Pricing uncertainty:
Ignore volatility at your peril

Current Issues in General Insurance
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About the presenters

Sherdin Omar is a senior manager with Ernst & Young's European actuarial services practice. He has significant technical and commercial motor insurance pricing experience building predictive models for motor and home pricing as well as managing the pricing structures for one the UK leading motor brands. He has advised a number of leading motor brands on a wide range of projects ranging from getting value out of data and elasticity.

SOmar@uk.ey.com

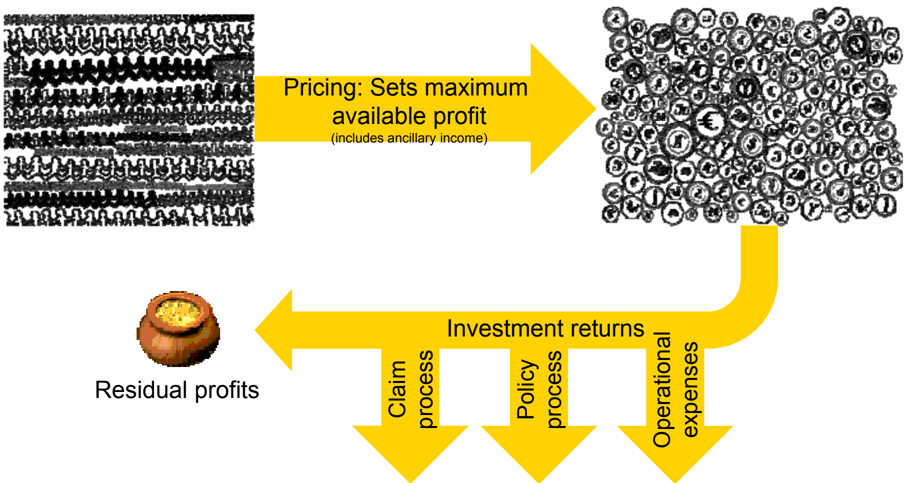
Dr. Ji Yao is a manager with Ernst & Young's European actuarial services practice. He has extensive experience in various modelling for pricing with a solid background in mathematics and statistics. He has extensive first-hand experience in risk models, demand models and price optimisation. Recently,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

JYao@uk.ey.com

Agenda

Background

Pricing is the primary lever that affects revenue and ultimately profitability



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

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

Please note all results are before ancillary income and investment returns

Source: S&P and Ernst & Young interpretation

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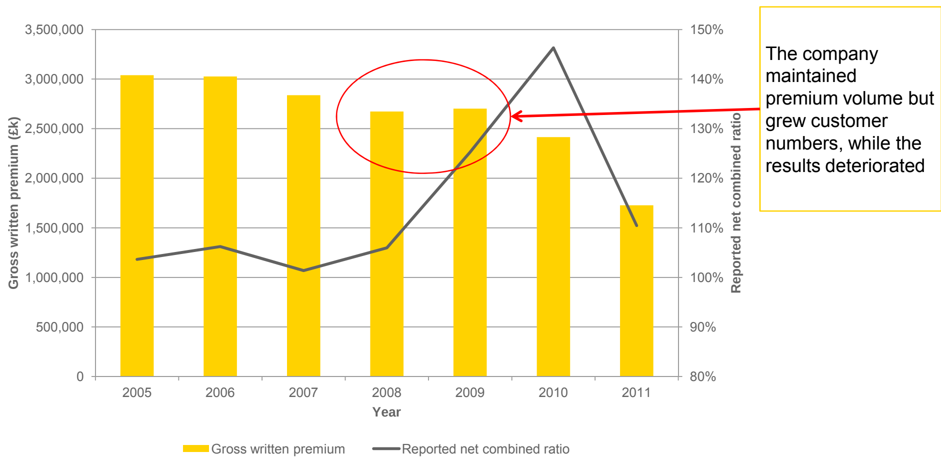
Case study: A UK motor insurer
Company maintained premium volume but grew customer numbers, while the performance deteriorated



Source: S&P and Ernst & Young interpretation

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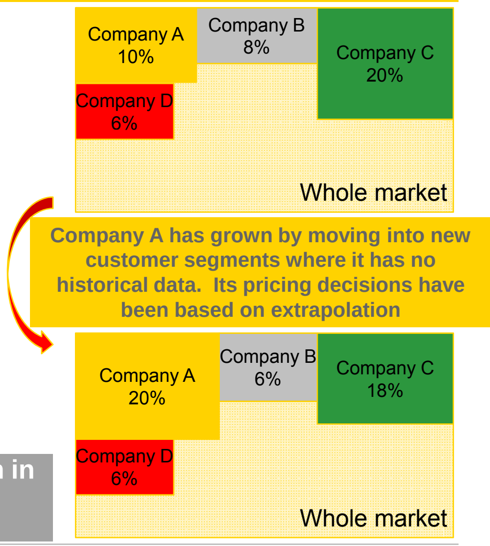
Any company's data only represents a small proportion of the market

- 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?



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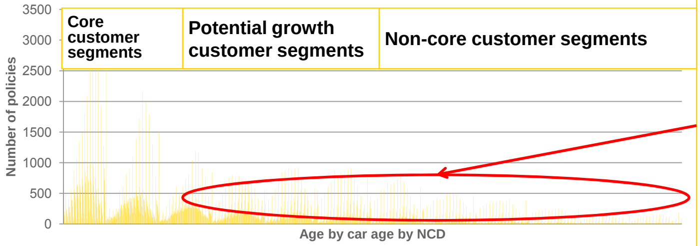
Looking at multiple factors at once, there is limited data to support pricing in the potential growth segments

Distribution of age by car age by NCD



- 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

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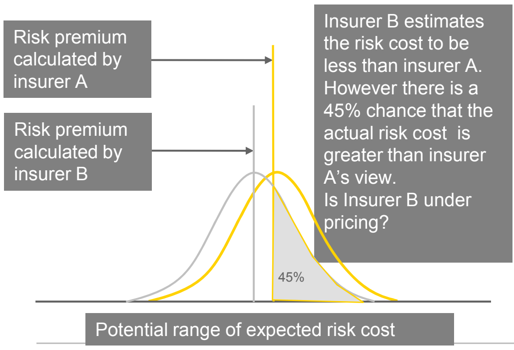
Key discussion point is to identify and apply pricing uncertainty into the pricing decision

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.

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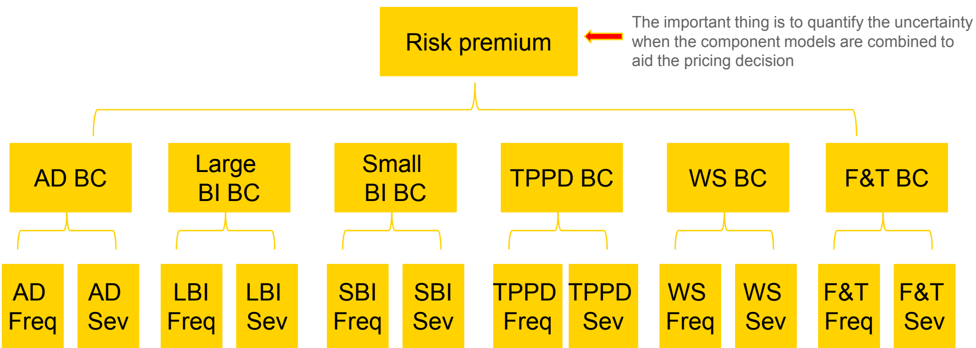
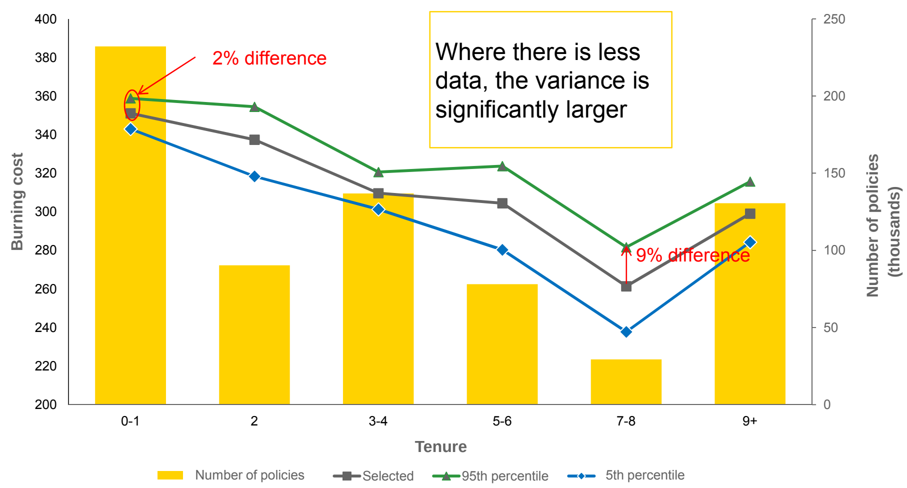
A typical approach to risk cost modelling ignores the uncertainty associated with each component model

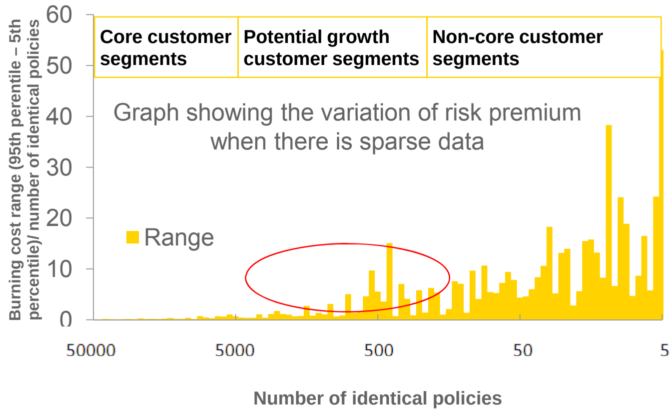


- Each model (frequency and severity) has some uncertainty associated with it
- Typically this uncertainty is ignored
- The combination of a dozen or more models could lead to some very uncertain point estimates

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



How does the range of the prediction intervals vary with the number of policies?

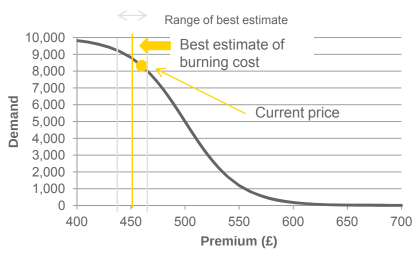


In our potential growth segment our estimate could differ by in excess of ± £10, which will make a difference in highly elastic markets
For non-core customer segments the results are highly uncertain

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

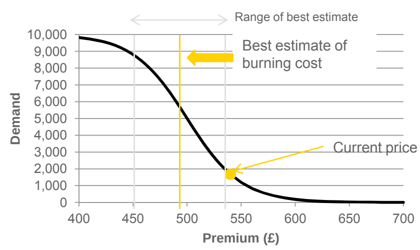
The scope to reduce price in potential growth customer segments is limited by pricing uncertainty

Core customer segments



- 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

Potential growth customer segments



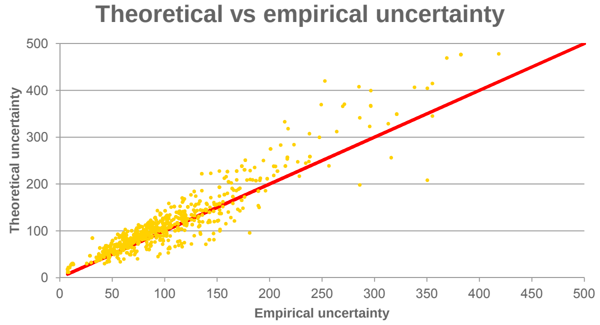
- Price is set with a margin to the burning cost and the price is not competitive
- A small change in price is expected to grow volumes significantly
- Due to the uncertainty of the burning cost we need to understand for which customers within the segment we can reduce the margin

The uncertainty around the burning cost prediction can be explicitly calculated

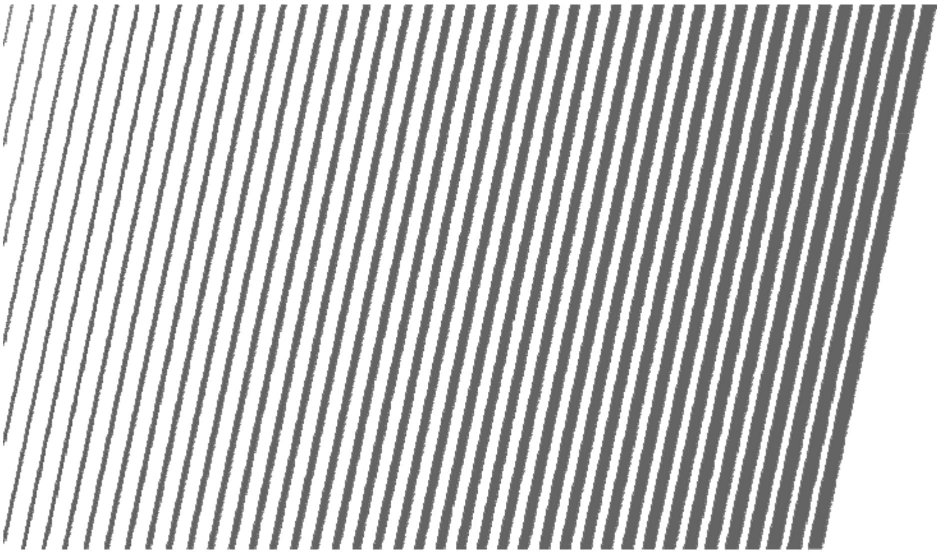
- Let F and S be the linear predictors of the frequency and severity models, respectively.
- The 95% confidence interval of the burning cost is defined as:
$$\exp\left(E[F] + E[S] \pm 1.96(\mathrm{Var}[F] + \mathrm{Var}[S] + 2\mathrm{Cov}[F,S])^{1/2}\right)$$
- The covariance is computationally difficult to calculate, so let
$$Cov[F,S] = 0$$
- So the 95% confidence interval is simplified to
$$\exp\left(E[F] + E[S] \pm 1.96(\mathrm{Var}[F] + \mathrm{Var}[S])^{1/2}\right)$$

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



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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,

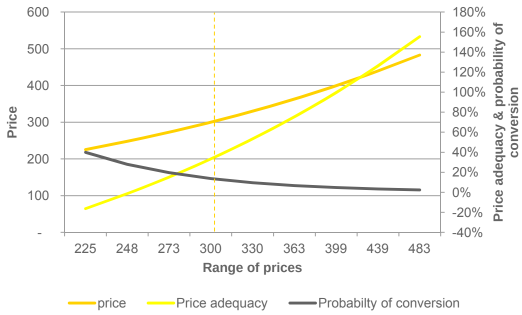
P is the price for the risk

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



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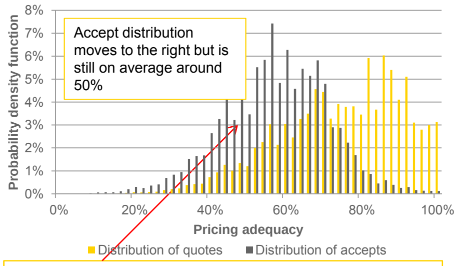
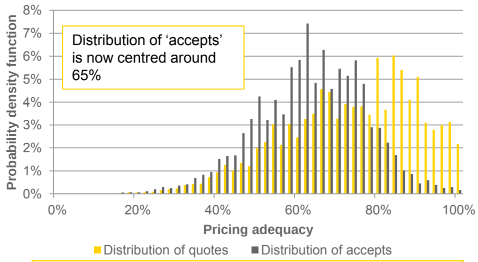
The pricing adequacy measure may help to provide a consistent basis to adjust quoted premiums

- 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

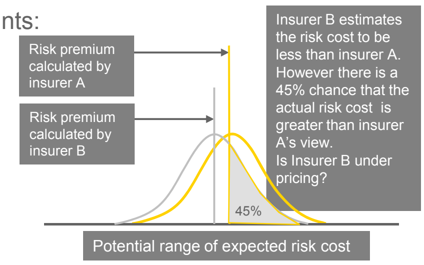


A flat increase will marginally improve the accept distribution of price adequacy

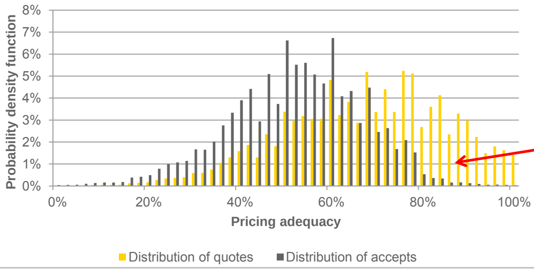
Price changes are made to maximise the pricing adequacy

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?

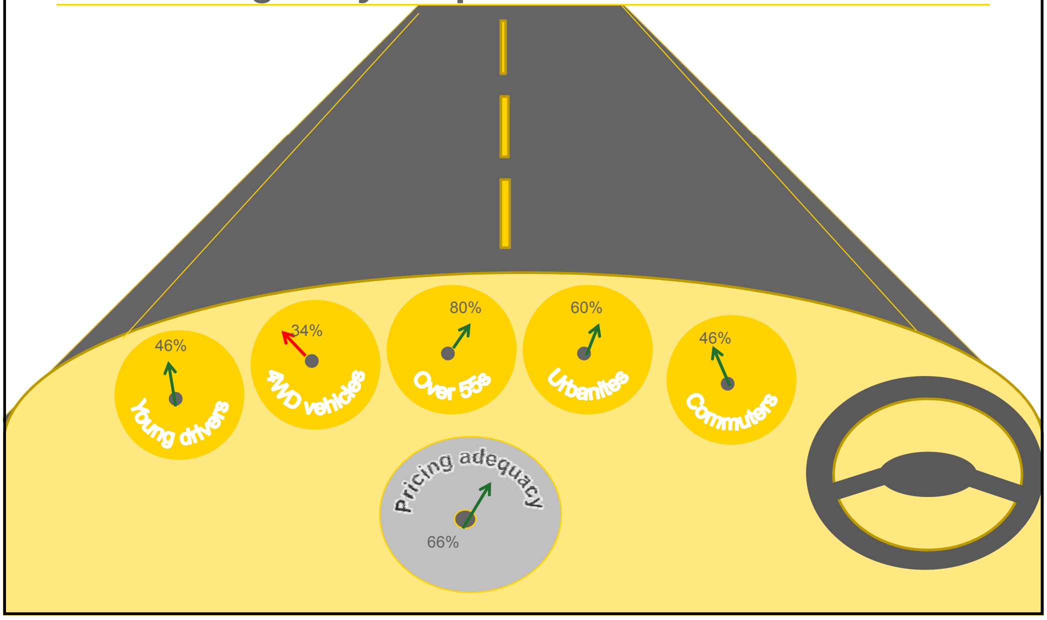


Distribution of pricing adequacy for quotes and accepts



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?



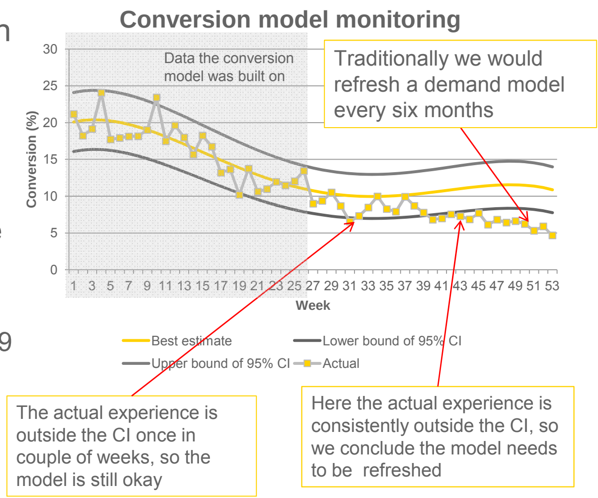
Having the information to justify deviances from plan and to spot potential opportunities

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

- 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



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Summary

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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