Measuring per-mile risk for pay-as-you-drive automobile insurance

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“Measuring per-mile risk for pay-as-you-drive automobile insurance”

Full text of CLF report: goo.gl/exuSp or Google “CLF PAYD”
Presentation Outline

- Background
- Datasets
- Per-mile risk modeling
- Equity and environmental impacts
- Conclusions
Background
What is pay-as-you-drive insurance?

- Cents-per-mile rate
- Customers billed for actual miles driven

Potential benefits
- Improved actuarial accuracy
- Opportunity for consumers to save money
- Reduced negative externalities (congestion, accidents, pollution)
Status of pay-as-you-drive insurance in U.S.

- MileMeter offers true cents-per-mile coverage in Texas
- Verified low-mileage or black box discount programs available from a variety of providers in many states
50 state regulators
16 prohibit PAYD
  – Including Massachusetts
Many regulatory barriers to introduction and adoption of PAYD
Our contribution

- Assess risk-mileage relationship with largest disaggregate dataset to date
- Classifies drivers by class and territory
- Characterize rate levels and relativities
- Model economic and environmental impacts
Data released by Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA)

- Odometer readings from mandated annual safety checks (Mass RMV)
- Insurance policy and claims data from Mass “statistical plan” reporting (Commonwealth Automobile Reinsurers)

- Original dataset: goo.gl/la5fJ
- Analytic dataset: goo.gl/GiVxW
Data processing

- Estimate mileage from odometer readings
- Estimate pure premiums from losses plus outstanding reserves
- Join on VIN
- Consider only compulsory coverage categories and levels
- Divide drivers into coarse rate groups (five classes, six territories)
- Parse VINs to obtain fuel economy estimates
Five classes

- Pure premium per car year:
  - Adult: $100
  - Business: $200
  - < 3 yrs exp: $400
  - 3 - 6 yrs exp: $300
  - Senior citizen: $100
Six territories

![Bar chart showing the pure premium per car year for different territories. The territories are labeled 1 to 6, and the premiums range from $- to $400. Territory 6 has the highest premium, while territory 1 has the lowest.](image)
Sample size

Policy year 2006:

- 3M car-years of earned exposure
  - 71% of private, insured autos in Massachusetts
- $502M in claims
- 34B miles
Per-mile risk modeling
Pure premium vs. ann. mileage (all drivers)
Pure premium vs. ann. mileage (all drivers)
Reasons for non-proportionality

- All drivers are considered together
- Regression to the mean
- Experience and driving habits
Pure premium vs. ann. mileage (all drivers)
Pure premium vs. ann mileage (T3 adults)
Pure premium vs. ann. mileage (all drivers)
Pure premium vs. ann mileage (T3 adults)
Feasibility Assessment

Pure premium vs. ann. mileage (T3 adults 90%+)
Regression analysis

• Poisson regression
  – Respects “rare event” nature of accidents
  – Allows true disaggregate analysis
  – Results in an exponential model of the risk-mileage relationship
Poisson regression #1

Pure premium = $6.53 \times (\text{ann}_{\text{miles}}^{0.36})
Poisson regression #2

- Pure premium = $2.35 \times (\text{ann}_{\text{miles}}^{0.40}) \times \text{(class relativity)} \times \text{(terr relativity)}
- Limitation: relativities only affect magnitude of curve, not its shape.
• T3 adults only
• Pure premium=$1.70\times\text{ann\_miles}^{0.46}$
• Exponent is higher for any *one* class-territory group than for all class-territory groups together
• Limitation: regression to the mean is still present
• T3 adults only
• 90% or greater overlap between mileage and policy periods—reliable mileage estimates
• Pure premium = $0.74 \times \text{ann\_miles}^{0.54}$
Poisson regression conclusions

• Mileage-risk relationship may be even stronger than we observe here as industry would use:
  – Finer rate groups
  – More rating factors
  – Better mileage estimates
Poisson regression conclusions

• Mileage and risk are strongly correlated
• Relationship becomes stronger and more nearly proportional when controlling for class, territory and RTM.
Regression analysis

• Linear regression
  – Shows how much of variation is explained by different factors
  – Results in a flat rate plus cents-per-mile model, a more realistic model of how PAYD might be priced
Linear regression

- Vehicles aggregated into “bins” by class, territory and 500-mile annual mileage range; weighted by number of vehicles

| Factors                          | Adjusted R² |
|----------------------------------|-------------|
| Mileage                          | .09         |
| Class and territory              | .57         |
| Mileage, class and territory     | .72         |
Linear regression conclusions

- The whole is better than the sum of the parts
  \[ 0.72 > 0.09 + 0.57 \]
  - Mileage is a better predictor of risk when paired with some control (class and territory) on where and how miles are being driven.
Per-mile risk assessment conclusions

- Mileage is correlated with risk
- Correlation is stronger with class-territory control
- PAYD could be priced with individual per mile rates based on class and territory
Equity and environmental impacts
VMT reduction model

- Model consumer response to increase in *marginal* cost of driving a mile due to PAYD
- Modeled for each individual vehicle based on its annual mileage, fuel economy and insurance rate group
- Constant elasticity of -0.15 assumed
VMT reduction model

• Results—if all MA drivers adopted PAYD:
  – 9.5% aggregate VMT reduction if pricing is strictly per mile,
  – 5.0% if a flat fee covers first 2000 miles, with a lower per mile fee thereafter
Fairness and equity impacts

Assumption: PAYD would be offered as a consumer option

Key findings:

• No geographic impacts
• Cross-subsidy alleviated
• Congestion and safety benefits
• Controllable individual factors improve fairness
Conclusions
Summary of key findings

• PAYD is actuarially justified
• PAYD is equitable and fair
• Statewide adoption would result in VMT reductions of 5 – 9.5%
Policy implications

- Regulators should support PAYD
- Consumer protections needed for:
  - Consumer awareness
  - Uninsured driving
  - ‘Tracking data’
