

## Demand Modeling to Price Optimization

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## 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.*

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## What does the customer think?



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## The Renewal Question

- 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?

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## 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

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## GLMs can be used to model demand

Logistic regression analyzes binomially distributed data of the form

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

where the numbers of Bernoulli trials  $n_i$  are known and the probabilities of success  $p_i$  are unknown. An example of this distribution is the fraction of flowers ( $p$ ) that germinate after  $n_i$  are planted.

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## 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  $X_i$  and the model then takes the form

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

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## 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  $X_i$ .\*

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

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

\* Logistic regression is from Wikipedia

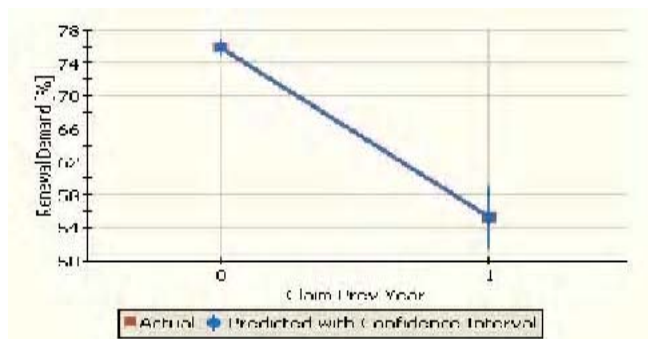
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## EARNIX

Effect of Previous Claim on Renewal Demand



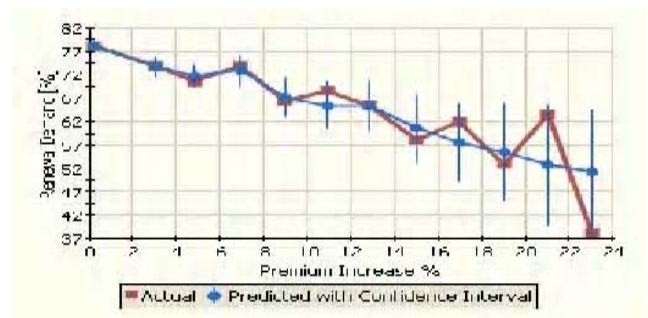
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## EARNIX

Effect of Premium Increase on Renewal Demand



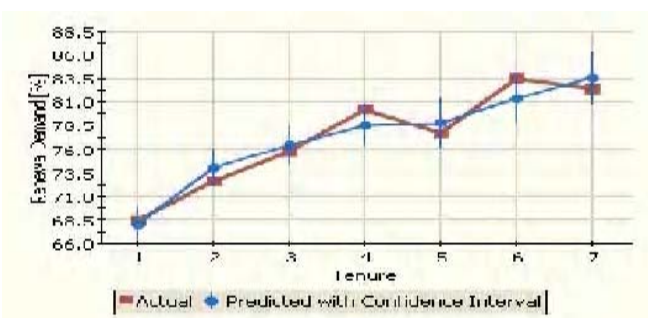
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## EARNIX

Effect of Tenure on Renewal Demand



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## Next step is optimization

### The "Objective Function"

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

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## Xs and Ys

### Optimization is not blind profit maximization!

#### Possible Objectives (X)

- More profit
- More volume
- More retention

#### Possible Constraints (Y)

- Volume
- Retention
- Profit
- Lifetime value

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## OJ Sidebar: 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?

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## 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, you will need to use software (or Excel Solver).

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## 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.

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## 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)."

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## 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.

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## Getting optimization into the rates . . .

## Going from Demand Modeling to Price Optimization

	Current Factor/Rates	Indicated Factor/Rates	Current Margin	Earnix Factor/Rates	Earnix Margin	
<b>Bodily Injury – Illinois Auto</b>	250	260	6.0%	249	<b>2.0%</b>	
Driver Class	35 Married Male	0.85	0.89	0.0%	0.90	<b>1.5%</b>
Points	Clean	1.00	0.99	0.0%	1.01	<b>2.0%</b>
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	<b>1.5%</b>
Credit Score	700	0.80	0.74	0.0%	0.75	<b>2.0%</b>
MultiCar	Yes	0.85	0.83	0.0%	0.84	<b>0.5%</b>
Homeowner*	Yes	0.95	0.93	0.0%	0.93	0.0%
<b>Final Rate for this Risk</b>	<b>208</b>	<b>202</b>	<b>6.0%</b>	<b>210</b>	<b>9.4%</b>	

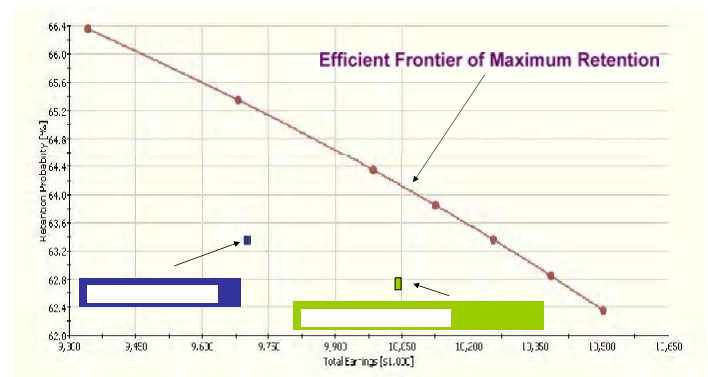
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## EARNIX

## Going from Demand Modeling to Price Optimization



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## Going from Demand Modeling to Price Optimization

## 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.

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## Going from Demand Modeling to Price Optimization

## 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

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## Going from Demand Modeling to Price Optimization

## What is optimization?

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

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## Going from Demand Modeling to Price Optimization

## Regulation

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

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## 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)

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## Final Thoughts

- 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
- Actuaries are very involved in the US, less so in Europe

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