Price optimization in nonlife insurance

Bernhard König, Aktuar SAV, CERA
Jan Küthe, Aktuar DAV
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Jan Küthe

Aktuar (DAV), Actuarial Data Scientist bei Akur8

About Jan

Jan ist ein Aktuar (DAV) aus Siegen und arbeitet bei Akur8 als Actuarial Data Scientist, um Versicherern zu helfen, die Potenziale der Pricing-Methoden des 21. Jahrhunderts nutzbar zu machen.

Zuvor hat er drei Jahre bei einer weltweit tätigen Aktuariellen Beratung gearbeitet. Er hat einen Master of Mathematics an der Universität Bonn abgeschlossen und wohnt in Köln.

Daneben ist er ein begeisterter Leser der Werke von Anna Seghers und Dietmar Dath.

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Bernhard König

Aktuar SAV, Principal bei Milliman

About Bernhard

Bernhard is a Principal at Milliman leading the Swiss nonlife practice. He joined Milliman in 2012 and supports his clients in pricing, reserving, capital modelling and risk management topics.

He has a Master of Mathematics ETH and is a Certified Enterprise Risk Actuary living near Zürich, Switzerland.

Akur8 & Milliman's strategic Partnership

Our clients benefit from:

- a scalable pricing solution that includes improved end-to-end pricing efficiency
- expert pricing teams (local regulatory requirements)
- faster time-to-market, greater modeling accuracy, improved internal governance, and complete compliance

What is price optimisation?

1. Cost based pricing: Premium is determined on historical data and expected trends accounting for the cost of risk, cost of capital, all expenses, a profit margin and discounting

2. By varying this premium, we can influence:

   a) The margin (economic profit)

   b) The probability of quotes to convert to policies.

Price optimisation has the goal to increase the premium volume or the profits (or both).

Why price optimisation?

Price optimisation impacts conversion, retention, gross written premiums and profits

Price optimisation (and more generally pricing sophistication) is a core driver of profitability

An experienced pricing team contributes to sustainable competitive advantage

Risk of falling behind

Dynamic Pricing

Dynamic Pricing is the ability to quickly adjust prices to changed circumstances, such as:

- changes in competitor prices
- changes in risk
- changes in customer behaviour
- changes at the insurer

It is a different term, but at least partially related to price optimisation.

Examples in the insurance industry are:

- adjusting rates based on competitor prices
- pay how you drive, where the premium adjusts based on a driving score

Today, some telematics solutions attempt to influence the driving behaviour (gamification, scores).

There are more advanced concepts in the works:
In motor insurance, imagine the insurer knows the route a policyholder is driving in the next hours. Based on weather data, accident data, traffic data, etc., alternative routes (and incentives) could be offered.

Price Optimisation in insurance and other industries

In insurance:

- Regulatory requirements may limit the possibilities of price optimisation
- One can argue about the fairness of price optimisation in insurance

In other industries:

Interestingly dynamic pricing and price optimisation is widely used other industries.
Its usage is also known by consumers and seemingly accepted.

- airlines
- ride sharing
- hotels / hospitality
- e-commerce
- brick and mortar stores

Automatic surge pricing (Uber/Lyft) has been criticized after a subway shooting in Brooklyn NY

Uber airbnb amazon

Ingredients of successful price optimisation at an insurer

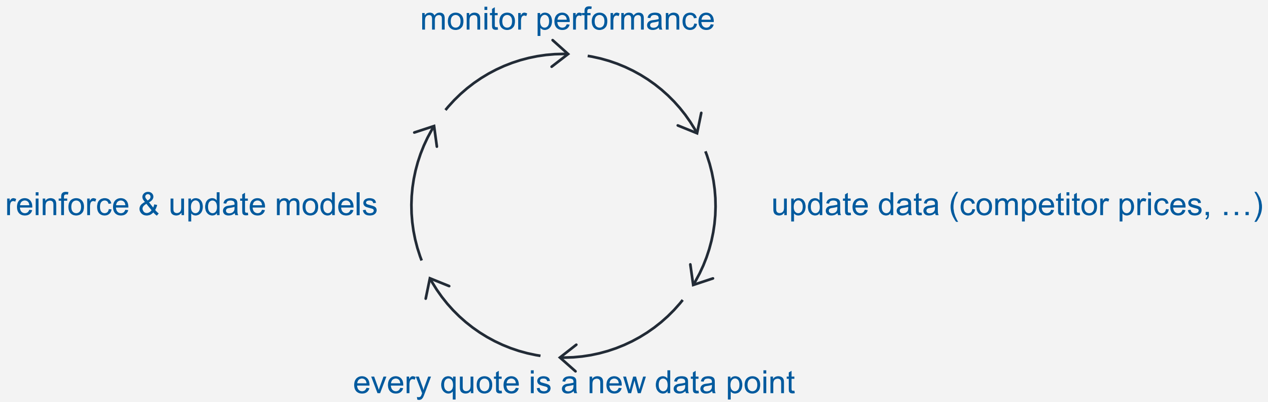
- Data: internal (claims, policyholder details, underwriting questions, elasticity, conversion and renewal rates) and external data (credit information, census data, socio economic)

- Infrastructure and tools to analyse, combine and digest the data

- Skills to manage the data, infrastructure and develop efficient and robust models (validate -> test -> deploy)

- Distribution channels / traffic

- Take into account specifics of the local market: client expectations, company culture/strategy, distribution channels, etc.



Impact of price optimisation

A recent McKinsey study considered five levels of pricing sophistication

1. Consistent application of GLMs
2. Use of machine learning pricing tools
3. Implementation of robo-pricing (account for competitor prices, monitor conversion rates, dynamic pricing, **price optimisation**)
4. Product simplification
5. Full scale pricing transformation

Price optimisation is one tool that needs to be an integrated concept in the entire pricing, UW and sales process.

Level of pricing sophistication →

	Consistent application of GLMs	Use of machine-learning pricing tool	Implementation of robo-pricing	Product simplification	Full-scale pricing transformation
Impact observed	Improved loss ratio of new business by **0.8–1.5 pp**	Improved loss ratio of new business by **2.1–4.2 pp**	Higher new business profitability by **2–4 pp** of combined ratio	Double-digit growth rates of new business year over year, while loss and cost ratio are improved by **1 pp**	**3–6 pp** of combined ratio improvement
	Improved loss ratio of renewal business by **0.2–0.5 pp**	Improved loss ratio of renewal business by **0.6–1.3 pp**	Higher new business premiums of **10–15%**		**3–4%** Additional GWP growth
			Improved retention by **10–12%**		Reduced severe cross-subsidization of more than **20%** and therefore, anti-selection for **10–15%** of the portfolio

Company overview

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Founded
2018

Global offices
Paris, NYC, London, Milan, Cologne, Tokyo

Employees
110+

Nationalities
25+

Activity
Non-Life Insurance Pricing
(e.g. P&C, Health, Travel, Pet)

Customers
100+

Price Walking, Demand Modelling & Price Elasticity

Milliman & Akur8 - Bahnhofskolloquium

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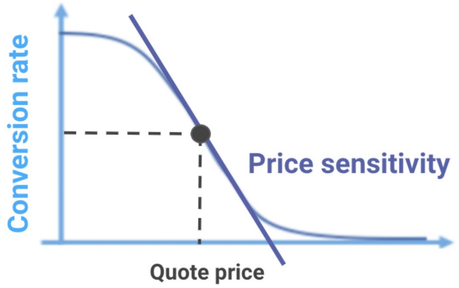
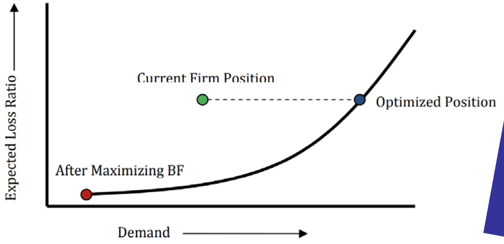
Motivation

Movement and Opposition





March 2023
Supervisory Statement

eiopa
European Insurance and Occupational Pensions Authority

January 2022
Price Walking Ban

FCA
FINANCIAL CONDUCT AUTHORITY

July 2021
Price Walking Ban

Banc Ceannais na hÉireann
Central Bank of Ireland
Eurosystem

Demand Modelling & Price Elasticity

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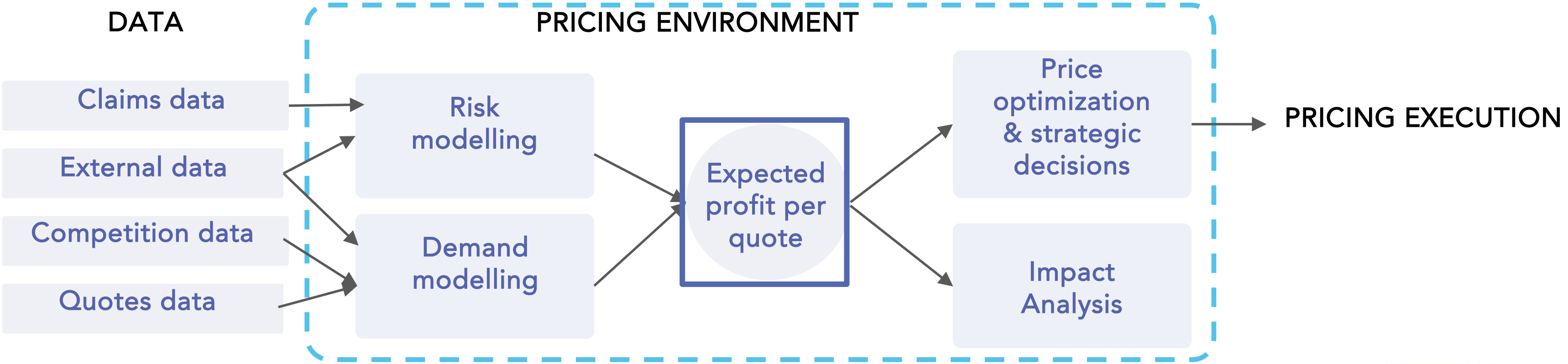
Demand modelling in pricing process

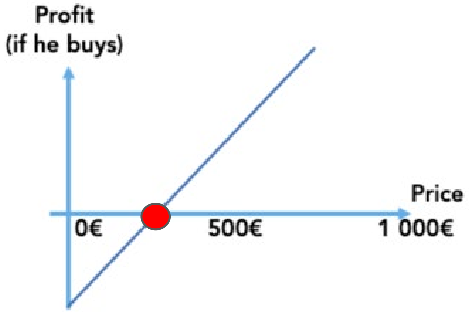
Combined with risk modelling, demand modelling returns the expected profit per quote.
We can then analyze, test and optimize the pricing strategy



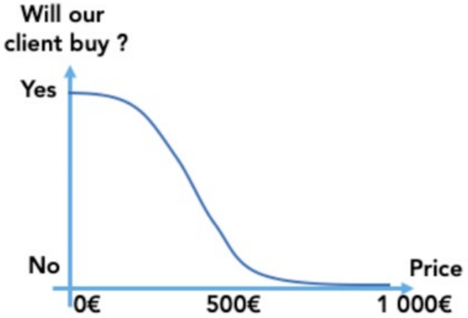
Demand modelling in pricing process

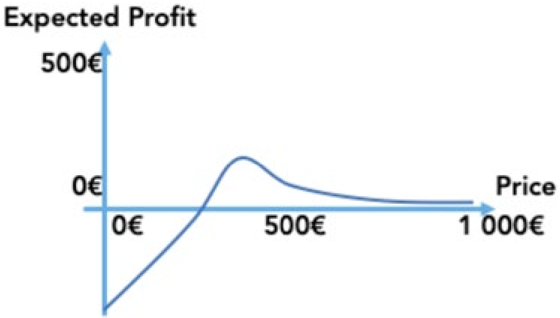
Expected profit for a given user

If a user converts, expected profit is **price - pure premium**



The behaviour of the user given **any** price is completely determined by the demand model.





The expected profit given independence of both

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Demand models: why is it challenging

It is unknown whether the conversion behaviour is determined by the type of experience or the price :

	Low Price	High Price
Experienced Drivers	**Conversion Rate: 5%**	/ (does not exist)
New Drivers	/ (does not exist)	**Conversion Rate: 1.5%**

Price is associated with the risk => The correlation leads to a wrong estimation of price sensitivity

It is key to fully **distinguish the personal variables from a pure price effect.**

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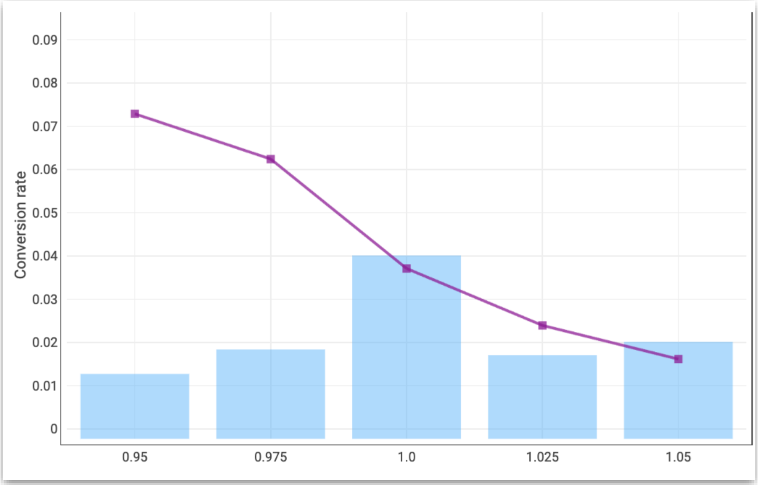
Different clients have different conversion probabilities and sensitivities to price changes (1)

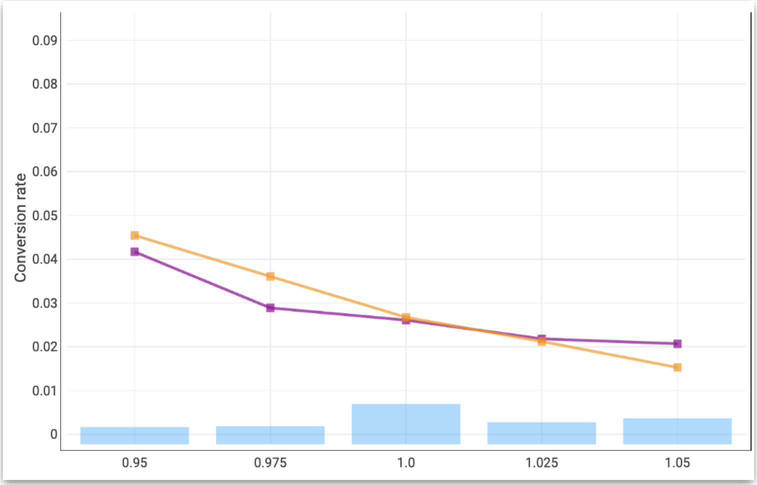
Group with average conversion and **low** price sensitivity



Group with average conversion and **high** price sensitivity

Different clients have different conversion probabilities and sensitivities to price changes (2)

We want to predict individual conversion probabilities, while at the same time segmenting clients with different reactions to price increases and decreases.



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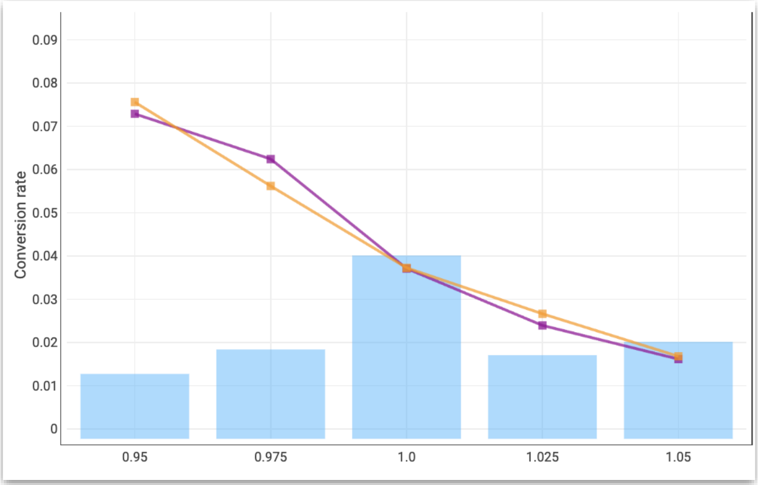

Group with average conversion and **high** price sensitivity

Interpretation of the impact price changes in a demand model

By what percentage does demand decrease, when I increase price by one percent?

Some clients react strongly, others not too much to price changes. We can formalize this with the price elasticity:

$$e = -\lim_{\Delta \to 0} \frac{\Delta d / d}{\Delta p / p} = -\frac{\partial d}{\partial p}\frac{p}{d}$$

Examples of economic price elasticities are (ref. Wikipedia)

Oil:		0.4
Coca-Cola:	3.8	
US Airline Travel:	First class 0.3	
	Discount	0.9
	Pleasure	1.5

Let d be the conversion probability, p the offered premium and X the features of the client.

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Can the elasticity of individual demand for insurance product be constant?

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Can the elasticity of individual demand for insurance product be constant?

$$\begin{aligned} \frac{\partial d}{\partial p} \frac{p}{d} \overset{!}{=} -K \Rightarrow \frac{\partial d}{d} &= -K \frac{\partial p}{p} \\ \Rightarrow ln(d) &= -K\, ln(p) + C \\ \Rightarrow d &= exp(-K\, ln(p) + C) \end{aligned}$$

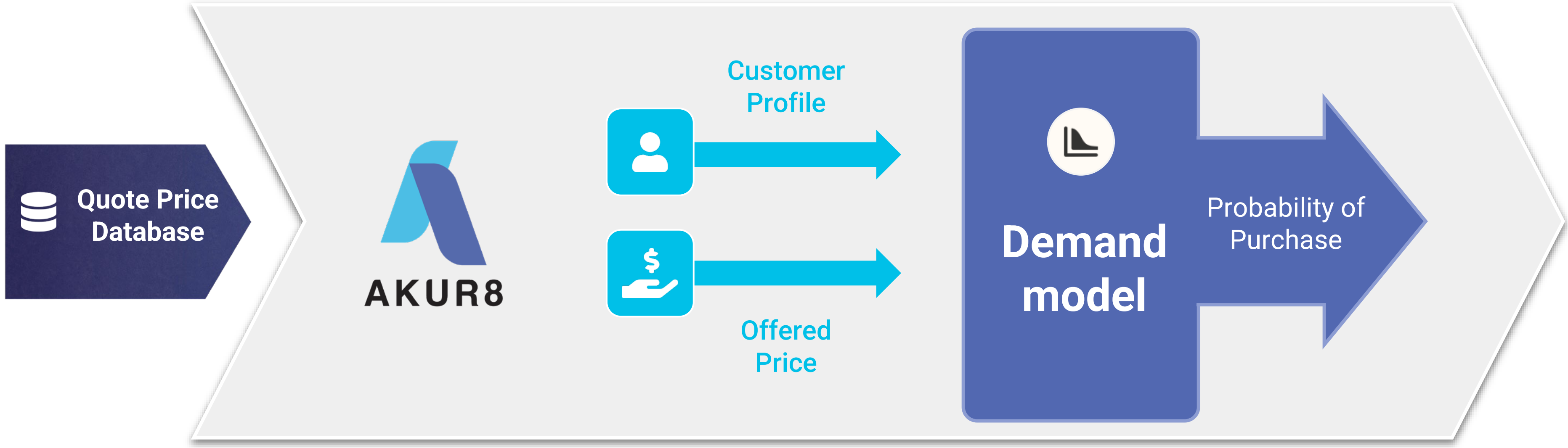
No, since:

$$\lim_{p \to 0} d(X, p) = +\infty \gg 1$$

Let d be the conversion probability, p the offered premium and X the features of the client. With constants K and C

Modelling demand allows you to estimate how likely each customer profile is to buy an insurance product at different price points

How likely is **Person A** to buy my product if I offer them **Price X**?



Formalisation of demand models

A commonly used framework

Let us formulate via **Offered Premium = Tariff Premium * π**
(possible, since Tariff premium is calculated with X_d , the features of the client.)

$$Demand(X,\pi) = Logistic\left(\sum_d f_d(X_d) + ln(\pi) \times \sum_d g_d(X_d)\right)$$

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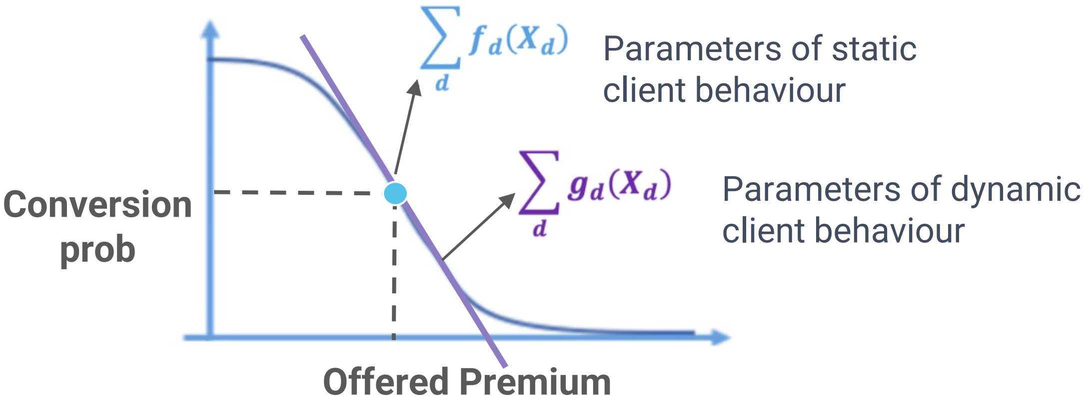
This yields nicely interpretable parameters:



Interpretation of the impact price changes in a demand model

From (linear-world) sensitivities to (probability-world) elasticities

How does demand of client I change?

$$e = -\lim_{\Delta \to 0} \frac{\Delta d / d}{\Delta \pi / \pi} = -\frac{\partial d}{\partial \pi} \frac{\pi}{d}$$

In case of a logistic regression we can state elasticity as: (since $logit(x) = \frac{1}{1 + exp(-x)}$)

$$e = (1 - d(X, \pi)) \sum_d g_d(X_d)$$

Now back to optimization. How can the elasticity be used to impact profits?

Interpretation of the impact price changes in a demand model

How does the profit change with price?

Be **Profit = (Tariff Premium * π - Technical Premium) * Demand**, the using **T** and **K**

$$\frac{\partial Profit}{\partial \pi} = T * d(X, \pi) + (T\pi - K) * \frac{\partial d}{\partial \pi}$$

$$= T * d(X, \pi) - (T\pi - K) * e * \frac{d(X, \pi)}{\pi}$$

$$= T * d(X, \pi) * \left(1 - e - e * \frac{K}{T\pi}\right)$$

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$$= T * d(X,\ \pi) * \left(1 - e - e * \frac{K}{T\pi}\right)$$

So that

$$\frac{\partial Profit}{\partial \pi} > 0 \Leftrightarrow e < \frac{T\pi}{T\pi - K}$$

Elasticities directly imply a optimization regime!

Elasticities should be modelled very robustly!

How to treat these very price sensitive clients?

Prediction of negative elasticities?!

Price Walking

Summary

Excerpt from "Supervisory statement on differential pricing practices [...]" of EIOPA

2.12. Due to the high risk of detriment, particular emphasis is
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3.8. Examples of "price walking" practices that are considered to lead to unfair treatment, and therefore not compliant with Article 17(1) IDD, and that are considered not to be aligned with the needs, objectives and characteristics of any target market, and therefore if applied not compliant with Article 6.2 of the POG Delegated Regulation, include the following:

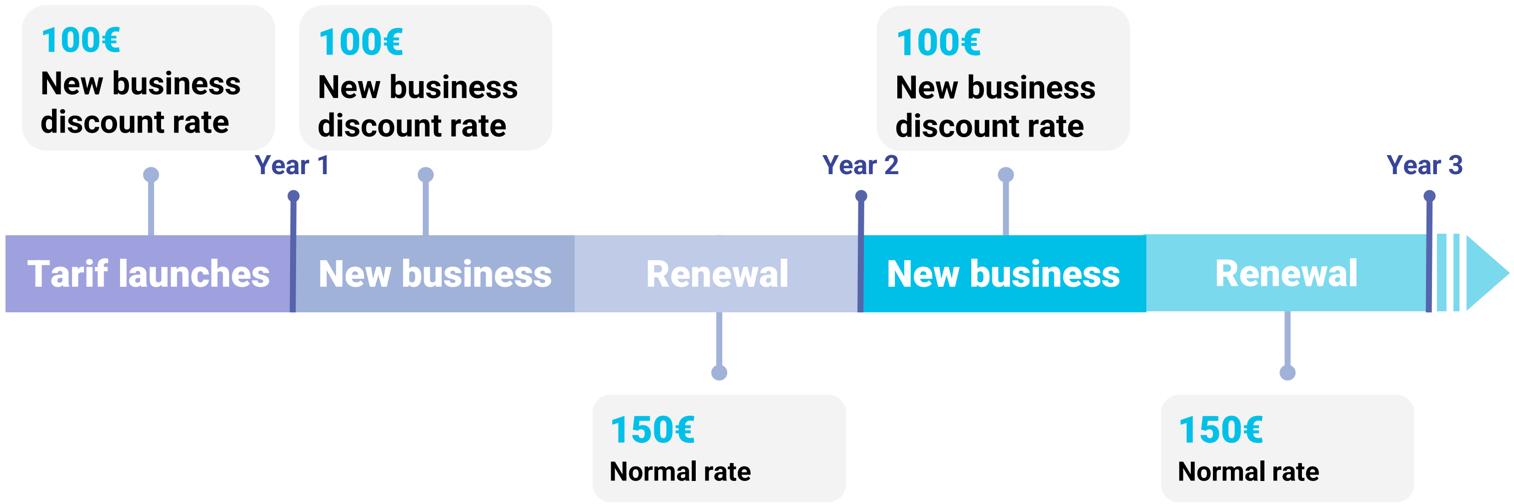
3.8.1. Repeatedly increasing for the same customer the price of the insurance product at renewal stage based on his/her low propensity to shop around (low probability of churn);

3.8.2. Repeatedly increasing for the same customer the price of the insurance product at renewal stage based on his/her low-price elasticity (also known as "willingness to pay");

3.8.3. Advising or nudging a potential customer to buy one insurance product (in some cases included in a bundle of financial and non-financial products) vs. another one because of very low initial price, and then applying sudden, unexpected, significant, and repeated price increases for customers at renewal based on reasons unrelated to underwriting risk or cost of service.

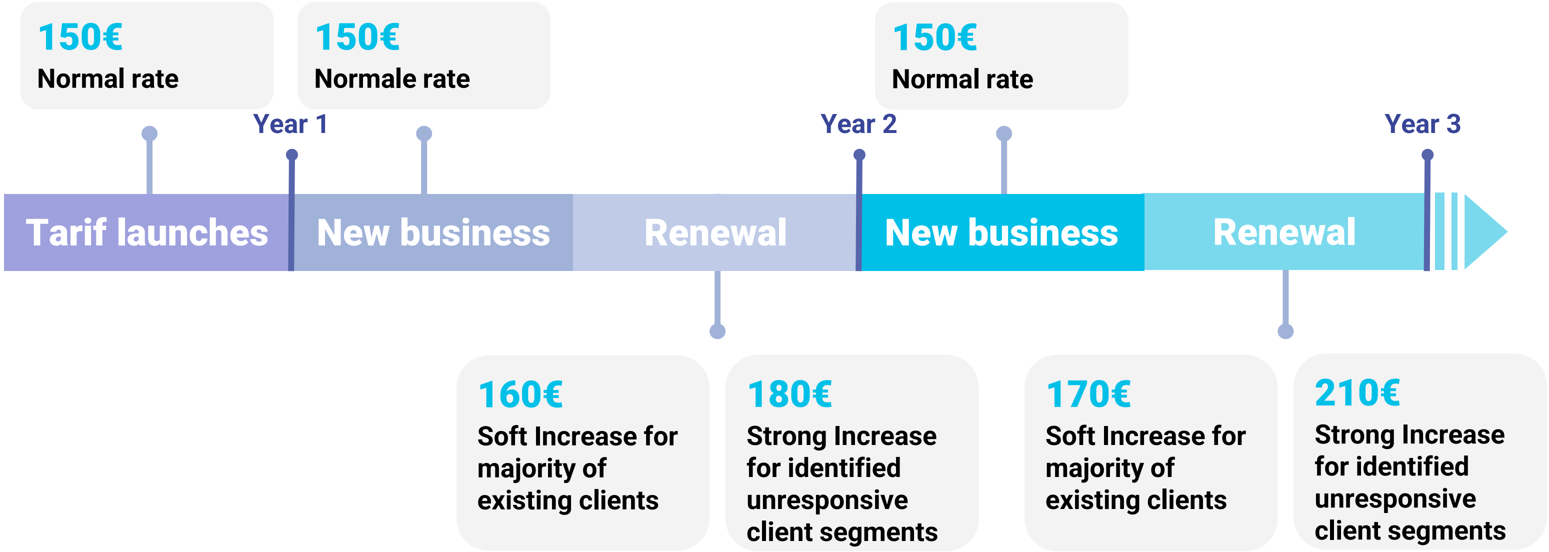
What EIOPA (likely) is not targeting:

One-time new business discount



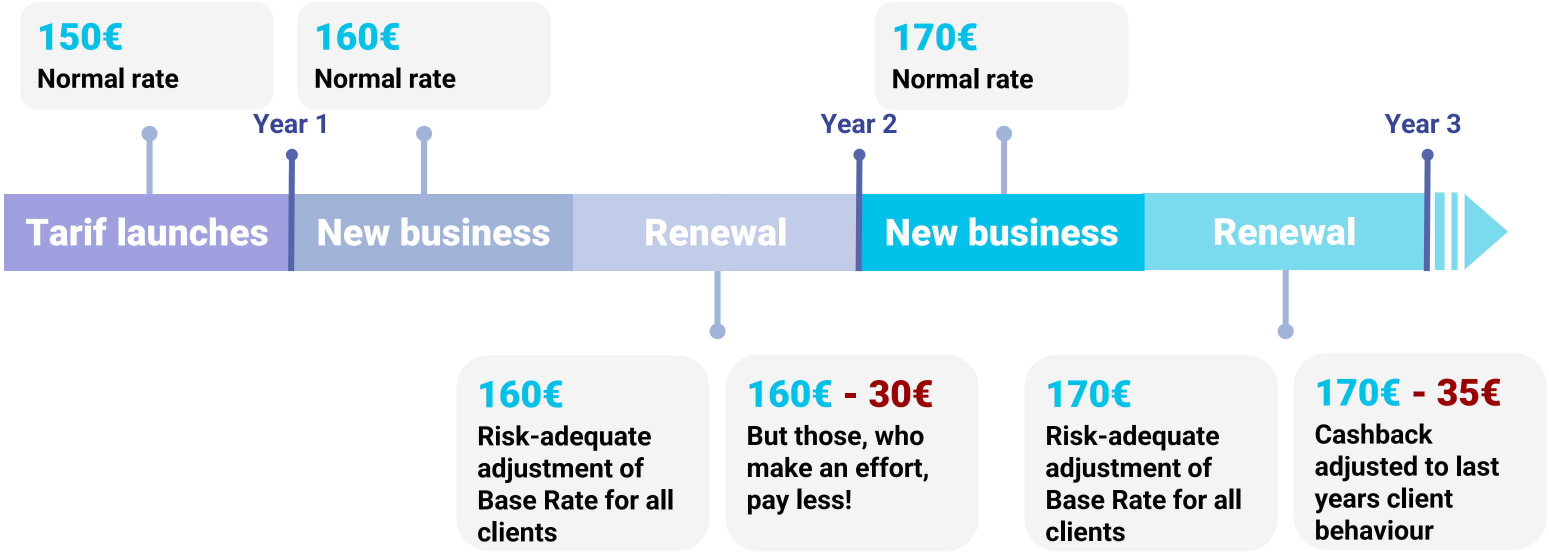
What is (rightfully?) targeted by EIOPA:

Different Price adjustment strategies for sensitive Customer segments
(e.g. Unresponsive clients: beneficiaries of sickness daily allowance, social benefits, people changing jobs)



It is not always clear, if you do Price Walking:

Cashback upon (trivially met) request - e.g. no claim, change of personal details
Basically all clients qualify, but who will actually make the effort to file the request?



Key takeaways

- Demand modelling is essential to quantify the impact of decision and to not systematically overestimate future performance.
- The quoted premium of an initial quotation, upsell, tariff update at the same time is a dependent and independent variable.
- Whenever a quoted premium was adjusted based on expected, non-risk related customer behaviour, mathematical and regulatory care is due.
- The traceability, motivation and documentation of pricing decision will be more and more important going forward!

Thank you!

Any questions?

jan.kuethe@akur8.com

bernhard.koenig@milliman.com