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Demand and Price Optimisation for Insurance Pricing

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Agenda

- Demand-based Pricing
- Elasticity and Price Sensitivity
- How Demand Modelling is Approached
- How Optimisation is Approached

Demand-based Pricing

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The different levels of Demand-based pricing

Risk-based pricing

Commercial premiums are built up from the best view of risk, with minimal commercial adjustments on top.

Static demand

Demand (conversion and retention rates) is actively tracked and monitored. Spikes in demand are met with a corresponding commercial adjustment.

Dynamic demand

We not only model demand, but we also measure or model price elasticity of demand and take this into account when setting the commercial premium.

Price optimisation

The commercial premium is built using an optimisation routine that takes our best understanding of risk and demand into account.

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Why move to Demand-based pricing?

Cons

- Cost in actuarial resource to build and maintain Demand models.
- Risk involved in moving away from purely Risk-based pricing:
  - Financial risk if our models are inaccurate.
  - Reputational risk if we are perceived to be "taking advantage" of customers.
- Potential to introduce price changes that can:
  - Be unstable in time.
  - Lack transparency.

Pros

- Greater understanding of the impact of a proposed change in rates.
- Ability to deliver rates that generate results that are more aligned with company strategy.
- Opportunity to improve overall business performance.

Elasticity and Price Sensitivity

What is Price Elasticity of Demand?

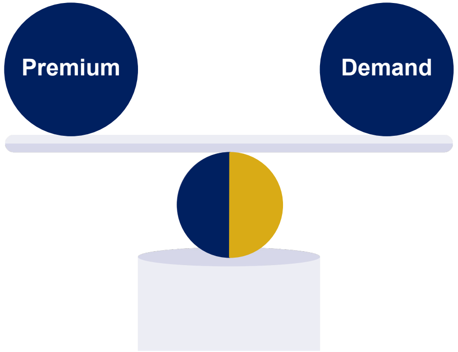
$$e(P) = -\frac{dD/D}{dP/P}$$

$e(P) =$ Price Elasticity
$D =$ Demand
$P =$ Price

Price elasticity at a certain price point is defined as the **percentage change in demand for a percentage change in price**.

Where price elasticity is *low* you can raise the price with only a small loss of demand.

Where price elasticity is *high* you can increase the demand with only a small reduction in price.

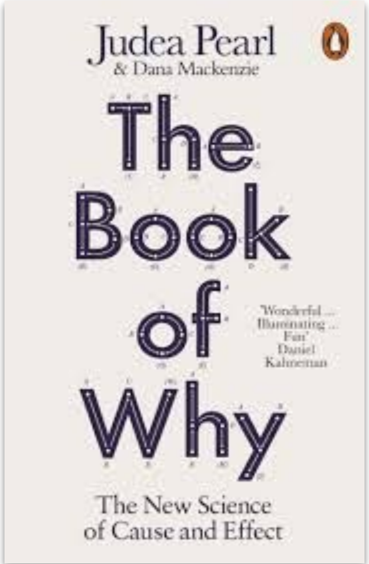


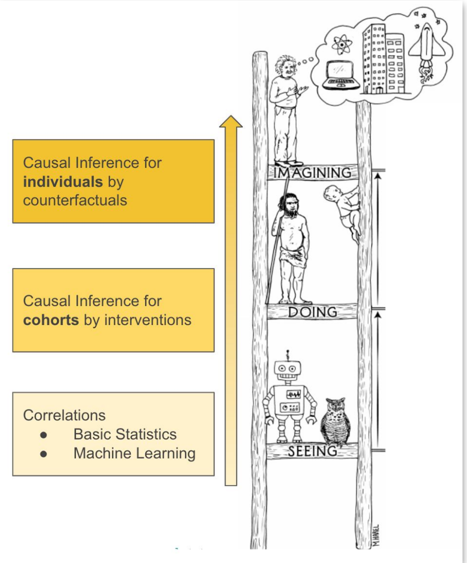
Elasticity modelling is causal

- For price elasticity modelling, we want to understand the *causal* relationship between **price** and **demand**, not simply build a model that fits historical data well.

- This is different from Risk pricing where we care about how accurately our models predict claims costs, and not whether our models capture causal relationships between pricing factors and risk.

- Unfortunately, we only know the price we offered and whether the quote converted. We don't have the counterfactual – what the customer behaviour would have been if the price had been different.





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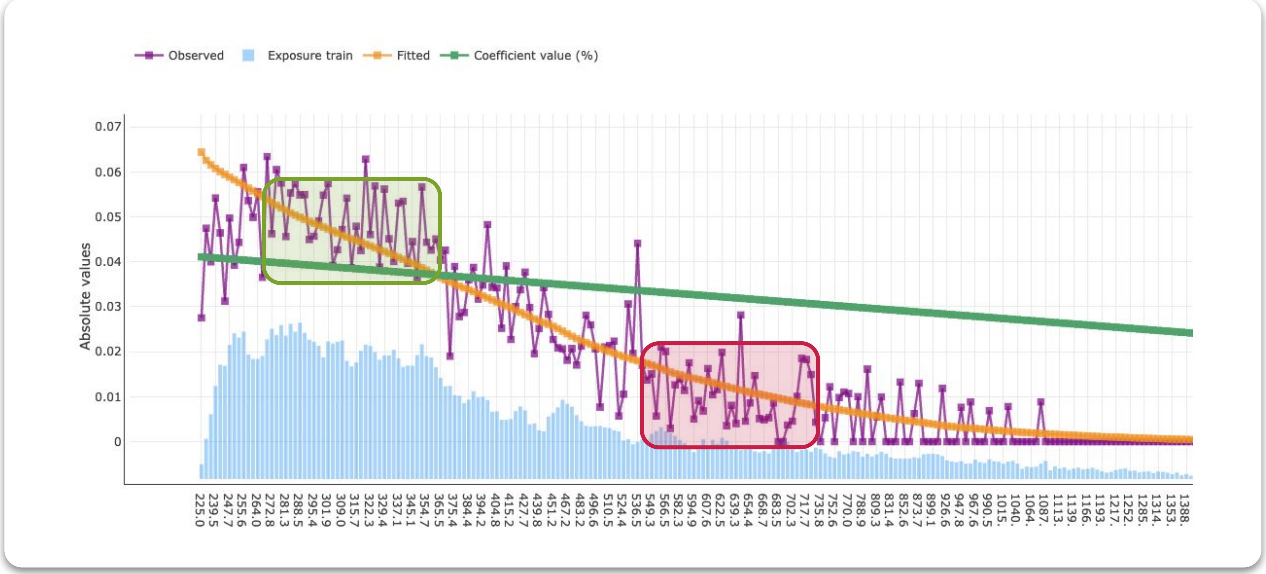
Price is based on personal features (correlation problem)



Low risk

- Low price (300)
- High conversion (5%)

High risk

- High price (700)
- Low conversion (1%)

Let us move a customer from £300 → £700. Price elasticity will be **underestimated** here, since **different profiles** have a **different expectation of price**.

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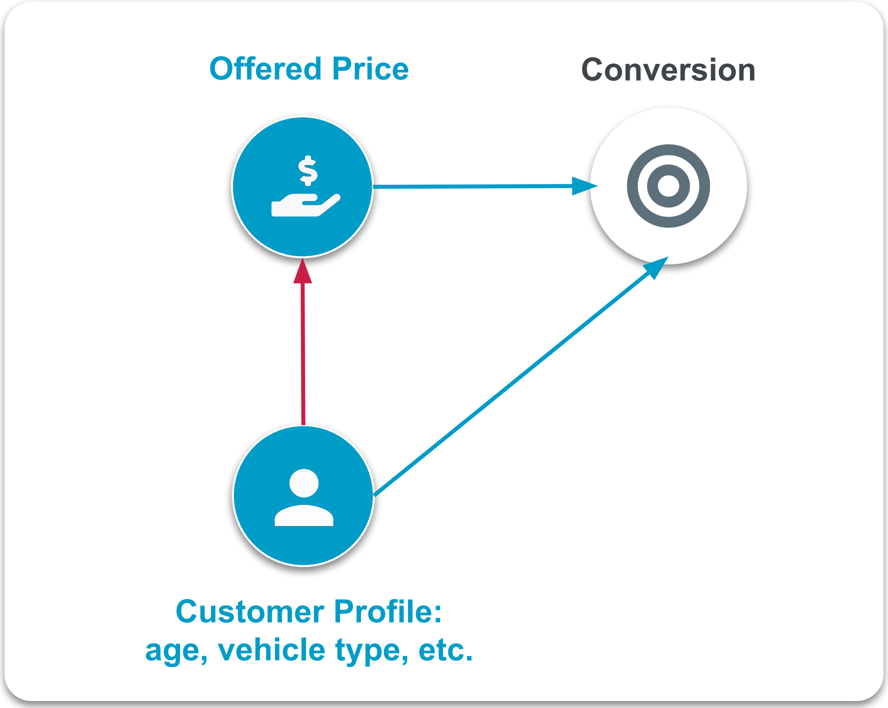
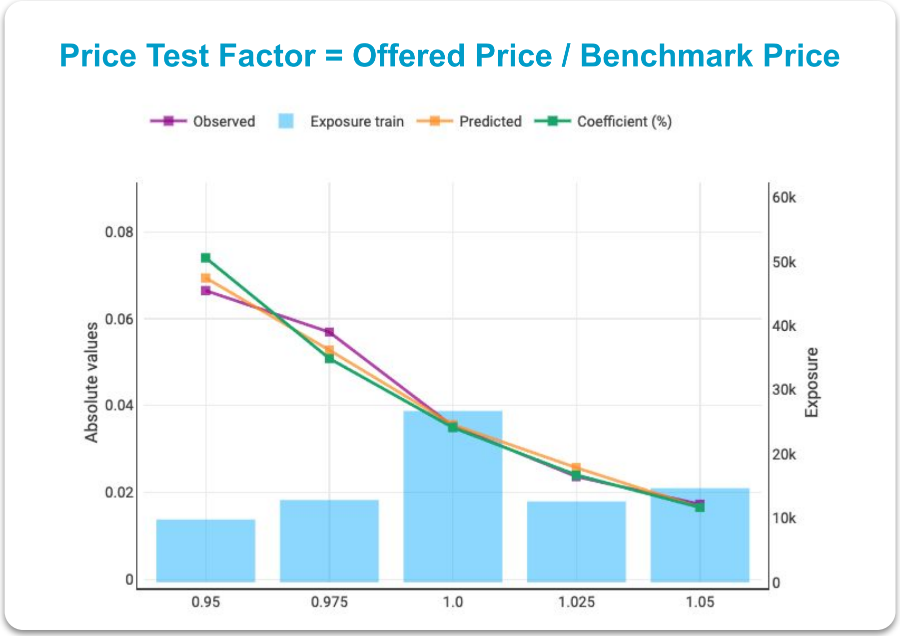
Why modelling demand is challenging



Price is not an independent variable

- Indeed, the price is calculated using the client profile so it is dependent from the age, vehicle type, etc.
- Thus, **we cannot isolate the effect of the price** from other variables in the dataset.

Random price changes



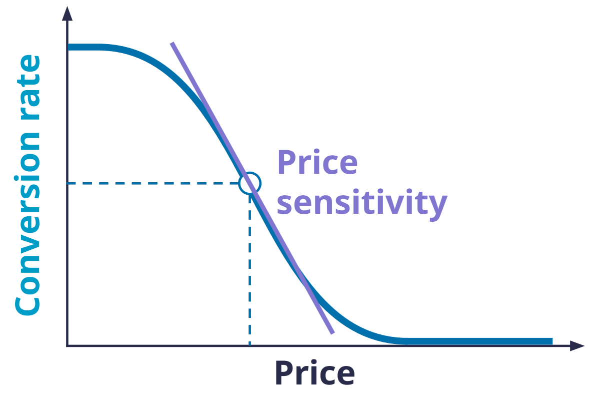
- Random price adjustments allow us to model the relationship between price and demand independent of the other policy characteristics.
- The slope of the demand curve through this factors tells us how sensitive the customers are to changes in price.
- This can be different across different segments of the book.

Desired properties of a Demand modelling process

- **Smooth** - A continuous, smooth and strictly monotonically decreasing relationship between price and demand.
- **Fast** - Fast time from data to insight.
- **Repeatable** - A different modeller following the same process would get similar results.
- **Accurate** - Accurately describe the causal relationship between price and demand.
- **Explainable** - Easy to understand which profiles have higher or lower price elasticity.
- **Appropriate** - The model must be built with its intended use in mind. For example, if it needs to be scored in real-time, then all the model inputs used must be available in the deployment environment.

How Demand Modelling is Approached

A robust methodology for demand modelling



Conversion rate

How likely are customers to buy with current prices?

Static Component

Price sensitivity

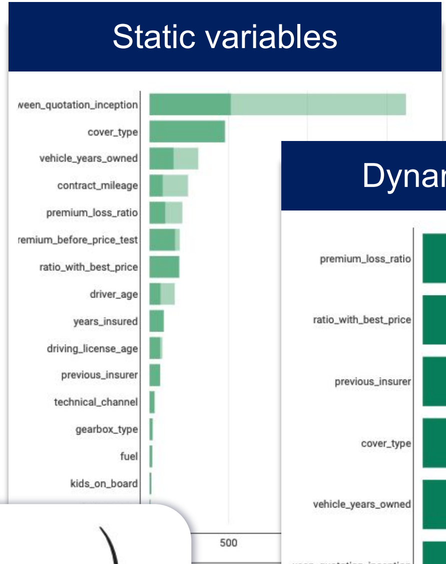
How does changing prices impact demand?

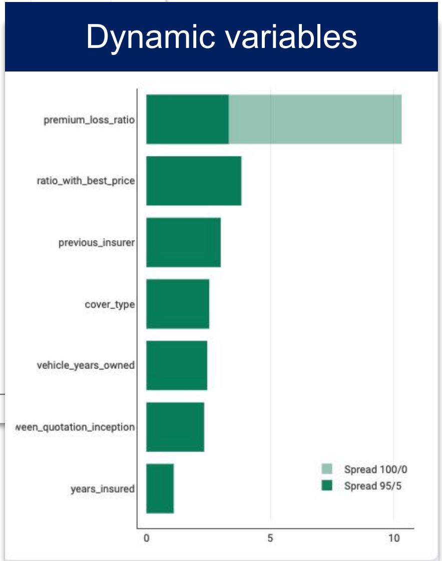
Dynamic Component

Example Approach

Two variable selections

1. What factors are responsible for **Static Conversion**.
2. What factors are responsible for **Dynamic Elasticity.**





$$Demand(X,\pi) = Logistic\left(\underbrace{\sum_{d} f_d(X_d)}_{\text{Static Component}} + \log(\pi) \times \underbrace{\sum_{d'} g_{d'}(X_{d'})}_{\text{Dynamic Component}}\right)$$

Static Component

Dynamic Component

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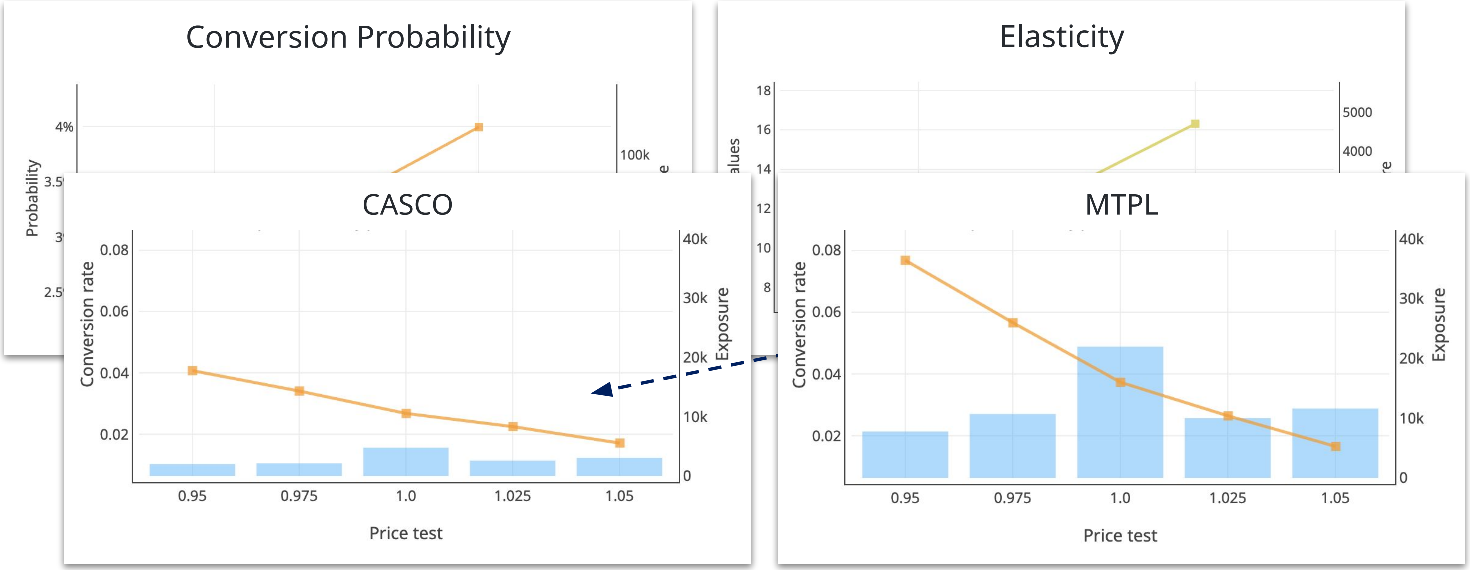
Static and Dynamic Example with Cover Type

MTPL has **higher Conversion** than CASCO, but also a **higher Elasticity.**



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How to validate price elasticity models

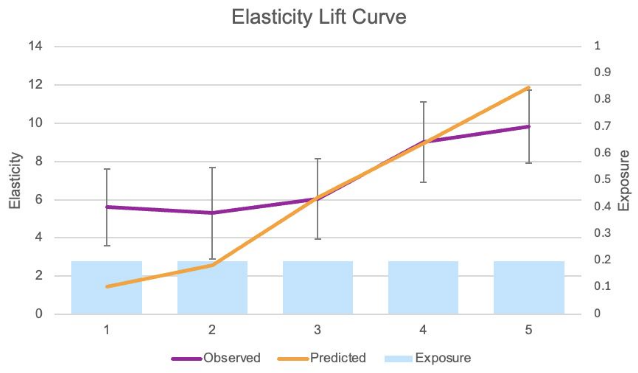
We want to check that on out-of-sample data, the predicted price elasticity matches the observed.

$$\text{logit}(\text{Demand}) = \beta_0 + \beta_1 \log(\text{PTF})$$

$$\text{Elasticity} = \beta_1(\text{Demand} - 1)$$

By fitting a logistic GLM with log of the Price Test Factor as the only regressor, we can measure an “observed” Elasticity on an segment of our data.

We can also use the confidence intervals of the beta value to build a confidence interval range for our “observed” price Elasticity.



We can repeatedly check predicted elasticity matches “observed” across different portfolio segments, and even build a lift curve equivalent.

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How Optimisation is Approached

What is Price Optimisation?

A formal procedure for generating prices to deliver the mathematically “best” results.

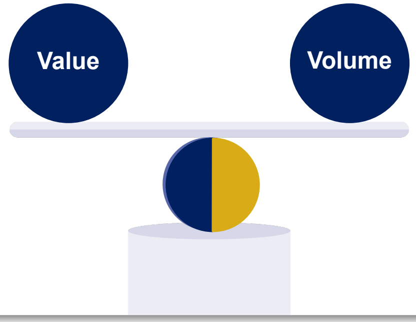
Target

- Maximise written margin.

Input Assumptions

- Risk models
- Variable costs
- Other revenue
- Demand &
  Price elasticity

Optimisation routine



Constraints

- Price within ±20% of technical premium
- Write £150m GWP
- Write no more than 5% policies in high risk segments.

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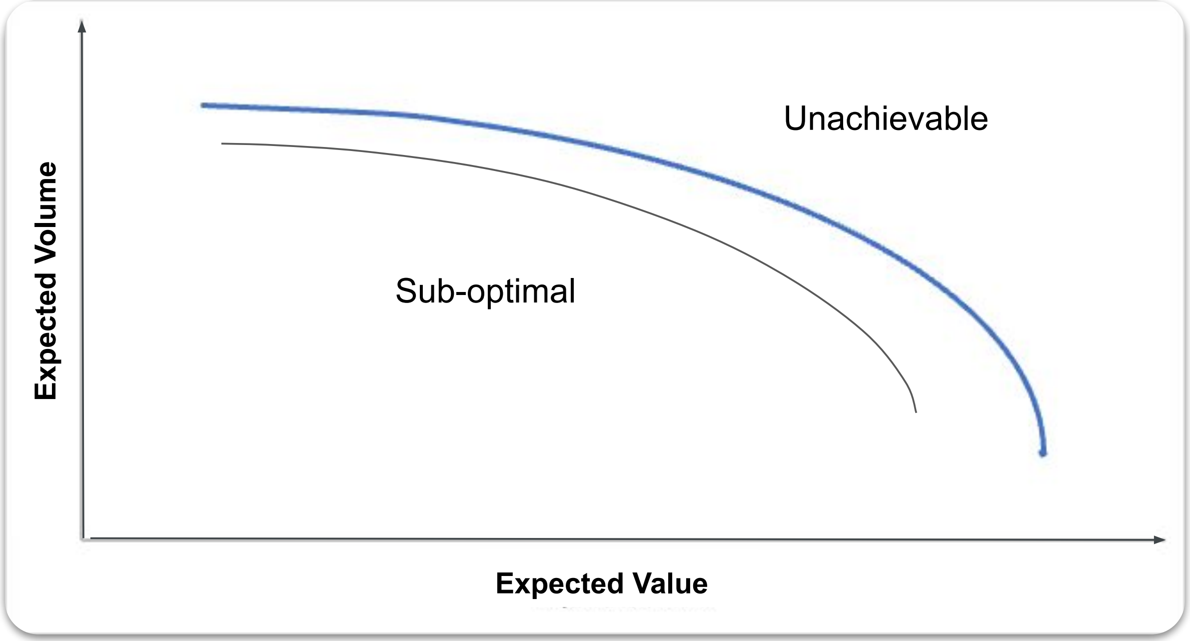
The Efficient Frontier



Types of Price Optimisation

Individual Optimisation

The optimal price adjustment is individually generated for each profile such that the overall result is optimal.

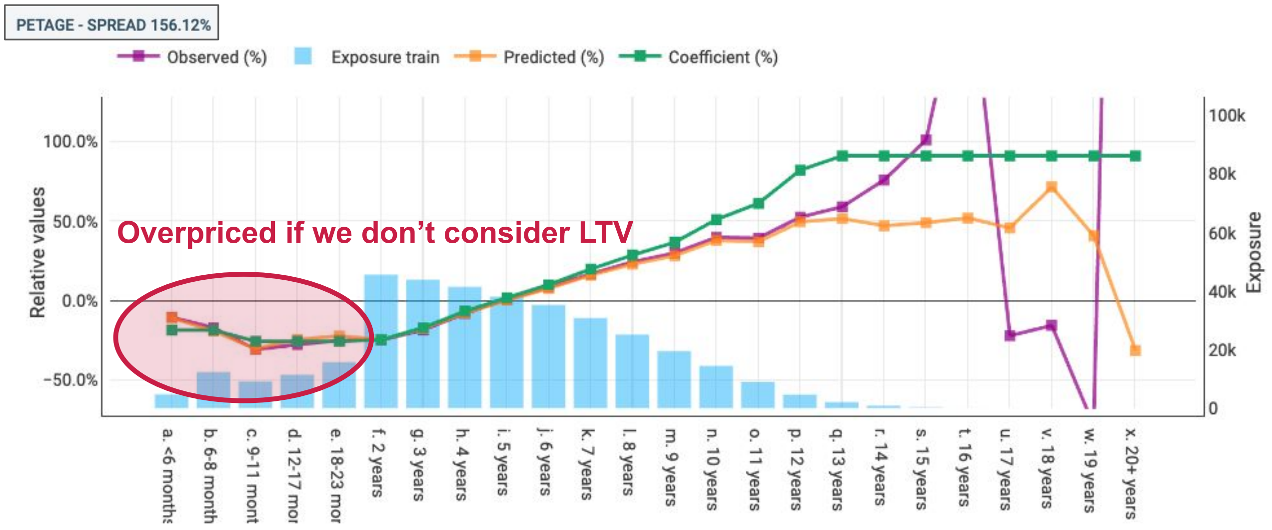
- (+) More mathematically optimal.
- (+) Optimisation routine is simple.
- (−) Results are less transparent and explainable
- (−) Optimisation procedure must be run every time we generate a price.

Rating structure optimisation

Optimal price adjustments are generated with the additional constraint that they must be described by a set of rating tables.

- (+) Results are more transparent and explainable.
- (+) Simple rating structure to implement.
- (−) Less mathematically optimal.
- (−) Optimisation routine is complex.

Lifetime value



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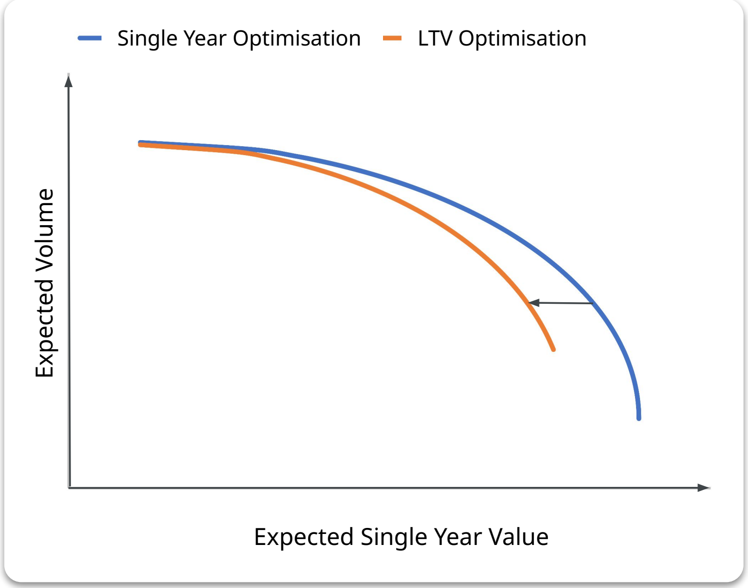
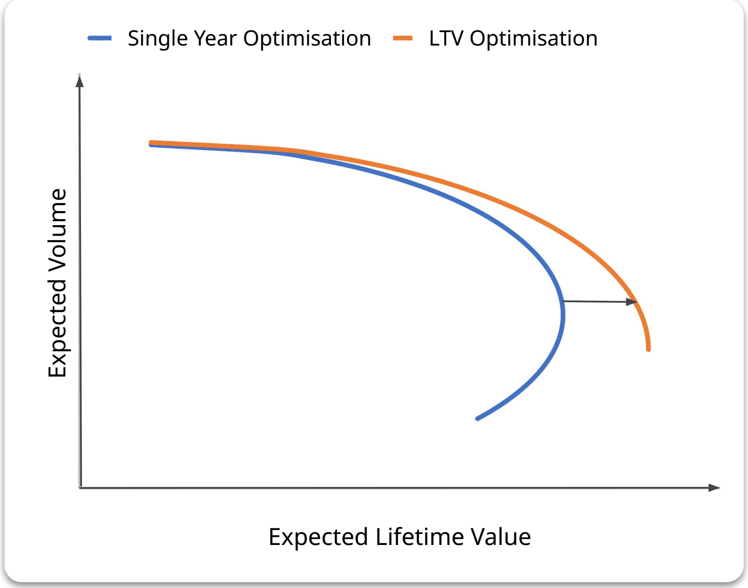
Lifetime Value





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Is Price Optimisation Fair?

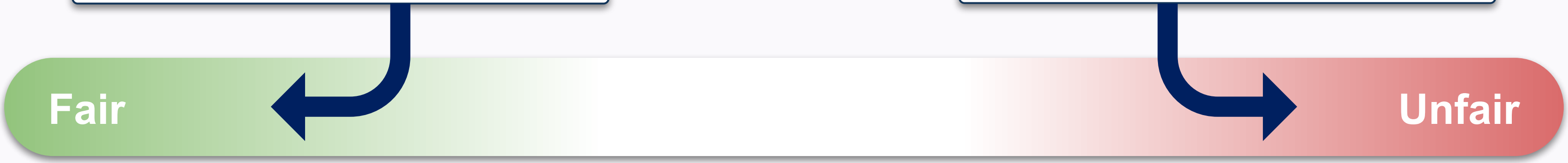
How Optimisation is Approached

Duty to treat customers fairly.

Reducing prices in uncompetitive segments.
Raising the base price for the rest of the portfolio to rebalance.

Duty to customers and shareholders to cover expenses efficiently.

Raising premiums excessively year-on-year for vulnerable customers less able to switch providers.



Properties of a successful Price Optimisation process

Stable
Price changes that don't reverse themselves every cycle.

Transparent
We understand which profiles are most affected and why.

Fair
The impacts on customers are reasonable and justifiable.

Simple
Where complexity does not add value it is removed.

Controlled
Risks are well understood with controls in place for mitigation.

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Questions

Comments