GIRO Convention

23-26 September 2008
Hilton Sorrento Palace

Workshop A1
James Tanser, Watson Wyatt
Owen Morris, Norwich Union
Demand Modelling Working Party

- James Tanser (Chair)
- John Light
- Sophia Mealy
- Owen Morris

Special thanks to:
- Julie Fairbank
- Matthew Barnes
GIRO Working party

- Provide an introduction to the topic describing the terms used
- Summarise the current methodologies used in the market
- Summarise possible alternate methodologies identified by a search of available literature
- Investigate several methods using agreed methodology to determine the descriptive and predictive power of the methods when applied to actual insurance data
- Provide a brief conclusion and highlight areas for further work.
Agenda

- Survey
- Practical matters
- Comparative study
- Questions
Survey

- Small response: 32 started and 11 finished
- Results interesting despite low response
- Champagne and Chocolates are equally popular!
Number of years working with demand models

- <1yr
- 1-2yrs
- 2-4yrs
- 4-6yrs
- 6-10yrs
- 10yrs+
Where are demand models used?
Frequency of analysis

- Weekly: 5.0%
- Quarterly: 30.0%
- Annually: 15.0%
- Minor project: 25.0%
- Major project: 35.0%

Personal involvement
Company practice
Methods in use

- Oneway/Twoway
- Logistic Models
- Other Binomial GLM
- Non-linear Models
- Clustering
- Non-statistical Methods
- Neural Networks
- Other Method

Legend:
- Regular
- Considering
- Rejected
- Not interested

The Actuarial Profession
making financial sense of the future
Who uses the methods?

- One-ways and two-ways always used in combination with other technique
- 7/10 used one-way with Logistic (with one more just using logistic)
- 4/10 used other Binomial models, and of these 4, 2 looked at non-linear models and 1 at clustering
Sources of information

Competitor Data Sources - Overall Use

- Batch quotations systems (e.g. Whatif): 100.0%
- Own conversion experience: 80.0%
- Mystery Shopping: 30.0%
- Customer "lowest quote": 0.0%
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Data

- Key to successful analysis
- Take care withmissings
  - Systematic effects may distort analysis
- More data = More detail
- Beware trends and changes
New business versus Renewals

- Inertia key to renewals
  - Can get reasonable models without market information
- Market premium key to new business
- Price sensitivity best measured through trials
Competitor premiums

- Key to analysis, and hard to get!
- Relevance of information varies by channel:
  - Quotation systems
  - Screen scraping
  - Customer self reporting
- Aggregators own key data
Use of models

- Price optimisation
- Scenario testing
- Marketing
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Generalised linear models

\[E[Y] = \mu = g^{-1}(X.\beta + \xi)\]

\[\text{Var}[Y] = \phi.V(\mu) / \omega\]
Models: traditional view

- A logistic model is most appropriate
  - considers $\log( p / (1-p) )$ with binomial error
  - maps $[0,1]$ to $[-\infty, \infty]$  
  - invariant to whether you model success or failure

- If lapses are low and results not to be used directly, a Poisson multiplicative model can help
  - theoretically wrong (can predict multiple lapses), but easier to communicate
Log versus Logit

Logit link function

Probability versus Linear predictor graph.
Log versus Logit

Logit link function

Probability vs. Linear predictor graph showing the relationship between the two.
Other models

- Could try:
  - log link
  - probit link
  - complementary log-log link

- Transform the data
  - Sampling
Link functions
Rescaled to be the same at 0 and -2

- Logit
- Probit
- Complementary log-log
Link functions
Rescaled to be the same at 0 and -2

- Logit
- Probit
- Complementary log-log

Probability ($\mu$) vs. Linear Predictor ($\eta$)
Link functions
Rescaled to be the same at $p=0.1$
Data analysis

- Two datasets examined:
  - “High” typical of traditional channels
  - “Low” typical of new channels
- Data split into Train and Test using time split
- Base model was Logistic
  - Briefly iterated to get reasonable model
  - Same variable selection applied everywhere
Lift curves: Definition

- Take out of sample data and add fitted values
- Sort data according to expected value
- Create N pots of equal exposure
  - N typically 10, here 100
- Calculate actual in each pot and plot on graph
- Key points:
  - Test of order only, not goodness of fit
  - Can compare very different models easily
Lift Curve - Low Conversion Data Set

Note: Y-axis on log scale
Lift curves: Conclusions

- All models appeared to do equally well in separating high and low conversion segments
Actual versus Expected: Definition

- Take out of sample data and add fitted values
- Sort data according to expected value
- Create 100 pots of equal exposure
- Calculate Expected / Actual in each pot and plot on graph

Key points:
- A flat line is equally good (or bad) everywhere
- Systematic over or under estimation revealed by departure from y=1 line (not shown)
Actual Vs Expected - Low Conversion Data Set

Expected Conversion Percentile

Expected/Actual Conversion Rate

LOGIT
POISSON
COMPLL
PROBIT
Poly. (POISSON)
Poly. (LOGIT)
Poly. (COMPLL)
Poly. (PROBIT)
Actual versus Expected: Conclusions

- Within any given model, there appears to be a systematic overestimation of low conversion segments
- Poisson/Log link is worst option
  - Poor at both ends for high conversion!
- Binomial/Probit appears flatter
  - Not clear what is happening for low conversion
- Binomial/Logit next best shape (but marginally better predictor)
  - Methodology may bias analysis to prefer this method
Future research

- More datasets would help firm up conclusions
- More exotic methods not examined:
  - Sampling
  - Non-linear models
- Some topics remain unpublishable:
  - Best interactions
  - Best data sources
  - Best way to treat competitor information
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