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Experience Rating Mechanisms in Auto Insurance

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Goal of Research

- Examine 2 experience-rating models and impacts for high risk / low risk / novice drivers.
 - Drivers are placed in a driving record class based on their history of at-fault claims experience.
- Is having more driving record classes better?



Research Questions

- Does having more driving record classes lead to
 - better matching of premiums with underlying risk?
 - lower premiums for novice drivers?
 - safer roads or more uninsured drivers?



Data

- In Alberta, Canada “low risk” drivers are priced on a 8 category experience rating model.
 - Differentials are set by firms, with little restriction except that riskier classes need to have higher differentials.
- “High risk” drivers are priced on 31+ step scale, called the ‘grid’.
 - Pricing is set by the government.
- Our data:
 - Premiums, losses, number of claims, and number of earned vehicles for high risk drivers on the grid and off the grid.
 - Premiums, losses, number of claims and number of earned vehicles for low risk drivers priced competitively, but placed in grid pricing categories.



Experience Rating for Off Grid Drivers

| Driving Record Class | Observed DR Class Differential for Urban Drivers |
|----------------------|--|
| Class 7 | 1.000 |
| Class 6 and 6* | 1.076 |
| Class 5 | 1.629 |
| Class 4 | 2.154 |
| Class 3 | 2.559 |
| Class 2 | 2.620 |
| Class 1 | 2.845 |
| Class 0 | 3.234 |

- Driving record class based on number of years of at-fault claims free driving.
 - Not-at-fault claims do not impact driving record.
- Typical framework:
 - Classes are 0, 1, ... and 7.
 - Class 7: 7 or more years of at-fault claims free driving.
 - An at-fault accident moves the driver from the current class to class zero.
 - At-fault claim for driver in class 7 moves driver to 6* class for 6 years.

Summary Data for Off Grid Drivers

| Driving Record Class | Number of Drivers | % of Population | 3 Year Average Claim Frequency | 3 Year Average Premium |
|----------------------|-------------------|-----------------|--------------------------------|------------------------|
| Class 7 | 2,395,978 | 42.07 | 2.75% | \$370.66 |
| Class 6 and 6* | 2,058,456 | 36.15 | 2.72% | \$365.88 |
| Class 5 | 275,162 | 4.83 | 4.56% | \$624.78 |
| Class 4 | 188,290 | 3.31 | 5.23% | \$852.05 |
| Class 3 | 286,788 | 5.04 | 6.65% | \$ 1,023.67 |
| Class 2 | 157,574 | 2.77 | 6.51% | \$ 1,039.29 |
| Class 1 | 194,527 | 3.42 | 8.13% | \$ 1,127.90 |
| Class 0 | 137,822 | 2.42 | 8.70% | \$ 1,277.33 |

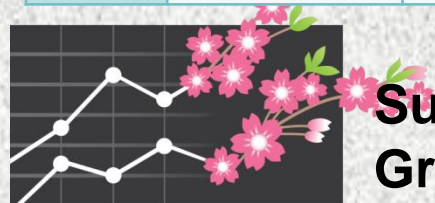


- 3 years of data for mandatory 3rd party liability for low risk drivers in 6 Alberta.

Experience Rating for High Risk Drivers in Alberta (On the “Grid”)

| | Claims Rated Scale | Surcharge / Discount | Claim? Move up: | | Claims Rated Scale | Surcharge / Discount | Claim? Move up: |
|-----------------|--------------------|----------------------|-----------------|------------------|--------------------|----------------------|-----------------|
| Discount Levels | -15 | 50% | 5 steps | Surcharge Levels | 1 | 10% | 5 steps |
| | -10 | 50% | 5 steps | | 2 | 20% | 5 steps |
| | -9 | 45% | 5 steps | | 3 | 30% | 5 steps |
| | -8 | 40% | 5 steps | | 4 | 40% | 5 steps |
| | -7 | 35% | 5 steps | | 5 | 50% | 5 steps |
| | -6 | 30% | 5 steps | | 6 | 65% | 5 steps |
| | -5 | 25% | 5 steps | | 7 | 80% | 5 steps |
| | -4 | 20% | 5 steps | | 8 | 95% | 5 steps |
| | -3 | 15% | 5 steps | | 9 | 110% | 5 steps |
| | -2 | 10% | 5 steps | | 10 | 125% | 5 steps |
| | -1 | 5% | 5 steps | | 11 | 170% | 5 steps |
| | 0 | 0 | 5 steps | | 12 | 193% | 5 steps |

| Grid Level | Number of Drivers | 3 Year Average Claim Frequency | 3 Year Average Premium | Grid Level | Number of Drivers | 3 Year Average Claim Frequency | 3 Year Average Premium |
|------------|-------------------|--------------------------------|------------------------|------------|-------------------|--------------------------------|------------------------|
| -15 | 4,264,775 | 3.56 | \$422.78 | -3 | 141,726 | 7.87 | \$1,065.79 |
| -14 | 180,810 | 4.95 | \$517.12 | -2 | 247,748 | 10.49 | \$1,190.64 |
| -13 | 189,030 | 5.02 | \$525.93 | -1 | 98,764 | 9.38 | \$1,134.78 |
| -12 | 208,674 | 5.29 | \$535.98 | 0 | 89,841 | 11.71 | \$1,252.79 |
| -11 | 233,121 | 5.38 | \$546.91 | 1 | 23,808 | 9.42 | \$1,330.65 |
| -10 | 234,267 | 5.81 | \$558.62 | 2 | 23,611 | 10.32 | \$1,488.88 |
| -9 | 158,502 | 5.95 | \$597.04 | 3 | 23,554 | 11.86 | \$1,623.00 |
| -8 | 152,458 | 6.18 | \$640.98 | 4 | 11,313 | 12.24 | \$1,592.80 |
| -7 | 145,873 | 6.37 | \$689.33 | 5 | 8,866 | 13.17 | \$1,686.86 |
| -6 | 142,675 | 6.51 | \$737.92 | 6 | 3,973 | 10.17 | \$1,673.17 |
| -5 | 142,493 | 7.13 | \$834.40 | 7 | 3,704 | 14.07 | \$1,844.56 |
| -4 | 137,705 | 7.29 | \$958.89 | 8 | 3,284 | 13.55 | \$1,979.85 |
| | | | | 9+ | 5,301 | 14.75 | \$2,388.64 |



Summary of Data by Driving Record Class Using Grid Steps

3 years of data for mandatory 3rd party liability for all drivers in Alberta.

Better Matching of Premiums to Risk

- Risk based pricing reduces adverse selection. When there are more risk classes, in theory there should be more homogeneity within each risk group and insurers should be able to more accurately price insurance
- Do more rate classes lead to a better matching of premiums to risk?
 - That is, is there less variation in loss ratios when there are more driving record classes?



Some Empirical Data

Average 6 Year Loss Ratio for Selected DR Classes

| DR Class | -15 | -10 | -5 | 0 | 5 | 10 | 15 |
|----------------|--------|--------|--------|--------|--------|--------|--------|
| Off Grid Risks | 49.48% | 68.58% | 65.54% | 71.40% | 64.93% | 58.23% | 51.97% |
| On Grid Risks | 61.08% | 75.22% | 54.90% | 74.38% | 80.13% | 43.88% | 10.09% |

Premiums for off grid risks are set using the 7 class scale.

C.V. of Loss Ratios across DR classes for On and Off Grid Risks

| Year | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|----------------|------|------|------|------|------|------|
| Off Grid Risks | 0.37 | 0.76 | 0.32 | 0.25 | 0.12 | 0.13 |
| On Grid Risks | 0.42 | 0.43 | 0.33 | 0.34 | 0.41 | 0.31 |

In 5 out of 6 years, (marginally) greater variability in loss ratios for on grid risks. No evidence that having more risk classes leads to better matching of premiums with underlying losses.



Experience Rating for Novice Drivers

- Most jurisdictions use some measure of experience rating in which the premium reflects driving history.
- Novice drivers do not have a driving record, and are often grouped with higher risk drivers.
 - This makes insurance very expensive for novice drivers (and was one of the justifications for the grid).
- From a public policy perspective, it is not evident that this is fair or desirable.
 - Having no information about driving ability is not the same as having no years of claims free driving.
- Does having more DR classes allow for better pricing model for novice drivers?



Approach

- Cannot use the empirical data to examine this as:
 - Grid prices are not set by marketplace.
 - Drivers on the grid are riskier than off grid drivers.
- Use a stochastic model to simulate movement through driving record classes.



Stochastic Model

- Based on historical data, we assume an average claims cost per earned vehicle of \$400, develop premiums using differentials / claims rated scales for both the 8 class system and the grid system.
- Insurer writes portfolio of uncorrelated risks.
 - We simulate a model with 10,000 independent drivers.
- Accident rate and distribution of drivers by DR class from Alberta is used to build an empirical distribution of drivers risk types.
 - Use 8 step data to create empirical distribution for 8 step model (off-grid driver histories for 2010 – 2012)
 - Use total grid data to create empirical distribution for grid model (both on and off grid driver histories for 2010 – 2012).



Analysis

- We analyze the system as a discrete-time Markov chain:
 - States are defined so that memoryless property holds.
- The time period is 1 year.
- The number of states depends on the model being used.
- The movement between classes is described in the claims rated scale for each jurisdiction.
- Underlying accident probabilities will be used to generate the probability of an insured being in a given state.
- For each class we can also calculate the expected accident frequency.



Fit of Model Gives Rise to Greater Percentage of “Good” Drivers

| Driving Record Class | Observed % of Drivers in Each Class | Theoretical % of Drivers in Each Class. |
|----------------------|-------------------------------------|---|
| Class 7 | 42.07 | 78.06 |
| Class 6 and 6* | 36.15 | 16.26 |
| Class 5 | 4.83 | 0.77 |
| Class 4 | 3.31 | 0.76 |
| Class 3 | 5.04 | 1.01 |
| Class 2 | 2.77 | 0.91 |
| Class 1 | 3.42 | 1.02 |
| Class 0 | 2.42 | 1.22 |

Fit of Model Gives Rise to Greater Percentage of “Good” Drivers

| Grid Level | Observed % of Drivers in Each Class | Theoretical % of Drivers in Each Class. | Grid Level | Observed % of Drivers in Each Class | Theoretical % of Drivers in Each Class. |
|------------|-------------------------------------|---|------------|-------------------------------------|---|
| -15 | 62.11% | 69.86% | -3 | 1.99% | 0.61% |
| -14 | 2.77% | 3.49% | -2 | 3.57% | 0.31% |
| -13 | 3.05% | 3.71% | -1 | 1.33% | 0.29% |
| -12 | 3.13% | 3.82% | 0 | 1.17% | 0.22% |
| -11 | 3.25% | 3.98% | 1 | 0.33% | 0.13% |
| -10 | 3.25% | 4.29% | 2 | 0.32% | 0.09% |
| -9 | 2.25% | 2.68% | 3 | 0.32% | 0.08% |
| -8 | 2.25% | 2.54% | 4 | 0.15% | 0.08% |
| -7 | 2.21% | 1.19% | 5 | 0.12% | 0.07% |
| -6 | 2.15% | 0.91% | 6 | 0.05% | 0.06% |
| -5 | 2.12% | 0.7% | 7 | 0.05% | 0.05% |
| -4 | 1.96% | 0.67% | 8 | 0.04% | 0.04% |
| | | | 9+ | 0.07% | 0.13% |

Calculated Premiums in 8 Class Model

Premiums calculated 2 ways:

1) using observed differentials from original dataset = Class Loss Frequency / Class 7 Loss Frequency.

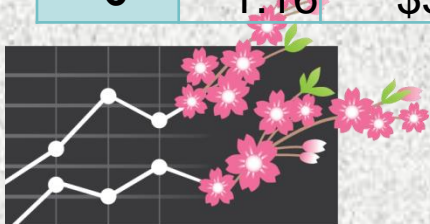
2) using differentials supplied by an insurer.

| DR Class | Observed Diffs | Premium Charged using Observed Diffs | Company Supplied Diffs | Premiums Charged using Company Supplied Diffs |
|----------|----------------|--------------------------------------|------------------------|---|
| 7 | 1.000 | \$366.01 | 1.00 | \$ 392.84 |
| 6 | 1.076 | \$391.57 | 1.00 | \$ 392.84 |
| 5 | 1.629 | \$593.99 | 1.05 | \$ 432.12 |
| 4 | 2.154 | \$660.62 | 1.10 | \$ 481.23 |
| 3 | 2.559 | \$850.91 | 1.15 | \$ 510.69 |
| 2 | 2.620 | \$843.62 | 1.23 | \$ 530.33 |
| 1 | 2.845 | \$1066.29 | 1.30 | \$ 549.97 |
| 0 | 3.234 | \$1144.36 | 1.38 | \$ 569.62 |



Calculated Premiums in Grid Model

| Claims Rated Scale | % of Drivers | Premium Charged | Claims Rated Scale | % of Drivers | Premium Charged | Claims Rated Scale | % of Drivers | Premium Charged |
|--------------------|--------------|-----------------|--------------------|--------------|-----------------|--------------------|--------------|-----------------|
| -15 | 67.05 | \$380.61 | -5 | 0.73 | \$ 570.92 | 5 | 0.07 | \$1141.80 |
| -14 | 3.74 | \$380.61 | -4 | 0.54 | \$ 608.98 | 6 | 0.06 | \$1,217.97 |
| -13 | 3.92 | \$380.61 | -3 | 0.45 | \$ 647.04 | 7 | 0.05 | \$1,370.21 |
| -12 | 4.38 | \$380.61 | -2 | 0.38 | \$ 685.11 | 8 | 0.03 | \$1,484.40 |
| -11 | 4.59 | \$380.61 | -1 | 0.22 | \$ 723.17 | 9 | 0.02 | \$1,598.58 |
| -10 | 4.71 | \$380.61 | 0 | 0.22 | \$ 761.23 | 10 | 0.02 | \$1,712.77 |
| -9 | 3.47 | \$418.68 | 1 | 0.12 | \$ 837.35 | 11 | 0.01 | \$2,055.32 |
| -8 | 2.38 | \$456.74 | 2 | 0.11 | \$ 913.48 | 12 | 0.01 | \$2,230.41 |
| -7 | 1.35 | \$494.80 | 3 | 0.10 | \$ 989.60 | 13 | 0.01 | \$2,419.98 |
| -6 | 1.16 | \$532.86 | 4 | 0.08 | \$1,065.72 | 14 | 0.01 | \$2,625.69 |
| | | | | | | 15 | 0.01 | \$2,848.87 |



New Driver Treatment

| Jurisdiction | With Driver's Education | Without Driver's Education |
|------------------|-------------------------------|-------------------------------|
| Ontario | DR class 3 | DR class 0 |
| British Columbia | DR class 0 | DR class 0 |
| Alberta | DR class -2 (10% reduction) | DR class 0 |
| New Brunswick | DR class 6 premium within RSP | DR class 3 premium within RSP |
| Nova Scotia | DR class 6 premium within RSP | DR class 3 premium within RSP |



- In Nova Scotia and New Brunswick, all new drivers (< 6 years experience) with no at-fault claims are placed in a provincial risk sharing pool.

Conclusion

| Class | 8 Class Model Calc. Diffs | 8 Class Model Supplied. Diffs | Grid Model |
|-------------------------------------|---------------------------|-------------------------------|------------|
| Lowest Risk | \$366.01 | \$ 392.84 | \$380.31 |
| Entry Class (driver's education) | \$850.91 | \$ 510.69 | \$685.11 |
| Entry Class (no driver's education) | \$1144.36 | \$ 569.62 | \$761.23 |
| Highest Risk | \$1144.36 | \$ 569.62 | \$2848.87 |

- Price charged to novice driver varies wildly.
- Impact of having many DR classes is marginal with respect to lowest risk, and substantial with respect to higher risk insureds.



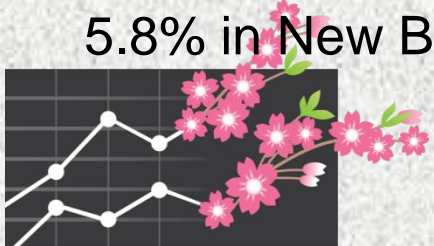
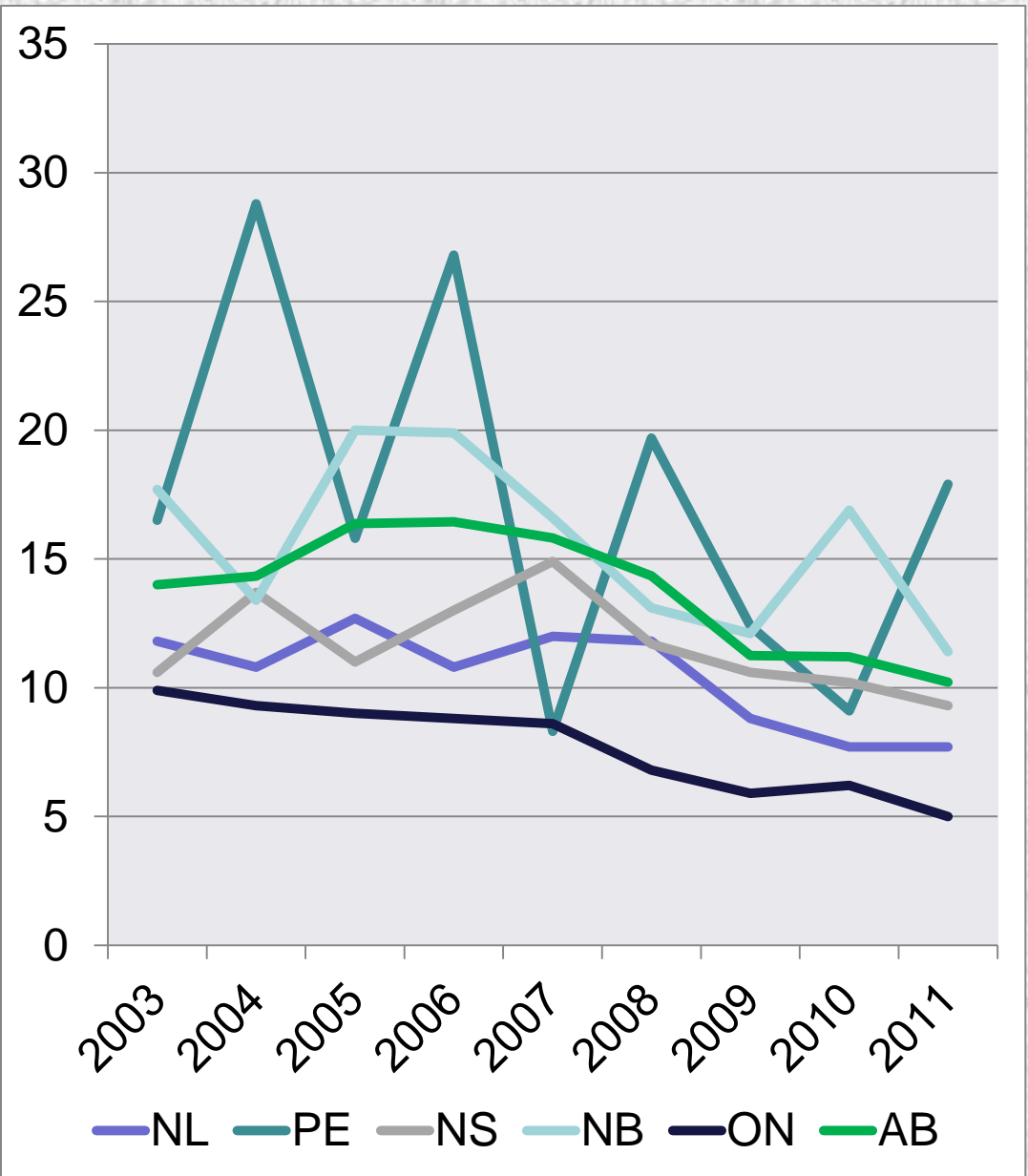
Other Impacts of More DR Classes

- Risk based pricing reduces moral hazard. Many authors (Dionne, 2002; Tennyson, Weiss and Regan, 2002; Grace, Klein and Phillips, 2002; Harrington, 1991, 2002; Derrig and Tennyson, 2011) find that both claims rates and accident costs are higher when auto insurance premiums do not accurately reflect a driver's expected losses.
- High risk drivers, if they receive the correct signal about their level of risk may choose not to drive or to drive with greater care.
- Does having more driving record classes lead to safer roads?



Fatal Crash Rates per 100,000 Drivers in Alberta vs. Other Canadian Provinces

- Introduction of more risk classes in 2007 in Alberta.
- Although there was a decline in Alberta fatal crash rates after 2007, fatal crash rates were falling in all provinces.
- Average annual rate of decline in Alberta fatality rates was 8.8% compared to a decline of 10.1% in Ontario and a decline of 5.8% in New Brunswick.



Other Impacts of More DR Classes

- Risk based pricing because it reduces cost subsidization increases the cost of insurance to high risk drivers.
- Some high risk drivers may not be able to afford insurance and therefore drive uninsured.
- Does having more DR classes lead to more uninsured driving?



Cannot Answer with Alberta Data

| Alberta | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| # of Earned / Reg. Vehicles | 0.88 | 0.90 | 0.92 | 0.91 | 0.91 | 0.90 | 0.89 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.92 |
| Driving W/out Ins. per 10,000 Pop | 16.39 | 16.48 | 17.60 | 18.65 | 19.15 | 17.44 | 17.66 | 17.43 | 18.25 | 17.82 | 15.74 | 14.07 | 13.45 |

- Grid pricing was set artificially – and was set at a price lower than what insurers wanted to offer.
- Number driving without insurance has been dropping since the introduction of grid in 2007 and ratio of earned to registered vehicles has been increasing



Observations / Conclusions

- Having more DR classes does not significantly decrease premiums to low risk, but substantially increases premiums to high risk. Impact on novice drivers is mixed.
 - From a social perspective, it is not clear that this is desirable.
- Making insurance more affordable to high risks might reduce the number of drivers that are uninsured. This reduces moral hazard, leading to safer roads.



Questions?



WRIA 2013