers have taken frequency and severity into account to assess losses in order to estimate the premium for an individual. Deloitte University Press has provided the conventional formula that insurers have used to calculate premium.

Equation 3 (Source: Werner et al.)

$$Premiums = Losses + Loss\ Adjustment\ Expenses + Underwriting\ Expenses + Undewriting\ Profit$$

Losses are comprised of two separate components. Paid losses are losses that have already been paid out to claimants. Case reserves are losses for a claim that have been reported and filed as a claim, but have not yet been paid. Together, the sum of the paid loss and case reserve is known as the reported loss. Sometimes, the reported loss needs to be readjusted due to inaccurate valuations of the amount of the case reserve. Loss adjustment expenses (LAE) are the expenses associated with settling claims. LAE is comprised of allocated loss adjustment expenses (ALAE), which are costs associated with claims, and unallocated loss adjustment expenses (ULAE), which are costs that are not directly associated with claims such as general and other administrative expenses. Losses and LAE comprise the largest component of expenses for insurance companies (Werner et al.). These expenses will continue to exist as long as policyholders continue to file claims. The most challenging aspect for insurers is to set enough aside to cover the costs of increasing losses and LAE accompanied by the entrance of autonomous vehicles.

Underwriting expenses are often classified into four separate categories: commission and brokerage fees, taxes and license fees, acquisition fees, and other general expenses. Each of these expenses can be also broken down into fixed and variable expenses based on the size of risk and varying levels of premium. In order for insurance companies to actually generate a profit, they need to generate enough underwriting profit, which is the net revenue associated with policies. Alternatively, insurers are also able to increase returns through investment income on policyholders' funds. Insurers can invest these funds to pay for claims that have not yet been settled. For lines of businesses such as personal automobile insurance in which there is a short time frame between premium payments and claim settlements, investment income may not be a profitable venue for insurers. However, for long-tailed lines of businesses such as bodily injury and commercial general liability in which the time frame between premium payments and claim settlements may take years, investment income can accumulate with interest over a longer time period. (Werner et al.).

Setting Premiums

I created a hypothetical prediction of what premium levels should look like in the future as shown in Figure 7. I utilized the DMV's average annual premium for a single male in California who drives 12,000 to 15,000 miles a year with 9-15 years of driving experience and one traffic violation ("Average Car Insurance Rates"). I used this premium of $929.74 as my starting point for 2016. I assume that insurance companies will keep premiums level for the next decade or so to incentivize consumers to try self-driving vehicles since it is still in the developmental stage. Over time, premiums should actually decrease as the decline in frequency of accidents outweighs the increasing severity. Premiums will eventually level out after a certain point as insurers will need to maintain a consistent baseline to generate enough profit to cover losses.

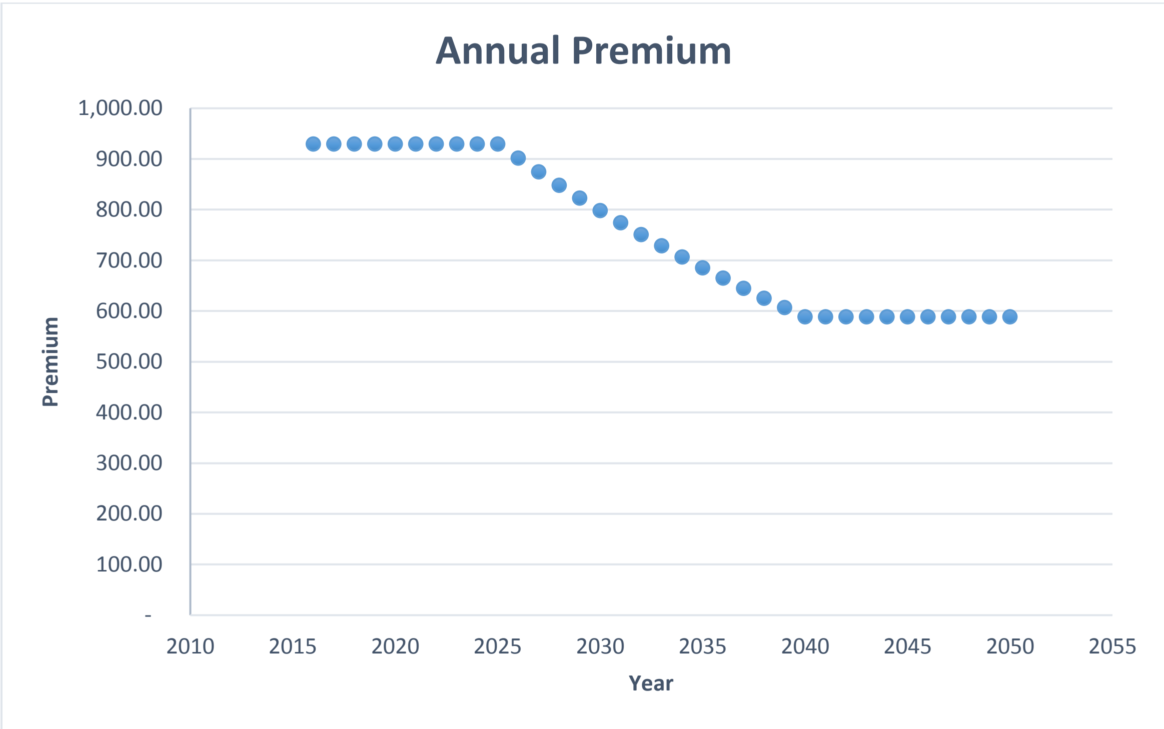

Figure 7 Predicted Annual Premium Trends

This model is a basic representation that I have created for an individual policyholder who pays annual premiums for his or her own vehicle. This is an important distinction as I have assumed that this is the risk for a policyholder who can also have full control over his or her autonomous vehicle when necessary. That is why it is important to determine who is at fault in an accident, the driver or the vehicle. I foresee that many consumers will be cautious of letting the vehicle have full control on the road. With the option of some autonomy over their car, they are more likely to trust this technology and physically drive the car themselves on some occasions.

But when the autonomous features of the vehicle are implemented, and there is a clear malfunction in the vehicle, the risk and liability are transferred to the manufacturers and developers of the vehicle and its technology. Manufacturers and/or software developers will have to purchase insurance and pay premiums to protect against technical failures. These losses can be pooled for similar types of vehicles. For instance, manufacturers that produce autonomous trucks that can seat up to five passengers that are similar models and have comparable technological capabilities may be charged similar premiums. The manufacturer is liable for any expenses that is the result of a defect or malfunction in the vehicle software or hardware. Essentially, individuals may still continue to purchase personal auto insurance, but manufacturers will need to purchase commercial insurance to protect against liability. This will be a new expense for manufacturers, and insurance companies will have to pay out more expensive claims to cover damages. Software and hardware developers may need to purchase cyber insurance as a result to protect against hacking and technical failures. This will increase costs for manufacturers, developers, and insurers over the next few years until autonomous vehicles become a more conventional form of transportation, and costs will drop.

The Future of Premiums

I believe that premiums should remain level in the short to medium term for consumers who decide to purchase self-driving cars. Even with declining frequency of accidents, individual claims will be costlier for insurers, so this may come as a loss in the short term. However, the transition to fully autonomous vehicles will be a tough shift since many individuals are hesitant to purchase autonomous vehicles for a variety of personal reasons, the biggest reason being the issue of safety. Most consumers are unwilling to give up their dependable vehicle for an overpriced machine that is run through wires and chips. To make this transition easier, insurance companies can charge the same premiums they do for that individual's current policy. Therefore, there will be no significant increase in expense for the customer besides the purchase of the vehicle. They also may be more willing to test a self-driving car to experience the reality for themselves.

For insurers, this could ultimately be a profitable venue as well even if it may not occur in the short term. Insurers may have to absorb some of the loss for the first few years to gain the trust of its customers. I believe that in the long run, the effects of decreased frequency and increased severity will cancel each other out. The reduction in frequency may even ultimately outweigh the increased severity, resulting in cheaper premiums in the long term. Insurers primarily generate profit from the premiums paid by their policyholders. However, if insurers are absorbing this loss, they may not be generating profit and could be facing increased expenditures they are unable to afford. In this case, reinsurance is a possible solution. Just as they are used in large catastrophic losses, reinsurance can be used for large correlated losses such as an accident involving multiple autonomous vehicles. This will alleviate some of the financial burden from the primary insurer and can transfer some of the risk to the reinsurer. Such an option can be extremely beneficial for smaller insurance companies who may not have the financial means to cover increasing costs.

With cutting edge technology, autonomous vehicles will become more and more vulnerable to cyber-attacks and hacking. According to Travelers, the average cost of resolving a data breach is around $7 million. This can be a significant loss for insurers that they have not had to account for previously, which is why it may be important for automobile insurers to insure cyber risk by forming partnerships with other insurance companies that offer cyber insurance. Cyber insurance can provide coverage for lost data and information, which is necessary for consumers who may have their smart phones and tablets linked to their vehicle. This can allow hackers to access private information such as location of their vehicle and even bank account information. Cyber insurers will also inform and advise customers of a breach and evaluate the scope of the breach to determine necessary further actions (Travelers). The threat of a cyber-attack is a realistic and impending threat that many consumers will be concerned about. By addressing these concerns, this is the first step in gaining the confidence and trust of the consumers and prevent catastrophic losses for insurers.

I doubt that vehicles will ever become fully autonomous aka vehicles with no steering wheel, gas pedal, or brakes. In the case of an imminent incident, the ability to gain control over the vehicle for that split second may make the difference. This may save lives on the road and save money for insurers who will have less claims to pay out. But until such technology is perfected and proven safe, consumers will be less willing to expose themselves to such dangers.

Chapter 6

Claims

Since there is no data to model how claims will change with autonomous vehicles, it is unclear how much more insurers will have to pay out. Frequency of claims for driver liability and automobile damages will decline as technology advancements continue to reduce the risk of human error. Severity of physical damage claims will increase in the short term as repairs become more expensive and complex but will gradually decline in the long term with the increased adoption of self-driving cars. For driver liability claims, severity is expected to steadily increase with increasing costs due to medical inflation. When claims for driver liability and physical damages are combined, overall severity is projected to decrease due to significant advancements in collision-prevention capabilities (Matley et al). These concepts apply to shared autonomous vehicles as well through commercial automobile policies. As self-driving cars flourish in the automobile industry, “vehicles may be cheaper and more utilitarian” (Matley et al.).

Below, I have predicted claim trends for insurers. In the short term, frequency of claims will not decrease significantly as the primary vehicles of choice are driver-driven vehicles. Severity will also increase, leading to more expensive claims for insurers. I have used information from The Insurance Information Institute based on average auto liability for physical damages and bodily injury claim costs in 2015. I used this as the starting value for my prediction ("Auto Insurance").

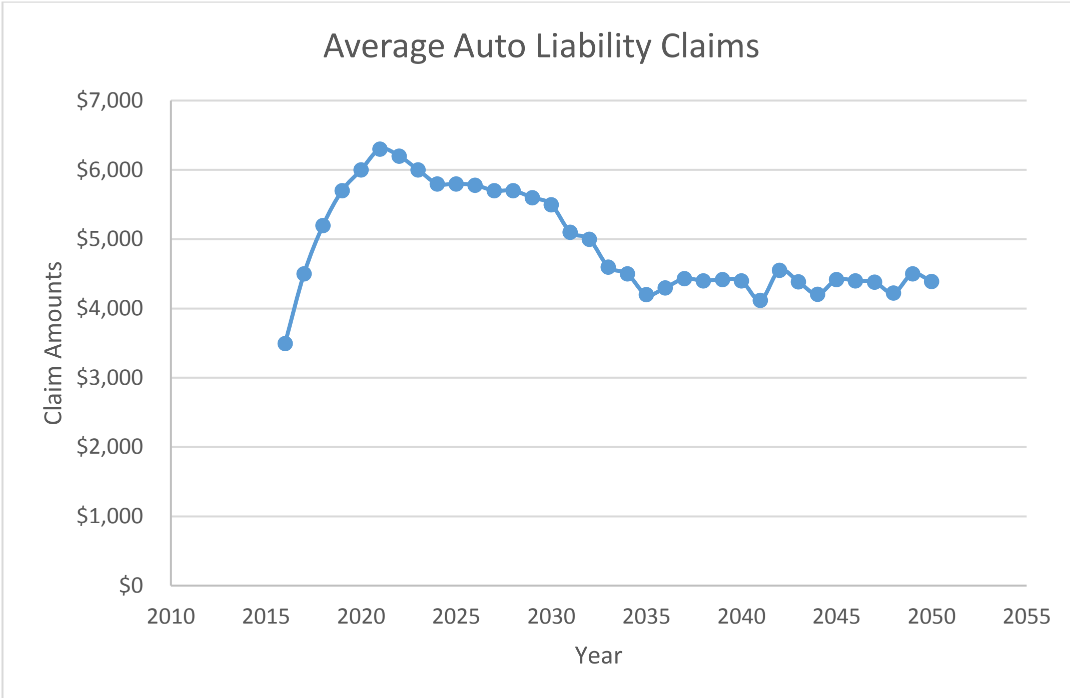

Figure 8 Average Project Auto Liability Claims for Physical Damages

For auto liability claims, I started with an average claim of $3,493 in 2015. I projected upwards at a rate between 1.1% and 1.3% for the next five years to illustrate increasing expenditures associated with repairs and maintenance for autonomous vehicles and pricier claims as a result. I projected a slight decline, around 2% per year, in claims costs starting around 2020. I contributed this to the fact that in a decade or so, manufacturers will begin to find cost-alternative and cheaper products and subsequent cheaper repairs. There is also a more noticeable decline in claims costs starting around 2030 since I took into consideration the shift into era 2, the adoption of autonomous vehicles as a more mainstream option for consumers. With the increasing presence of autonomous vehicles, I projected expenses will progressively decrease around 2% annually with the increased adoption of self-driving cars. Claims will remain relatively stable after 2030 as losses will begin to follow a consistent pattern, and insurers will have more information to model claims.

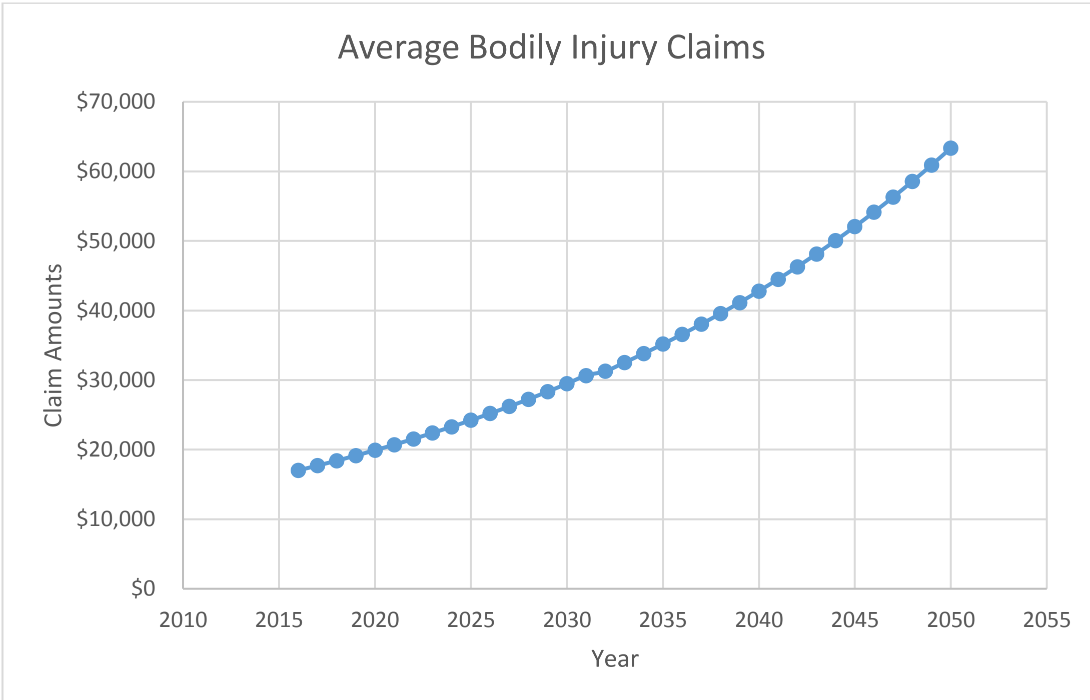

Figure 9 Average Projected Bodily Injury Claims

For average bodily injury claims, I started with an average claim value of $17,024 in 2015. Assuming a continually increasing medical inflation rate, I have assumed rates will continue to increase at a steady rate of 4% as that appears to be the trend from the past year (U.S. Bureau of Labor Statistics). Therefore, average bodily injury claims will increase by the same rate for the next few decades. It is unclear if this trend will continue, but I used a consistent rate of 4% to depict increasing medical costs.

I have used these two examples to detect how claims, more specifically auto liability and bodily injury claims, for autonomous vehicles will vary over the next few decades. However, the first step in the claims process is to determine how much claims will be in the case of an accident or vehicle-related incident.

Generalized Linear Modeling

Generalized linear modeling is a common model that insurers have used to set reasonable rates for different insurance policies. However, this model can become complex, so I will utilize a basic model for the purpose of my thesis. Generalized linear modeling or GLM is a method of modeling the relationship between the predictor variable and singular or multiple explanatory variables. In statistics, this is similar to the concept of multiple linear regression in which variable *y* is estimated based upon multiple values of x. The predictor variable, also known as the target variable, is denoted as *y* and can represent claim count, claim severity, pure premium, or loss ratio. The explanatory variables are represented as $x_1 \ldots x_n$ where n represents the number of explanatory variables in the corresponding model. These variables often represent policyholder and vehicle characteristics that are utilized in pricing insurance such as age of policyholder and make and model of vehicle just to name a few (Goldburd et al.).

The target variable is comprised of a systematic and random component. The systematic component is the proportion of variation that is driven by the predictors in the model. For example, if the predictor, a target variable, is the frequency of the claims and the explanatory variable is the age of the driver, the systematic component would be the relationship between the age of the driver and the frequency of the claim. The random component is the proportion of variation that is driven by factors not included in the model. This is the randomness that is unaccounted for in the model. For example, if age is unaccounted for in the model, this comprises a portion of the random component of the model. In a sense, this component is comparable to the error term in a typical linear equation as it accounts for a differentiation that is not represented in the equation (Goldburd et al.).

Equation 4 (Source: (Goldburd et al.)

$$g(\mu_i) = B_0 + B_1 x_{i1} + B_{12} x_{i2} + \cdots + B_{p1} x_{ip}$$

Equation 4 represents that a transformation of μ, represented by $g(\mu_i)$ is the sum of the intercept (B_0) and a combination of predictors and their respective coefficients. This depicts the relationship between the prediction and the predictors. However, in insurance, it is beneficial to use the natural log function instead, g(x)=ln(x). This results in a multiplicative rating structure. When the natural log function is applied, the following equation is obtained:

Equation 5 (Source: (Goldburd et al.)

$$ln(\mu) = B_0 + B_1 x_{i1} + B_{12} x_{i2} + \cdots + B_{p1} x_{ip}$$

Then, the exponential function is applied to both sides of the equation.

Equation 6 (Source: (Goldburd et al.)

$$\mu_i = \exp(B_0 + B_1 x_{i1} + B_{12} x_{i2} + \cdots + B_{p1} x_{ip})$$

Equation 7 (Source: (Goldburd et al.)

$$\mu_i = e^{B_0} \times e^{B_1 x_{i1}} \times e^{B_2 x_{i2}} \times \ldots \times e^{B_p x_{ip}}$$

This results in the multiplicative model insurers typically use when setting rates. These models are beneficial because it is a simplistic model that always warrants positive premiums.

Intuitively, this models makes the most sense for insurers when pricing insurance (Goldburd et al.).

Now I will construct a simplistic example to provide a better understanding of how generalized linear modeling works in a practical example that I have based off an example from Goldburd et al. I wanted to estimate the severity of 1,000 claims based on loss amounts using the variables age, driving record, credit score, and make and model of car. I have created the values for the following coefficients as most insurers run this data through software that provides the coefficient values. Since I do not have access to this information, I am using made up values for the coefficients. For the values of x, x_1 corresponds to age, x_2 corresponds to driving record, and so forth. For x_1, drivers who are younger than the age of 30 or over the age of 60 tend to be worse drivers and will need to pay higher premiums. I have divided up drivers by age groups as shown below:

Table 1 Distribution of X_i for Age

Age	X_i
Age < 30	Min (30 – Age, 10)
30 < Age < 65	0
Age > 65	Min (Age – 65, 10)

For individuals, younger than 30 or older than 65, I used the minimum value between the difference in ages and 10. So if an individual, is 16, the value of x_i would be 10. Therefore, individuals between the ages or 16 and 20 would be charged the same premium. For this example, I chose a 21-year-old driver, which means x_1=9.

For x_2, I used x_2=1 if the driver has a bad driving record, x_2=0 if the driver has a good driving record. This is subjective based on the number of accidents. For this example, if the driver has been in more than 3 accidents in the last 2 years where he or she is at fault, then they would get a value of 1. Credit scores can range anywhere from 200-700. A higher credit correlates with safer driving behavior and lower premiums.

For make and model of the vehicle, it becomes more complicated. Insurers typically use auto symbols that represent the make and model of the car, which they then input into the equation. They typically use a software that can match the symbol with the type of vehicle. Typically, cars with higher rating symbols have higher premium values. These vehicles may have higher repair costs and are more appealing to thieves (ISO). For this example, I chose 6 to represent a traditional large car provided by a Polk Segmentation Code that utilizes predictive modeling to estimate the value of the car based on certain vehicle characteristics (Boison). I want to reiterate that these are purely hypothetical values and not based on insurer data.

Table 2 Generalized Linear Modeling Example

Parameter	X_i	Domain	Coefficient
Intercept (B_0)	N/A	N/A	5.4
Coefficient: Age (B_1)	9	(20-70)	0.3
Coefficient: Driving Record (B_2)	1	(0,1)	0.8
Coefficient: Credit Score (B_3)	600	(200-700)	-0.01
Coefficient: Make and Model (B_4)	6	(1-10)	0.9

Coefficients that are closer to the absolute value of 1, represent a stronger relationship between the coefficient and the target variable, which in this case is the severity of 1,000 claims.

For example, driving record has a coefficient value of 0.8, which means that an individual that has more accidents on their record is more likely to have higher severity claims. There is a weaker relationship between age and severity of claims, but the negative correlation shows that younger people tend to get into more accidents, and therefore will have higher severity of claims. The auto symbol 6 represents a traditional large vehicle, and these vehicles are expected to have higher severity of claims since repairs will be more expensive, which is represented by its coefficient 0.9.

Using Equation 6 or 7 given earlier in this chapter, we can predict the mean severity for the 21-year-old driver.

$$\mu_i = \exp(5.4 + \ 9(0.3) + 1(0.8) - 600(0.01) + 6(0.9)) = \ \$4023.87$$

This is a tentative model that can be used for self-driving vehicles. Unfortunately, these computations are not this simple in real life. These rating models are likely to change as insurers utilize new ratings methods to adapt to changes in frequency and severity of accidents. Not all insurers utilize the same methods of ratemaking, and it is difficult to say how ratemaking structures will change with this new information.

In an accident, it is important to distinguish who is at fault, the driver or the vehicle to avoid possibilities of fraud. There needs to be a precise and accurate method of identifying and reporting the cause of damage. Devices similar to black boxes with high performance functions that can pinpoint the source of failure can increase accuracy and efficiency of filing claims. Self-driving cars have an assortment of sensors that can evaluate an extensive amount of information in the case of an accident, determining who was controlling the vehicle at the time of the accident. This is especially important for manufacturers who may be blamed for product malfunction even if the driver was at fault. Insurance companies estimate that between 13% and 17% are fraudulent, which has cost insurers around $6 billion annually (Matley et al.).

Another issue insurers are beginning to encounter is the method of reporting claims for ride-sharing service companies. Claims can now be filed by the vehicle owner aka the ride-sharing service company and not the driver of the vehicle in an accident. Because owners of the vehicle can now file claims, the driver does not need to report the accident at the scene, which will complicate matters for insurance companies. This will increase the time and cost to process the claim as insurers will have to work through the events at the scene of the accident since it may not be reported on-site (Matley et al.). This has both positive and negative implications for insurance companies. Insurers will need to ensure claims are reported, filed, and processed in an efficient manner. A more efficient and precise process will reduce faulty claims and the costs associated with those claims. However, insurers will face higher costs as they will have to retrospectively examine an accident if it is not reported right away.

Chapter 7

Underwriting

There is insufficient data to underwrite new risks associated with self-driving cars so insurers will need to evaluate existing data to predict future trends. Usage based policies are extremely common in which telematics devices, which are similar to black boxes and are used to track an individual’s driving habits. Insurers can then use that information to relate a driver’s behavior to the probability of loss (Matley et al.) However, most of that information is no longer applicable as such data only examines the correlation between driver performance and loss but not between software and hardware functionality and loss.

Underwriters will need to develop technical backgrounds in order to implement new measures of underwriting risks associated with the mechanical failure. There are a variety of prototypes for hardware and software mechanisms, but there is no set standard that these models need to follow. These components may have different performance proficiencies and expected lifetimes and failure rates. Different autonomous vehicles will also have distinctive competencies, varying in degree of complexity. They can be vulnerable to cyber-attacks and hacking, which could threaten the security of the vehicle and components of the vehicle. To address these risks, underwriters need to build new models that focus on these cyber security (Matley et al.).

I foresee that underwriting expenses will increase in the near future as well as losses and Loss Adjustment Expenses (LAE) with higher claims. Underwriters will need additional expertise to price autonomous vehicles as new factors come into play. This may require additional research and data mining to generate the most accurate predictions and create new models that encompass all possible scenarios. Big insurance companies have larger customer bases, and more data and will be at the forefront of this movement. They will set the precedents for smaller insurance companies who can use this information to price their products. In order for insurance companies to generate a profit, the underwriting profit must exceed the sum of their expected loss and other expenses. Keeping these thoughts in mind, it is important for insurers to continue to utilize other lines of business to generate revenue as personal line auto insurance for driver-driven vehicles begin to phase out.

Connectivity of autonomous vehicles can prove to be an essential asset for underwriters. These vehicles can provide massive amounts of data for underwriters, which will help to price policies and set rates (Fastenrath and Keller). This data will be beneficial for smaller insurers as well who do not have the customer base to produce such an extensive amount of data. It is unclear when autonomous vehicles will be available on the market for consumers. Even after autonomous vehicles enter the market, they may not be a preferential form of transportation for another decade. Underwriters will therefore need a means of evaluating risk prior to the entrance of self-driving cars in the market, which will be a difficult task with the lack of information available.

Chapter 8

Preparing for the Revolution

As autonomous vehicles begin to transform the automobile insurance industry, insurers will need to restructure their business models to account for different scenarios. New information will be available for insurers that can pinpoint “where, how, and when a vehicle is being driven” (Matley et al.). By evaluating these elements, insurers can then use this information to assess the impact on their profits and estimate potential costs. The process of collecting and analyzing data, and pricing reasonable plans is challenging and costly. Insurers will need to remain flexible and adapt to imminent changes in order to remain competitive in the industry and keep up with changing trends. Insurers will need to understand complex data to understand how to underwrite the risk and determine potential correlations with losses (Matley et al.).

It is necessary for automobile insurers to establish relationships and form partnerships with businesses they will be working with in the future. The advancement of technology has provided an interconnectedness that will bring together different sectors of the industry. By assimilating automobile manufacturers, software developers, and mobility management providers, insurers can “leverage partnerships to gain broader and more diversified access” (Matley et al.). Automobile manufacturers may need to purchase insurance to protect against losses due to technical failures and even potential lawsuits associated with such failures. Software and hardware developers may also encounter the same problems and will face large losses if not insured. In Chapter 5, I also discussed the possibility of forming partnerships with reinsurance companies and cyber insurance companies. Reinsurance will primarily help smaller insurers who may not have the fiscal means of absorbing larger losses associated with higher claims.

With the changing automobile industry, insurers will need to continue to innovate to establish a competitive advantage over their peers. They will need to streamline existing business models and product and service portfolios (Matley et al.). However, the most prevalent issue lies within the willingness of consumers to purchase self-driving cars. Generation Y, individuals born between 1977 and 1994, is currently the largest customer segment for businesses since the Baby Boomers. This is the generation that “crave connectivity and convenience, and frequently base their transportation decisions on overall cost and the quality of their customer experience” (Giffi et al.). Insurers need to target this consumer segment as they will be the ones purchasing insurance policies for their vehicles. The presence of Generation Y is growing in the workforce, and with higher purchasing power, they are more likely to purchase vehicles. In fact, a study conducted by Deloitte shows that around 80% of Generation Y will purchase a vehicle in the next few years (Giffi et al.).

This is an important consideration for manufacturers as costs for building and maintaining self-driving vehicles will not be cheap. However, if these cars can prove to be efficient and tailored to the needs of the customers, this can reduce the need for more vehicles in the household. For instance, a self-driving car can pick up a child from school, drive home, and drive back to pick up another family member from work. With fewer vehicles, they can reduce insurance and maintenance costs, which will be more cost-effective option in the long run. If autonomous vehicles can provide the desired comfort, safety, and convenience, individuals would be more likely to purchase their own self-driving car. Customers will also be unlikely to pay a much higher premium that exceeds their budget. Insurers will need to take note of this to ensure they are still generating a consistent revenue stream, retaining business, and growing their customer base. Insurers will need to cater to both individuals and businesses to provide affordable prices and adequate coverage.

With the rising popularity of ride-sharing services, 42% of Generation Y prefer to use ride-sharing services as long as such amenities are convenient and available. Such services enable individuals to use this extra time to stay connected amongst their peers and complete tasks during rides (Giffi et al.). The appeal of such a tradeoff has spurred the popularity of ride-sharing services, which has in turn prompted the testing of autonomous ride-sharing services. The first step to acceptance of autonomous vehicles is to prove that autonomous vehicles are safe. As shown in Figure 10, BCG concluded that drivers' primary concerns are that they don't feel safe in a car that drives itself, don't have control over the vehicle, and don't want to get in an accident in the chance of a hardware or software malfunction.

Figure 10 Concerns About the Safety of SDVs Are a Significant Hurdle (Source: BCG)

The best way to address these concerns is for individuals to experience a self-driving car for themselves. Individuals can utilize these services for a reduced price provided curtesy of Uber, and there is a driver in the car at all times in case there is a glitch or failure (Chafkin). "Digital tools have changed the way people meet, access knowledge, and navigate—all built upon networks, sensors, mobile communication, and real-time information" (Claudel and Ratti). These self-driving vehicles can quickly evaluate traffic conditions and determine the shortest and quickest route from Point A to Point B and save time and money for customers (Corwin et al., 2015). Once more research is conducted and can prove that self-driving vehicles are indeed safer, more individuals will be likely to experience or purchase a self-driving car.

Chapter 9

Conclusion

No one is sure what the future state of mobility will look like, even insurers. With the lack of data and information, a lot of the hypotheses are purely speculation. It will be difficult to assess the situation until autonomous vehicles officially enter the market and transition into a mainstream mode of transportation. There is no accurate way of pricing insurance that can accurately predict losses and claims until we have more data. This will change with time as more data becomes available, and insurers will have a more suitable model to set rates. This paper seeks to evaluate how insurance will change based on predictions from actuaries and professionals within the insurance industry and my own hypotheses. However, this is speculation from both ends, and no one really knows what the impact until autonomous vehicle officially take on the road.

Appendix A

Private Passenger Auto Insurance Losses, 2006-2015 (Source: "Auto Insurance")

	Liability			
	Bodily injury (2)		Property damage (3)	
Year	Claim frequency (4)	Claim severity (5), (6)	Claim frequency (4)	Claim severity (5), (6)
2006	0.98	$12,907	3.40	$2,796
2007	0.90	13,361	3.46	2,847
2008	0.91	14,067	3.42	2,903
2009	0.89	13,891	3.49	2,869
2010	0.91	14,406	3.53	2,881
2011	0.92	14,848	3.56	2,958
2012	0.95	14,690	3.50	3,073
2013	0.95	15,441	3.55	3,231
2014	0.87	16,640	3.66	3,290
2015	0.91	17,024	3.73	3,493
	Physical damage (7)			
	Collision		Comprehensive (8)	
Year	Claim frequency (4)	Claim severity (5)	Claim frequency (4)	Claim severity (5)
2006	4.87	$3,194	2.40	$1,528
2007	5.20	3,109	2.48	1,524
2008	5.35	3,005	2.57	1,551
2009	5.48	2,869	2.75	1,389
2010	5.69	2,778	2.62	1,476
2011	5.75	2,861	2.79	1,490
2012	5.57	2,950	2.62	1,585
2013	5.71	3,144	2.57	1,621
2014	5.95	3,161	2.80	1,567
2015	6.05	3,350	2.73	1,671

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Maastricht University (Maastricht, Netherlands) **June-July 2014**

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Actuarial Examinations

- Exam P/1- Passed **Jan 2015**
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- VEE Finance Certified

Work Experience

Deloitte Consulting LLP (Chicago, Il) **June 2016- August 2016**
Human Capital Summer Scholar

- Examine various public pensions plans by analyzing differences in COLA and DROP provision plans and Social Security benefits
- Draft annual Schedule SB forms to adhere to government regulation
- Streamline valuation by converting processes from Qbasic to Excel to restructure system of estimating paid sick time obligation
- Prepare sensitivity tool for client to estimate pension expenses
- Create model decks for different lines of business for Property Casualty insurers

Hampton Consulting (Washington Crossing, PA) **June 2015- Sep. 2015**
Financial and Underwriting Analyst Intern

- Completed monthly transactions for hourly benefit program for home care clients
- Processed hours by applying accounting algorithms to accommodate for discrepancies between payroll and time and attendance systems
- Accommodated various analytical tasks such as reviewing CRM platforms, compiling target leads lists and preforming some pre sales activities

Leadership Experience

Homecoming Finance Director **November 2015-November 2016**

- Create and maintain an operating budget of $200,000 for Homecoming
- Plan and coordinate all local and alternative fundraising events
- Oversee 6 Finance Captains to organize fundraisers and manage budget and transactions

Homecoming Donor Relations Captain **February 2015-October 2015**

- Secure food, drink, and monetary donations from sponsors
- Create timelines for events and coordinate pick-ups and drop-offs of donations

Relay For Life Fundraising (Specialty Event) Captain **October 2014-April 2015**

- Execute and plan fundraising events throughout the year including Date Auction and Mr. Think Pink to provide support to families with Cancer
- Generate new fundraising means to raise $111,000 for American Cancer Society