
Damiano Massimi and Thibault Imbert discuss the potential benefits of behavioural modelling in general insurance, particularly in combining it with price elasticity

Price elasticity is a well-known concept in economics and its adoption is becoming more ubiquitous in the field of airline, hotel and car hire reservation pricing. However, its inclusion in the general insurance pricing process has not yet been fully implemented.

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## What is behavioural modelling?

Behavioural modelling attempts to explain the purchasing behaviour of a customer and identify the main factors influencing the decision.

In an insurance context, behavioural modelling is addressed at different milestones in a policy's lifecycle, from the first quote issued to renewal and beyond. Its four main applications are:

- Conversion: predicting the purchase of a new policy
- Midterm cancellation: predicting the cancellation of the policy during its lifetime (subject to regulations)
- Retention: forecasting the renewal of the contract at expiration
- Cross-sell/upsell:
  - Cross-sell – which products the customer may buy from the company (for example buying home insurance while already owning motor insurance)
  - Upsell – which extra coverage will be added (for example adding fire and theft to the existing motor product).

Behavioural modelling can be used regardless of the distribution channel, but usually brings the most value to direct business – especially on aggregators, where the price sensitivity is the highest and the most information is available. We will assume this context in the rest of the article.

## Price elasticity and price test

Price elasticity is defined as $e = -\frac{dD/D}{dP/P}$ where $D$ is the demand and $P$ is the price. Elasticity measures how sensitive demand is in response to a change in price.

The process of randomised price testing refers to a randomly assigned price adjustment (independently of risk) on every quote or policy – for example, -$a$%,0%,+$a$%, assuming that this is permitted from a regulatory perspective. This process is used to capture the price sensitivity at conversion or renewal. The resulting loading or discount is a variable called price test ($PT$), which contains the value of the price adjustment applied to each quote or policy.

## Modelling approach

Behavioural models are developed similarly to risk models. Generalised linear models (GLMs), generalised additive models (GAMs) and machine learning (ML) models represent the vast majority. Using a GLM or GAM approach, we obtain the following formula for demand:

$$D(\mathbf{X}, \mathbf{P}) = Logit\left(\sum_i f_i(\mathbf{X}, \mathbf{P})\right) \quad (1)$$

Where: $\mathbf{X} = (X_1 \dots X_n)$ is the vector of client details.

$\mathbf{P} = (P_1 \dots P_p)$ is price-related information (proposed price, competitors' prices, price positioning, etc.).

$f = (f_1 \dots f_q)$ are functions obtained from GLM or GAM modelling.

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Accounting for price elasticity requires adding additional terms to equation (1):

$$D(\mathbf{X},\mathbf{P},PT) = Logit\left(\sum_i f_i(\mathbf{X},\mathbf{P}) + \sum_i g_i(\mathbf{X}) * h_i(PT)\right) \quad (2)$$

This extra term $\sum_i g_i(\mathbf{X}) * h_i(PT)$, to test elasticity, can be seen as introducing interactions between $PT$ and other variables ($X$), with $PT$ independent from $P$.

Like $f = (f_1 \dots f_q)$, $\mathbf{g} = (g_1, \dots, g_l)$ and $\mathbf{h} = (h_1, \dots, h_l)$ are functions obtained during modelling, with $\forall i = 1, \dots, l$, $h_i(0) = 0$.

Demand can then simply be estimated by applying formula (2), with $PT=0$, which leads to (1)=(2).

## How to measure and predict price elasticity

Because both the demand information and the price test variable are available, it is possible to assess the price elasticity per variable (for example driver age, vehicle make), thus obtaining the observed price elasticity.

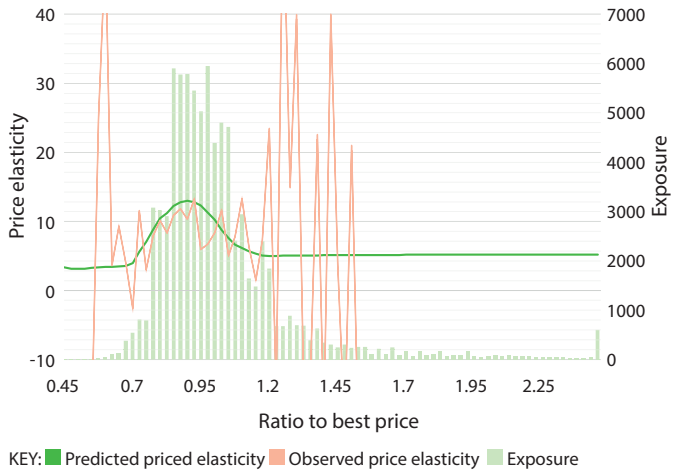
However, this can lead to high volatility and significant noise in the results due to a potential lack of exposure for some modalities. It may therefore not be possible to correctly assess price elasticity for all possible profiles. Moving from the observed to the predicted price elasticity is the solution to address this problem.

This can be done using the equation (2):

1. Simulate demand for each line of the database and each level of price testing, obtaining the expected demand for each profile and different levels of the premium.
2. Assess price elasticity using the expected demand and obtain the expected price elasticity at the policy level.
3. Visualise or use the obtained predicted elasticity.

Figure 1 shows an example of price elasticity depending on how close the price proposed is to the 'best market price', defined as the cheapest price offered in the market for the same product. It can be provided (for example external data) or predicted (for example reverse engineering).

FIGURE 1: Price elasticity versus ratio to best price.




"Estimating price elasticity shows that more than price, ranking drives demand"

## Benefits

The main benefit of behavioural modelling for insurance is to enhance the pricing strategy and optimise the performance of the book. Figure 1 shows that price elasticity is much higher for policies that are priced close to the cheapest price ('ratio to best price' close to 1) than for the policies priced below or above, increasingly so as you move towards the extremes.

Three immediate conclusions can be derived from this example (for aggregator business):

1. Being significantly cheaper than the market does not increase demand.
2. Being unreasonably more expensive does not reduce demand.
3. Being the cheapest or not has a strong impact on demand: more than the price, ranking drives demand.

## Looking beyond

Price elasticity will support the assessment of the change in demand in response to pricing changes. The insurance company can then quantify the expected evolution of demand following a change in the pricing strategy, and design improved strategies.

Two main approaches are usually followed when it comes to the next steps:

- Scenario testing – simulating several scenarios, assessing the impact on performance and volumes, and making a decision on the best scenario to implement, as per the desired outcome.
- Price optimisation – finding the optimal premium level for each client such that the company's ambition is reached at a portfolio level.

The advantages and disadvantages of both approaches are summarised in Table 1.

TABLE 1: Scenario testing versus price optimisation.

| | SCENARIO TESTING | PRICE OPTIMISATION |
|---|---|---|
| PROS | High control over the rating structure | Best possible premium level |
| CONS | Premium level partially optimal | Limitedcontrolandunderstanding of the premium level |

Behavioural modelling, especially including price elasticity, is still a relatively new topic in the field of insurance and its potential is not yet fully perceived. However, implementing a modelling framework that integrates this aspect can provide various advantages, from a better customer understanding to higher sales, and from better profitability to improved relevancy of the commercial rating structure.