Price Optimization

Presented by:

Lee M. Bowron, ACAS, MAAA
Kerper and Bowron LLC
Birmingham, AL
www.kerper-bowron.com
www.earnix.com

Graphs courtesy of Earnix

What is an insurance CEO's number one concern?

From Dow Jones:

Insurance executives say insurance pricing weakness is the biggest risk their industry faces in the next few years.

What does the customer think?

The Renewal Dilemma

- The more tenure, the better the loss ratio
- But switching can be hard, tenure = value
- Most companies will ignore renewals or not give the full actuarial discount – is that the optimal treatment?

Demand Modeling

- Given a quote, will we convert?
- Start getting the data now (the ether of the renewal offer)
- Different for new business and renewals
- A key variable is the amount of rate change as well as the tenure of the policy

GLMs can be used to model demand

Logistic regression analyzes binomially distributed data of the form

$$Y_i \sim B(p_i, n_i), \text{ for } i = 1, \ldots, m,$$

where the numbers of Bernoulli trials *ni* are known and the probabilities of success *pi* are unknown. An example of this distribution is the fraction of flowers (*pi*) that germinate after *ni* are planted.

Demand models (Continued)

The model is then that for each trial (value of *i*) there is a set of explanatory/independent variables that might inform the final probability. These explanatory variables can be thought of as being in a *k* vector *Xi* and the model then takes the form

$$p_i = \mathrm{E}\left(\frac{Y_i}{n_i}\middle| X_i\right).$$

Demand Models (Continued)

The logits of the unknown binomial probabilities (*i.e.*, the logarithms of the odds) are modeled as a linear function of the *Xi*.

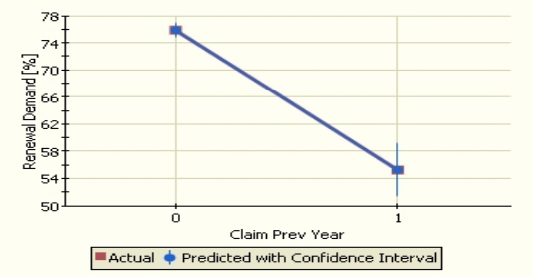
$$\operatorname{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i}.$$

Note: there are other ways to analyze demand, but make sure you are doing it in a statistically significant manner.

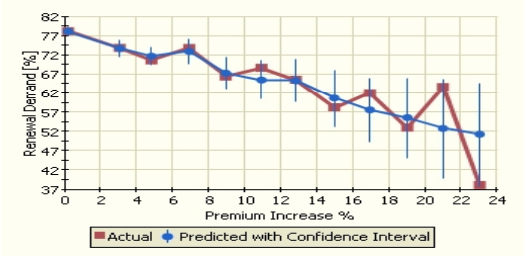
Generalized Additive Models

- You can potentially improve the fit using Generalized Additive Models
- These allow for non-parametric fits
- You have to watch for over fitting.

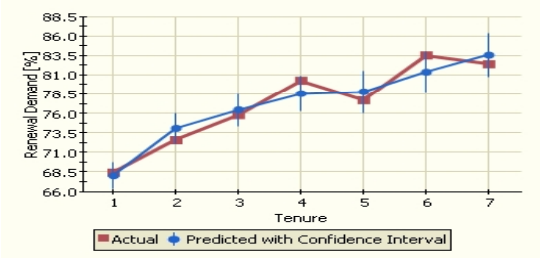
Effect of Previous Claim on Renewal Demand



Effect of Premium Increase on Renewal Demand



Effect of Tenure on Renewal Demand



Next step is optimization

The "Objective Function"

Given an objective of X subject to the condition Y what is the price I should charge?

Xs and Ys

Optimization is not blind profit maximization!

Possible Objectives (X)
- More profit
- More volume
- More retention

Possible Constraints (Y)
- Rate Change
- Actuarial Indications
- Volume
- Retention
- Profit

Lifetime Value

- Lifetime value is the present value of a piece of business today to the company
- Easy to explain, but hard to implement

Example: a 25 year old single male buys a liability only policy
- Will he eventually get full coverage?
- Will he eventually get married (and stay with the company)?
- Will he buy a homeowner's policy from us?
- Will he buy life insurance?

Optimization

- Once you have defined the objective function, you must find the optimal points
- Use calculus to find the minimum/maximums
- Because of the complexity of the objective function and the constraints, this is a difficult problem to solve.

Optimization Methods

- Gradient projections – converges to the optimal solution along a line.
- Ellipsoid projections – "shrinks" an ellipsoid to the optimal solution.
- In general, gradient projections are faster but ellipsoid projections are more robust.
- Barrier functions – functions which increase to infinity at the barrier point or constraint. This is how constraints are implemented.

Arguments against optimization

1.We are getting away from expected costs.

•European companies are monitoring this issue, they haven't seen major problems.

• Hard market would likely see focus return to costs.

Arguments against optimization

2. "I want to maximize PIF and take no policies below the cost of capital, therefore I don't want to under price (capital destruction) and I don't want to overprice (I won't sell as many policies)."

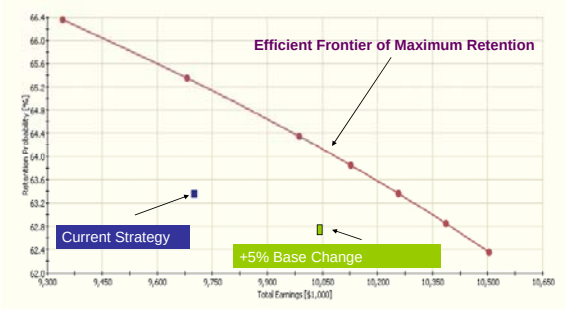
Arguments against optimization

Answer: Focus on Marginal ROE

- Determine the amount of expenses fixed over the policy term.
- Throw these OUT!
- If fixed expenses are 10% of last year's premium, and you need to price to a 4% underwriting profit, you can now price a policy to -6% underwriting profit and still make your return on capital.

Getting optimization into the rates . . .

		Current Factor/ Rates	Indicated Factor/ Rates	Current Margin	Optimal Factor/ Rates	Optimal Margin
Bodily Injury – Illinois Auto		250	260	6.0%	249	2.0%
Driver Class	35 Married Male	0.85	0.89	0.0%	0.90	1.5%
Points	Clean	1.00	0.99	0.0%	1.01	2.0%
Territory*	Carbondale	1.20	1.14	0.0%	1.14	0.0%
Symbol*	13	1.10	1.12	0.0%	1.12	0.0%
Model Year	2004	1.15	1.22	0.0%	1.24	1.5%
Credit Score	700	0.80	0.74	0.0%	0.75	2.0%
MultiCar	Yes	0.85	0.83	0.0%	0.84	0.5%
Homeowner*	Yes	0.95	0.93	0.0%	0.93	0.0%
Final Rate for this Risk		208	202	6.0%	210	9.4%



Regulatory Issues

Regulation – Open Issues

- **Optimization began in Europe and Israel where there is little rate regulation.**
- **Easier to implement in commercial lines.**
- **Might be possible to optimize a regulated line if you have related products (example: worker's comp)**
- **Personal lines implementation will vary by state.**

Regulatory Issues

Regulation – Open Issues

Most companies don't currently file actuarially indicated rates for every cell

- **Ignored Classification Issues (Renewals versus New Business)**
- **Credibility**
- **Competitive Issues**
- **Stability**

What is optimization?

Optimization is a tool to assist rating judgment to balance these factors as well as actuarial considerations, it's just formalizing what we currently do.

Regulation

Regulation is generally done at the program level, but optimization is at the individual rate level.

Price optimization in the travel industry

Differences:

- Demand can be more elastic in travel than insurance due to ease of substitution. This will vary by consumer and (in the case of airlines) the specific route.
- High variable costs in the insurance industry means that one less policy causes significantly less costs.
- Supply is highly constrained in the short term for travel, especially hotels. (Check New York hotel rates)

Final Thoughts

- People like optimized prices – Optimization makes some prices more affordable. This could lower uninsured rates since marginal customers are the most elastic.
- Entrenched in Europe
- Still early in the process for the US – early adapters may make a lot of money (See "Credit Scoring" circa 1990)
- Regulatory impact unclear