Pricing uncertainty: Ignore volatility at your peril

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About the presenters

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Dr. Ji Yao is a manager with Ernst & Young’s European actuarial services practice. He has extensive experience in various modelling for pricing with a solid background in mathematics and statistics. He has extensive first-hand experience in risk models, demand models and price optimisation. Recently, he has worked on elasticity modelling for a large insurance-related company.

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Agenda

Background
Describing pricing uncertainty and adequacy
Quantifying pricing uncertainty
Applications of pricing uncertainty
Summary
Q&A
Pricing is the primary lever that affects revenue and ultimately profitability

Pricing: Sets maximum available profit (includes ancillary income)

Once a policy is written, there are limited levers an insurer can use to influence the final profit for that business.

The UK insurance market is one of the most competitive markets in the world

Reported net combined ratio

Motor
Home

Year

Please note all results are before ancillary income and investment returns

Source: S&P and Ernst & Young interpretation
Case study: A UK motor insurer
Company maintained premium volume but grew customer numbers, while the performance deteriorated

The company maintained premium volume but grew customer numbers, while the results deteriorated

Any company’s data only represents a small proportion of the market

► Remember that the best estimate is only a point estimate from the sample of the total market

► Typically, the standard error of predicted values is related to the sample size

\[ s/\sqrt{n} - 1 \]

► where \( s \) is the sample standard deviation
► \( n \) is the number of observations

Can Company A be sure it has grown in a sustainable fashion with accurate pricing?
Looking at multiple factors at once, there is limited data to support pricing in the potential growth segments

- 30% of book is non-core segments
- Under-pricing these segments by 5% will lead to 1.5% increase in loss ratio of total book

- Pricing models will extrapolate the experience from the core customer segments into the potential growth customer segments and non-core segments
  - The less data available in these segments, the greater the uncertainty in the predicted values
    - For example the pricing models become increasingly unreliable as we consider the customer segments to the right
  - The key issue is how much reliance is placed on these predicted values?
  - For smaller companies, these issues could arise in some two way interactions.

Creating a rating structure is a combination of science and art

- Typically we use science (statistical models) to set the relativities for the technical price
- And overlay ‘art’ to set the future claims and premium assumptions to calculate ‘street price’
- However are we considering the volatility in our models?
  - Is that volatility significant?
  - What could we do about it?

An insurer that understands the volatility in their pricing models should be able to gain a long-term competitive advantage
Describing pricing uncertainty and adequacy

Key discussion point is to identify and apply pricing uncertainty into the pricing decision

Hypothesis

- Each insurer's own experience is only a sample of the overall market experience for any risk.
- The smaller the sample the higher the risk of mispricing.
- Over-pricing: potentially profitable business is lost.
- Under-pricing: has the potential to be a significant issue, especially on a price comparison website.

Challenges

- Competitors may have lots of data for a specific segment, but you do not.
- How much to adjust the basic risk price by customer segment to allow for sample error.
- Checking that the under-pricing risk across the portfolio is within the insurer's risk appetite.
- Putting in place real-time portfolio management.

Risk premium calculated by insurer A

Risk premium calculated by insurer B

Insurer B estimates the risk cost to be less than insurer A. However there is a 45% chance that the actual risk cost is greater than insurer A's view. Is Insurer B under pricing?

Potential range of expected risk cost

45%
A typical approach to risk cost modelling ignores the uncertainty associated with each component model

The important thing is to quantify the uncertainty when the component models are combined to aid the pricing decision.

Each model (frequency and severity) has some uncertainty associated with it

Typically this uncertainty is ignored

The combination of a dozen or more models could lead to some very uncertain point estimates

Result of bootstrapping: the estimated burning cost can have significant variation

Where there is less data, the variance is significantly larger
In our potential growth segment our estimate could differ by in excess of ± £10, which will make a difference in highly elastic markets. For non-core customer segments the results are highly uncertain.

The potential growth customer segments have enough uncertainty to skew predicted results significantly, while the non-core customer segments have a wide uncertainty on predicted results.

The scope to reduce price in potential growth customer segments is limited by pricing uncertainty.

- Price is set with a margin to the burning cost and the price is not competitive.
- A small change in price is expected to grow volumes significantly.
- Due to the uncertainty of the burning cost we need to understand for which customers within the segment we can reduce the margin.

Price is set with a margin to the burning cost but is already competitive.

To increase sales in this segment efficiently, a combination of price, product and marketing is needed.
The uncertainty around the burning cost prediction can be explicitly calculated

- Let $F$ and $S$ be the linear predictors of the frequency and severity models, respectively.
- The 95% confidence interval of the burning cost is defined as:
  \[ \exp(E[F] + E[S] \pm 1.96\sqrt{Var[F] + Var[S] + 2Cov[F, S]}) \]
- The covariance is computationally difficult to calculate, so let $Cov[F, S] = 0$
- So the 95% confidence interval is simplified to
  \[ \exp(E[F] + E[S] \pm 1.96\sqrt{Var[F] + Var[S]}) \]

The simplification holds true against the results from the bootstrap exercise

- We can ‘measure’ the uncertainty around the burning cost using confidence intervals with a simplification for independence.
- The results are similar to those obtained from the bootstrap, except when the uncertainty is very large, in which case we over-estimate.
Applications of price uncertainty

We reserve to a defined percentile. Should we also manage our prices actively to a level of adequacy?

Let’s define **Pricing Adequacy** (PA) for a policy as

\[
\text{Pricing Adequacy} = \frac{P - P_L}{P_U - P_L}
\]

where,

- \(P\) is the price for the risk
- \(P_L\) is the lower bound of the burning cost estimate
- \(P_U\) is the upper bound of the burning cost estimate

**Example**

- The current price for this risk is £300
- For a nominal 10% increase we can increase the pricing adequacy substantially while minimally affecting the probability to convert
- The challenge is to analyse the portfolio and understand where price increases could be established to gain margin and fund segments where the uncertainty is greater
The pricing adequacy measure may help to provide a consistent basis to adjust quoted premiums

- A price increase across the whole portfolio is unlikely to increase the price adequacy efficiently as only the cheapest quotes are accepted.
- The trick is to identify customer segments that can carry a rate increase.

Flat increase

- Use pricing uncertainty

Accept distribution moves to the right but is still on average around 50%

Distribution of ‘accepts’ is now centered around 65%

A flat increase will marginally improve the accept distribution of price adequacy.

Price changes are made to maximise the pricing adequacy.

Does pricing uncertainty lead to anti-selection?

- Recall each insurer has a distribution of price points:

  - In a highly competitive market, such as a price comparison site, generally only the cheapest (underpriced?) risk is sold.
  - This effect is known as the winner’s curse.

- Key question is what to do with this information?

Distribution of pricing adequacy for quotes and accepts

Quotes with high pricing adequacy rarely convert because the quoted premium is uncompetitive in the market place.
Which way are you heading? How strong are your prices?

Having the information to justify deviances from plan and to spot potential opportunities

<table>
<thead>
<tr>
<th>Customer segment</th>
<th>Target volume</th>
<th>Actual volume</th>
<th>Current price adequacy</th>
<th>Price adequacy to meet target volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young drivers</td>
<td>10%</td>
<td>9%</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>4WD drivers</td>
<td>30%</td>
<td>20%</td>
<td>53%</td>
<td>26%</td>
</tr>
<tr>
<td>Over 55s</td>
<td>30%</td>
<td>25%</td>
<td>72%</td>
<td>62%</td>
</tr>
<tr>
<td>Urbanites</td>
<td>5%</td>
<td>7%</td>
<td>66%</td>
<td>66%</td>
</tr>
<tr>
<td>Commuters</td>
<td>5%</td>
<td>7%</td>
<td>58%</td>
<td>60%</td>
</tr>
<tr>
<td>Young couples</td>
<td>20%</td>
<td>32%</td>
<td>45%</td>
<td>57%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>57%</td>
<td>50%</td>
</tr>
</tbody>
</table>

- Assume a price adequacy target of 60%
- The “4WD drivers” segment is behind its target volumes but the cost to get to target is too high, if considering the price adequacy
- The “Over 55s” segment volume is also behind target but there is scope to reduce prices and still maintain a healthy price adequacy
Understanding the model’s confidence intervals can indicate when a model needs refreshing

- Confidence intervals can be calculated based on the previously defined formulae.
- Check whether the observation is within the confidence interval.
- At the 95% confidence level, it is expected that 19 out of 20 times, actual observations are within confidence interval.

Conversion model monitoring

Traditionally we would refresh a demand model every six months.

The actual experience is outside the CI once in a couple of weeks, so the model is still okay.

Here the actual experience is consistently outside the CI, so we conclude the model needs to be refreshed.

Summary
Knowing how to use pricing uncertainty is crucial for sustainable growth in a competitive market

- Rate setting for high volume business has to be automated
- However all statistical models have an error term associated
- Understanding customer segments where the error term is uncertain will help to make different pricing decisions

Price setting is not a science, the key is to understand how to blend science and judgment in a cost effective matter

Q&A