

Predictive Modeling and Price Optimization Methods

CASE 2010 Spring Meeting

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Predictive modeling is...

...the process by which a model is created or chosen to try to best predict the probability of an outcome

Source: Geisser, Seymour (1993). *Predictive Inference: An Introduction*.

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Applications for insurance companies

- Cost-based pricing and underwriting
- Retention/conversion analysis
- Lifetime customer value modeling
- Price optimization
- Targeting insureds for premium audits
- Targeting insureds for risk management intervention
- Target marketing (including cross-sell and up-sell [limits])
- Identifying suspicious/fraudulent claims/claim triage
- Studies of agent effectiveness

Benefits to pricing/risk selection variables

- Refine existing rating/pricing variables
- Identify variable interactions
- Include additional internal variables (e.g., loss history of other lines, payment history, account penetration, years with carrier...)
- Include external variables (e.g., credit score, years in business, socio-demographic variables, geographic variables including weather...)
- Refine territorial variables via clustering
- Refine by peril/coverage for Homeowners/BOP

Predictive modeling techniques

- These are “supervised learning” techniques — i.e., they predict a target variable
 - Regression
 - **...relaxing some distributional assumptions**
 - Generalized Linear Models (GLM)
 - **...trying to automatically capture nonlinearities**
 - Generalized Additive Models (GAM)
 - Classification and Regression Trees (CART)
 - Multivariate Adaptive Regression Splines (MARS)
 - Neural Networks

Predictive modeling techniques

- Choice of modeling technique is *somewhat* important
- Factors that can influence model power *more*:
 - Type of data available
 - Quality of data
 - Subject matter expertise in designing predictive variables

What is price optimization?

What is price optimization?

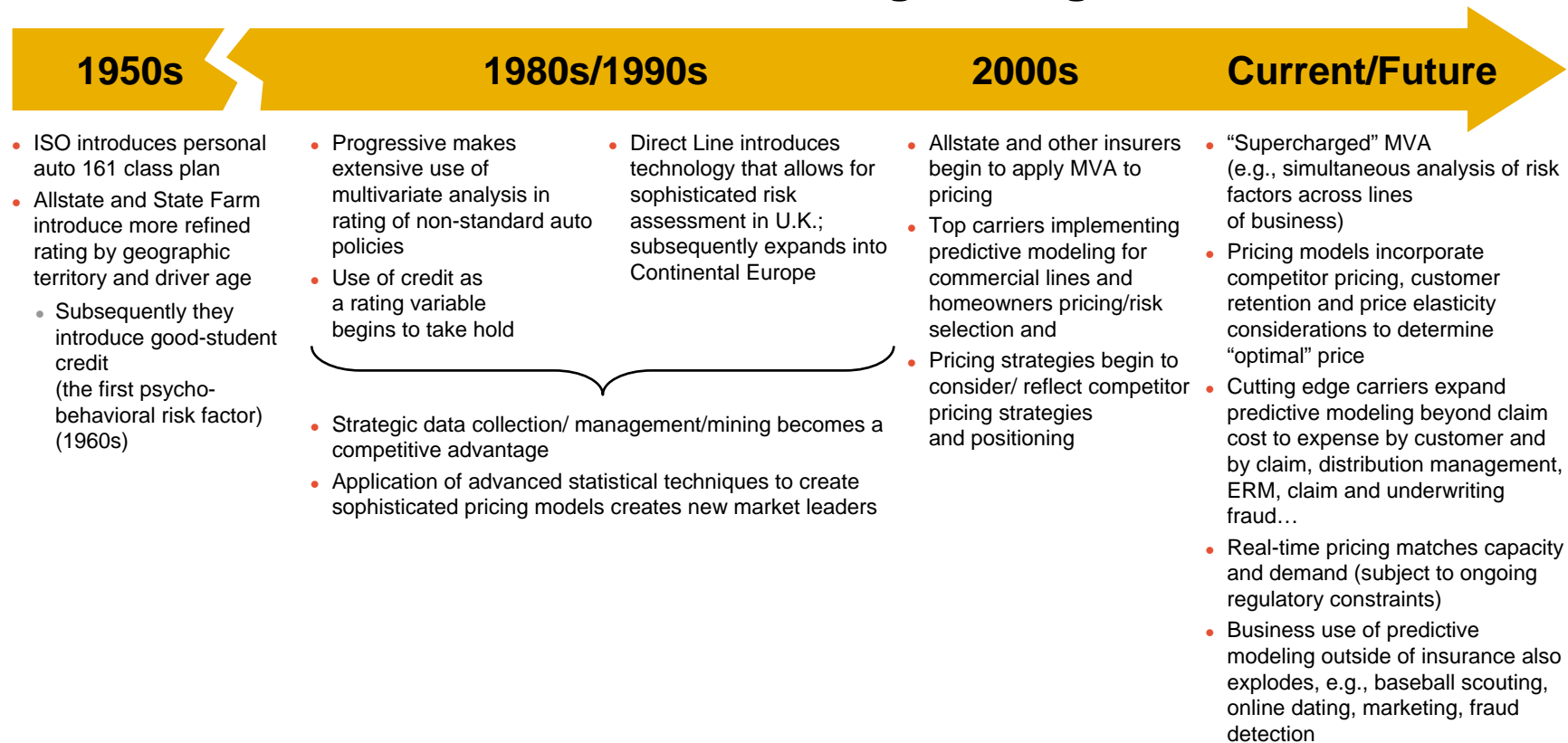
- Setting prices by customer segment so that
 - One attribute is maximized (or minimized)...
 - ...Given constraints on other attributes
- For example:
 - Maximize underwriting profit, with the constraint that retention is no less than X
 - Maximize growth in written premium, with the constraint that profitability remains at current levels
 - Minimize lapse rate, with the constraint that combined ratio is no more than Y

Price optimization inputs

- Understanding of:
 - Actuarial, cost-based price (from traditional predictive modeling)
 - Elasticity of demand, by customer segment
 - (When possible) Competitor pricing in the marketplace (from competitive market analysis)

Developments in rating/pricing have changed the competitive environment

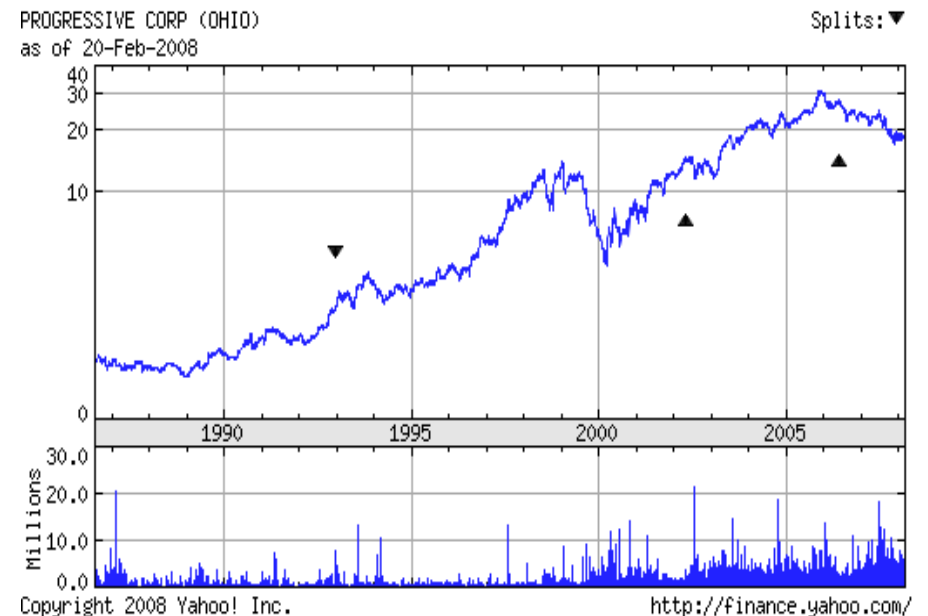
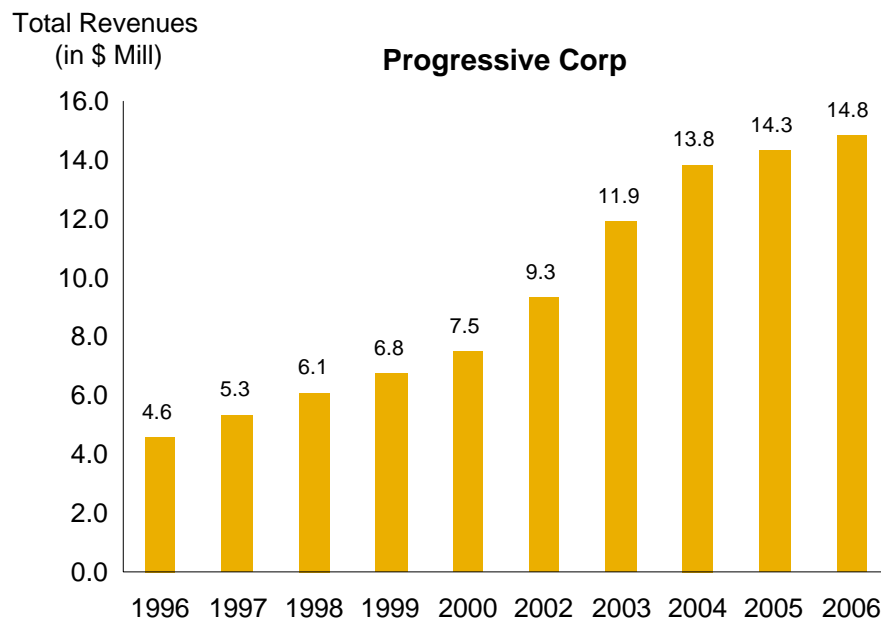
Evolution of Rating/Pricing



Profound changes in market leadership occurred because of dramatic advances in risk assessment, coupled with the courage to implement that knowledge via more accurate pricing

Progressive: Growing volume while maintaining profitability through price segmentation

- Late 1990s: Predictive modeling gained more attention in the U.S.
- In ten years, Progressive grew from 43rd to 3rd largest personal auto insurer in the U.S.
 - Share price quadrupled



Why price optimization?

- Both the personal and commercial lines insurance industries are highly competitive, and maintaining underwriting profits will continue to prove a challenge for the industries
- Opportunities for improving profitability through efficiency and cost reduction are becoming more difficult
- Pricing management presents the best opportunity for a company to improve its profitability — optimizing prices is the next step

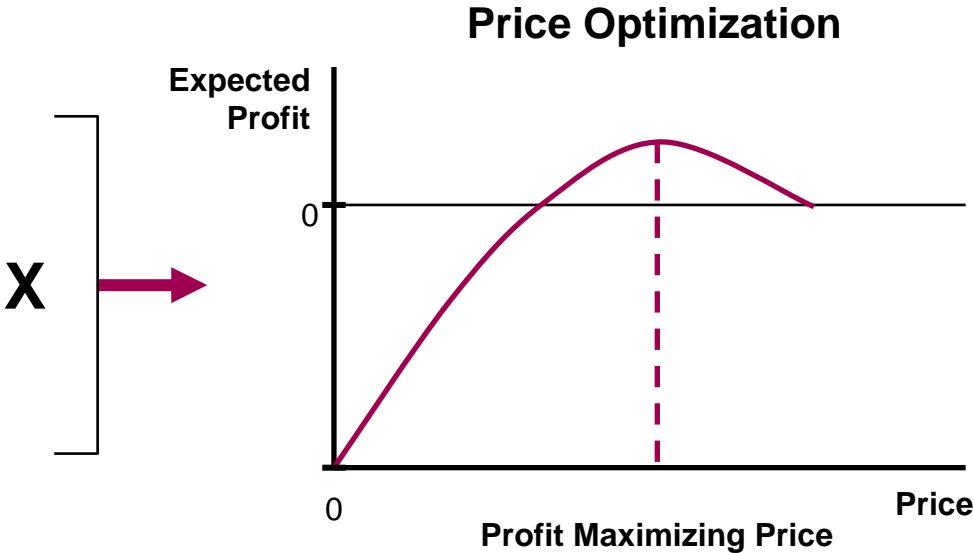
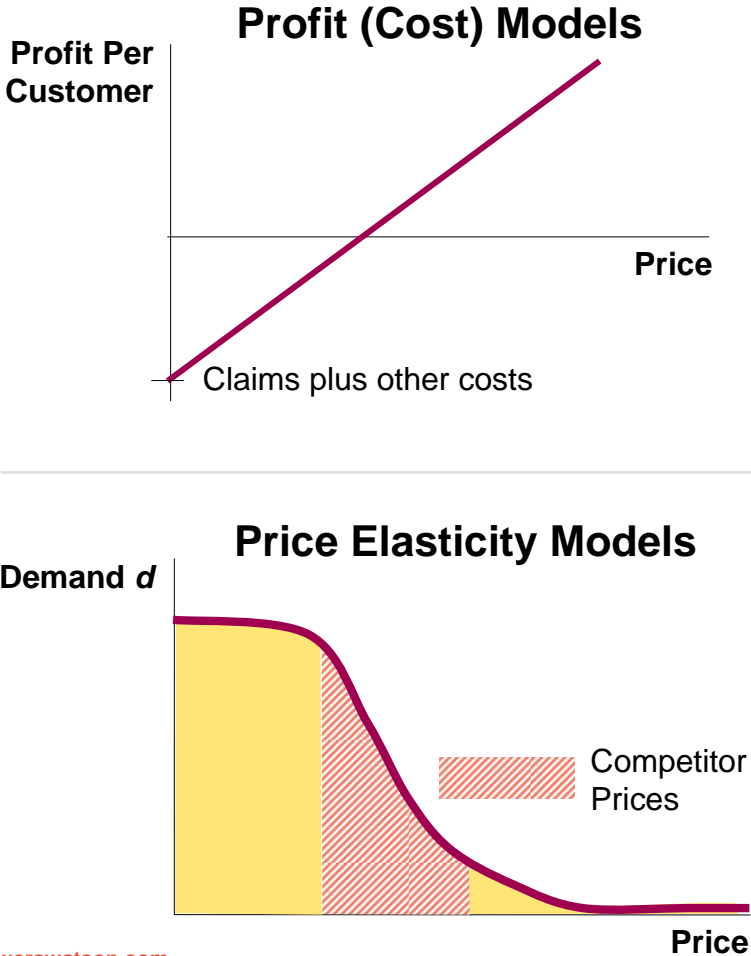
Why price optimization?

- Price optimization methods allow carriers to:
 - Gain a better understanding of the marketplace
 - Collect extra premium when below market price
 - Price more aggressively to retain profitable business
 - Identify profitable niches for new business marketing
 - Gain insight into how prices impact performance
 - Quantifiably balance profits and market share
 - Establish stronger pricing governance framework
 - Ultimately...realize a sustainable increase in profitability

Local regulatory restrictions exist. In the U.S., pricing regulation is more influential for personal lines.
We will discuss how price optimization strategies are adapted to comply with local regulations.

Price optimization balances the trade-off between supply/cost and demand/revenue

By integrating profit (cost) models by customer segment and distribution channel with price elasticity models, prices can be set to optimize the trade-off between the contribution per policy and volume of business expected to meet given financial objectives and business constraints



A simple example will help illustrate how price optimization works

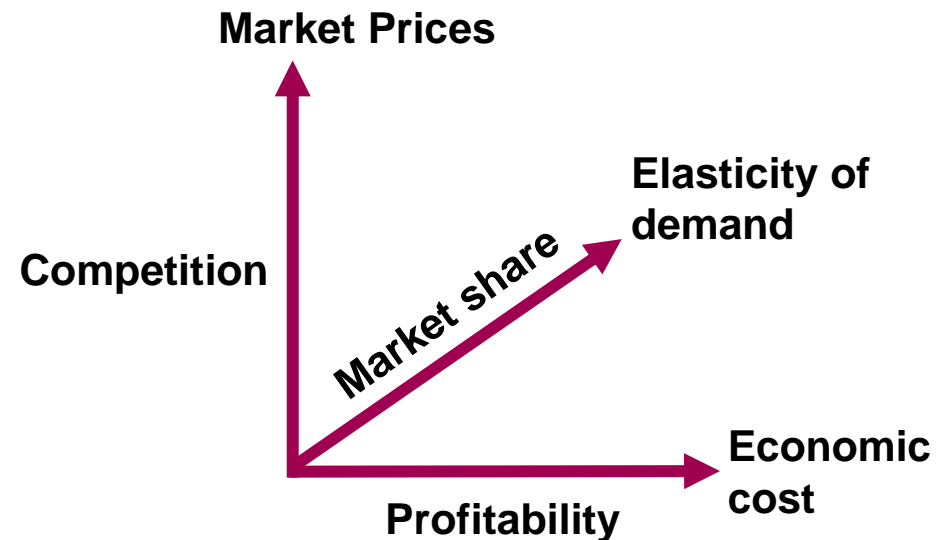
Base Scenario			
	Segment A	Segment B	TOTAL
Premium	100	100	
Profit	25	25	
Volume	1,000	1,000	2,000 units
Total Profit	25,000	25,000	50,000
Elasticity	8	2	

Scenario 1: Prices that maximize the profit with the same volume			
	Segment A	Segment B	TOTAL
Premium	95	120	
Profit	20	45	
Volume	1,040	960	2,000 units
Total Profit	20,800	43,200	64,000

Scenario 2: Prices that maximize the volume with the same total profit			
	Segment A	Segment B	TOTAL
Premium	85	115	
Margin	10	40	
Volume	1,120	970	2,090 units
Total Profit	11,200	38,800	50,000

The next frontier in pricing management

- Cost models that predict the net losses and expenses for different types of customers (based on frequency, severity, pure premiums, loss ratios...)
- Competitive Market Analysis that provides a thorough understanding of the marketplace in which a company is operating (price dispersion and company position)
- Customer price elasticity models that reflect market competition and customer behavior to predict the volume of new business and renewal acceptances at various prices for different types of customers
- Optimization techniques that integrate these models to predict the profit/volume impact of price changes, and to identify the best price changes for given financial objectives and constraints



Two of the three types of predictive models required to support price optimization are “leading edge”

1. Claim Propensity Models

Customer Attributes

Predictive of

Claim Propensity

- Frequency
- Severity
- Loss ratio

2. Market Situation Models

Customer Attributes

- Price dispersion
- Current position

3. Customer Behavior Models

Customer Attributes

- Hard attributes (rating plan)
- Soft attributes
- Claim event
- Other event

Predictive of

Take-Up Propensity/Customer Behavior

- New business take-up rates
- Renewal rates
- Cross-sell rates

Widely adopted

Leading edge — not widely adopted

Case study

- Based on a European carrier
- Different regulatory environment
- Analysis can be applied in the U.S.
 - Note: Top 10 U.S. personal lines carriers already pursuing or executing price optimization strategies

Optimization project focused on better management of the renewal portfolio

Context

- The company was providing quotes for renewal considering only profitability, past claims experience and previous premium
- The market entered a price war

Objectives

- Improve the renewal process
- Forecast the impact of different strategies on profitability and premium volume
- Maximize retention and expected profit

Solutions Provided

- Claims cost per policy
- Competitive market analysis for the specific profile of the portfolio
- Elasticity of demand study
- Forecast tool to estimate renewal rate for a given pricing strategy
- Provide direction for agent application of discounts
- Optimized prices subject to the objectives and restrictions of the company
- Evaluate different pricing strategies

Steps

- An analysis of claims (GLM model) and expenses was performed previously
- The steps were the following:
 1. Agree to objectives and constraints
 2. Gap analysis
 3. Competitive market analysis
 4. Renewal analysis
 5. Measure and model customer price elasticity
 6. Optimization
 7. Implementation

Case study is based on a European company — rate regulations are different in the U.S.

Agree to objectives and constraints

ILLUSTRATIVE EXAMPLE

Step 1

- Initial project workshop to define the company's strategy and financial objectives for the price optimization process
- Establish:
 - Maximization/minimization function: Maximize expected profits
 - Time horizon (one year)
 - Business constraints:
 - Target overall retention rate: 85.0%
 - Individual criteria based on individual policy profiles
 - Number of claims in the previous years (0, 1, 2, >2)
 - No claims discount (<55%; => 55%)
 - Tenure (< 4 years; >= 4 years)
 - Historical loss ratio (<55%; >= 55%)

Gap analysis

ILLUSTRATIVE EXAMPLE

Step 2

- Understand how much of the information and analysis is already available through previous work
- Use existing company pure premium pricing models based on expected cost of claims as an input to the price optimization process
- Understand the current rating structure and what enhancements and additional flexibility might be required to meet the objectives
 - Flexibility may not be available in the U.S.
 - In Europe, agents have a “budget” of “discount amounts” that they may use to reduce premiums for given insureds to increase retention rates or new business volume

Competitive market analysis (CMA)

ILLUSTRATIVE EXAMPLE

Step 3

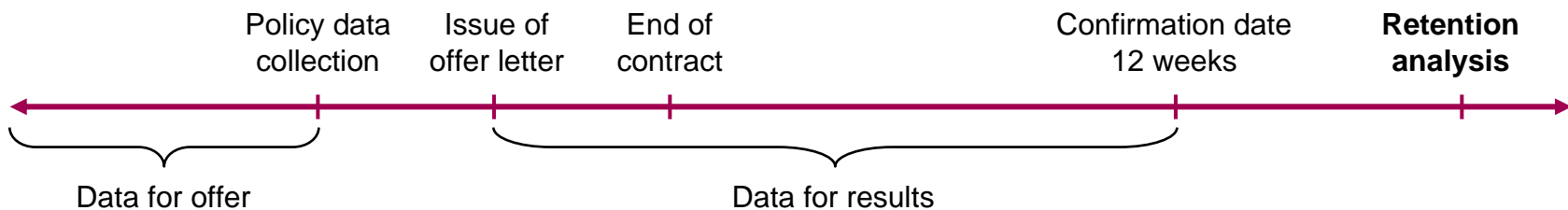
- CMA is a fundamental part of an insurance company's pricing management processes and a key input into the process of price optimization
 - Understand the positioning of the company's rates in the market at any point in time
 - Help identify segments where the company's prices are relatively cheap/expensive relative to the market
 - Understand the intensity of competition in each segment
 - Understand the scope for price changes and what impact such changes would have on market positioning
 - Key input into later steps

Renewal analysis

ILLUSTRATIVE EXAMPLE

Step 4

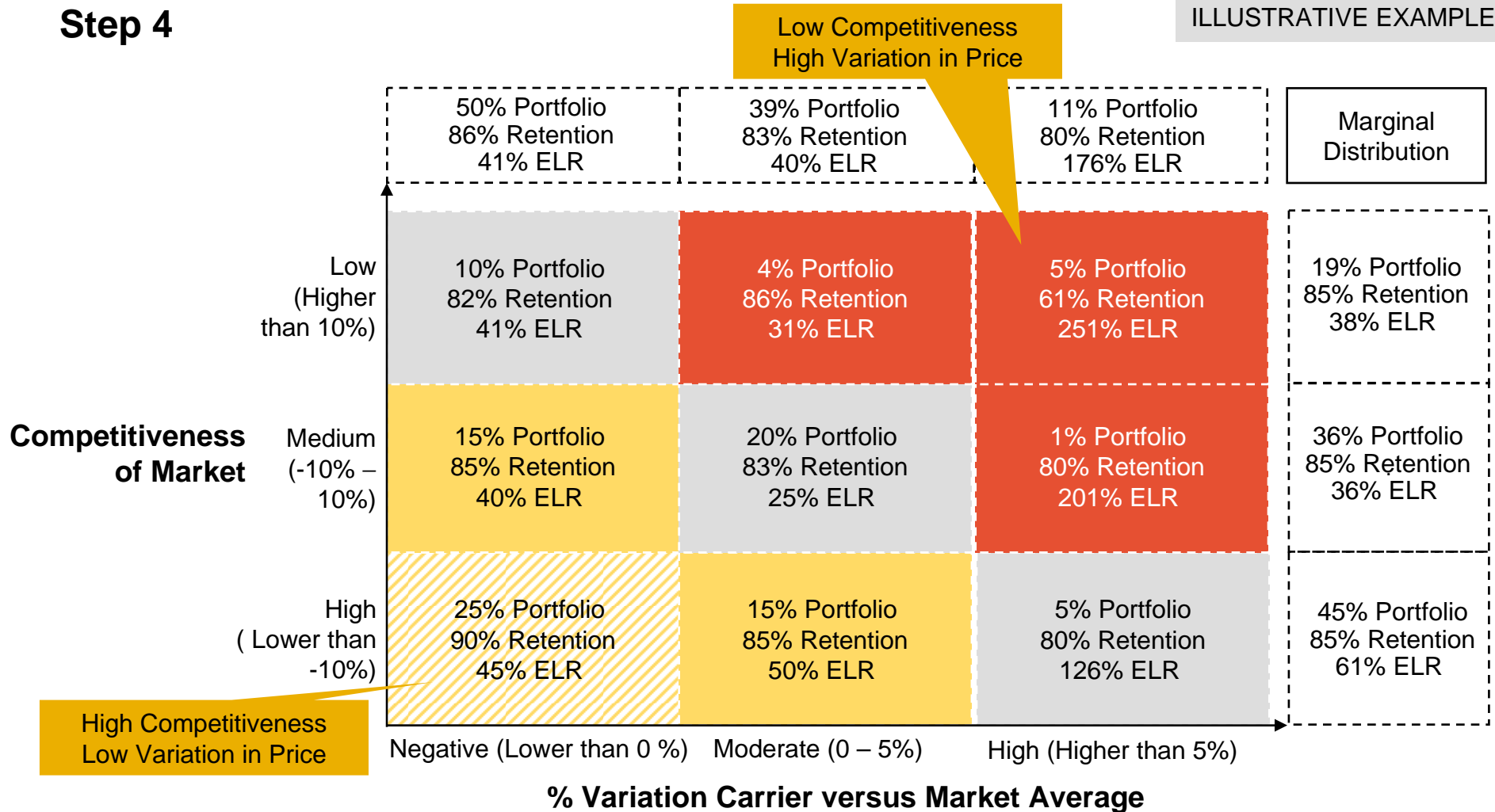
- How was it measured?
 - A policy is “renewed” if a customer who has been offered a renewal policy stays with the company 12 weeks after expiring date
- How was it used?
 - Assess how variable the renewal rate is across the portfolio and identify segments of the business that have higher/lower than average renewal rates
 - Combine with the CMA to assess how good a predictor the competitiveness measure is of retention — by customer segment and over time
 - Provide initial insight into customer elasticity, e.g., what happened to retention rates when previous price changes were implemented?
 - Assess how retention rate varies as a function of price change at renewal
- Data used



Price variation versus competitiveness position

Step 4

ILLUSTRATIVE EXAMPLE



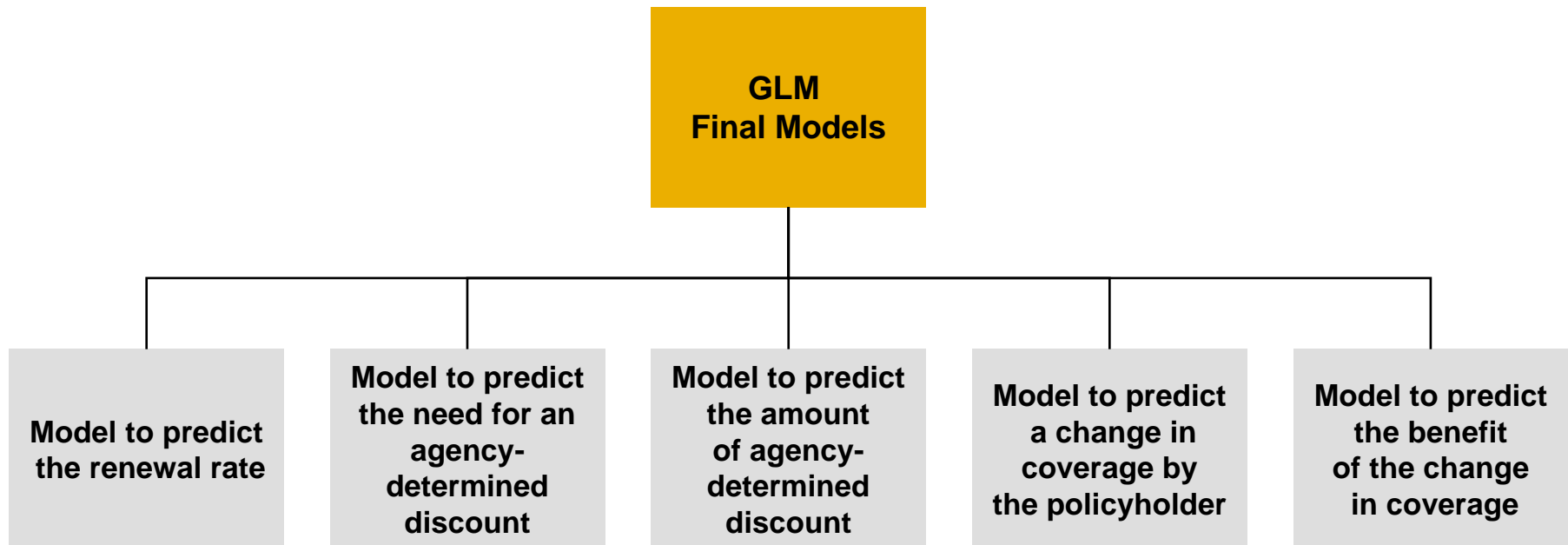
ELR: Expected Loss Ratio.

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Customer price elasticity Summary of models

ILLUSTRATIVE EXAMPLE

Step 5



Note: in Europe, agencies are given discretionary “budgets” to offer discounts to insureds — sometimes referred to as “commercial discounts” — In the U.S. , this could apply to schedule rating credits for commercial lines business.

Customer price elasticity

Possible explanatory variables

ILLUSTRATIVE EXAMPLE

Step 5

Policy Characteristics

- % Premium change
- Renewal month
- Discounts
- Coverage
- Actual premium
- Absolute change in premium
- Amount of difference with market
- Percent of difference with market
- Policy tenure
- Customer tenure
- Discounts/surcharges
- ...

Risk Characteristics (Driver)

- Years without claims
- Driver's age
- Driver's gender
- Driver's license age
- Driver's occupation
- Additional driver presence
- Additional driver's age
- Additional driver's license age
- ...

Risk Characteristics (Vehicle)

- Type of vehicle
- Age of vehicle
- Usage
- Value
- ...

Others

- Payment type
- Payment term
- Distribution channel
- Cross sell
- Amount of agency-determined discounts
- Broker classification
- ...

A key step in the process is to develop demand elasticity models for different customer segments

- This table summarizes the results of one such model

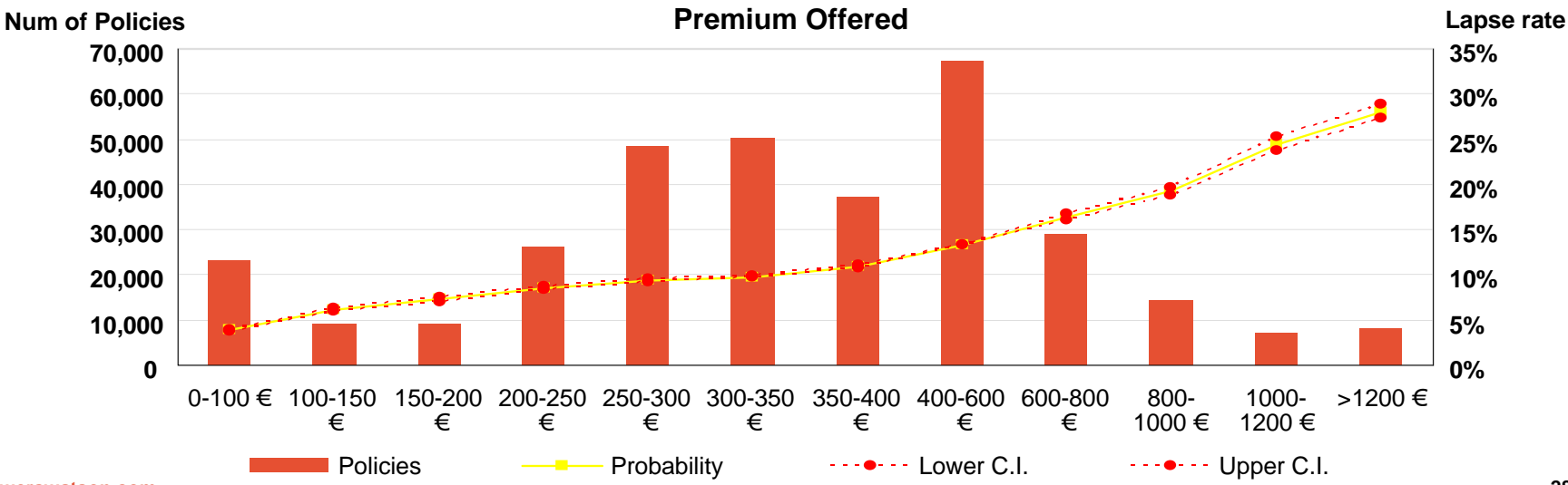
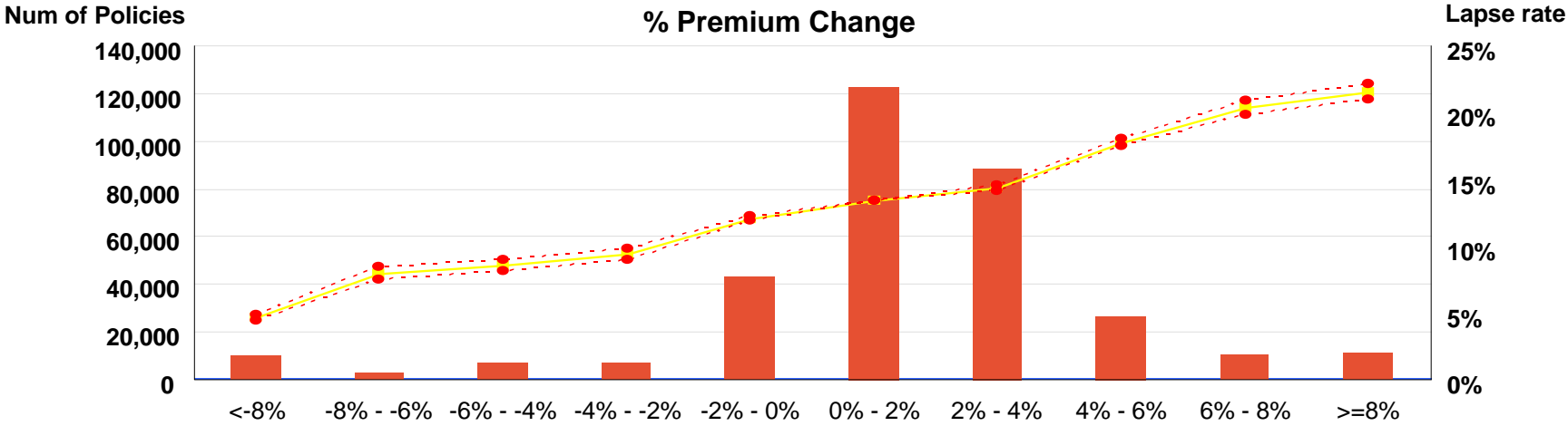
EXAMPLE

Variables	Base Profile	Relativities Range	Explaining Capacity
Cross-sell	Auto only	0.40 – 1.00	31.0%
Premium offered	600 – 800 €	0.35 – 2.15	20.8%
Coverage	Collision	0.50 – 1.20	9.3%
Percent change premium	0% – 2%	0.40 – 1.60	8.4%
Payment method	Bank account	1.00 – 1.80	6.8%
Competitiveness	< -5% market	1.00 – 1.75	6.3%
Intermediary type	Broker	0.80 – 2.10	4.1%
Geographical territory	Zone 2	0.70 – 1.30	3.4%
Num. years policy held	3 – 4	0.75 – 1.15	2.4%
Commercial classification of broker	2	0.80 – 1.35	2.3%
Years without claims	5	0.80 – 1.25	2.2%
Sex — age	Male 40 – 54	0.70 – 1.25	1.3%
Driver experience (years)	>20	1.00 – 1.50	0.9%
Vehicle type	Automobile	0.85 – 1.45	0.4%
Xb = Linear Predictor			0.15
Lapse probability = $Xb/(1+(Xb))$			13.4%
Renewal probability = $1-Xb/(1+(Xb))$			86.6%

Customer price elasticity results — Elasticity curve

Step 5

ILLUSTRATIVE EXAMPLE

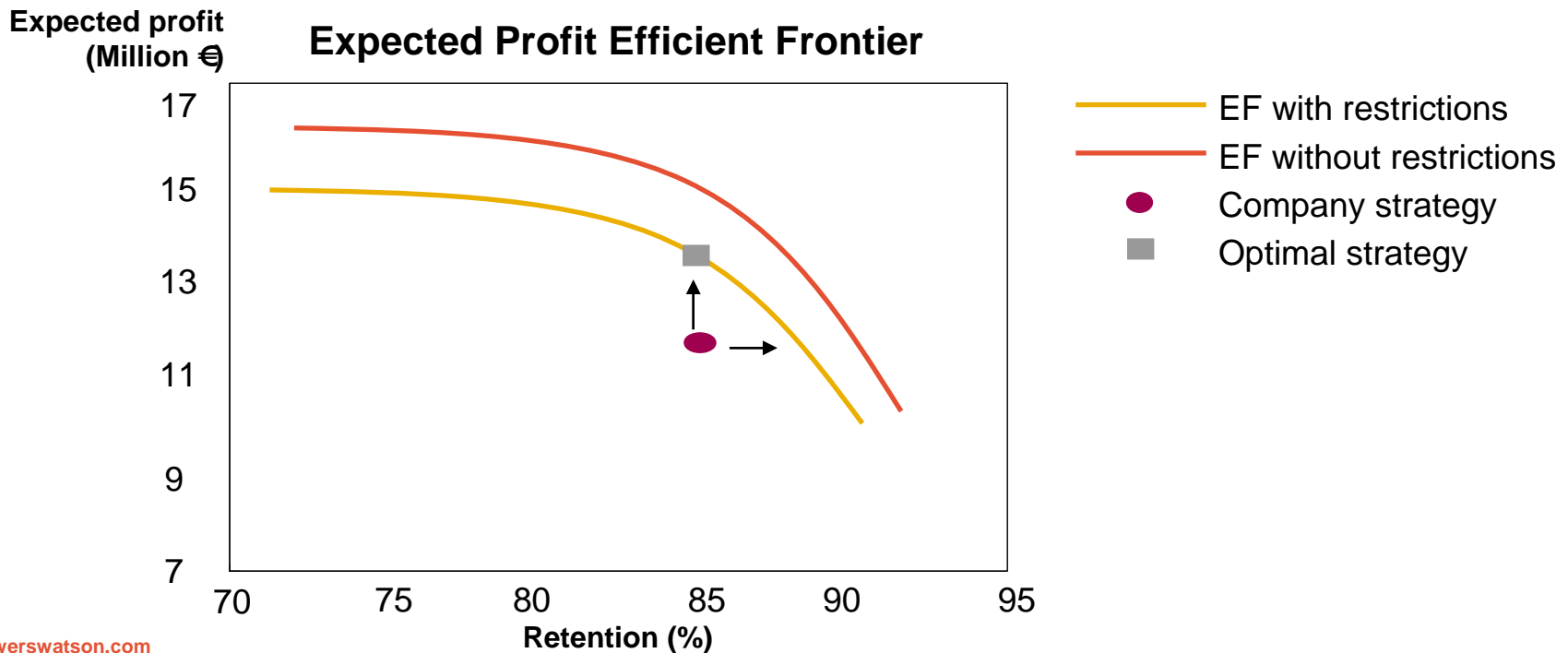


Optimization

ILLUSTRATIVE EXAMPLE

Step 6

- This step involves combining the cost models (claims and expenses) and the customer price elasticity models derived in previous steps in order to determine the optimal price by customer type
- The optimal price will be the one that satisfies the company's objectives and constraints maximizing profitability subject to a certain volume of business

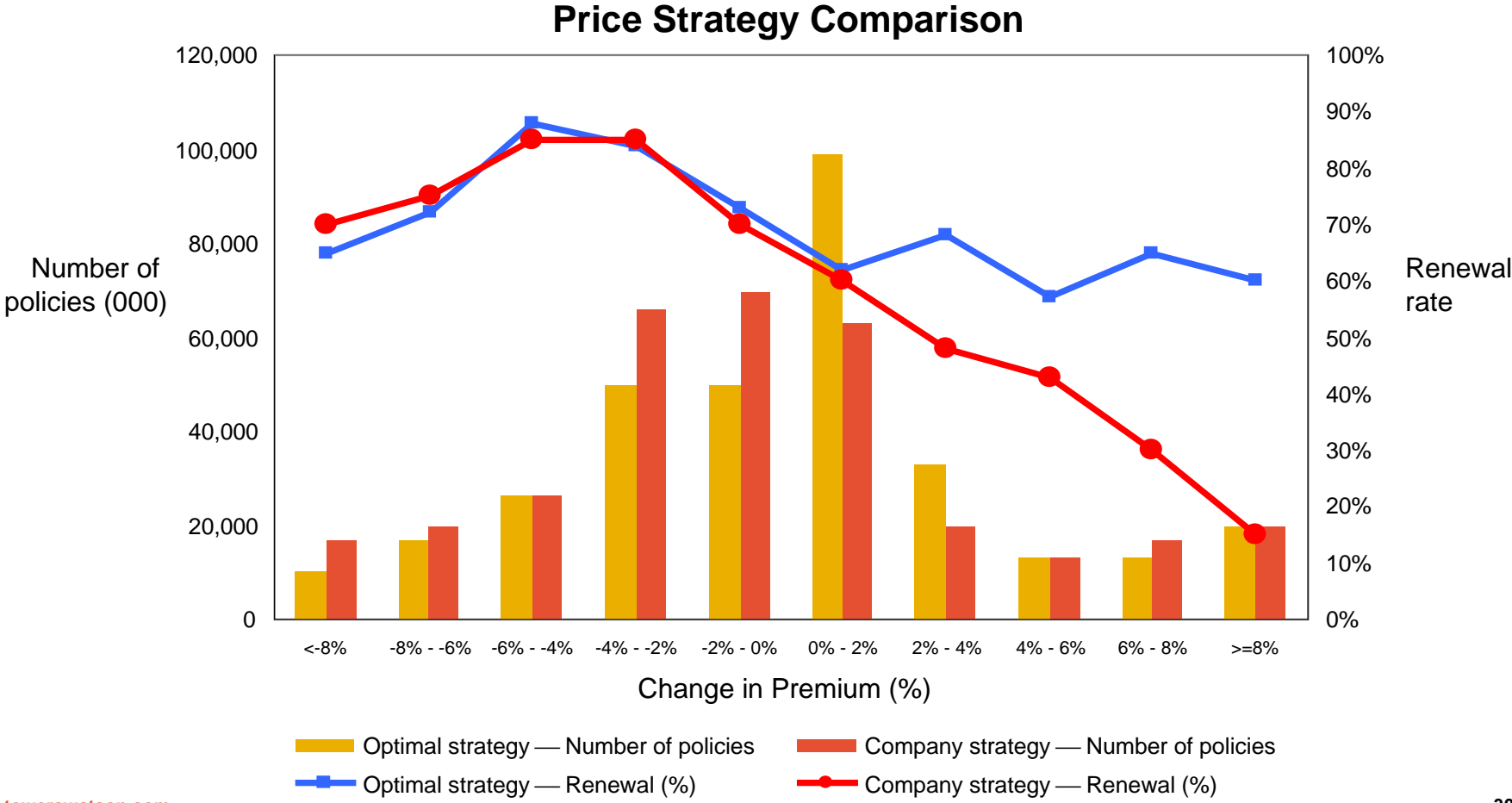


Optimization

Step 6

ILLUSTRATIVE EXAMPLE

- Comparison of company and optimized pricing schemes



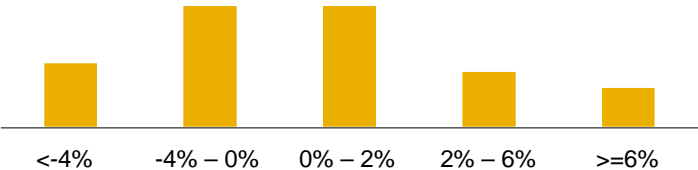
Optimization

Step 6

ILLUSTRATIVE EXAMPLE

Distribution of Premium Changes

Optimal Strategy



Average Premium Change

Retention Rate

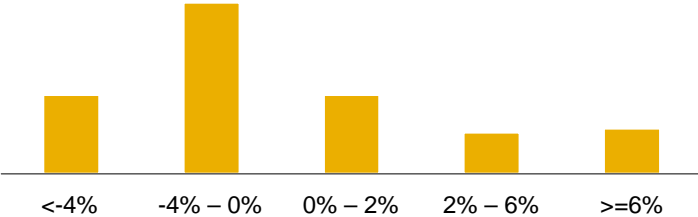
Expected Profit (million)

1.2%

85%

13.8 €

Company Current Strategy



0.5%

85%

11.2 €

Implementation

ILLUSTRATIVE EXAMPLE

Step 7

- Optimized rates can be implemented in different ways:
 - A. An algorithm that calculates the optimized price per individual customer based on their particular rating attributes. The algorithm can be built into the rating structure and operate in real-time
 - B. A set of optimized premium rates that would fit into a tabular rating structure
- Option A is the best long term
- Option B has the advantages of
 - Lower IT investment and lead time
 - More consistent with regulatory constraints in the U.S. (especially for personal lines)
- Recently, U.S. personal lines carriers have been able to achieve profit increases of 1.5% to 2.5% of DWP with price optimization, even while pursuing Option B

Conclusions

Conclusions

- Advanced statistical techniques are necessary for effectively managing a portfolio:
 - Selecting profitable customers, leaving unprofitable ones to competition
 - Implementing gradually to reduce market disruption
 - Maintaining benefits over time
 - Providing a solid basis to monitor the portfolio
- It is possible to grow market share without compromising profitability
- Stay ahead of competition/avoid adverse selection

Conclusions

The insurance industry is highly competitive and maintaining underwriting profits will continue to prove a challenge for everyone

Pricing management presents the best opportunity for a company to improve and sustain its profitability — *optimizing prices* is the next step