

Demand & elasticity modelling for P&C insurance pricing under various conditions

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28 August 2024



01 Introduction

02 Business applications

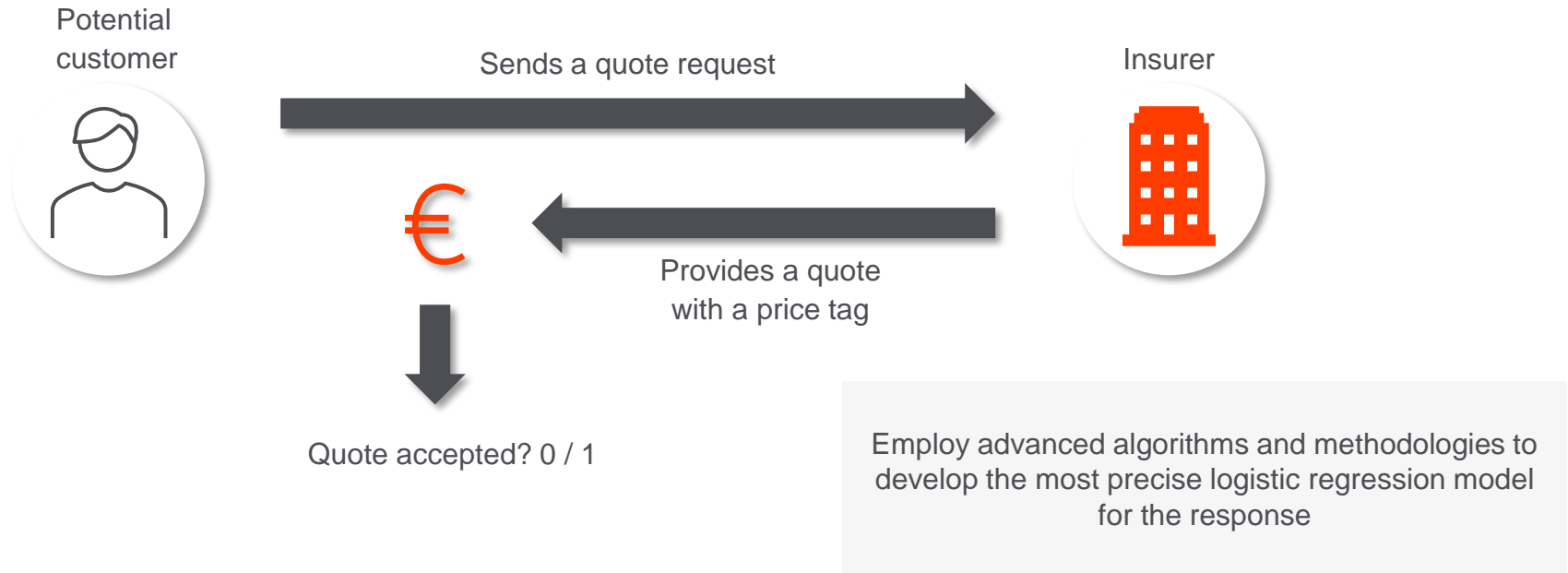
03 Data gathering

04 Critical elements in demand model development

1

Introduction

Customers shop around for affordable insurance quotes



Digital channels facilitate effortless comparison of multiple quotes

Potential customer



Quote request



Price Comparison Website

# 1	€ € €	2
# 2	€ € €	
# 3	€ € € €	

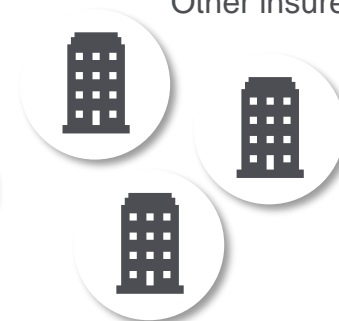
Quote



Insurer



Other insurers



Quotes



Things to consider

- 1 What / how to model?
- 2 Influence of the price?
- 3 What is the market doing?

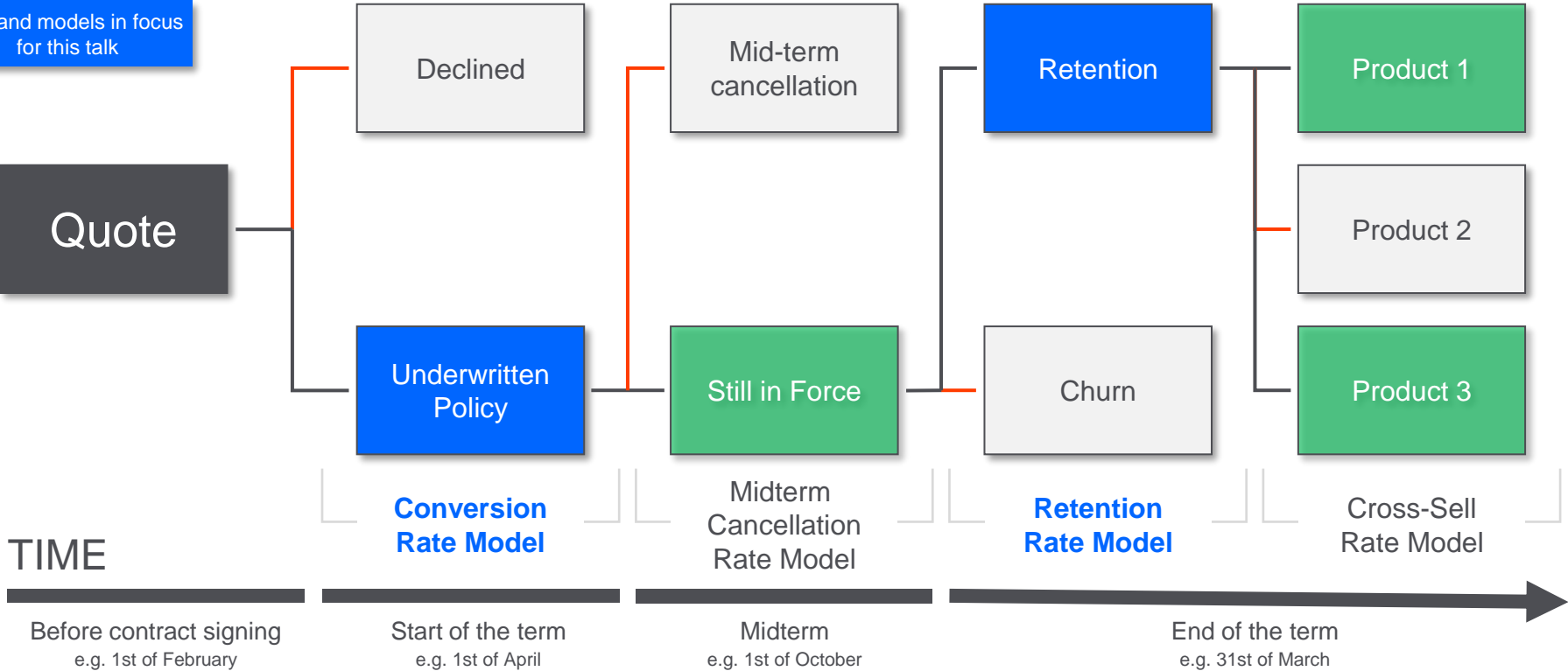
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Quote accepted? 0 / 1

Demand models enable insurers to analyse customer purchasing behaviour across different price levels

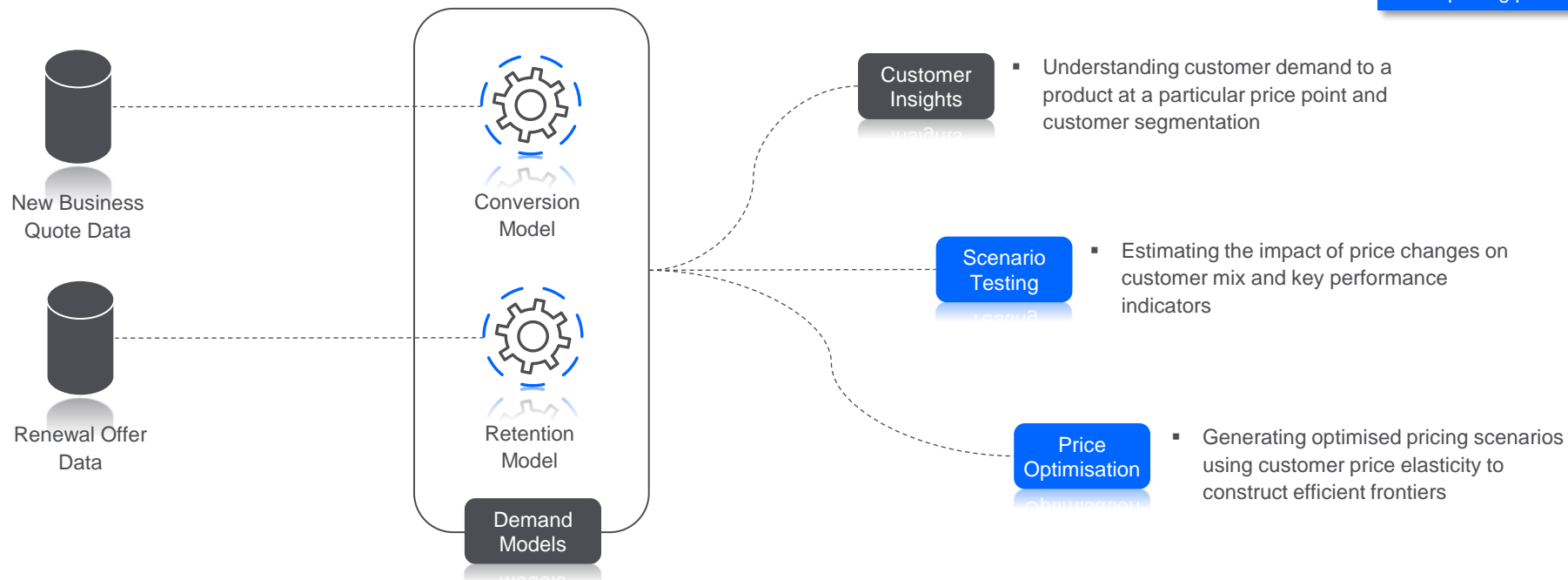
Demand models in focus for this talk



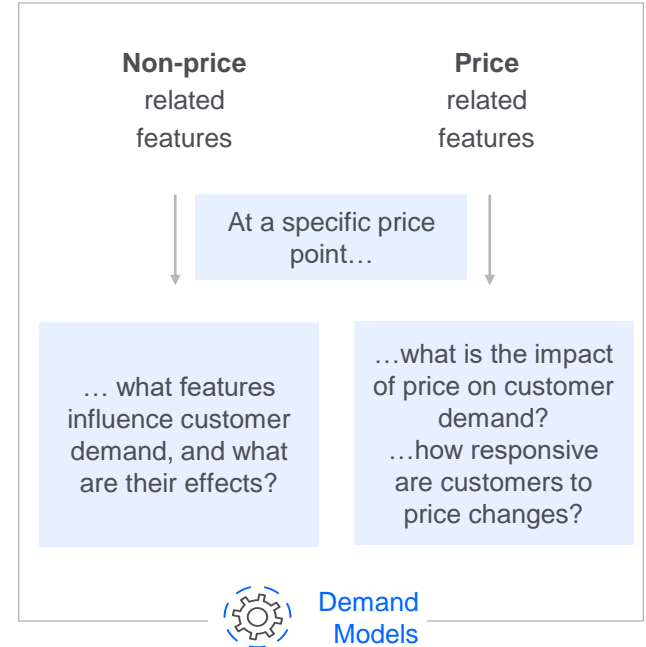
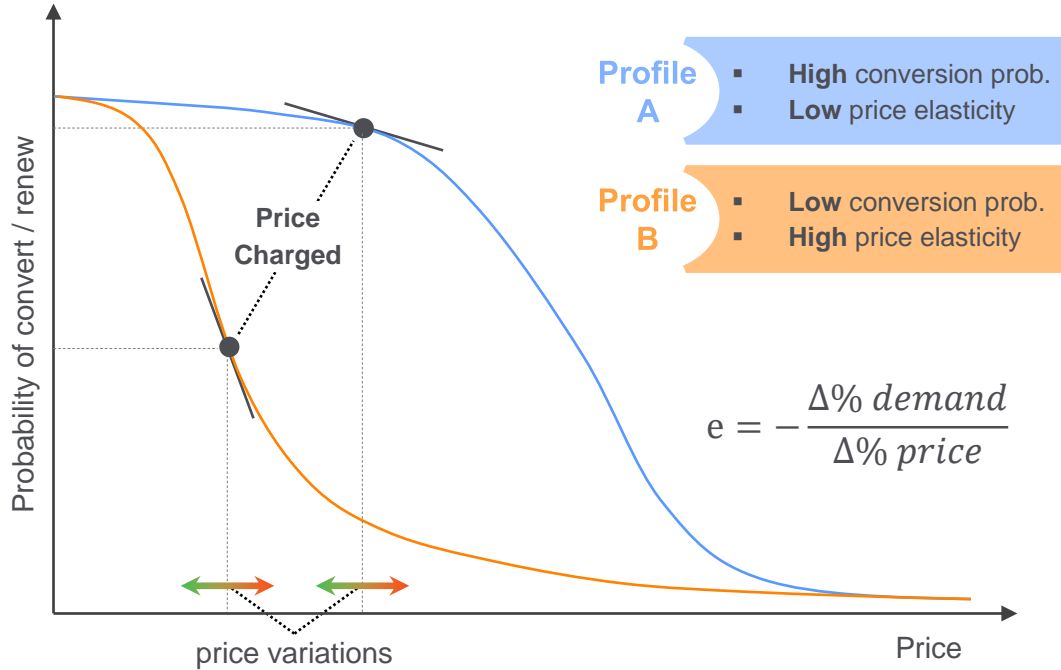
2 Business applications

Practical applications of demand models provide valuable solutions for diverse business challenges

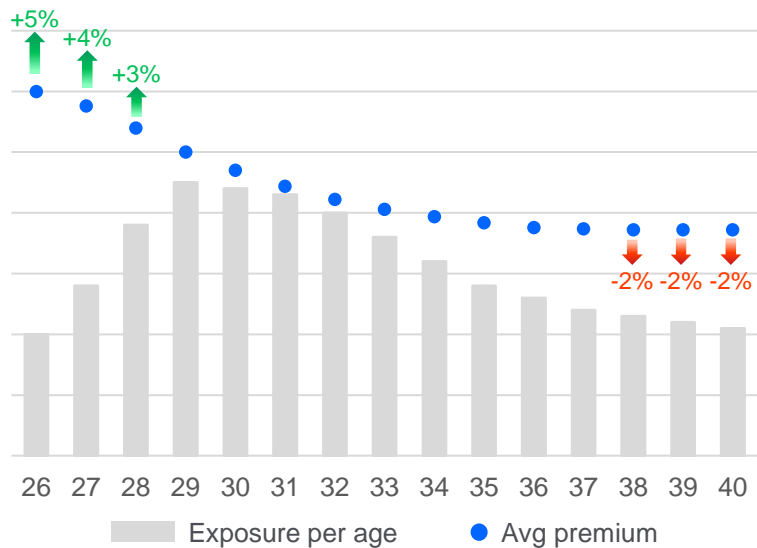
Advanced integration into the pricing process



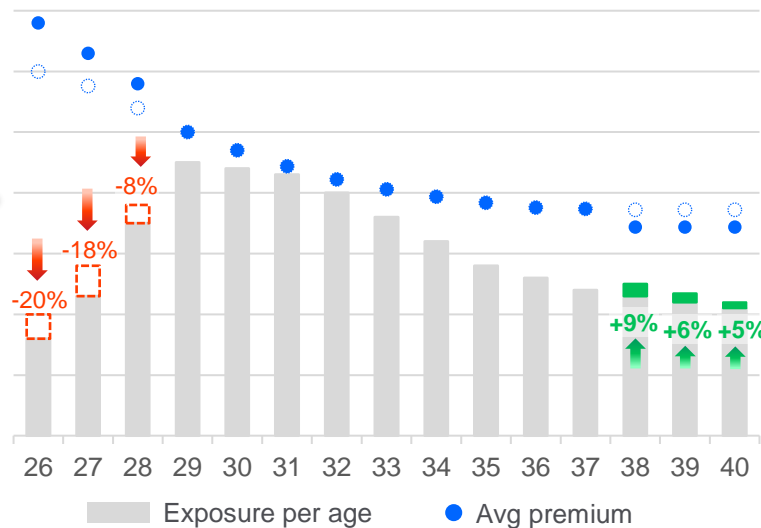
Demand drivers are identified for customer segmentation and isolating the effect of price



Quantifying price impact on segment volumes is crucial for managing insurance portfolios effectively



Price change



Demand modelling
for scenario testing

Price changes have asymmetric
effects on the customer mix

3

Data gathering

Demand models are trained on new business and renewal offers structured similarly to policy databases



Customer

- Driver Age
- License age
- Marital Status
- Occupation
- Previous Company
- Tenure
- ...



Vehicle

- Make
- Model
- Vehicle's age
- Horse Powers
- Fuel type
- Sum insured
- ...



Claim's History

- Number of claims in the last "n" years
- Total claim amount in the last "n" years
- Bonus Malus
- NCD
- ...



Territorial / Economical

- Zip-Code / Postal Code
- Region
- Geo-demographical info
- Payment Method
- Instalment
- Credit Score
- ...



Additional Info

- Actual premium (previous year)
- Offered premium
- Commercial premium
- Risk premium
- Discount amount
- Competitive market analysis
- Premium variation (between price test groups) (%)
- Other policies (e.g. house, health)
- Change of product
- Type of cover
- Number of endorsements (risk changes)
- Distribution channel
- ...

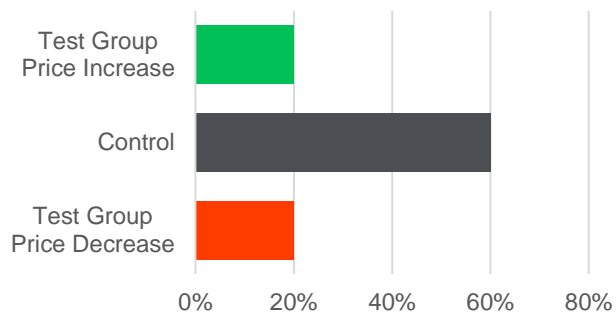
Quote ID	Driver Age	Vehicle Make	Payment Type	Price	...	Purchased?	Predicted Rate
12345	35	BMW	Monthly	750	...	0	0.05
12346	22	Audi	Yearly	1250	...	1	0.10
12347	55	Jaguar	Yearly	1000	...	0	0.02
...

Data gathering with randomised price tests allows insurers to observe changes in demand resulting from price variations

Experiment design

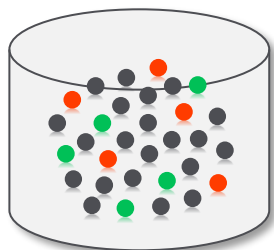
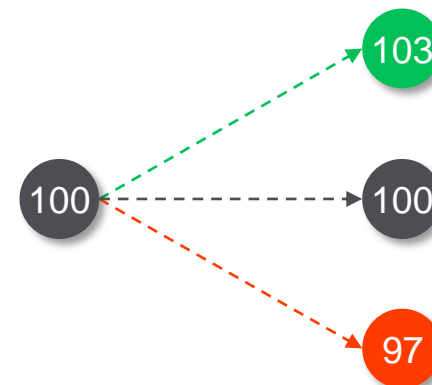
- **Pseudo randomly** assign parts of the portfolio to a higher / lower price
- Then use this information as a predictor variable in the model

Randomised price test groups



Current Price

Price Variations



Quote Data /
Renewal Offer Data

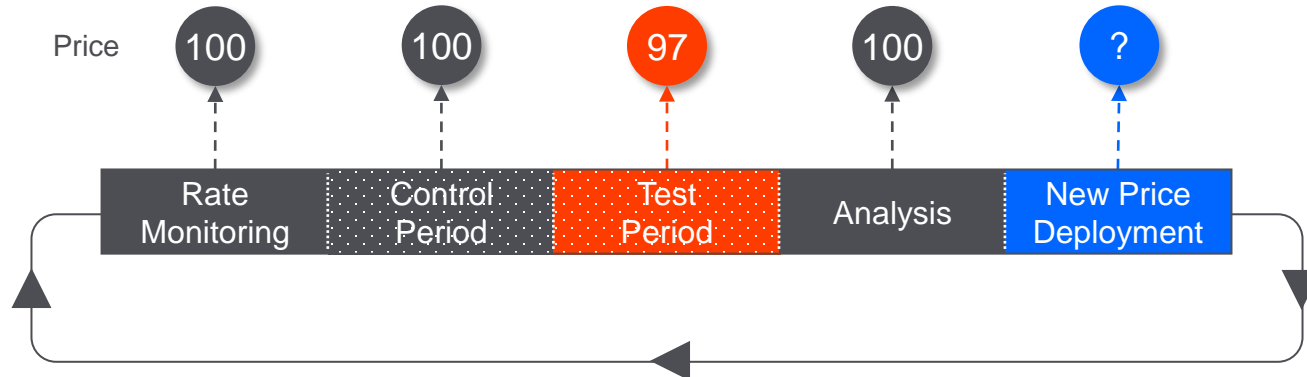
Considerations

- Deliberately mispricing generates a “cost”
- A trade-off must be found between these costs, the size of the test groups, and the duration of the test
- Reputational and legal aspects must be considered as well

When randomised price test isn't feasible, a short-term price change is applied to capture price-demand relationship

Experiment design

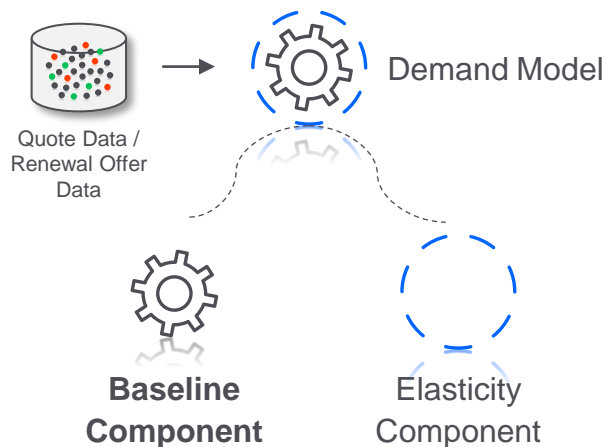
- Use a control date period instead of a randomly selected control group
- Apply a price shock to all quotes during the test period
- Assume no significant change in external factors that could affect customer demand during the experiment period



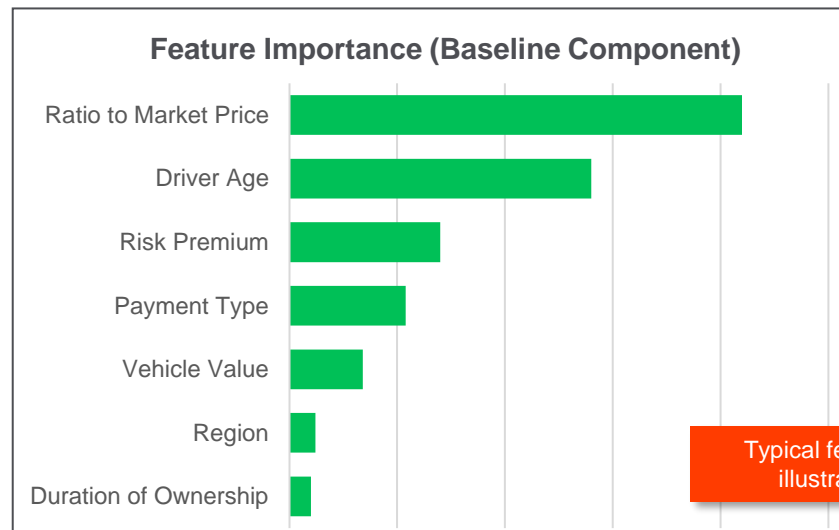
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Critical elements in demand model development

Baseline component of the demand model provides foundation for understanding demand patterns

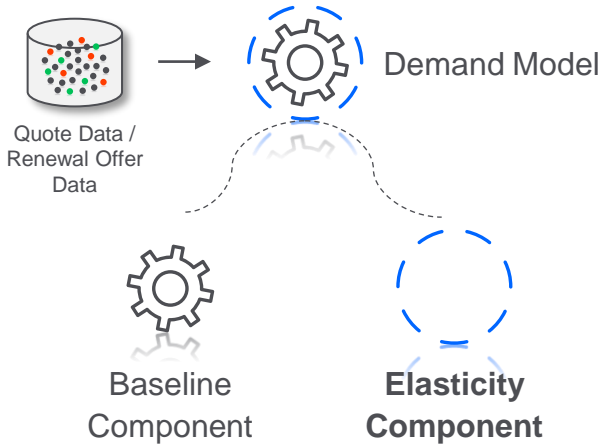


model = glm(data, family = binomial,
response ~ Feat.1 + ... + Feat.N)

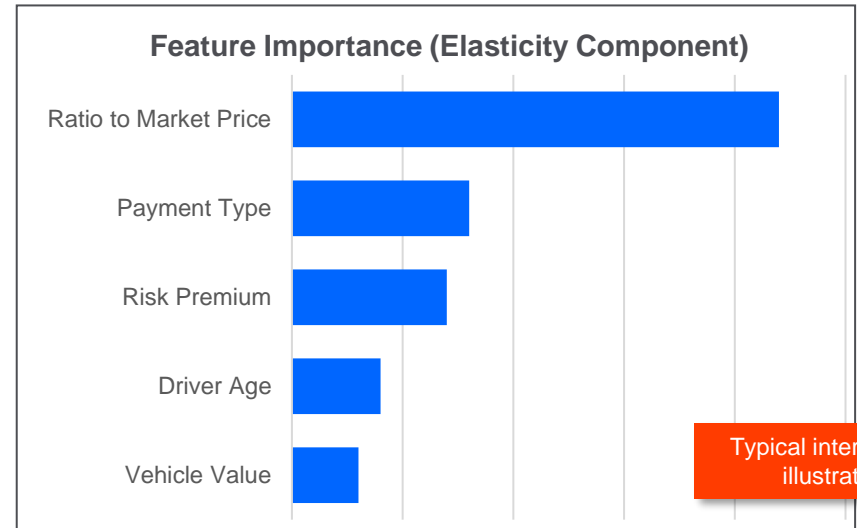


- Starting point of demand model development
- Aims to establish baseline level of demand by focusing on features unrelated to price variations
- Statistical success is predominantly achieved here

Elasticity component estimates the effect of price variations and segments price elasticity



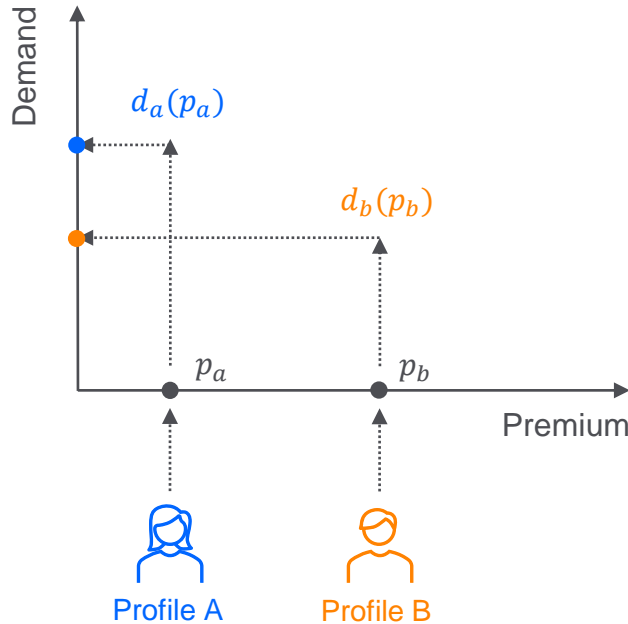
$$\text{model} = \text{glm}(\text{data}, \text{family} = \text{binomial},$$
$$\text{response} \sim \text{Feat.1} + \dots + \text{Feat. N} + \text{Price.Var} +$$
$$\text{Feat.1*Price.Var} + \dots + \text{Feat.K*Price.Var})$$



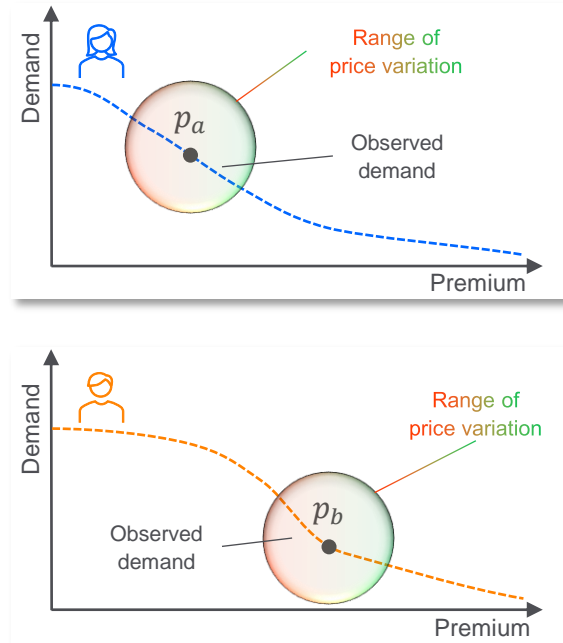
- Price variation features integrated into the model
- Interactions between the baseline component and price variation features are tested to align predicted elasticity with observed elasticity

Price variation range must be aligned with price change limits to ensure accuracy of elasticity component

Outputs from the **baseline** component



Outputs from the **elasticity** component

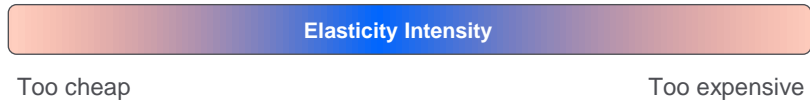
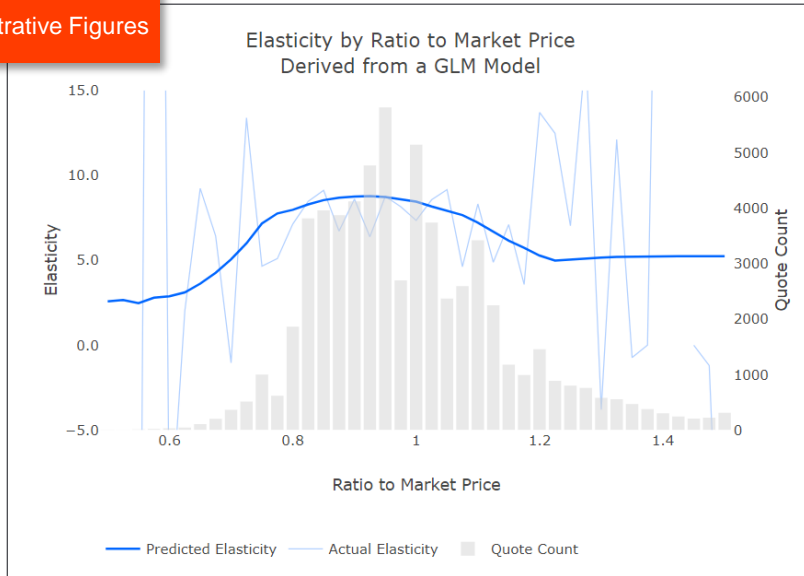


The accuracy of predicted demand decreases as the magnitude of the price change exceeds the range of the tested price variations.

However, if the range of tested price variations is set too wide, the model cannot accurately estimate changes in demand in response to small price changes.

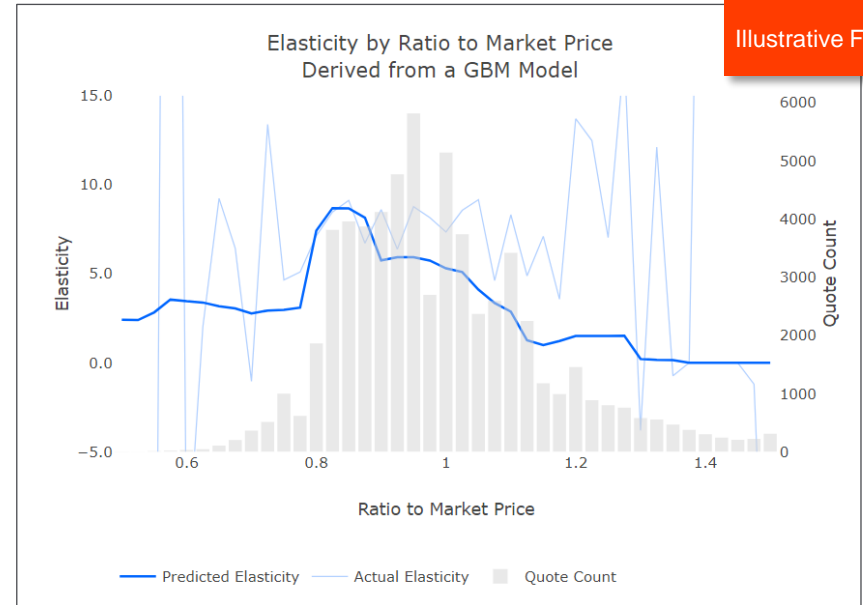
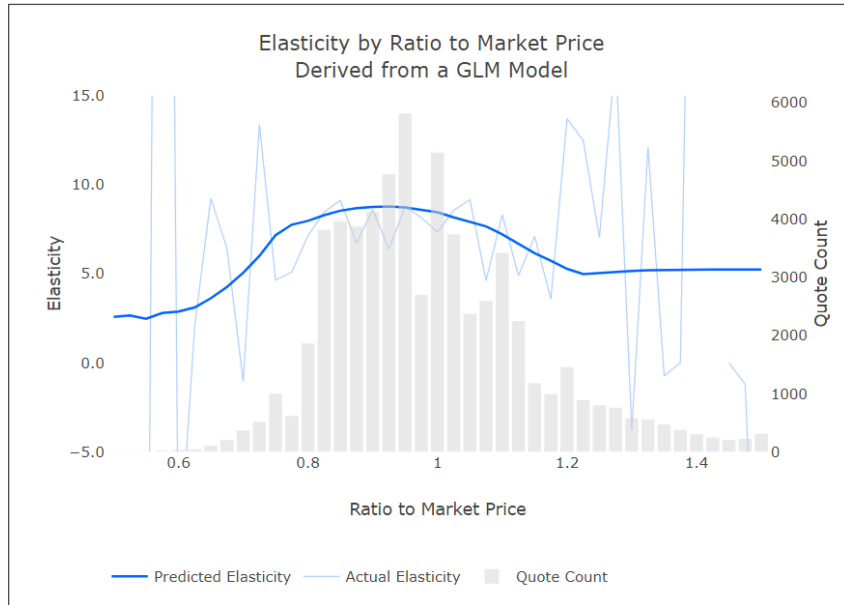
Visual comparisons between actual and predicted elasticity guides the construction of the elasticity component

Illustrative Figures



- Within each interaction term included in the elasticity component of a demand model, **price elasticity varies.**
- One of the most important features explaining demand and price elasticity is the relative price position of our product in the market in terms of price.
- Customers show **higher price elasticity** when our prices are **close to market average.**
- Price elasticity decreases in segments where our prices are either too low or too high relative to the market

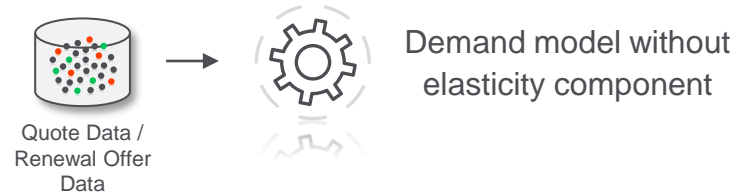
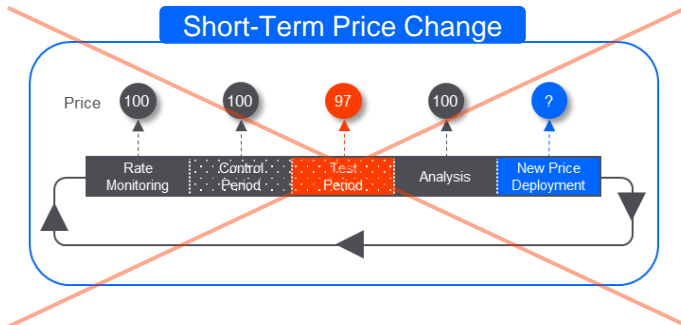
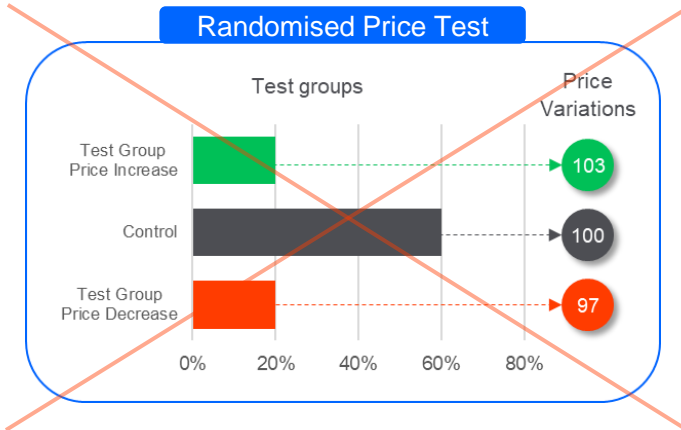
Tree-based demand models improve accuracy but produce less smooth and plausible elasticity curves



Illustrative Figures

- It is more difficult to control the smoothness of the elasticity curves generated by demand models built using tree-based algorithm compared to those built using GLMs. Although modelers can prevent overfitting, weak learners capture a higher degree of interaction involving price variation features, resulting in jagged elasticity curves.

When direct measurement of elasticity is not feasible, it can be estimated through simulated pricing experiments



- No observed price elasticity is available.
- A feature representing the final price charged to each customer (commercial price after all discounts) should be included in the model.
- After constructing the model, final price values will be shifted up and down, and predicted demand will be calculated by the demand model.
- Predicted elasticity can be calculated and visualised by comparing the change in demand with respect to changes in the final price, to validate the results.
- A variation of this method can be applied with a set of features representing different layers of prices charged to the customers.

Thank You

28 August 2024



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