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Car Insurance Rate-making with an eye toward the future

By: Stephen Howard
Introduction

The insurance industry has been undergoing many changes lately. There are many types of insurance. I will focus solely on car insurance. It is quite possible that car insurance is on the verge of a major overhaul. The car insurance industry is likely to undergo these major changes in the upcoming decades. This paper seeks to outline what they may be, along with suggestions for the industry on how to move forward. With the advent of driverless cars, we may see a total reshaping of the industry. This is likely to occur in the next 15-20 years. I will give a summary of the prevailing speculations. I will also cover how car insurance rates are calculated, and how this may change as the industry changes.

This will be very applicable to my future work as an actuary. Actuaries are businesspeople who primarily work for insurance companies. Actuaries will typically work for life and health insurance companies, as well as property and casualty insurance companies. Property and casualty insurance companies, such as Nationwide Insurance, are where actuaries will set the rates for car insurance. There are differing opinions as to how the likely change in driving habits will affect property and casualty actuaries, although there seems to be broad agreement that some change is coming.

Driverless Cars

Before analyzing the various opinions surrounding the future of the insurance industry, I will first give a background on the expected timeline of driverless cars. There are varying opinions, but most projections have driverless cars becoming mainstream sometime in the next decade. There are numerous hurdles to clear before driverless cars become the norm, though. The main hurdle will be the transition away from “normal” cars. In order for driverless cars to really reach
their full potential, especially with safety, cars that are driven by humans may have to eventually be outlawed. It may seem extreme today, but I believe this is where the conversation may be headed within 15-20 years. This could, however, be an impediment to driverless cars becoming the norm. There is also some concern that the computer systems in driverless cars could be hacked, although it is unclear at this time whether that concern will manifest itself or not.

There have been numerous hypotheses as to what these changes will look like. Some speculators believe that individual car insurance policies will no longer be necessary. According to the CAS (Casualty Actuarial Society), a driver’s age, their gender, the car’s model year, and their accident history are all taken into account when writing an individual insurance policy. The rationale behind removing individual car insurance policies makes a lot of sense on its face. If individuals are no longer driving the car, should they be held responsible if it crashes? What follows, then, would be hypothesizing that the car companies will be liable for any vehicle malfunction. If this is the case, it could very well lead to a large reduction of demand for property and casualty actuaries. Instead of having millions of insurance policy-holders, there may be 8-10, or so, large companies with “umbrella” policies that cover all of the cars they have manufactured.

**Insurance Rates**

I will now give an overview of insurance rates. Before doing this, I must give definitions of common insurance terms. Exposure is the basic unit of risk that underlies an insurance premium. For example, one insured car is one unit of risk. Earned exposure is represent the portion of a policy that has been covered, while unearned exposure represents the portion of a policy that has not been covered. Written exposures = earned exposures + unearned exposures. The price the insurance consumer pays to the insurance company is known as a premium. This can vary based on the consumers history; in this case, driving history. An insurance claim is when the consumer
(referred to as the claimant) has undergone an event which causes them to “trigger” their insurance policy. Losses are what the insurance company pays to the claimant. In the actuarial community, claims and losses are sometimes used interchangeably. One final insurance term to consider is deductibles. Deductibles are what the policyholder is responsible to pay. If a policy has a deductible of 500 dollars, then on a claim of say, 1000 dollars, the consumer would be responsible for the first 500 dollars. Limits are the maximum amount the insurance policy will pay in the event of a claim. For car insurance policies, common limits are 100,000 dollars and 250,000 dollars. For further coverage on this topic, see “Basic Ratemaking”, by CAS (2016).

Insurance companies incur expenses besides those incurred when settling claims. These are called loss adjustment expenses (LAE), and can be broken up into allocated loss adjustment expenses (ALAE), and unallocated loss adjustment expenses (ULAE), with LAE = ALAE + ULAE. Outside legal services, which could be allocated to a specific claim, is an example of ALAE. Any expense that can’t be attributed to a specific case is an example of ULAE. When paying claims, insurance companies must also pay the underwriters. Insurance underwriters determine the risk of insuring a consumer. In addition to loss adjustment expenses, insurance companies also are responsible to pay taxes, commission, brokerage fees, and license fees. These are known as underwriting expenses.

According to the CAS, the “fundamental insurance equation” is price = cost + profit. The price, in this instance, is the premium paid to the insurance company. The cost of an insurance policy, from the perspective of the insurance company, is the sum of the losses and claim-related expenses, as the well as any other fees. Profit, in this instance, is defined as the difference between underwriting income and outflow.
There are some important insurance ratios that I will cover here. LAE Ratio is defined as the ratio of loss adjustment expenses to total losses. Severity is the ratio of the total loss amount to the number of claims (2,000,000 in 1,000 claims = 2,000). Frequency is defined as the ratio of the number of claims to the exposure amount. The retention ratio is the ratio of the number of policy renewals to the number of possible policy renewals.

**Data Aggregation Methods**

The rates consumers pay are calculated using rating algorithms. These algorithms take into account various factors. Most of the rules and regulations around these factors are included in a rating manual. There are four main methods of data aggregating for the length of a certain policy. These four methods are by calendar year, accident year, policy year, and report year. Only calendar year and policy year can be used when aggregating exposures. As explained before, exposure is the basic unit of risk insurance companies take on. According to the CAS, there are three criteria that a good exposure base should meet: “it should be directly proportional to expected loss, it should be practical, and it should consider any preexisting exposure base established within the industry.” Directly proportional to expected loss simply means that a policy with two exposures should have an expected loss that is twice that of a policy with only one exposure. A practical exposure base is simply one that is easy to obtain and verify. For further coverage on this topic, see “Basic Ratemaking”, by CAS (2016).
4.3 Example Policies

In this graph, the x-axis represents the dates, and the y-axis represents the percentage of the policy that has expired.

4.5 Policy Year Aggregation

In this graph, as in the one above, the x-axis represents the dates, and the y-axis represents the percentage of the policy that has expired. This graph is an example of policy year aggregation. A policy year aggregation would take into consideration any and all exposures during a given year. Because of this, the above graph utilizes parallelograms to show each time period of exposure the company looks at. PY stands for policy year.
4.4 Calendar Year Aggregation

The above graph is a representation of using the calendar year aggregation method. In the calendar year aggregation, the insurance company will look at exposures throughout the calendar year, without regard to when the policy was actually issued. Because of this, the above graph utilizes squares to show each year. CY stands for calendar year.

4.6 Calendar Year Written Exposures

In the above graph, we can see a breakdown of written exposures, or the total exposures from writing a policy. Since B, C, D, and E all have effective dates (large circles in the above graph) in calendar year 2011, their entire exposure would contribute their written exposure for calendar year 2011.
4.8 Policy Year Written Exposure

This graph shows the written exposure using the policy year method of aggregation. Because policy year does not use calendar years as cutoffs, this graph utilizes parallelograms to show policy year cutoffs.

4.14 In-Force Exposure

The above graph shows an example of in-force exposures. According to the CAS, “in-force exposures are the number of insured units that are exposed to having a claim at a given point in time.” Insured units are typically defined individually (i.e. if one policy covers 2 cars, there are 2 insured units).

It is worth mentioning that all of the above examples look at policies that are year-long. There are some types of policies whose lengths may differ slightly (i.e. one may be six months and
another may be two years. For further coverage on this topic, see “Basic Ratemaking”, by CAS (2016).

**Driverless Cars and Insurance**

Here I will begin to take an in-depth look at how driverless cars may impact the insurance industry. As mentioned earlier, there is some thought that car owners will not be held responsible for accidents when in a self-driving car. An article in Forbes from 2016 took an introductory look at this issue. They spoke to Marc Mayerson, a lawyer and professor at Georgetown University. Mayerson says, “In theory self-driving cars would not create negligence liability for the passenger/non-driver/owner of the car.” The article goes on to note that a large majority of the insurance bill consumers pay is liability coverage. Mayerson goes on to suggest that someday in the near future we may see car manufacturers foot the bill for liability coverage. The author notes that there will still be a need for insurance in case of theft, indicating that he believes car insurance will not be entirely up to the manufacturer.

The law firm of Aronberg, Aronberg, and Green also researched this issue. In their study, done in 2017, they gave an example that illustrates how insurance plans may change. Their first example is that of a young man, “To help illustrate the difference between insuring a normal driver and a self-driving car, consider the hypothetical case of John Smith, a single, 25-year-old male with 9 years of driving experience, 2 speeding tickets in the last 2 years, a claims history of $10,000, and a credit score of 750. Assume John drives a 2018 Auto ABC, drives 20 miles per day, and lives in zip code 01010.” They note that John’s age, gender, and speeding tickets will work against him when pricing his policy while driving an owner-operated vehicle. However, when John owns a driverless vehicle, these factors will not matter. They note that with these factors not taken into account, the focus will shift from insuring the driver to insuring the vehicle. They also
bring up an interesting point about DUIs. While operating a vehicle while intoxicated is illegal without question, would it remain this way with self-driving cars?

Another question to consider is how changes to the law may impact people’s ability to operate their vehicle. While people are able to drive their vehicles unimpeded now, it is possible, maybe even likely, that this will change in the next 15-20 years. An article on the website TechCrunch, written by Jay Samit in 2015, took a look at this issue. In the article, Samit reports that 1.2 million people around the globe are killed in auto accidents each year, with 33,000 Americans being killed in preventable auto accidents.

Samit makes the point that despite the advent of airbags, seatbelts, and other safety devices, human error has been, up to this point, impossible to account for. Driverless cars will be able to eliminate the impact of human error, thus making transportation safer for all. As Samit says, “Autonomous vehicles don’t drive drunk, don’t drive distracted, and don’t fall asleep at the wheel.”

Elon Musk, the founder and CEO of Tesla, made a good point when he said that “It would be like an elevator. They used to have elevator operators, and then we developed some simple circuitry to have elevators just automatically come to the floor that you’re at ... the car is going to be just like that.” Musk also notes, however, that with 2 billion drivers worldwide, a move like this could easily take 20 years (Verge 2015). While far from a certainty, I think one can see how human-operated vehicles could potentially become outlawed.

There is the possibility that the computer system in driverless cars could become hacked, which is a concern that has been raised by some. An article in the Guardian written in 2016 touched on this issue, and included an interview with Finnish security expert Mikko Hypponen. Back in
2015, a hacker admitted to taking control of some systems aboard a plane. Hypponen also agrees that eventually human-driven cars will be outlawed. While the issue of hacking has not gotten much attention, I believe this is a mistake, and something that should be investigated.

**Suggestions for Insurance Companies**

Here I will briefly give an overview of some of the suggestions that are commonly given as to how the insurance industry will be able to adjust to the coming reality of driverless cars. While these suggestions may not pan out, as of now, they are the best suggestions out there.

Amy Danise wrote an article in Forbes in 2016 titled “Driverless Cars May Herald ‘The End Of Auto Insurance’”. Danis writes about what certain insurance companies, such as State Farm, have already been doing to prepare for the coming availability of driverless cars. State Farm has considered (it’s not clear how seriously though) reinventing themselves as a life insurance company. To this end, they would try to keep close track of a person’s blood pressure, fitness habits, sleeping patterns, etc., and would then charge them based on these measurables. It is unclear how likely this is to develop. Danise says that State Farm sees a promising future in “life management” and “consumer analysis”, and are likely to continue pivoting that way.

Travelers Insurance has also been looking to possibly make some adjustments as the industry looks set for significant change. According to Danise, Travelers has “applied to patent a device that offers specific suggestions for managing errands and other travel.” This is designed to help consumers plan out their day, with an eye toward activities that may be riskier than they had previously thought.

Donald Light, a director of P&C insurance for Celent, does not believe that taking on new forms of insurance will be enough for companies to make up the difference. He says “There aren’t
other kinds of insurance lying in the street waiting to be written”. Unfortunately, however, it does not appear that many insurance companies have begun seriously looking at this issue. Thirty-two percent of auto insurance executives say that their company has done nothing to prepare for the possible upheaval of the car insurance industry, while twenty-three percent have little to no knowledge of driverless cars.

In my personal opinion, what will most likely happen is that people will have the option of buying insurance for things like theft and damage from falling trees or other natural causes. While some may forego buying insurance, it is likely that insurance companies will still be able to count on a sizable number of consumers in the future. It is also likely that most major insurance companies will have to reinvent themselves in some way to stay competitive.

**Conclusion**

The car insurance industry has had to deal with many changes in the past. However, I think there is reason to believe that the coming changes with driverless cars will upend the industry unlike anything seen in the last few decades. It will certainly be interesting to see how the industry adjusts, and what the job outlook is for actuaries in the future. I look forward to following these developments closely as I begin my career.


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