EXPERIENCE RATING AUTOMOBILE DRIVERS

William DuMouchel
Massachusetts Institute of Technology

10/9/84

Contents

I. HISTORY and BACKGROUND

- Experience Rating Began in Workmen's Compensation
- WHITNEY (1918) Proc. Cas. Act. Soc.

$$\hat{p} = z Y + (1-z) p_0$$

$$\left(z = \sigma^2/(\sigma^2 + p_0(1-p_0)/N\right.$$

- The Hearings Process in Massachusett
- Previous implementation of Bayes methods to determine Geographical Territories and Class*Territory Rat Dumouchel (1983) The Statistician
- 1983 Law mandates a "Safe Drivi Plan"

The MERIT RATING Board

- established 1977
- state agency
- levies "surcharges", distributes "cred based on Moving Violations and "at fault accidents"
- Collection Problems

II. THE BAYESIAN UPDATING PARADIGM

Gamma - Poisson model

λ_{st} "true" claim rate for t^{th} person in stratum s.

prior: $\lambda_{st} \sim$ GAMMA ($f(\lambda) \propto \lambda^{\alpha_{st}-1} e^{-\beta_{st}\lambda}$

f_{st} = # of claims observed in n_{st} yr

posterior: Gamma$(\alpha_{st}+f_{st}, \beta_{st}+n_{st})$

How to include Traffic Violations:

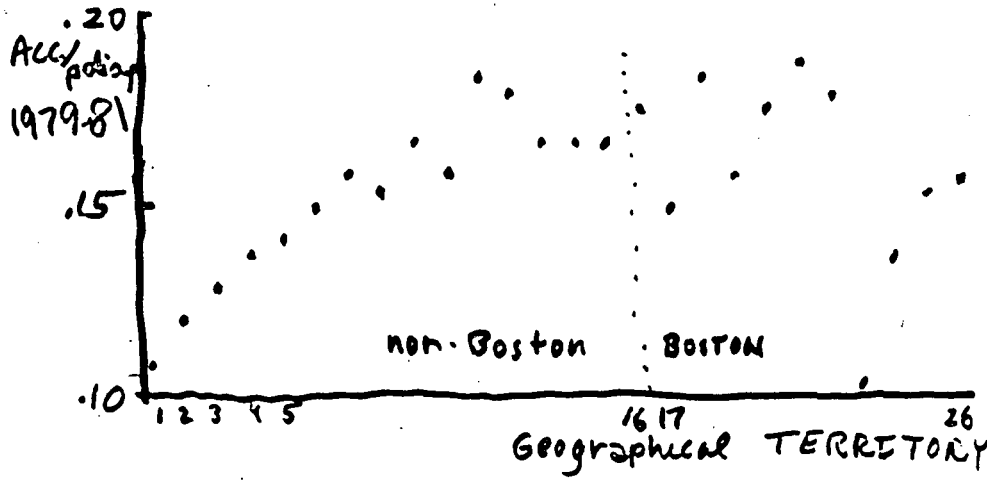
$v_{st} \sim$ Poisson$(n_{st} k_s \lambda_{st})$

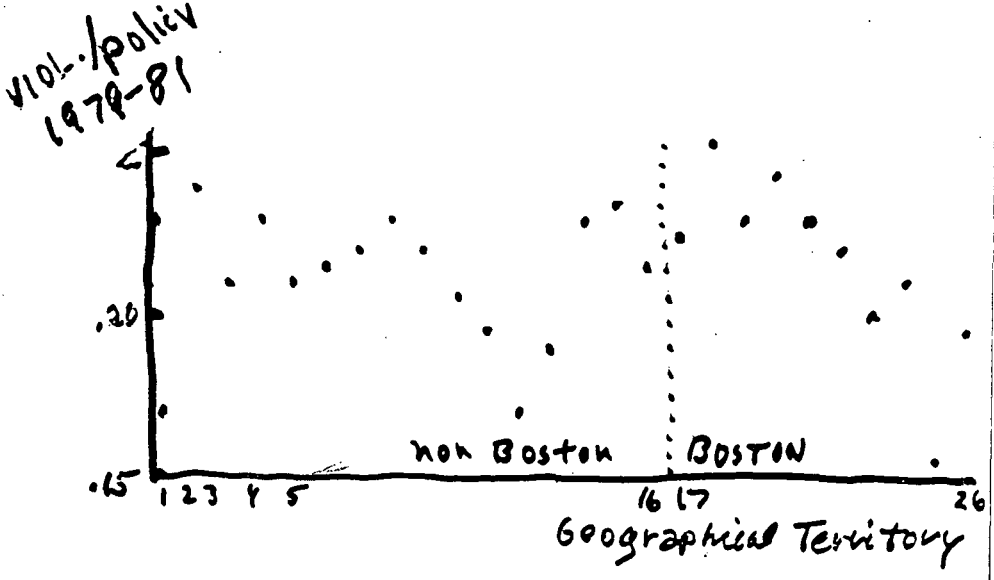
The desirability of a single Point System.

4 pts Driving Intoxicated/ENDANGE
2 pts "At fault Accident"
1 pt. other moving violations

PROBLEMS w/ Bayesian Updating

- 3 yr. limitation in law on "memory"
- How believable is v_{st} as a measure of λ_{st}?


.20
Acc./policy
1979-81
.15
.10
non-Boston
BOSTON
1 2 3 4 5
16 17
26
Geographical TERRITORY


Viol./policy
1979-81
.20
.15
non Boston
BOSTON
1 2 3 4 5
16 17
26
Geographical Territory

III. PRACTICAL PROBLEMS IN DESIGNING A SYSTEM

- TRANSITION FROM MERIT RATING (Double Jeopardy?)
- Multiple cars, policies, Drivers per household
- Estimating effect of 1983 Law on increasing the propor of high-rated drivers (perhaps 40% of inexperienced occasional operators are unliste
- Drivers who owe surcharges

The State Reinsurance Facility

- Companies can opt to cede drive
- Now over 30% are ceded
- Actuarial Deficit is Flat-load by Class and Territory
- Companies do not often adjust Facility Claims carefully
- Interaction w/ Double Jeopardy and multiple car issues.

2 DATA and MODELS

:160 000 f_{ijkl} – 1982 "AT FAULT" Accident

:2 400 000 n_{ijkl} – 1982 Policy-yrs of exposure

i = Driver class
1. Experienced > 6 yrs
2. 3-6 yrs exp, principal
3. 3-6 yrs exp, occasio
4. 0-3 yrs exp, principal
5. 0-3 yrs exp, occasional

j = Geographical Territory
1-16 non Boston
17-26 Boston

k = "Points" on a 1-2-4 scale 1979-8
$k \in \{-1, 0, 1, 2, \ldots, 8, 10\}$ [≈70% have $k=-1$]

l = "at Fault accidents" 1979-81
$\in \{0, 1, 2, 3, 4+\}$

$5 \times 26 \times 10 \times 5$ Table
$i \quad j \quad k \quad l$

$f_{ijkl} \sim$ POISSON $(n_{ijkl} \lambda_{ijkl})$
The "all-2-factor model" fits well.

An *additive* model fits better:

Let $Y_{ijkl} = \frac{f_{ijkl}}{n_{ijkl}}$

$E(Y_{ijkl}) = A_{ij} + B_k + C_l$

$V(Y_{ijkl}) = E(Y_{ijkl})/n_{ijkl}$ use iterative weighted

V. RESULTS

Ideally $C_l \approx 0$. But this was not true

Defining k pts by a 2-3-6 would be more accurate than 1-2-4 (D.D. / Thior V. Acc. D.S.)

Political considerations kept the 1-2-4 ru resulting in bad fit for k = 4, 6, 8 pts. (reversals!)

There was an (i,k) interaction. For i=4 (principal drivers 0-3 yrs exp.) k=-1 was no bet than k=0 or 1. "New drivers have not earned a credit". Plan was modified accordingly.

Apriori, a *multiplicative* model seemed more appropriate, esp. for credits (k=-1). "Additive surcharge, percentage credit

$E(Y_{ijk}) = A_{ij} + B_k\,(k>0) - C(PD)_{ij}\,(k=-1)$ if

$E(Y_{ijk}) = A_{ij} + B_1(k^+) + B_2(k^+)^2 - C\,(PDL)_{ij\cdot}(k=1)(i\neq 4)$

The quadratic was approximately $50. per pt for 1st 2 pts, $75./pt. thereafter, counting $4686. per acci

---

Political Question: Should $A_{ij} = \bar{Y}_{ij\cdot}$?

Should the k=0 group pay average rate or indicated rate ?

"Hidden surcharge" of about $50. was indicated

See figures p. 8 and p. 9.

Setting $A_{ij} = \bar{Y}_{ij\cdot}$ results in much smaller surcharges and credits.

How to fit a model that doesn't fit ?

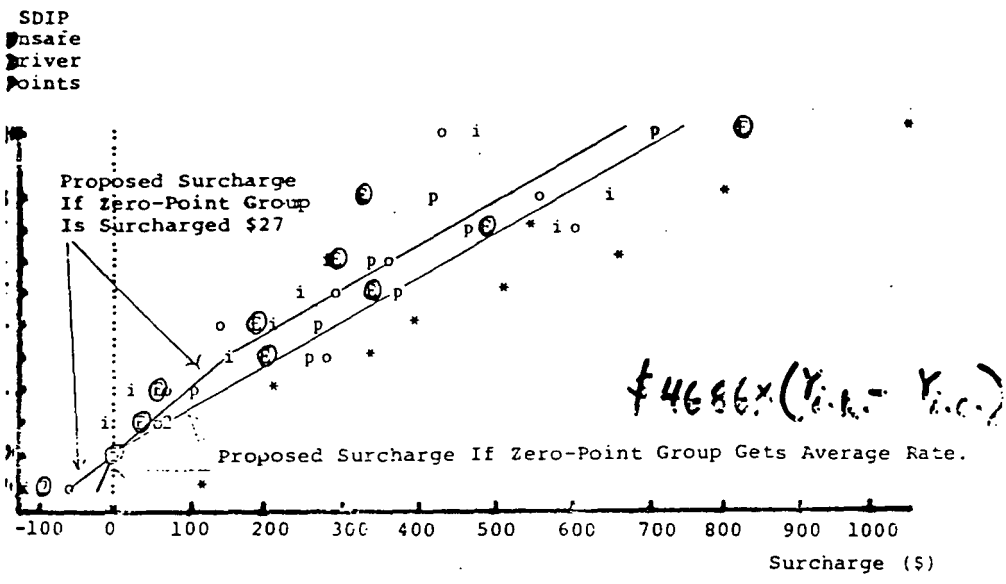
Let $V(Y_{ijk}) = \sigma^2 + \frac{\hat{Y}_{ijk}}{n_{ijk}}$,

add a lack-of-fit variance component.

I.E. The prior distributions for each cells' lack of fit are exchangeable.

Finally, adjustments are made to every (i,j) cell to avoid double counting.

Stipulated Surcharge Amounts vs. Surcharge Class



Based on the Merit Rating Board tabulation without "forgiveness" for surcharges paid, adjusted to the 1982 territorial exposure mix.

Plotted symbols represent indicated surcharges for each driver class:

E Experienced (including Senior Citizen and Business Use); Classes 10-15-30.

p Principal operator, 3-6 years of experience; Class 17.

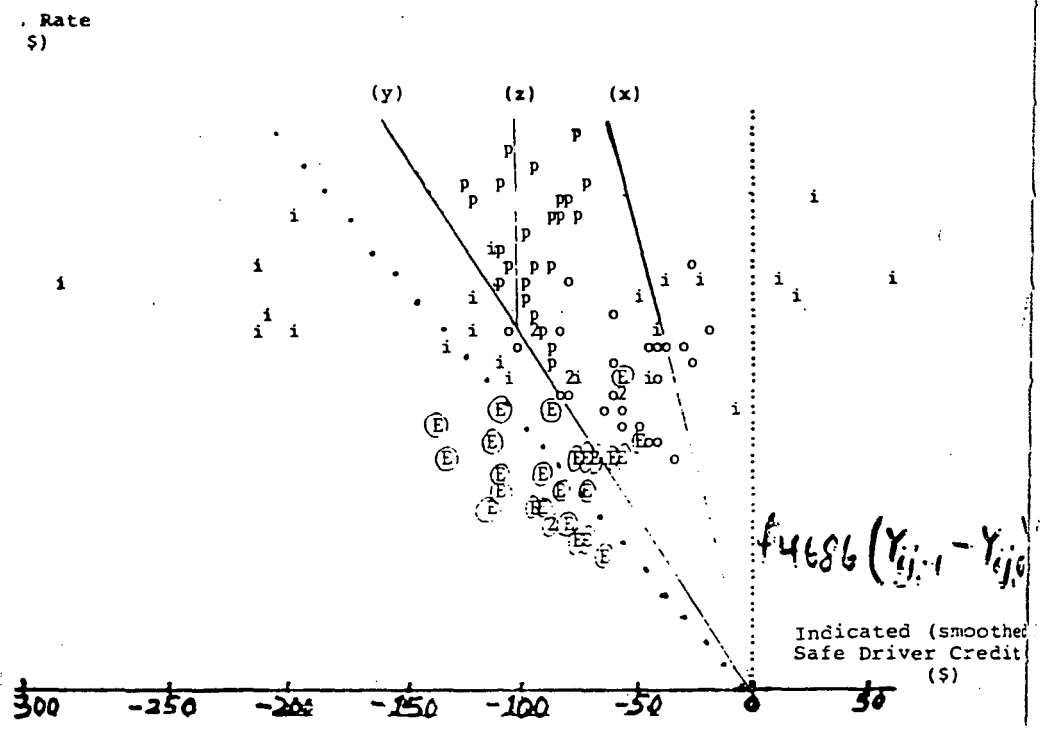
o Occasional operator, 3-6 years of experience; Class 18.

* Principal operator, 0-3 years of experience; Classes 20-25.

i Occasional operator, 0-3 years of experience; Classes 21-26.

± Two points coincide.

Indicated Credits vs. MARB Proposed PDL Rate for Each Class-Territory Cell



From Merit Rating Board tabulation without "forgiveness" for surcharges paid.

(x) Credit allowable if the zero-point class receives the average rate.

(y) Credit allowable if the zero-point class is surcharged an average of $27.

(z) Effect of capping credits at $100.

Meaning of symbols as in Exhibit 3 of AG's filing.

Indicated credits have been smoothed as described in the AG's filing.

Class 20-25 omitted.