# Modeling Policyholder Retention

## 2006 CAS Seminar on Predictive Modeling


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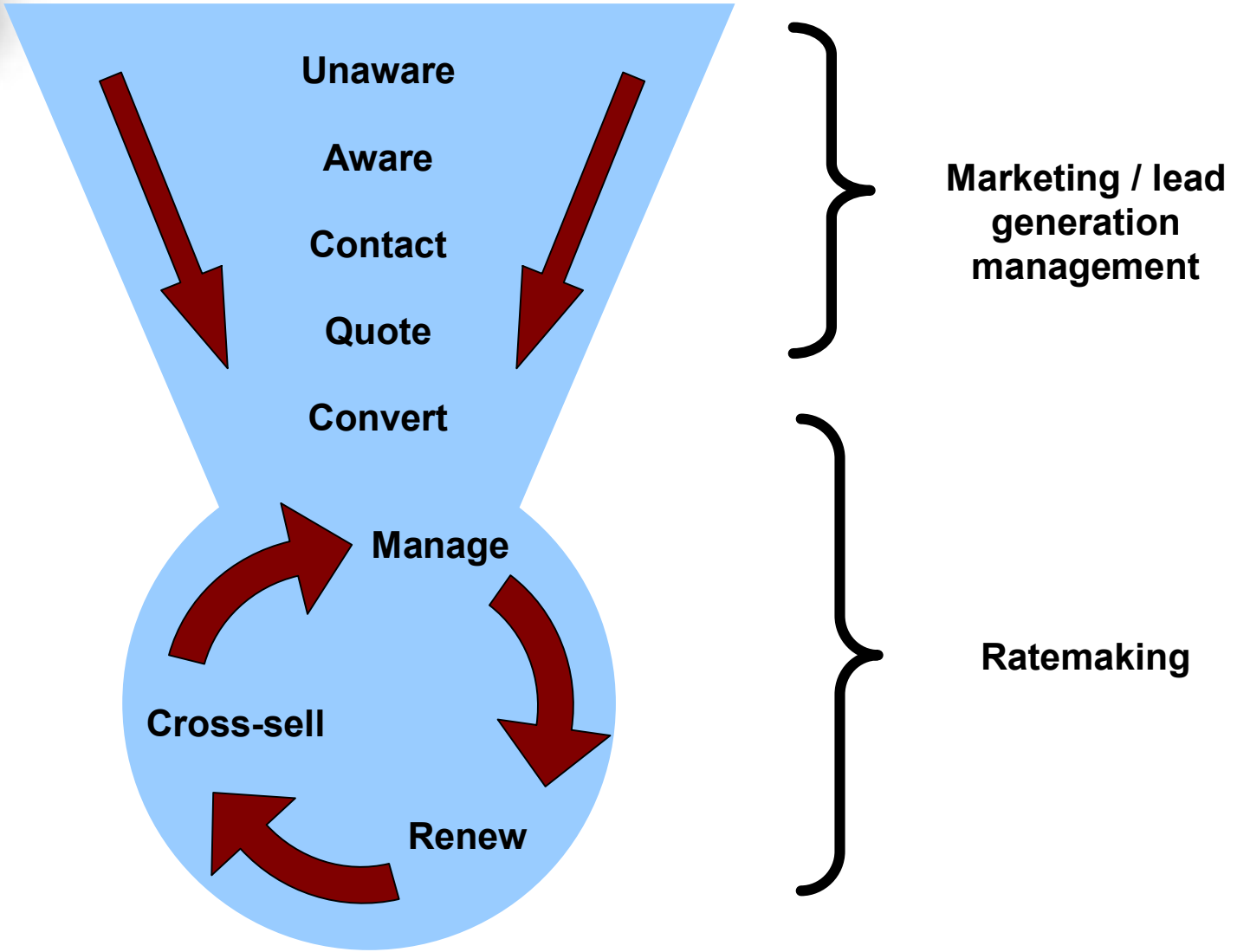
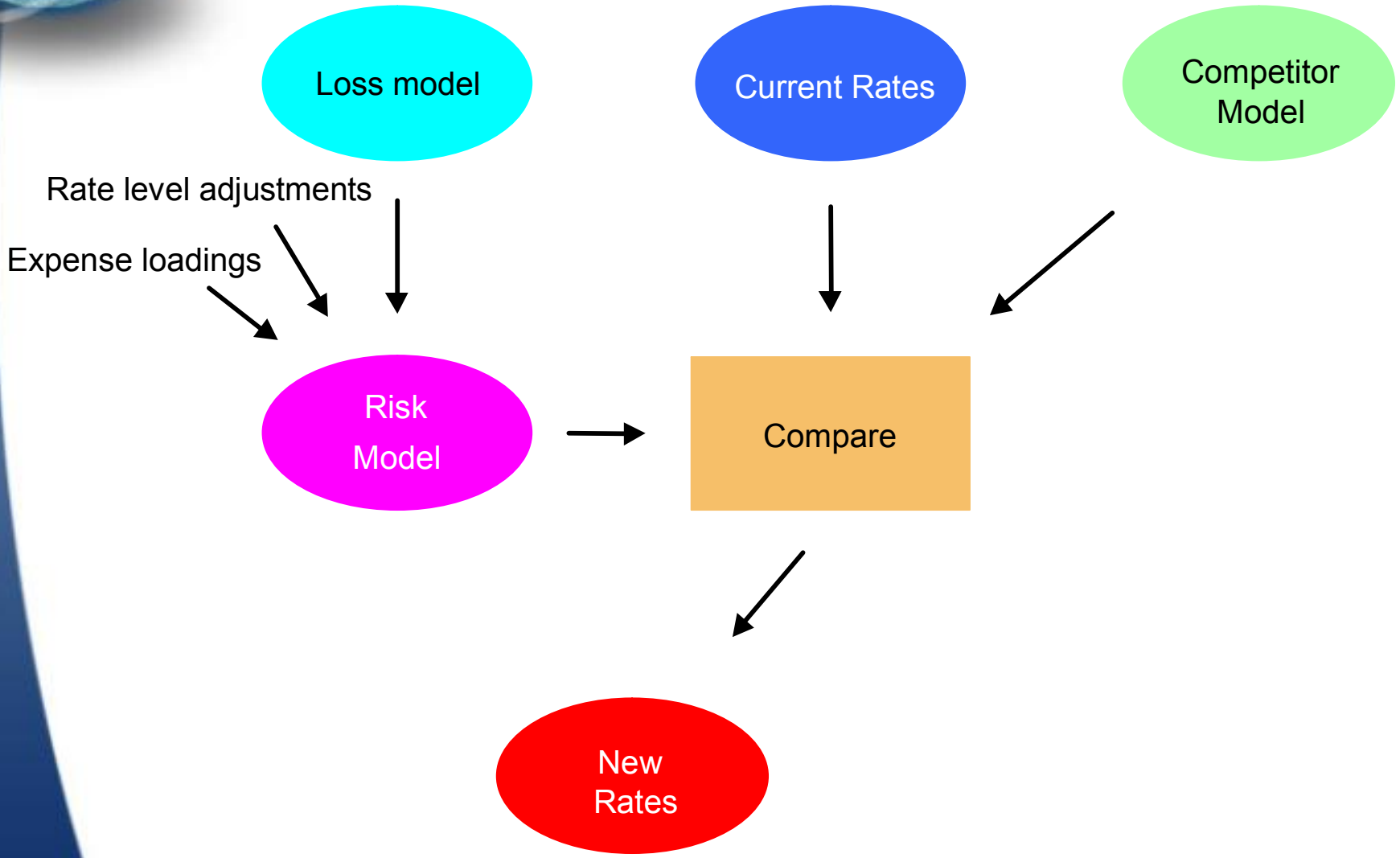
# Fishing for value



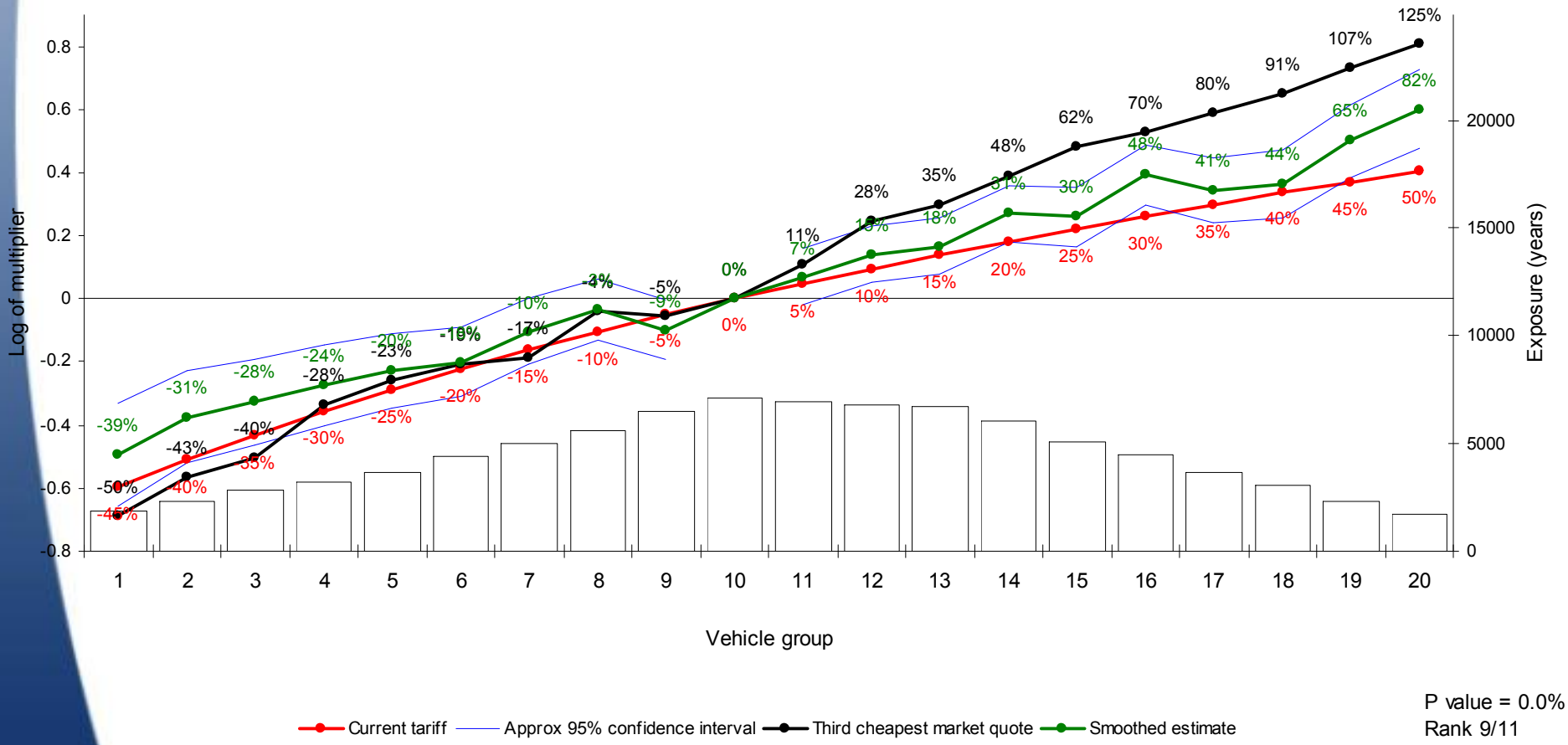
# Ratemaking analysis process without retention modeling



# Rate relativity indication

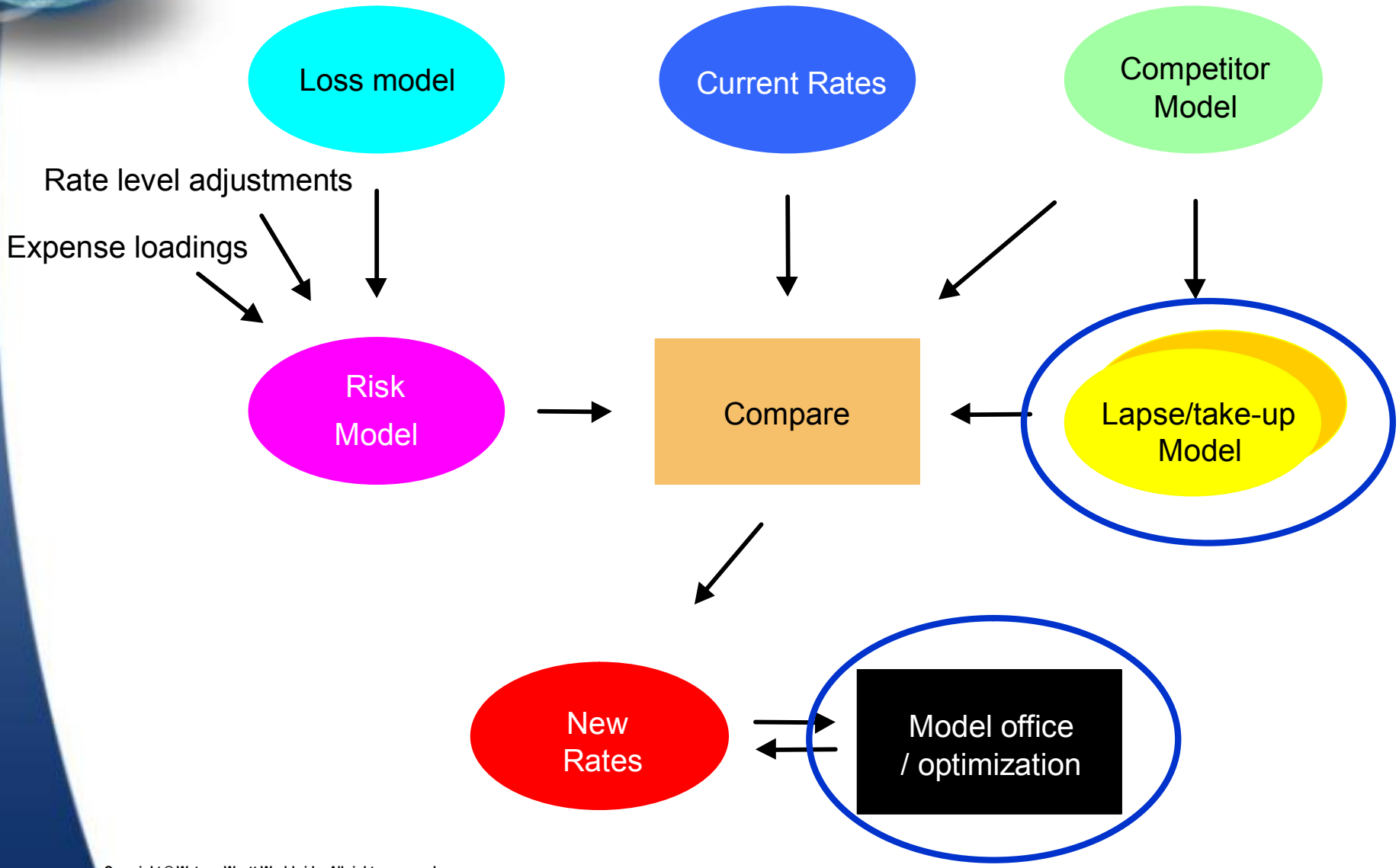
## Example of competitor analysis

Third party cover



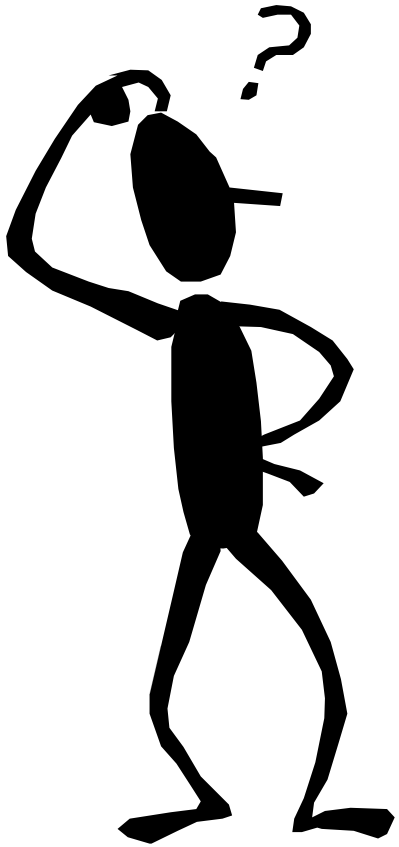

P value = 0.0%
Rank 9/11

# Full ratemaking analysis process



# Retention / conversion analysis

- What to measure
- Models / practical tips
- Elasticity modeling
- Why do it



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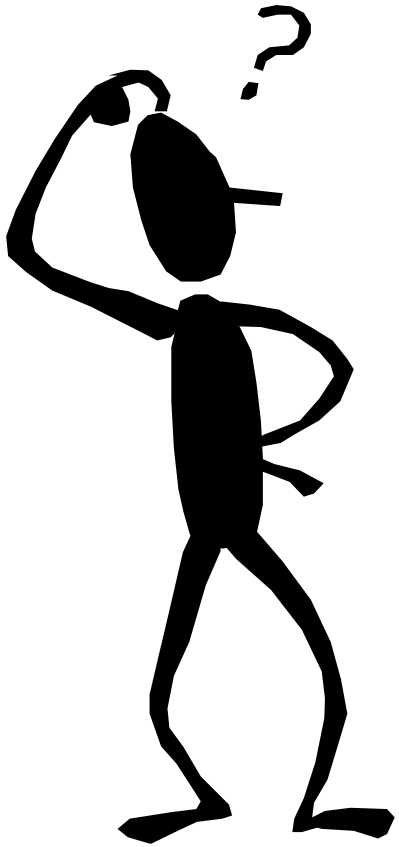
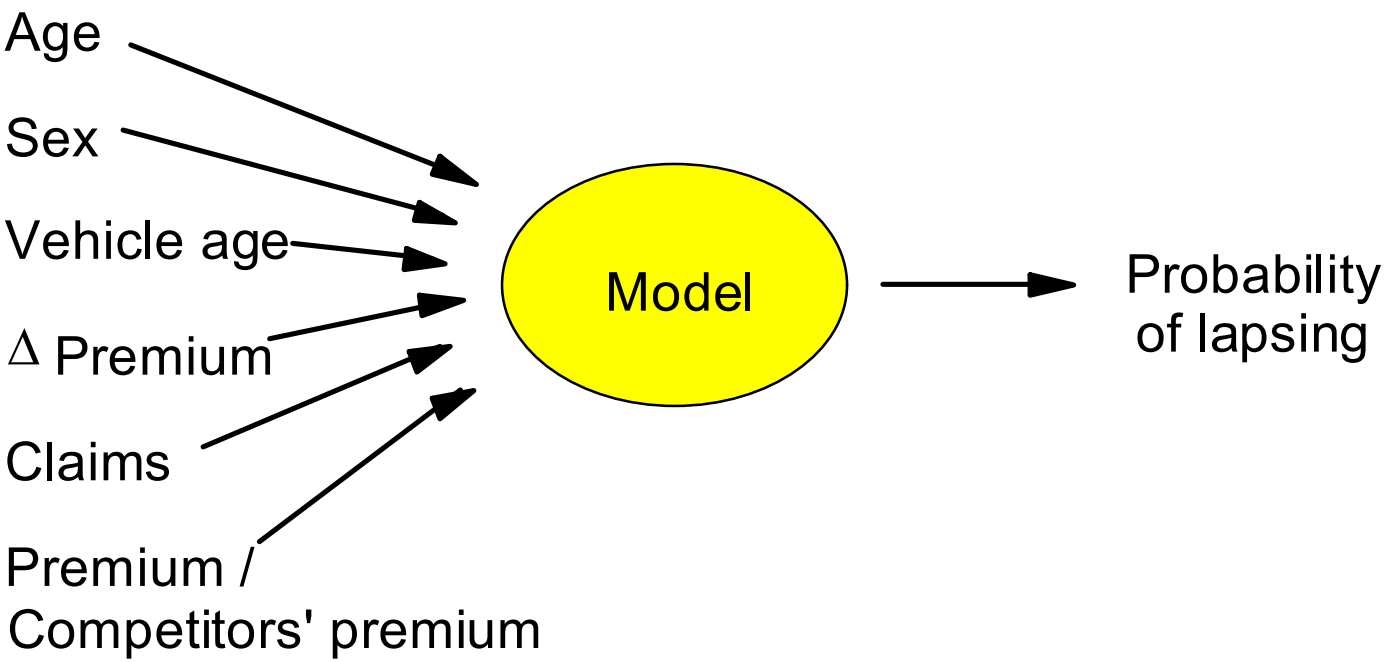


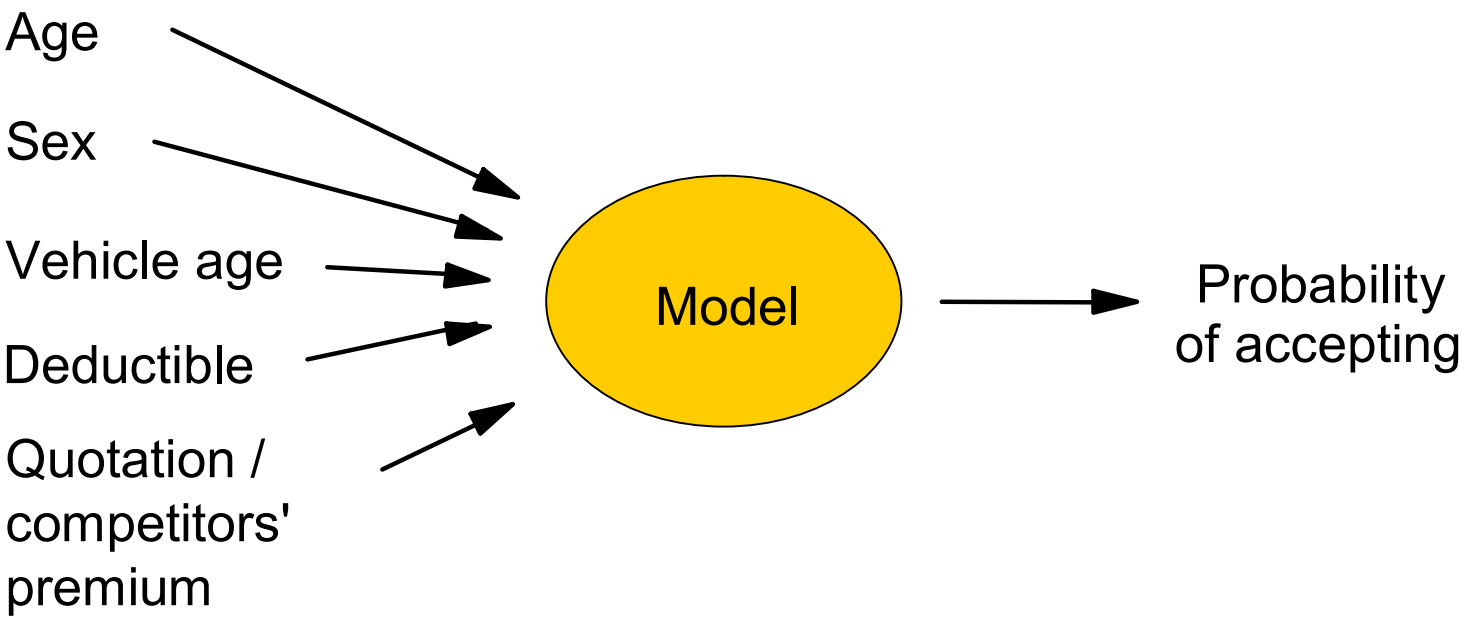
# Modeling retention

- Probability that an invitation to renew accepts
- Most companies have data on renewal offers



# Modeling new business rates

- Probability that a new business quotations accepts
- Requires details of failed quotes otherwise much simpler analysis is all that can be undertaken



# What drives a customer's retention behaviour?

- How much do they shop around?
- How bothered are they about price differences of differing amounts?
- How much do they value the relationship and brand?
- What is their experience of dealing with the insurer?
- How affected are they by competitors' marketing?
- What else is going on in their lives?

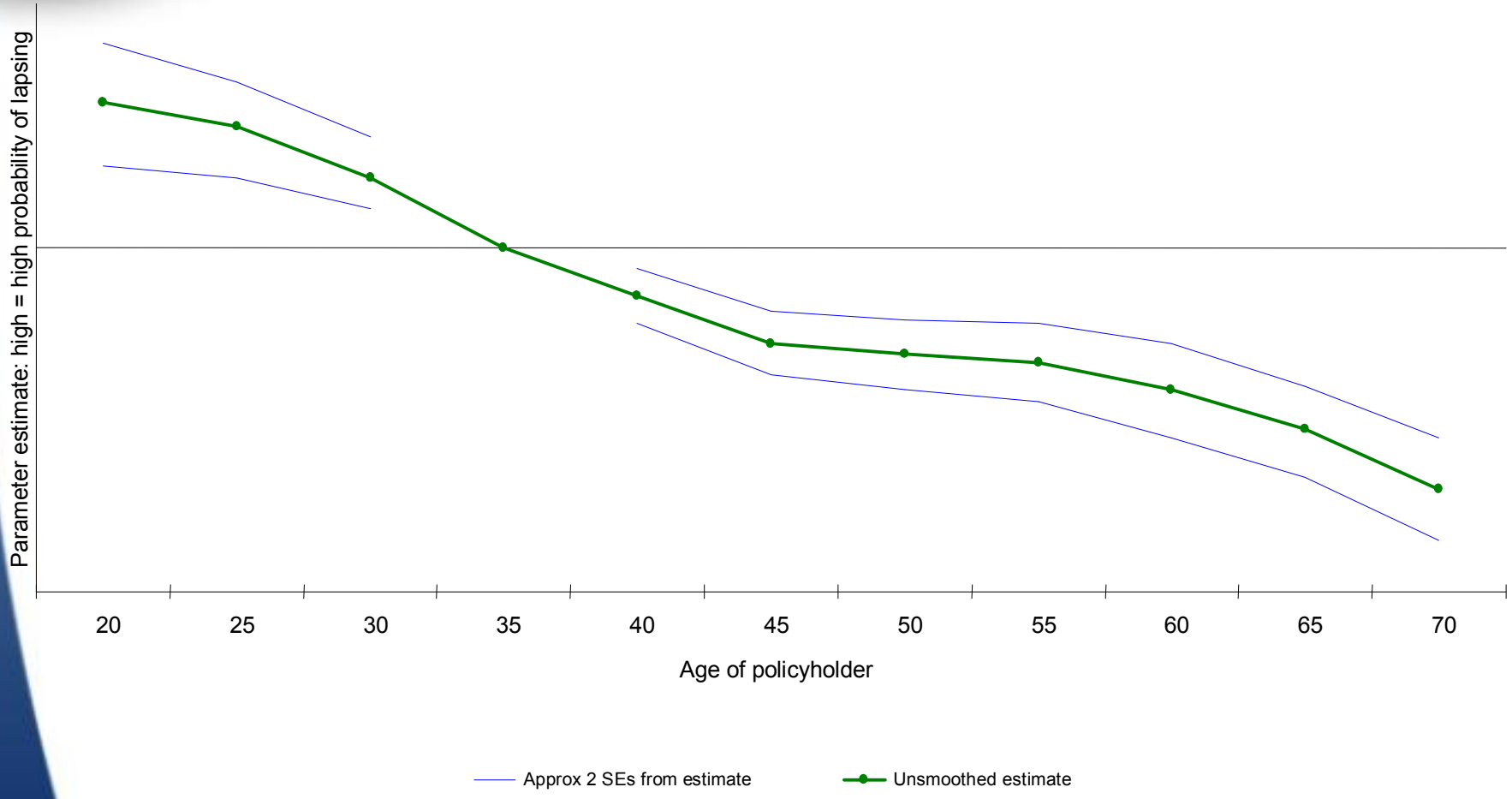
# Measurable factors to consider

- Who are your customers?
- How do you connect?
- What have you done to them?
- What have others done to them?

# Who are your customers?

- Age of policyholder
- Age of car
- Claims history
- Product features
- Other rating factors
- Endorsement activity
- Lifestyle factors

# Effect of age of policyholder on lapses

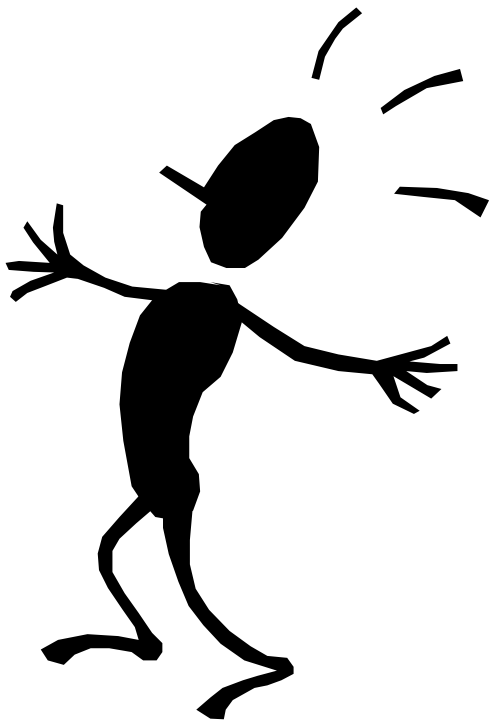


# How do you connect with them?

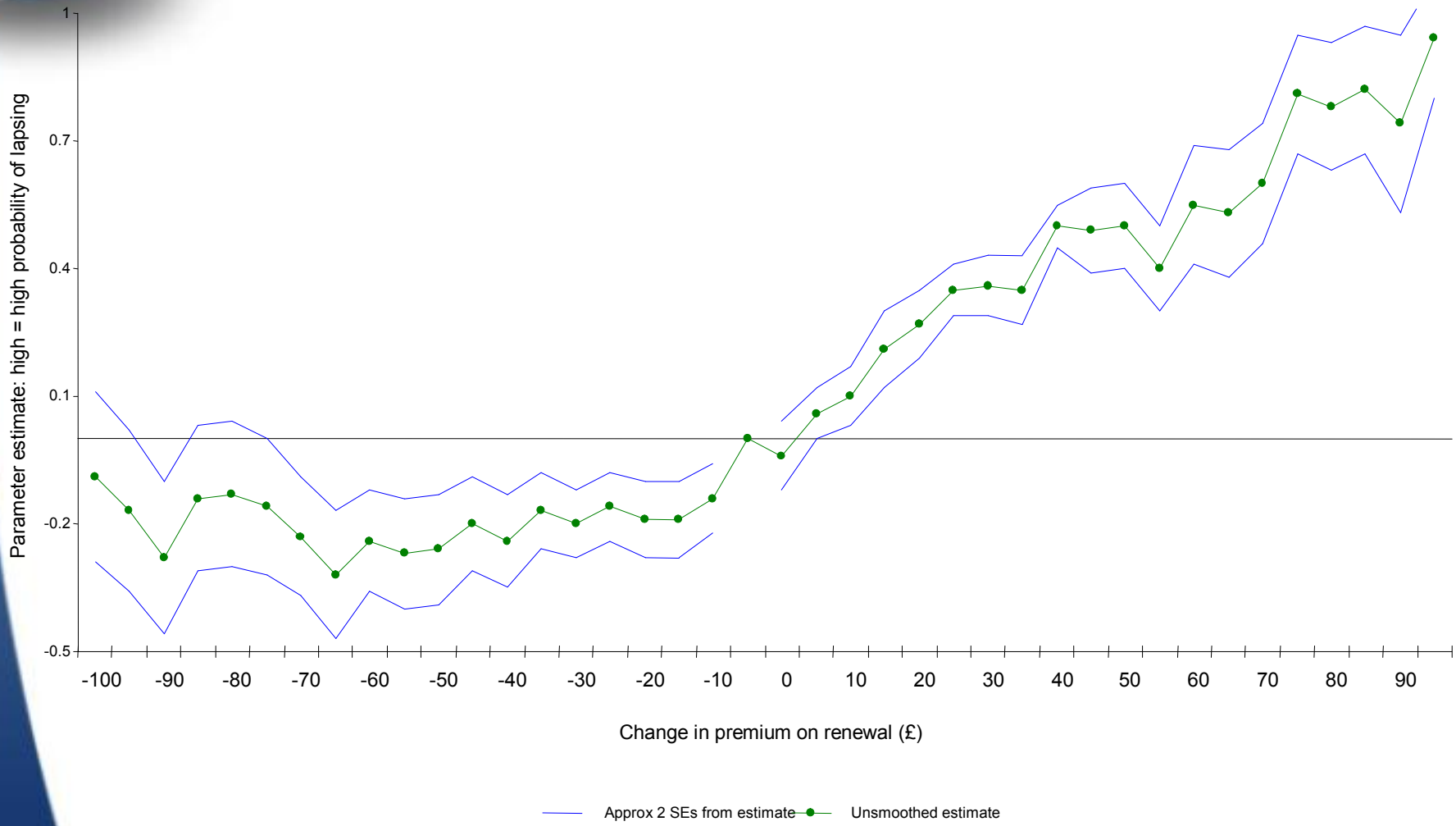
- Distribution channel
- Payment plan
- Affinity membership
- Other products held
- # years with company

# What have you done to them?

- Proposed rate change
- Last year's rate change
- Cumulative rate changes
- Communications
- Claims service
- Agent service

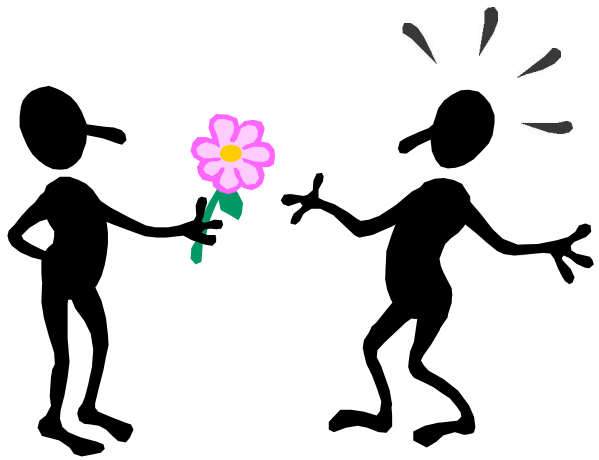


# Effect of premium change on lapses



# What have others done to them?

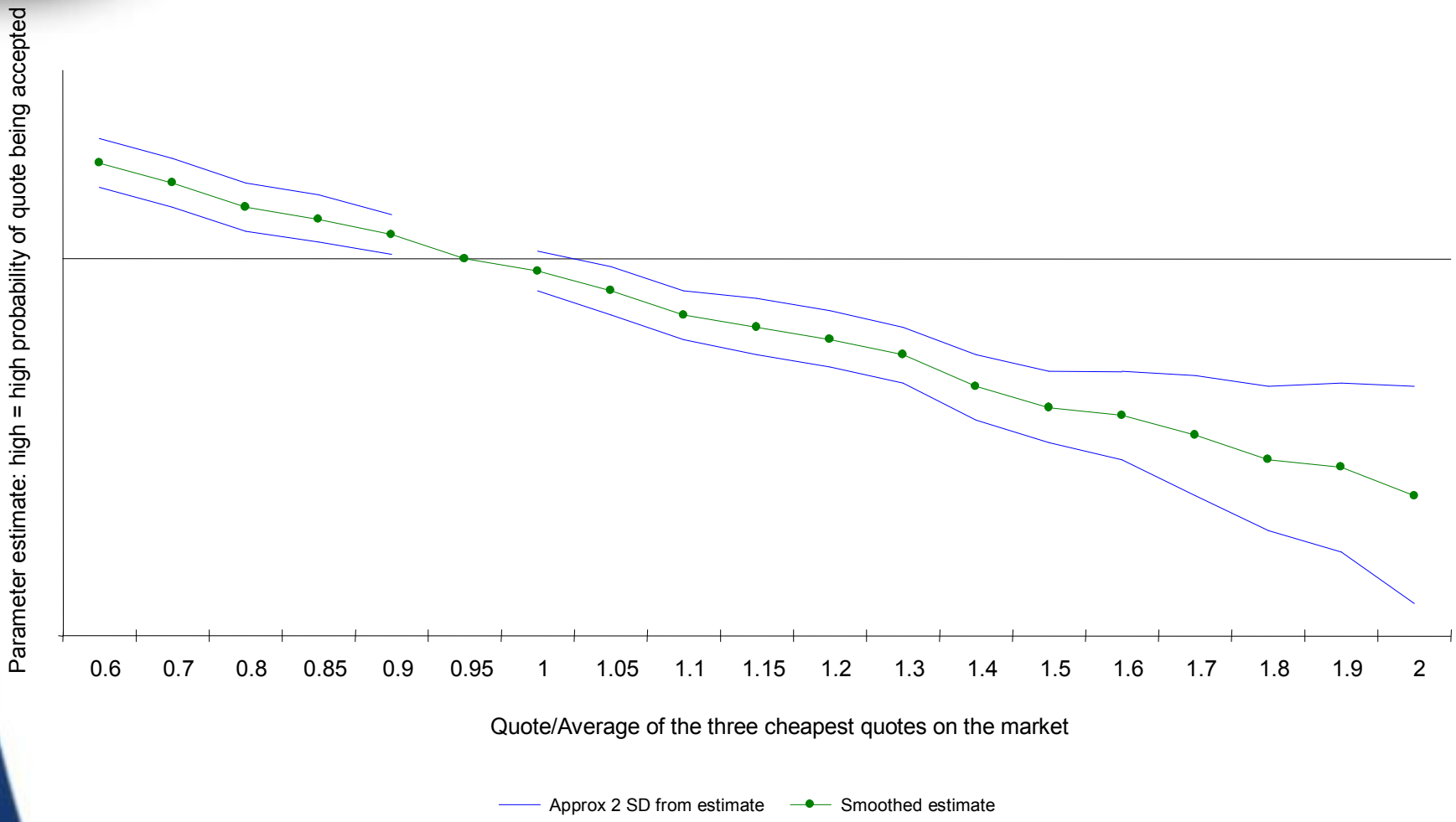
- Competitors' premium
- Competitors' marketing
- Product differentiation
  (may not be applicable to some products)



# Competitive indices

- For full modeling, required at individual policy level
- Sources of competitor info
  - rate manuals
  - comparative rating software
- Measures
  - index (comparing to one competitor or averaged across several)
  - rank of quote relative to competitors
- Challenges
  - tier criteria
  - point in time
  - cost

# Effect of competitiveness on new business



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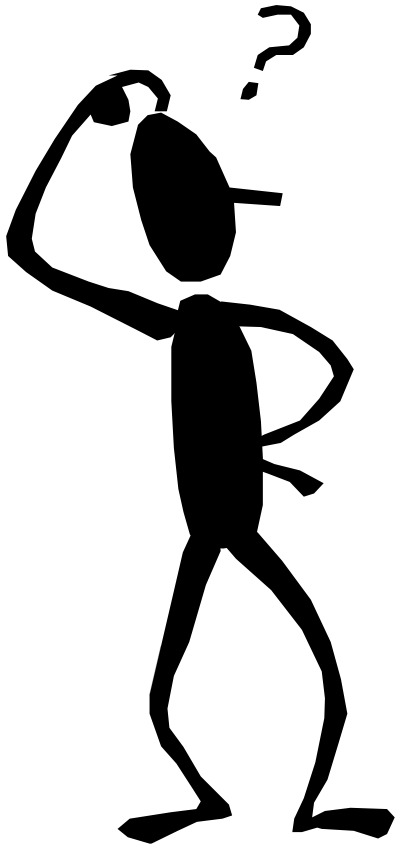


# Data required

- Individual policy (or quote) level
- Offer & resulting accept/lapse
- Policy characteristics and other information
- Rate change information
- Period during which rates changed

# Models

- Generalized linear models cope well with most common requirements
- A logistic model is most appropriate
  - considers log( p / [1-p] ) with binomial error
  - maps [0,1] to [- ∞, ∞]
  - invariant to whether you model lapse/renew
- If lapses are low and results not to be used directly, a Poisson multiplicative model can help
  - theoretically wrong (can predict multiple lapses), but easier to communicate

# Beware expectations

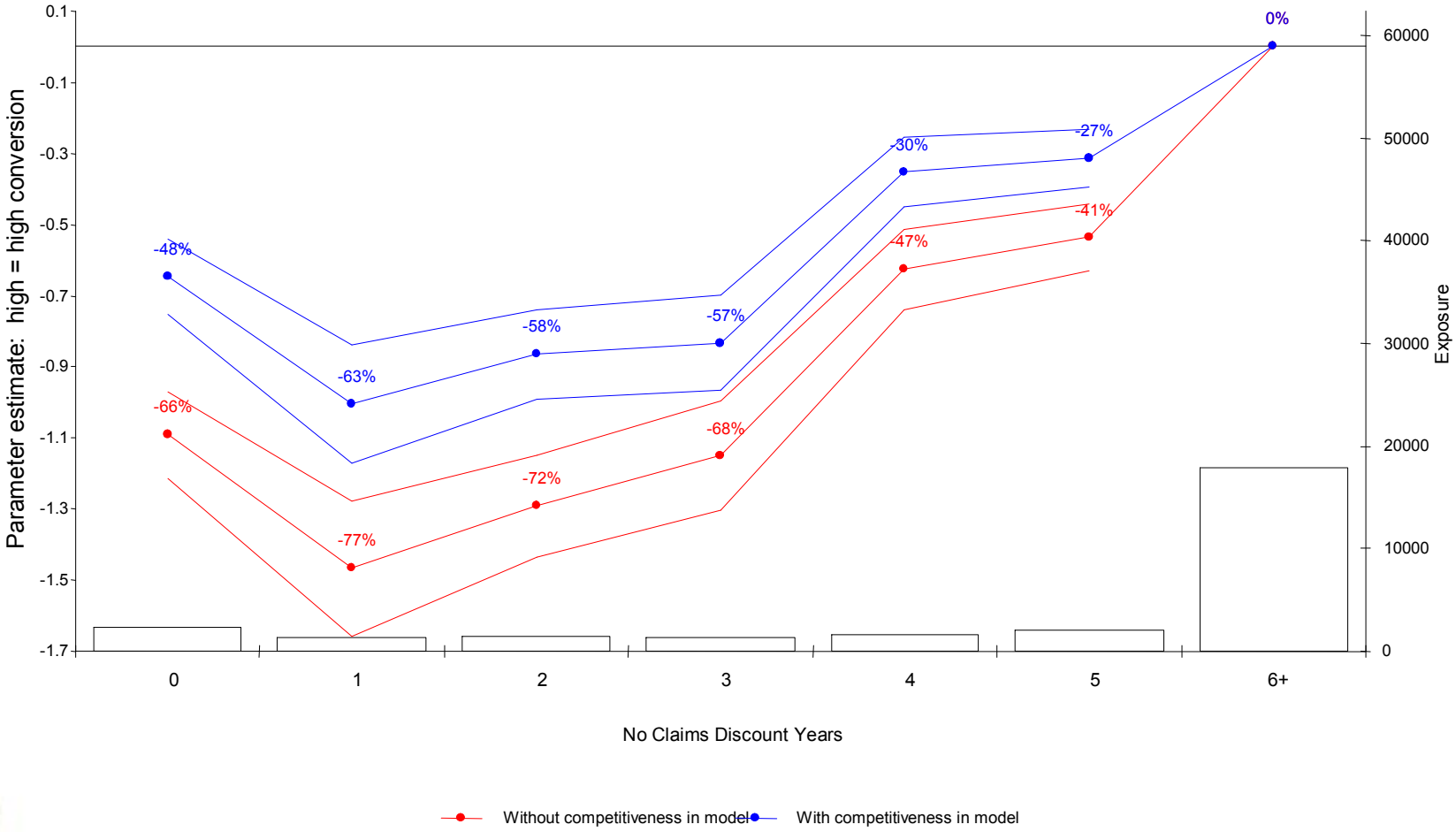
- Customer expectations of premium change
  - try to isolate rate change from risk criteria change which affects premium
  - consider premium change adjusted for change in risk criteria (ie new rates for new risk / old rates for new risk)

# Beware absolute premium

- GLM shows effect *all other factors being equal*
- For varying premium all other factors are never equal
- Results, while statistically correct, can be hard to interpret
  - for example adding premium size can reverse the multivariate result for age of driver
- Consider fitting separate models for different premiums bands

# How much is down to competitiveness?

- Superimposing models with and without competitiveness will show extent to which effects are simply price related



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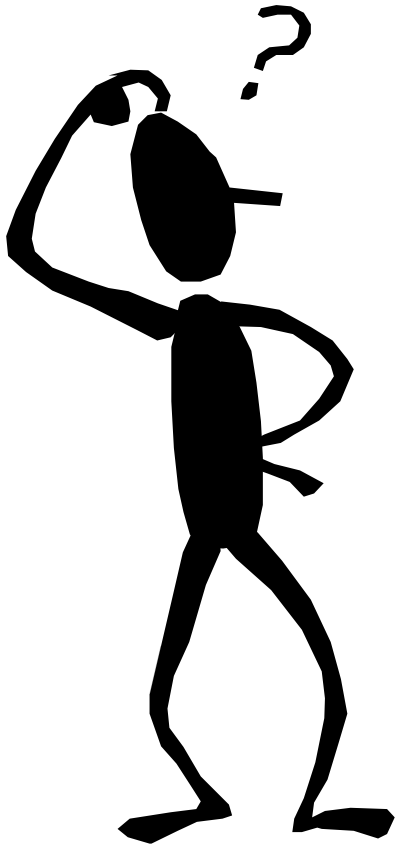


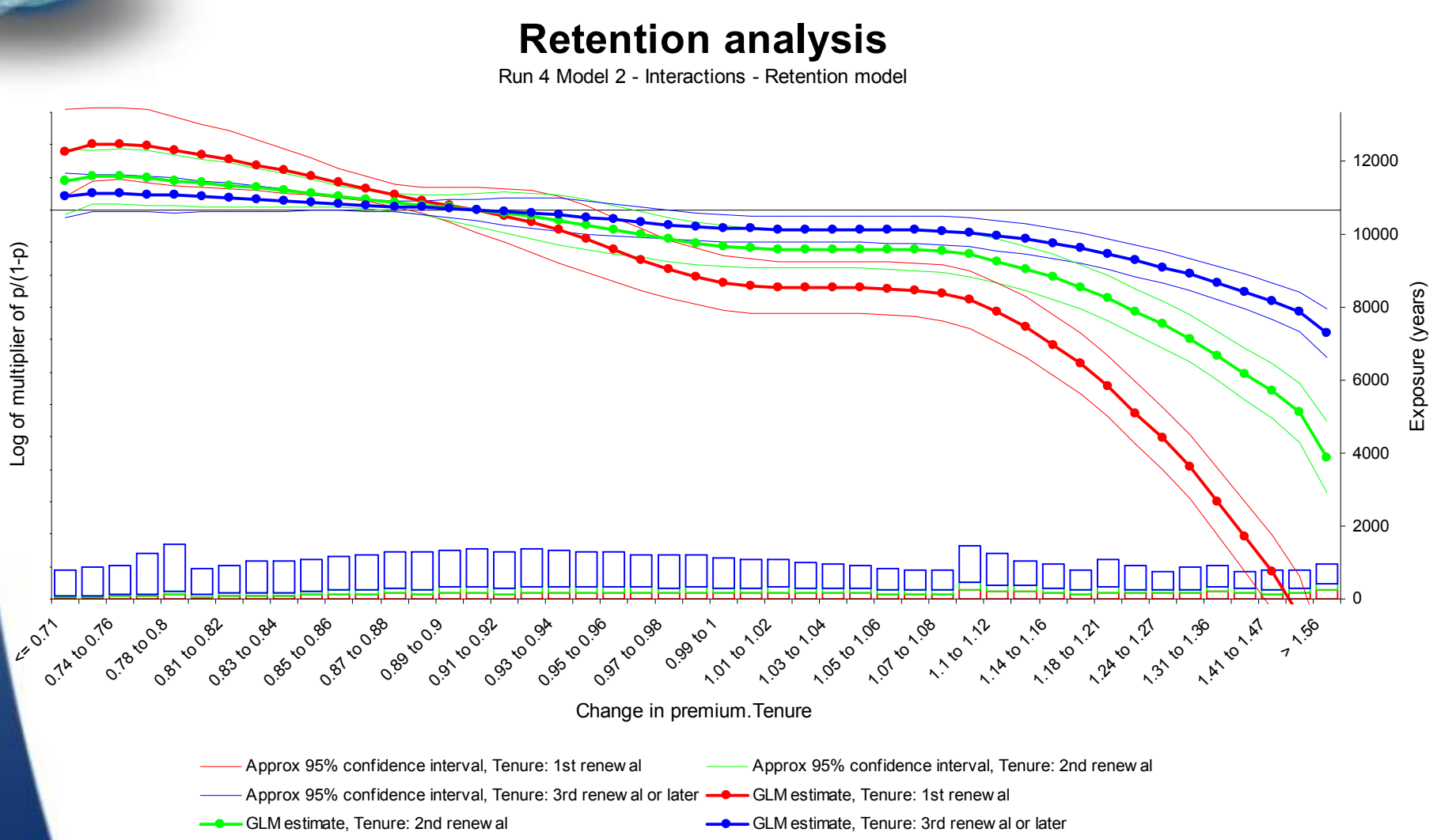
# Elasticity modeling

- Focussing on the rate change variable
- Seek to understand how new business and renewal volumes will respond to different future rate changes
- Key in scenario testing and price optimization analyses

# Elasticity modeling

- Data
  - need a range of historic rate changes
  - not linked to particular events
  - ideally randomized trials
  - if not, other legitimate model changes might yield range of rate changes to provide insight
  - balance credibility of volume with relevance of experience period
- Model
  - Elasticity curve may need to be smooth - splines
  - Consider interactions of price change with key variables - elasticity can vary by type of policy

# Example retention curve



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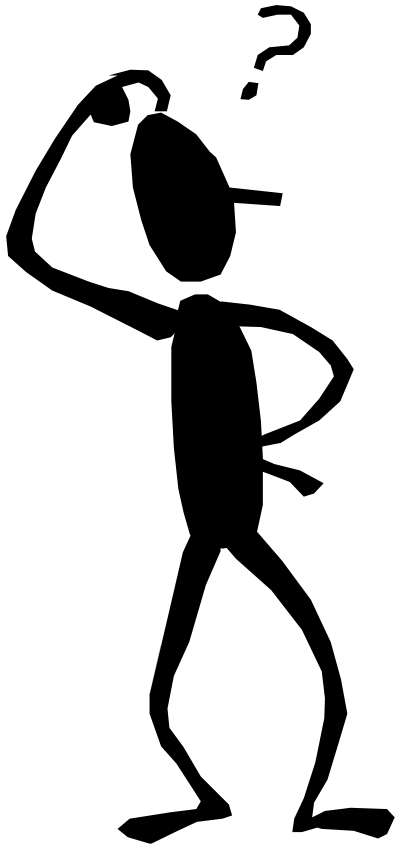
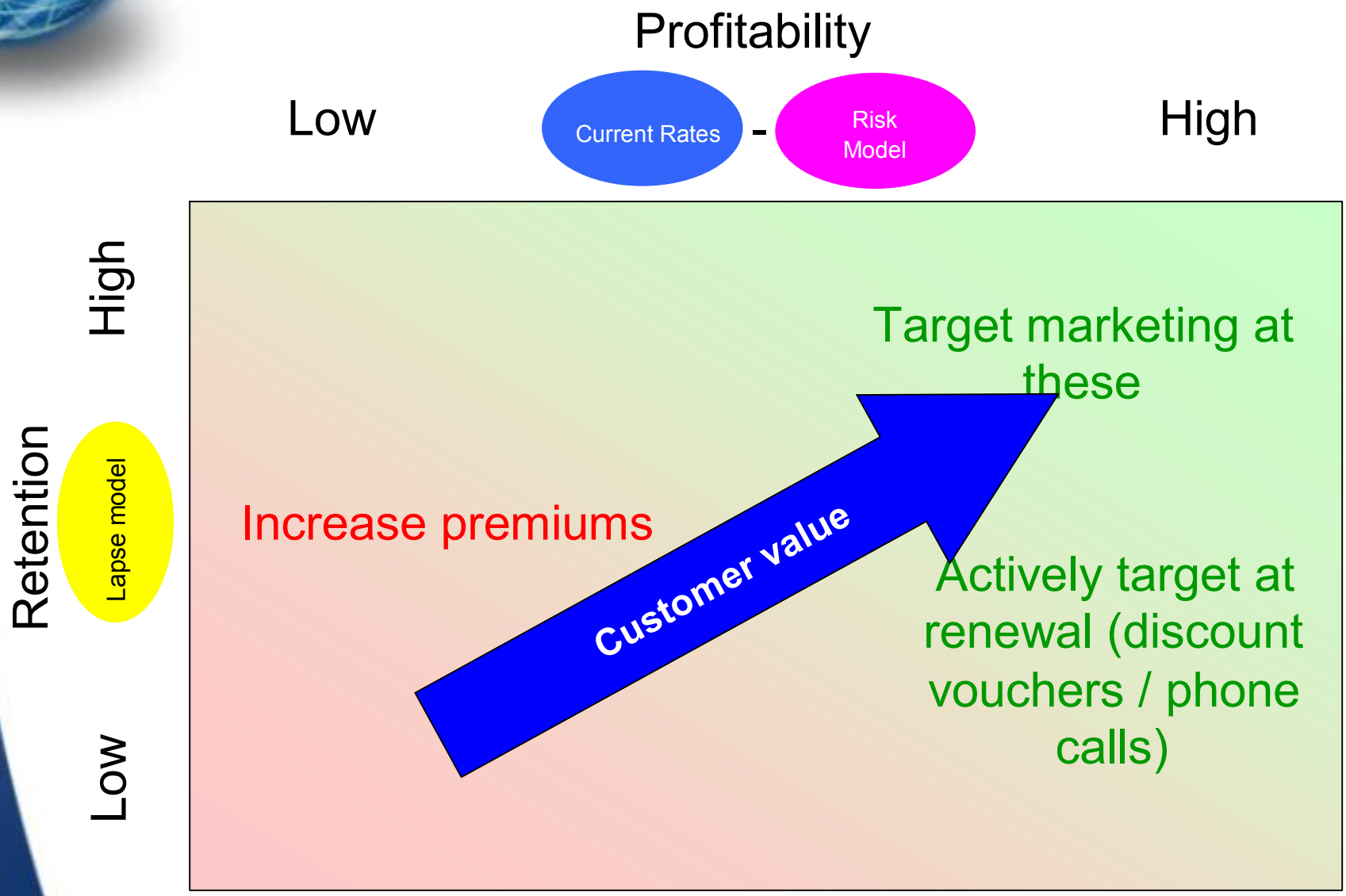


# Why model lapses / new business?

- Qualitative management decisions
  - marketing strategies
  - renewal campaigns
- Modeling
  - expense loading
  - simple lifetime modeling
  - detailed "model office" scenario testing
  - price optimization

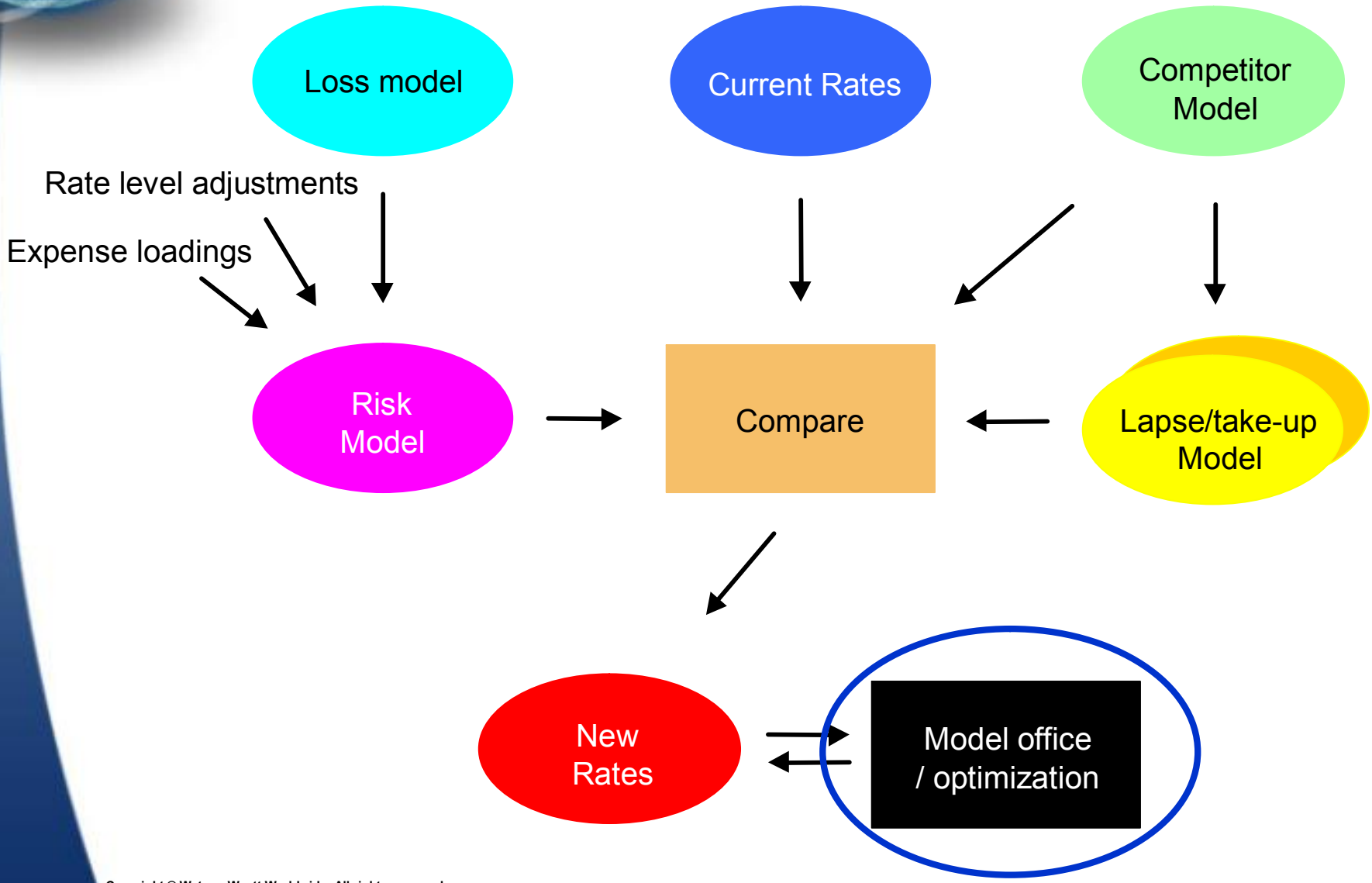
# Customer value



# Lifetime expense loads

- Expenses per policy
  - acquisition 100
  - renewal 30
- Expected lifetime
  - young 2 years
  - old 5 years
- Lifetime expense loadings
  - young ( 100 + 1 * 30 ) / 2 = 65
  - old ( 100 + 4 * 30 ) / 5 = 44

# Price optimization



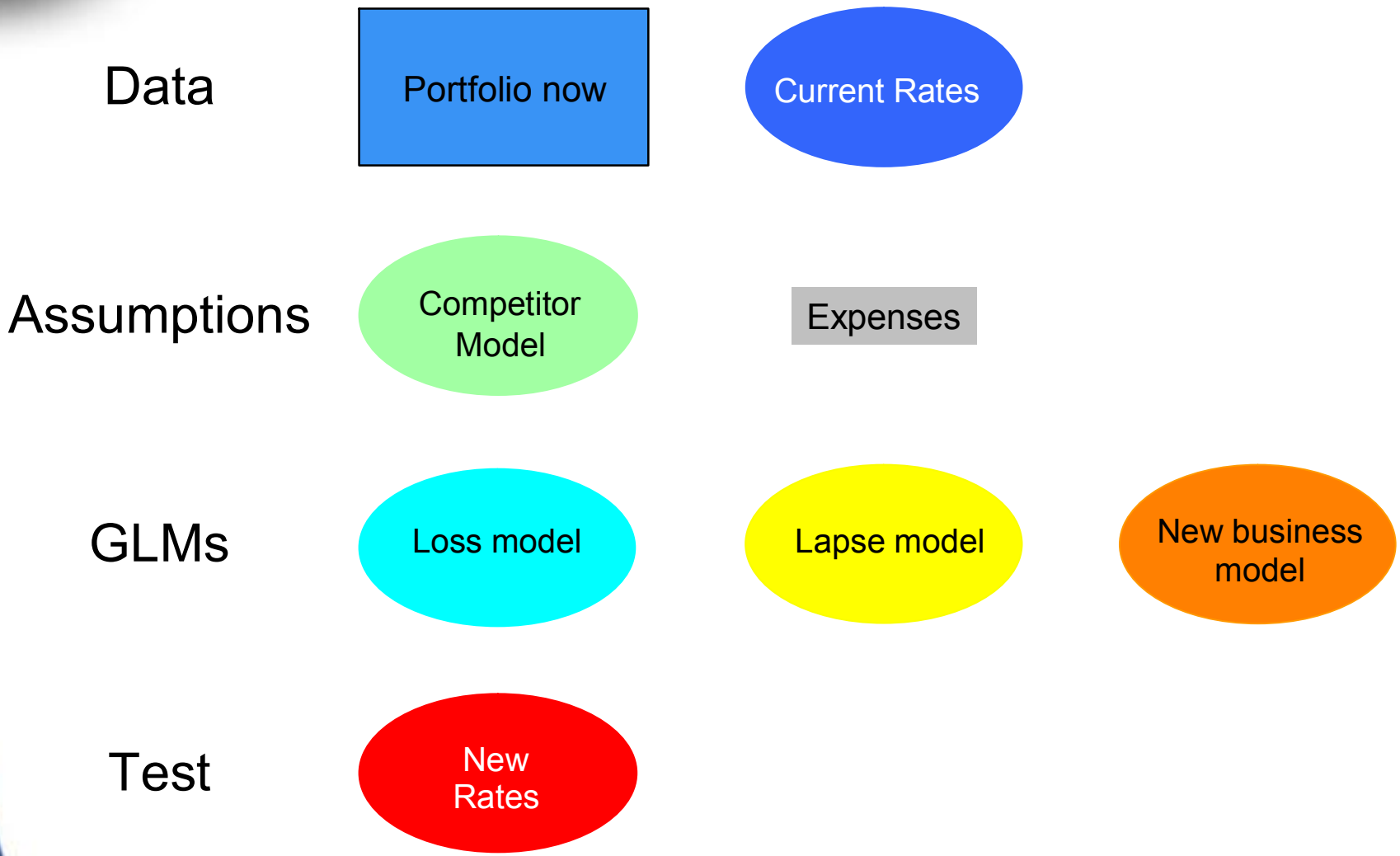
# Scenario testing and price optimization

- What will happen if I do rating action X?
- What is the "best" rating action?
  - given a form of rating structure, seek the parameters which maximize a company's strategic objectives, perhaps with defined constraints

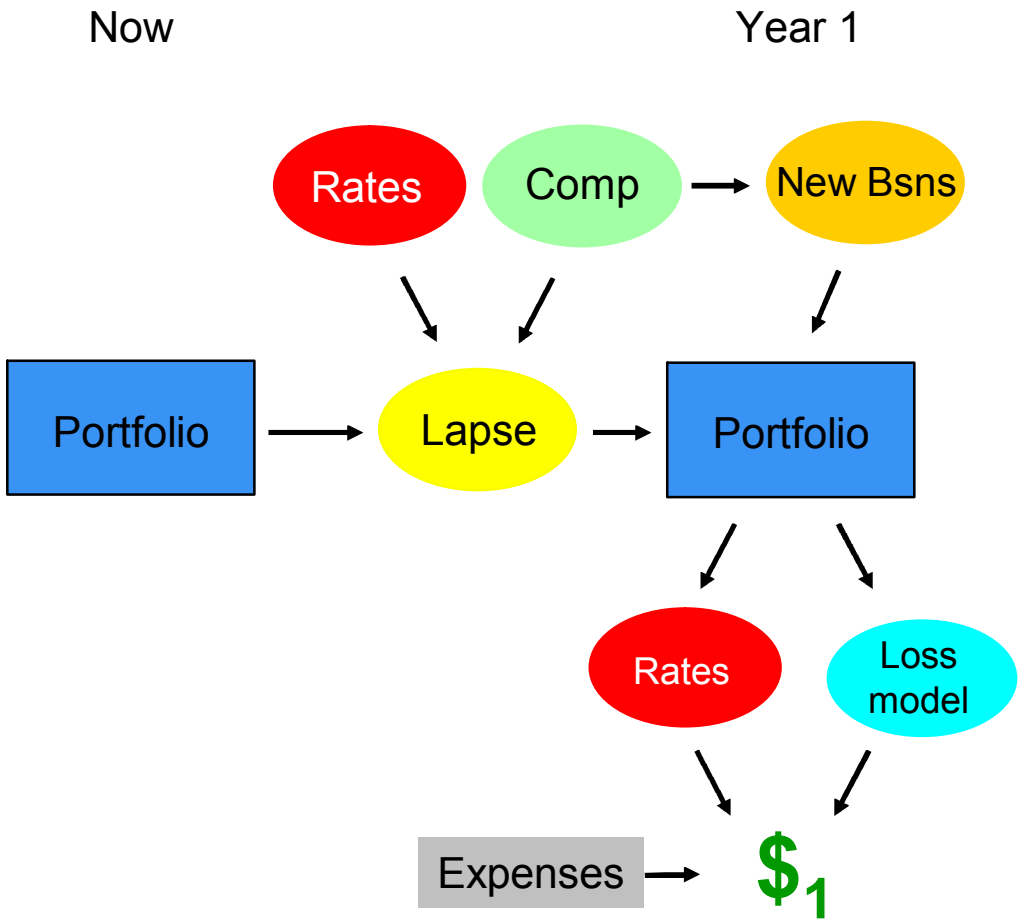
# Price optimization in four easy steps

1. Assemble ingredients
2. Build a "model office" scenario test
3. Define problem and success criteria
4. Optimize

# Ingredients



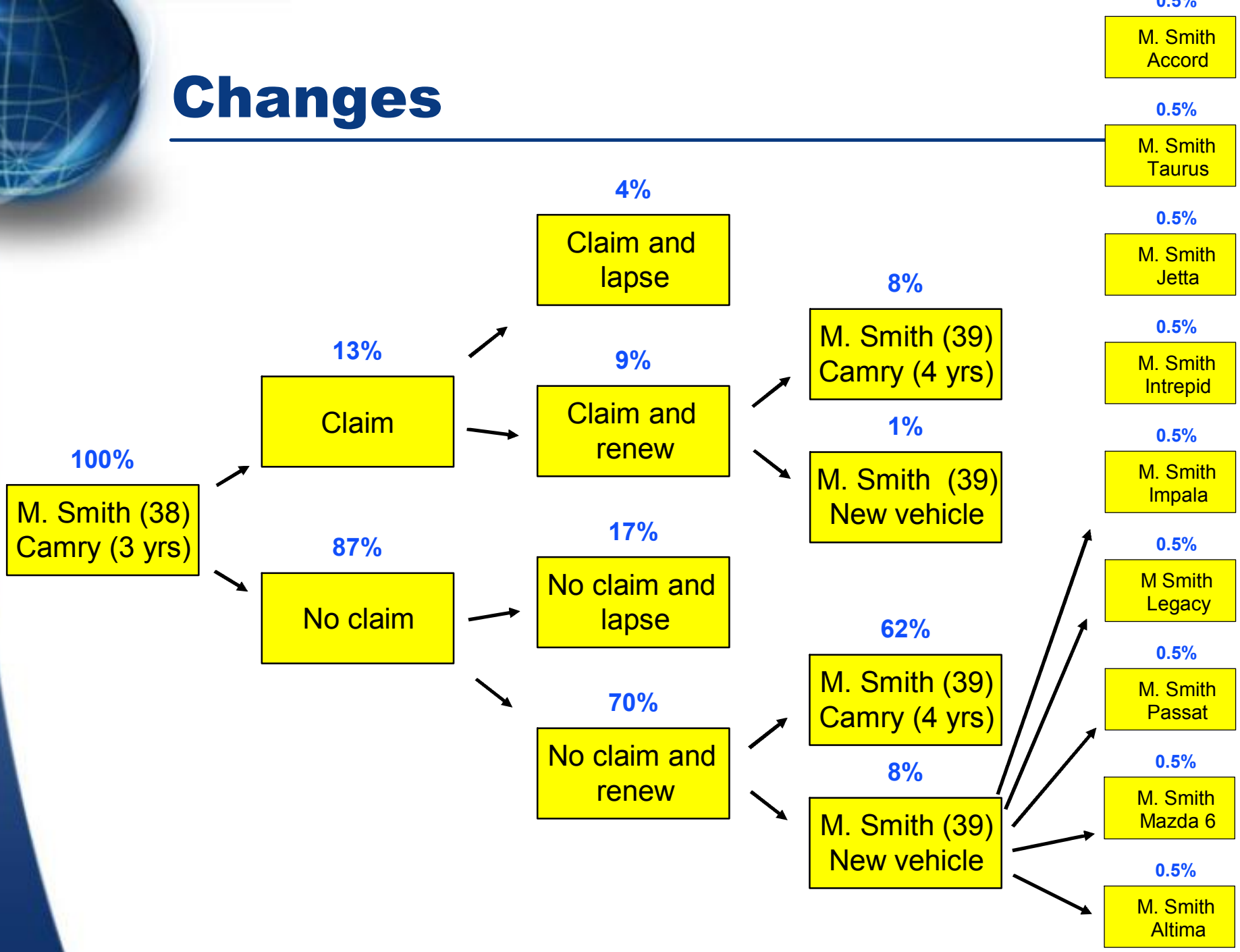
# Scenario testing



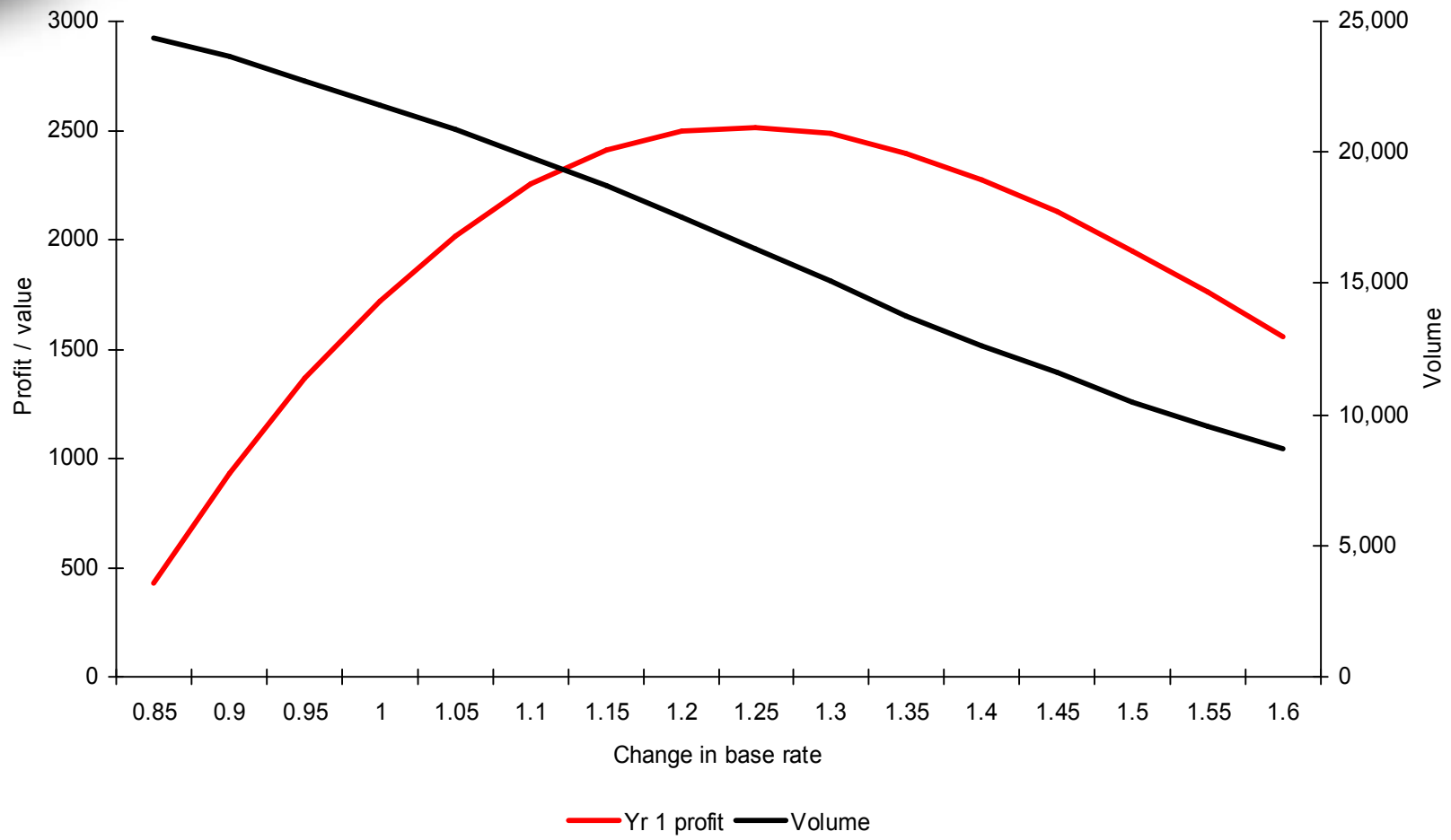
# Issues

- Competition
- Changes to model
  - age of insured
  - age of vehicle (home)
  - claim surcharges
  - vehicle (home)
  - address
- Programming issues
- Period of projection
- Success criteria

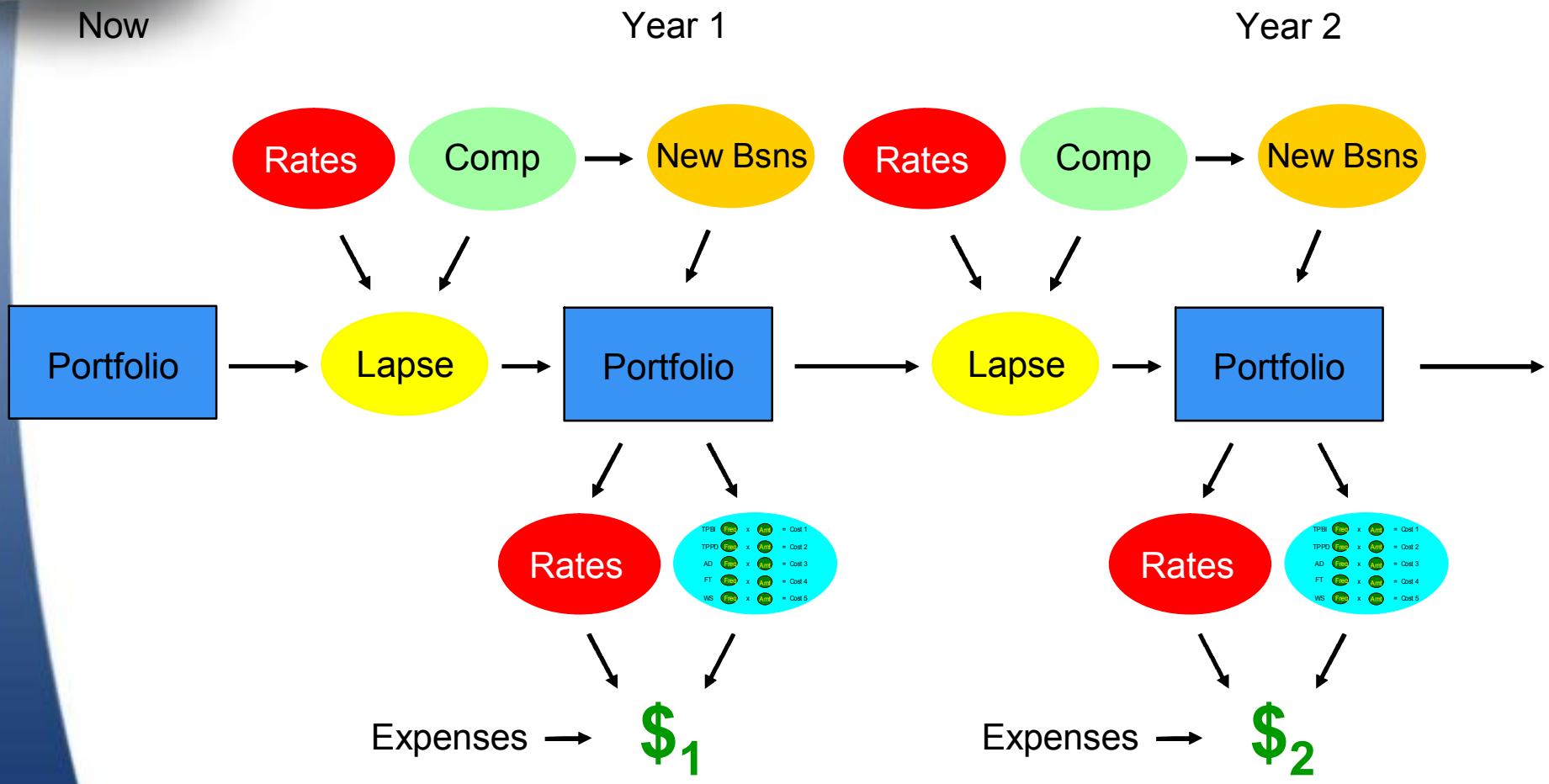
# Changes



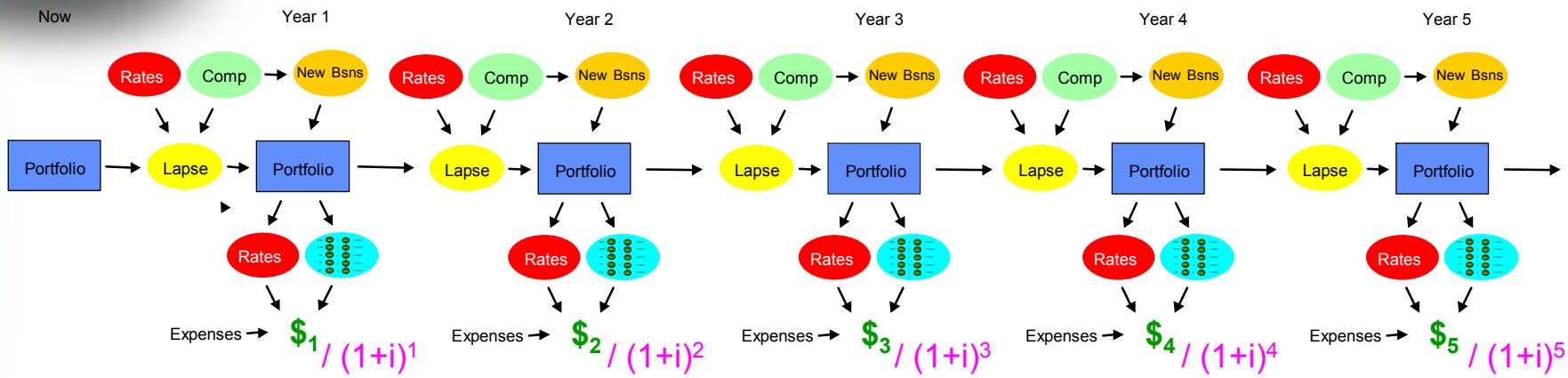
# Period of projection



# Multiple year projections

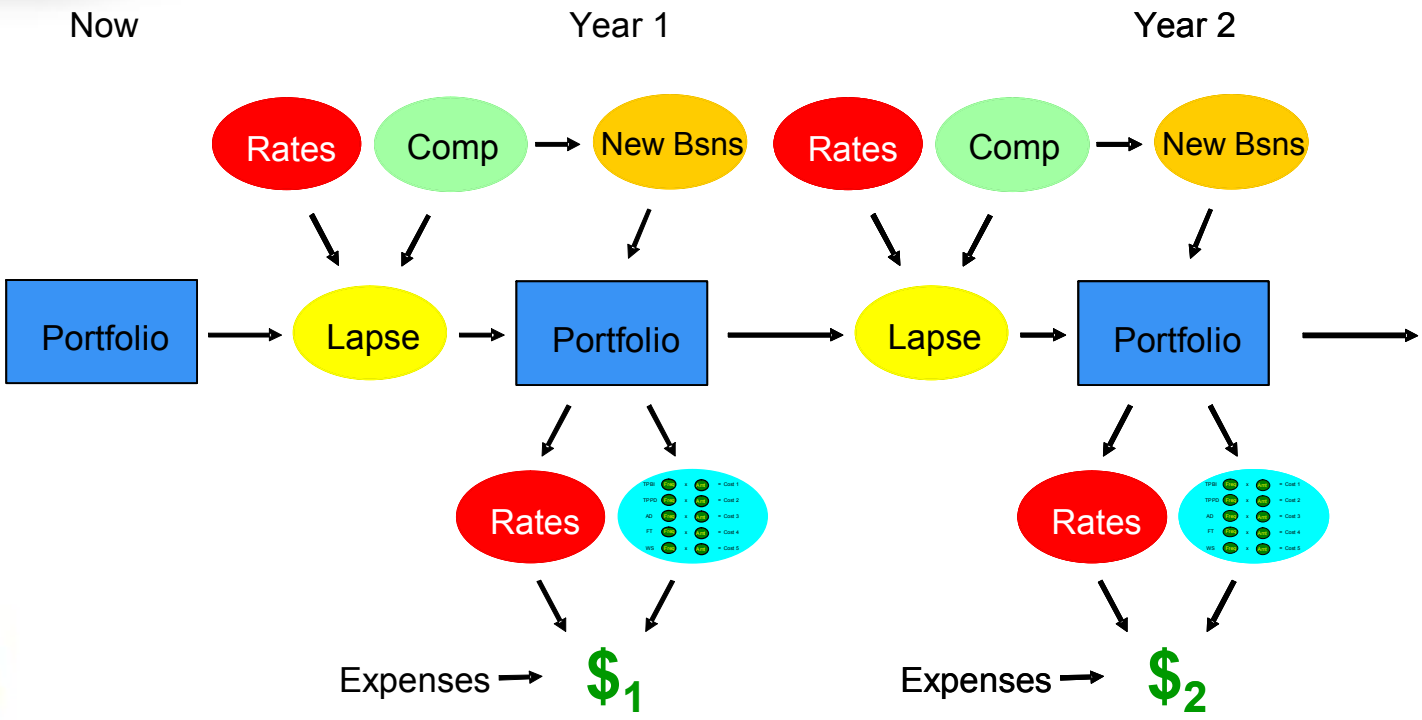


# Multiple year projections




- In theory project many years
- In practice assumptions become too uncertain and model becomes too complex

# A pragmatic compromise?



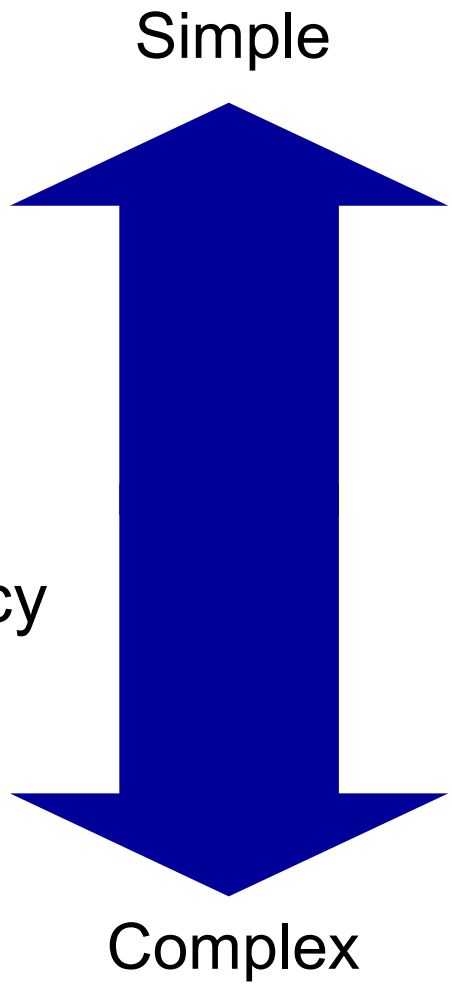

**+ $X per policy in force, perhaps as a function of factors to make allowance for lifetime value**

# Success criteria

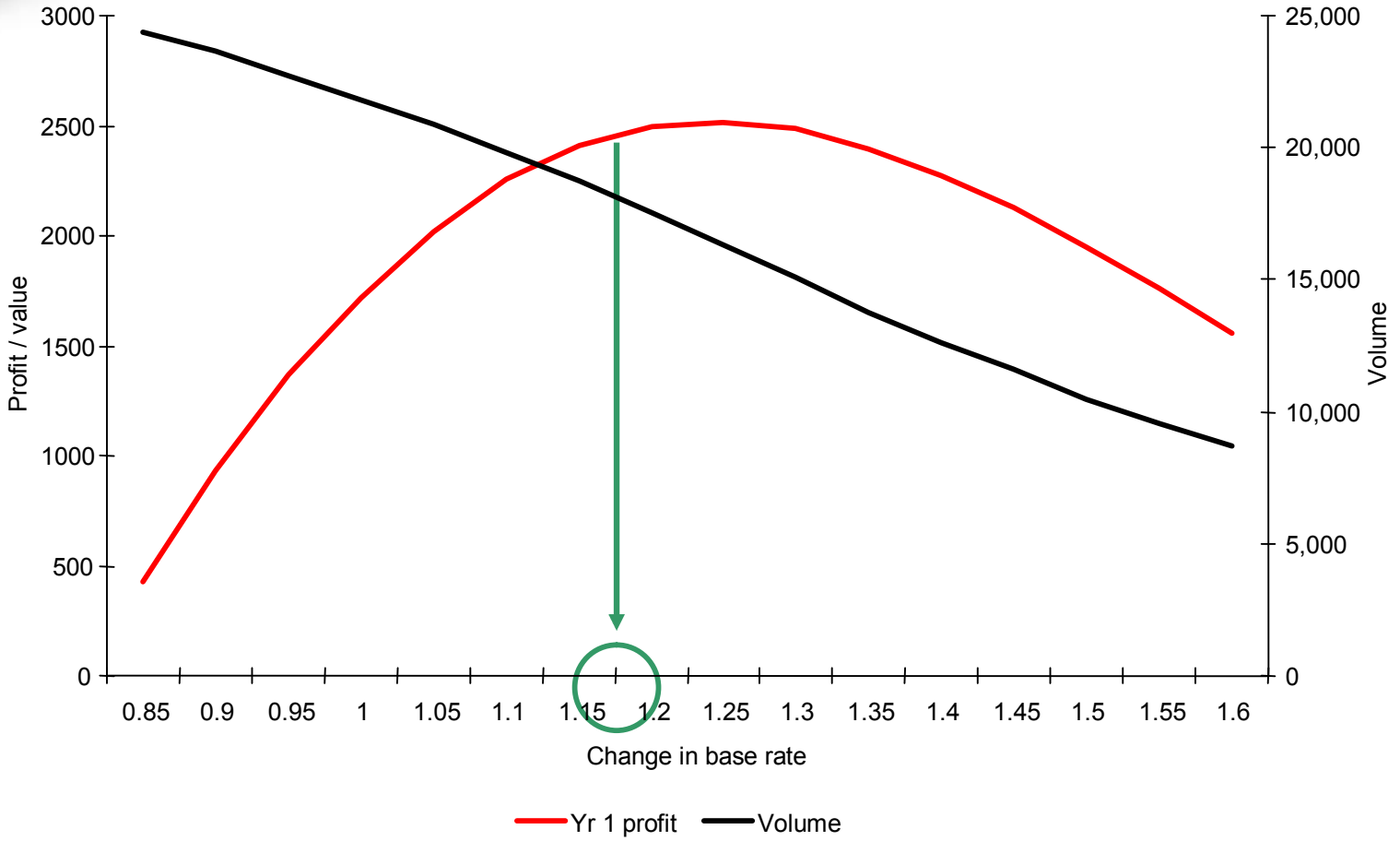
- Depends on problem being solved
- Simple scenario tests to consider a one or two parameter problem:
  - consider many success criteria eg both volume and profit in each of first two years
- Full optimization with many parameters or at individual policy level:
  - combined measure eg *Profit* + $\lambda$ . *Volume*
- Constrained optimisation

# Types of optimization

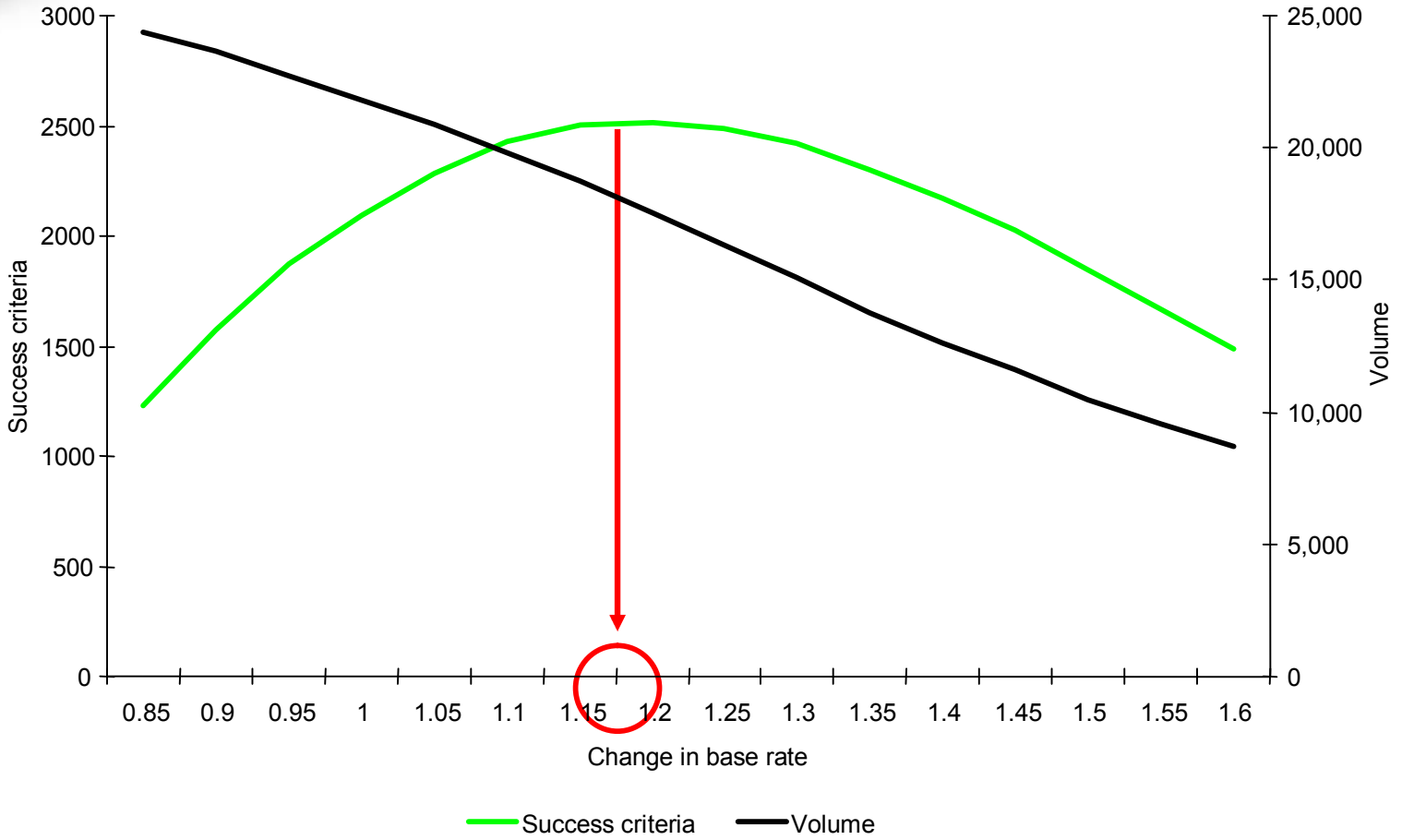
- Optimization via scenario tests
  - base rate change
  - simple relativity tweaks
  - moderator algorithms
- Full optimization
  - rating structure via individual policy
  - individual policy
  - calibration of point of sale optimisation algorithm



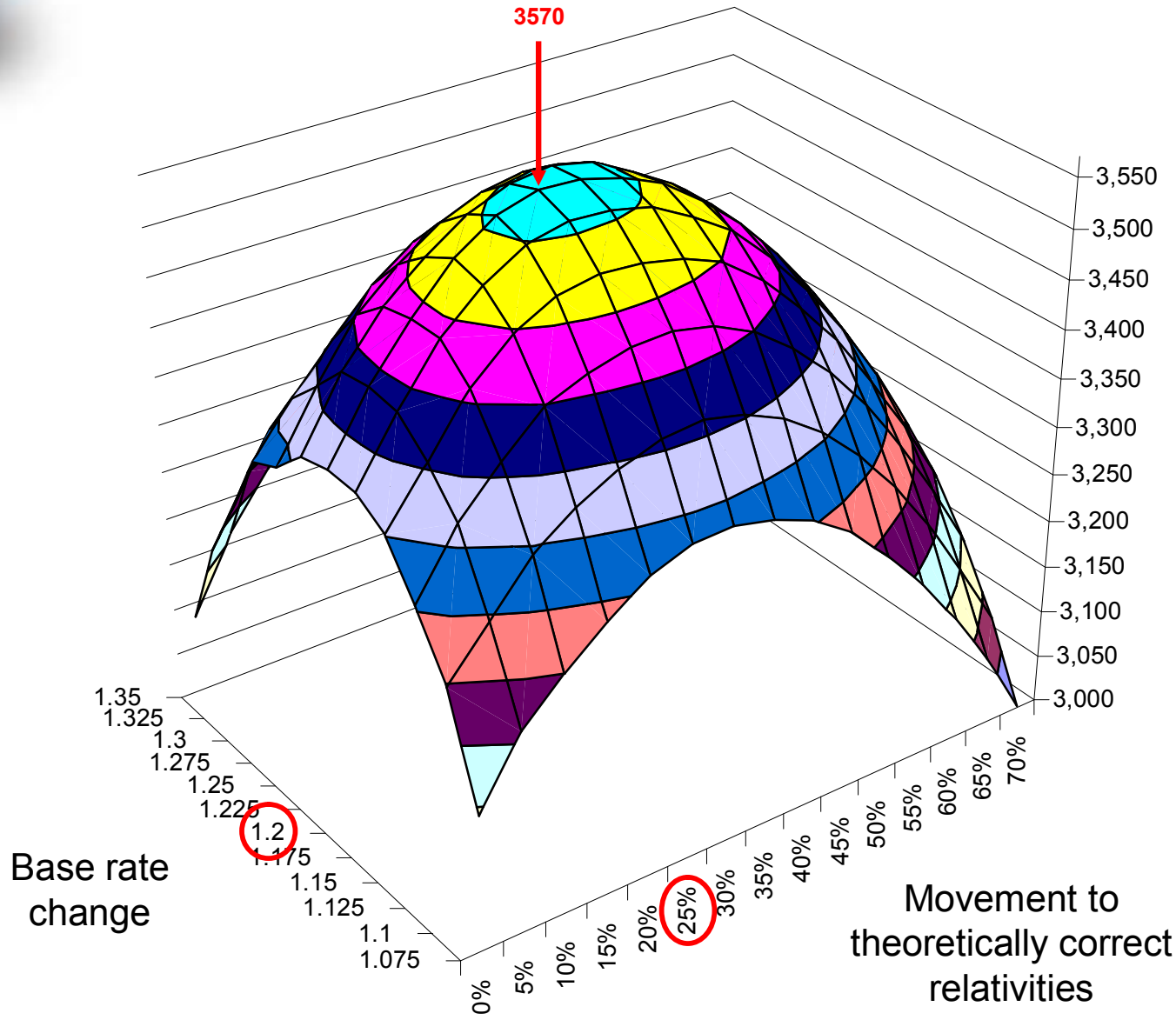
# Base rate change - consider profit vs volume



# Base rate change - single success criteria

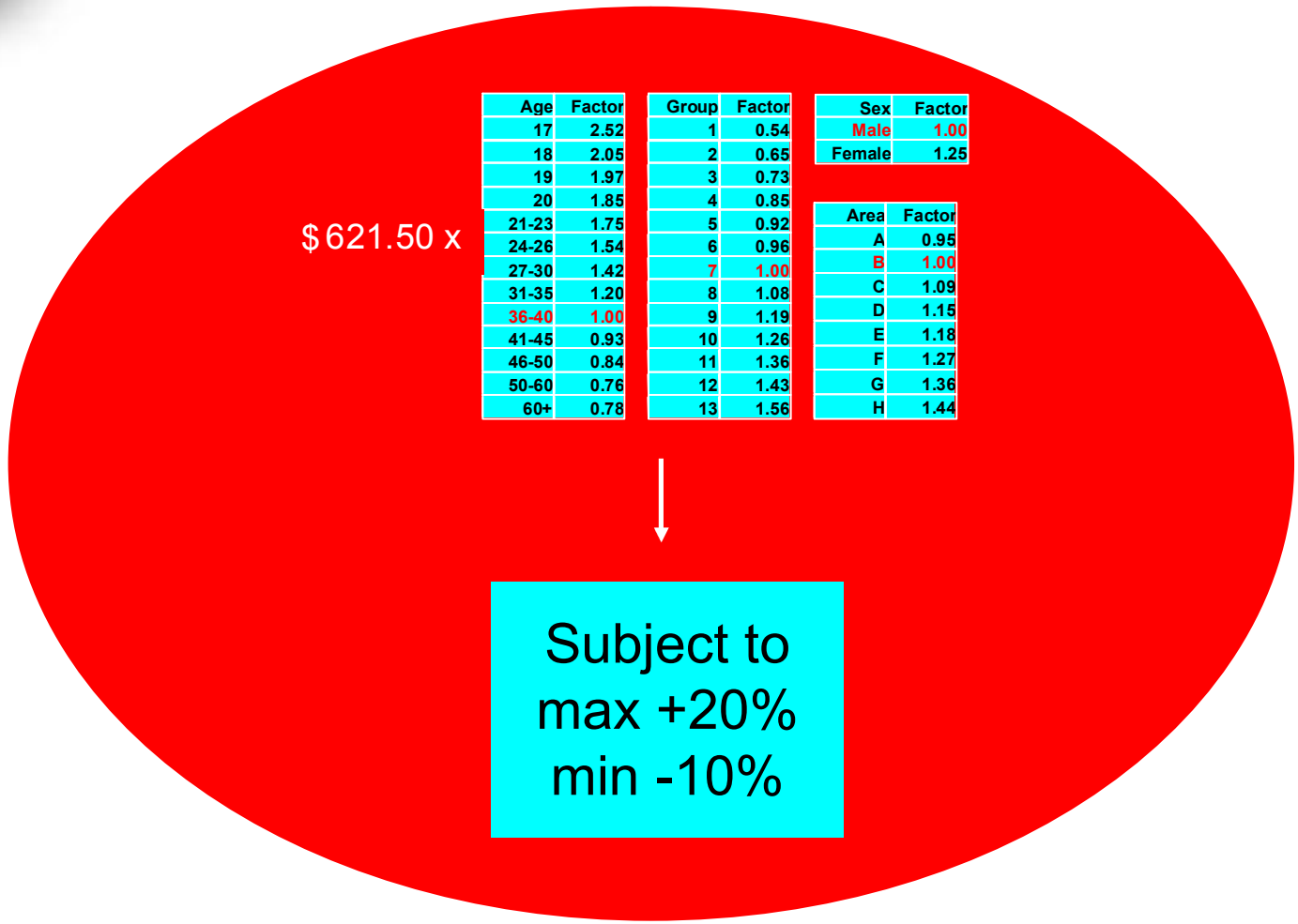


# Base rate change with simple relativity change

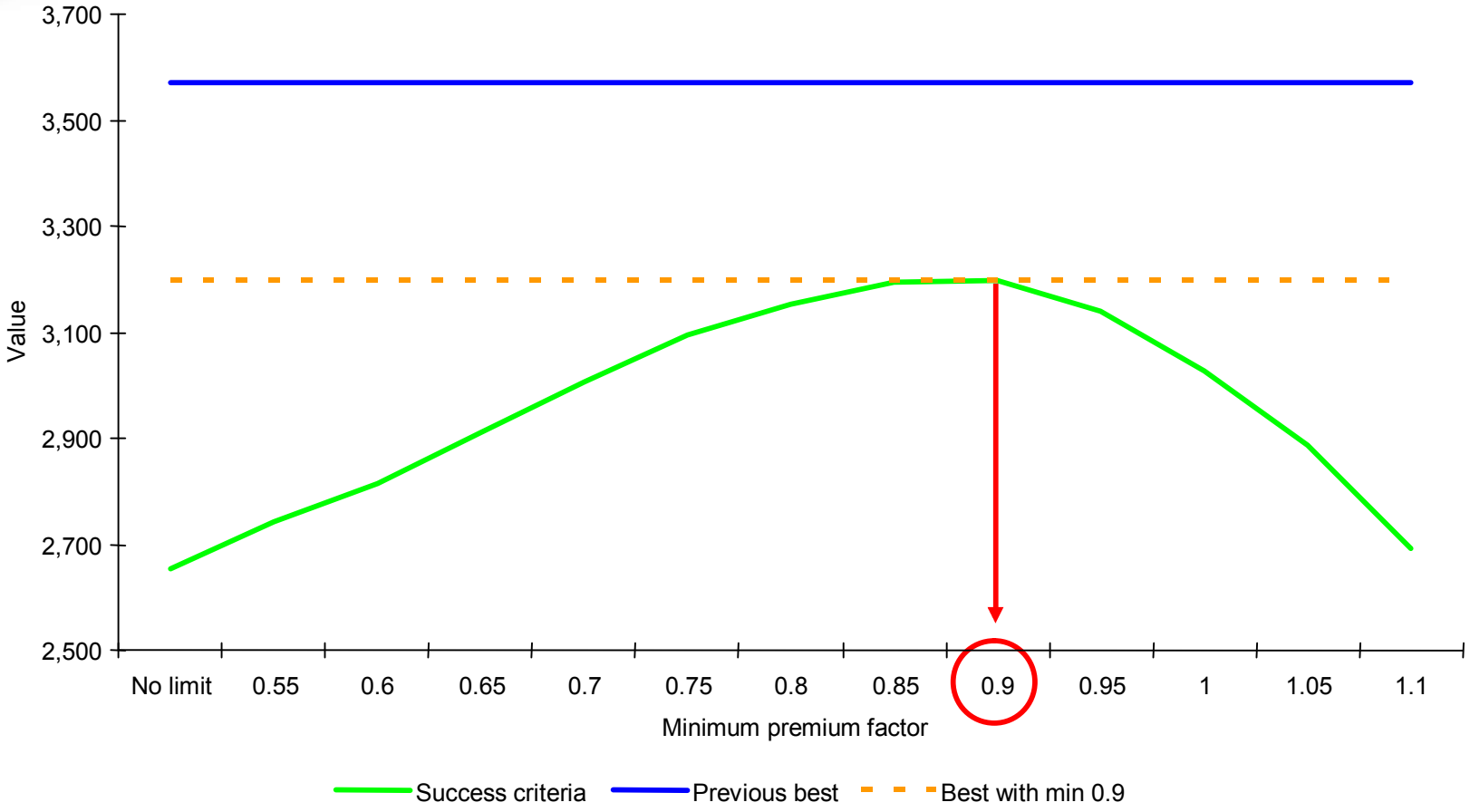


# Moderators

## Types of rating structures - multiplicative with moderator

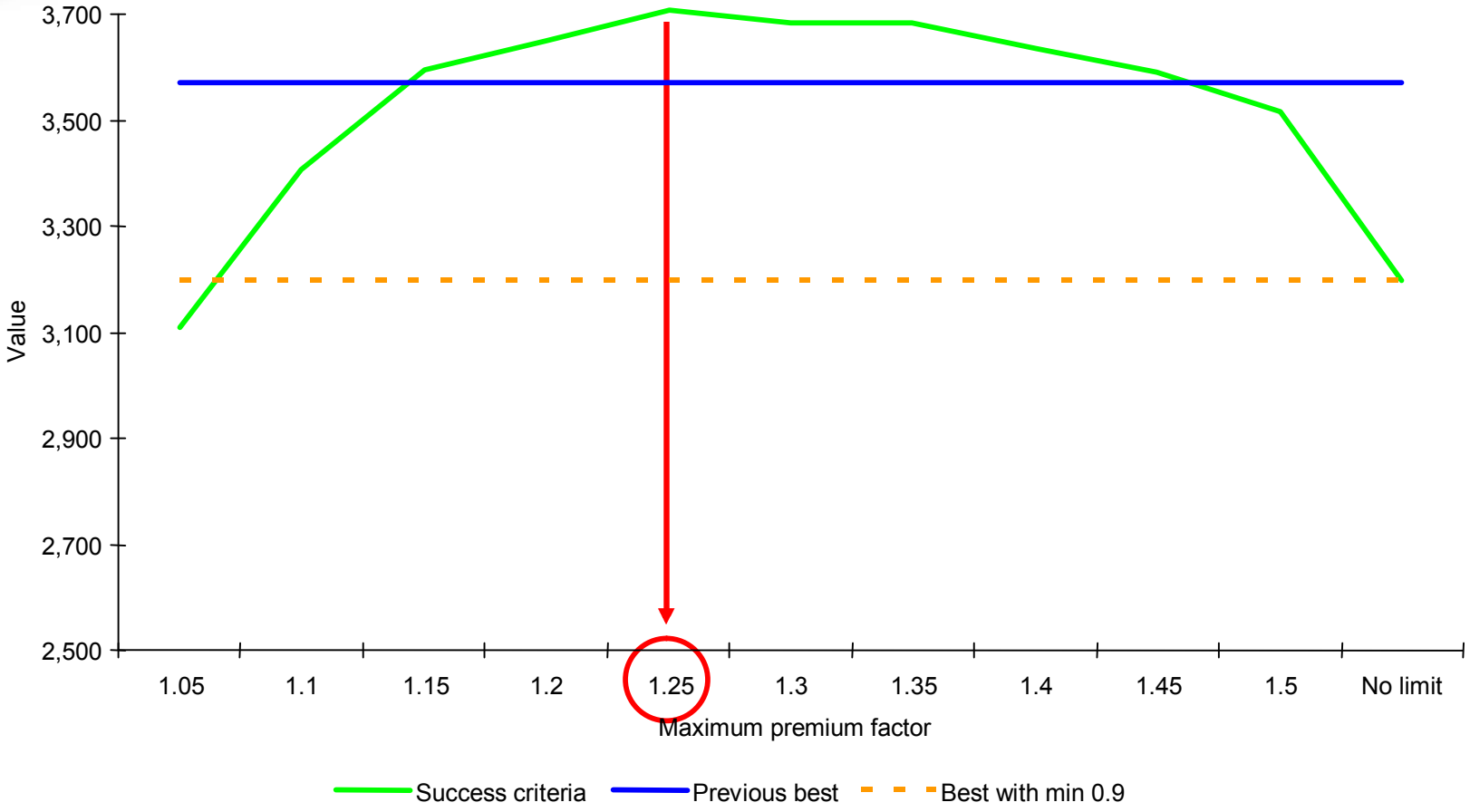


# Parameterizing the moderator
## Investigation of limiting premium decreases



# Parameterizing the moderator

## Investigation of limiting premium increases given 10% limit on decreases



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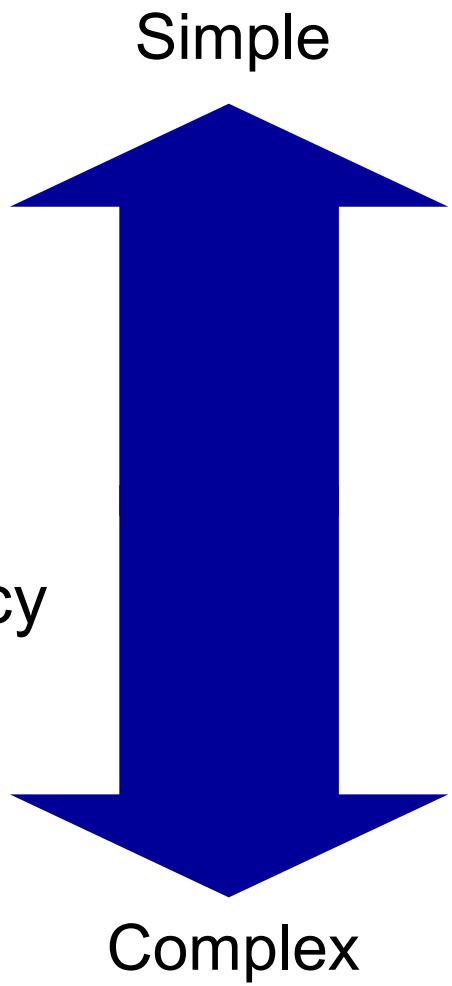
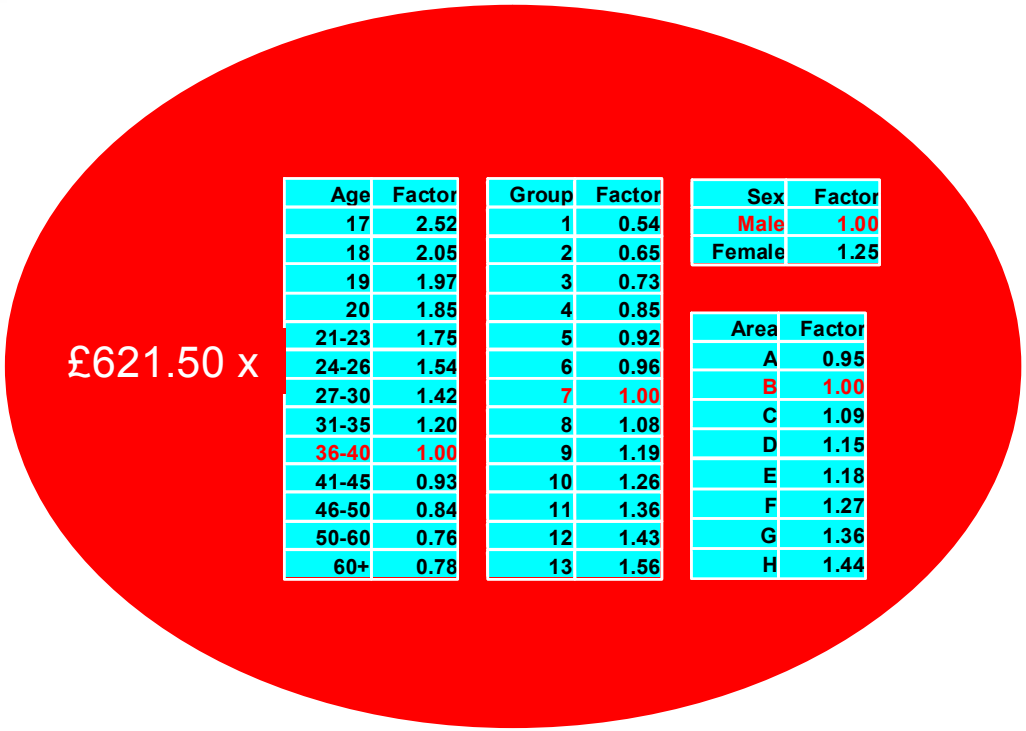


# Full optimisation




- A typical rating structure contains too many dimensions in which to search easily

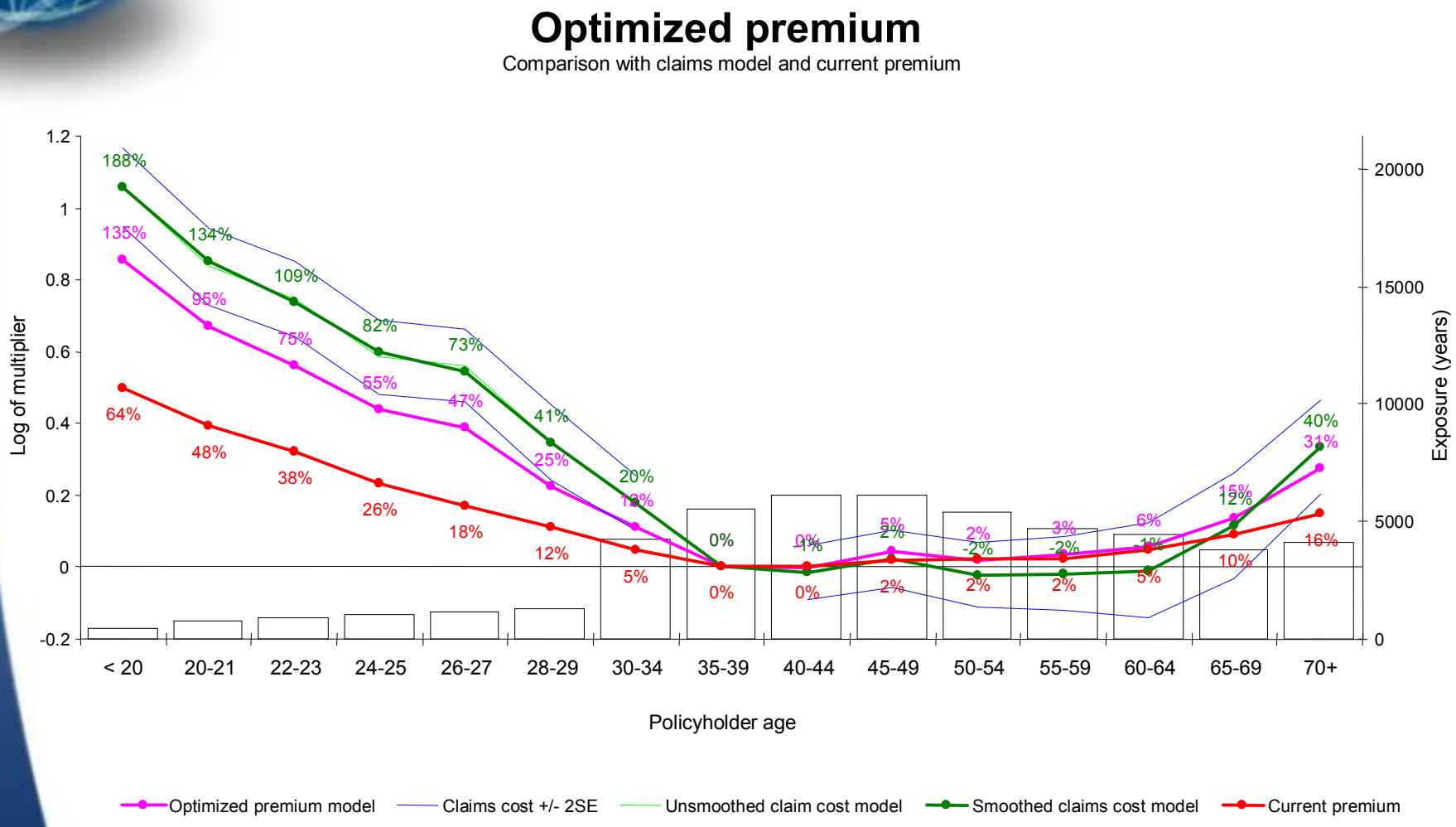
# Full optimisation

| | Exposure | Age of driver | Gender | Marital status | Territory | Credit score | Earned Premium | # claims BI | Incurred losses BI | # claims PD | Incurred losses PD | Optimal premium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | 22 | M | S | 12 | 178 | 2,331 | 0 | - | 0 | - | 2,651 |
| 2 | 0.65 | 39 | F | D | 2 | 569 | 512 | 0 | - | 1 | 650 | 561 |
| 3 | 0.35 | 39 | F | D | 4 | 569 | 440 | 0 | - | 0 | - | 412 |
| 4 | 1.00 | 58 | F | M | 6 | 715 | 968 | 0 | - | 0 | - | 745 |
| 5 | 0.66 | 47 | M | M | 19 | 202 | 760 | 1 | 16,138 | 0 | - | 699 |
| 6 | 1.00 | 35 | M | M | 32 | 550 | 815 | 0 | - | 0 | - | 894 |
| 7 | 1.00 | 46 | M | S | 17 | 420 | 1,012 | 0 | - | 0 | - | 1,242 |

- For each policy optimize desired success criteria
- Result is individual premium for each renewal
- For new business and amendments, and if required for renewals, can approximate results with a single structure by fitting GLM to optimized individual rates

  Optimized rates can be rather non-linear - a few interactions might be needed to approximate well

# Example of full optimisation



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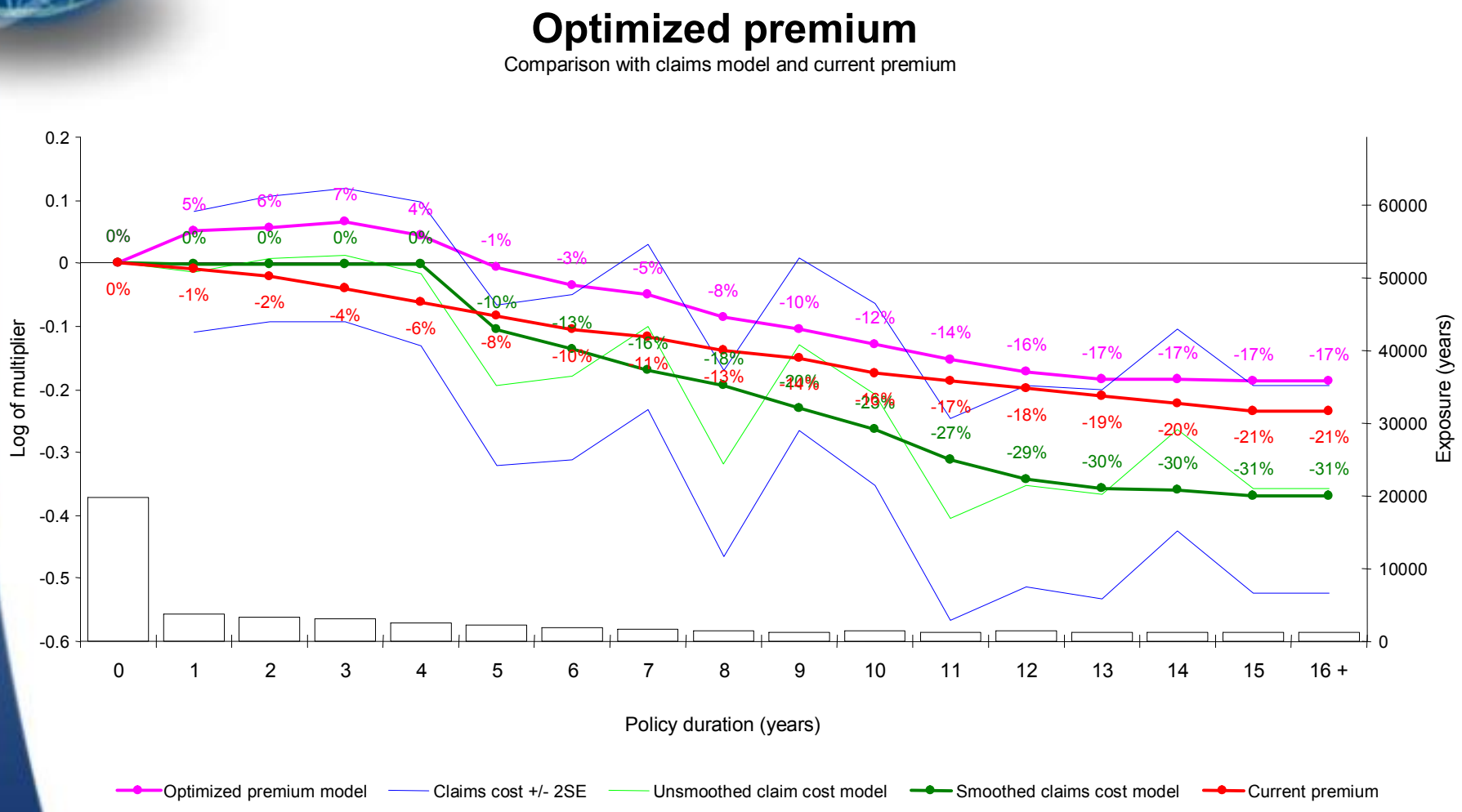


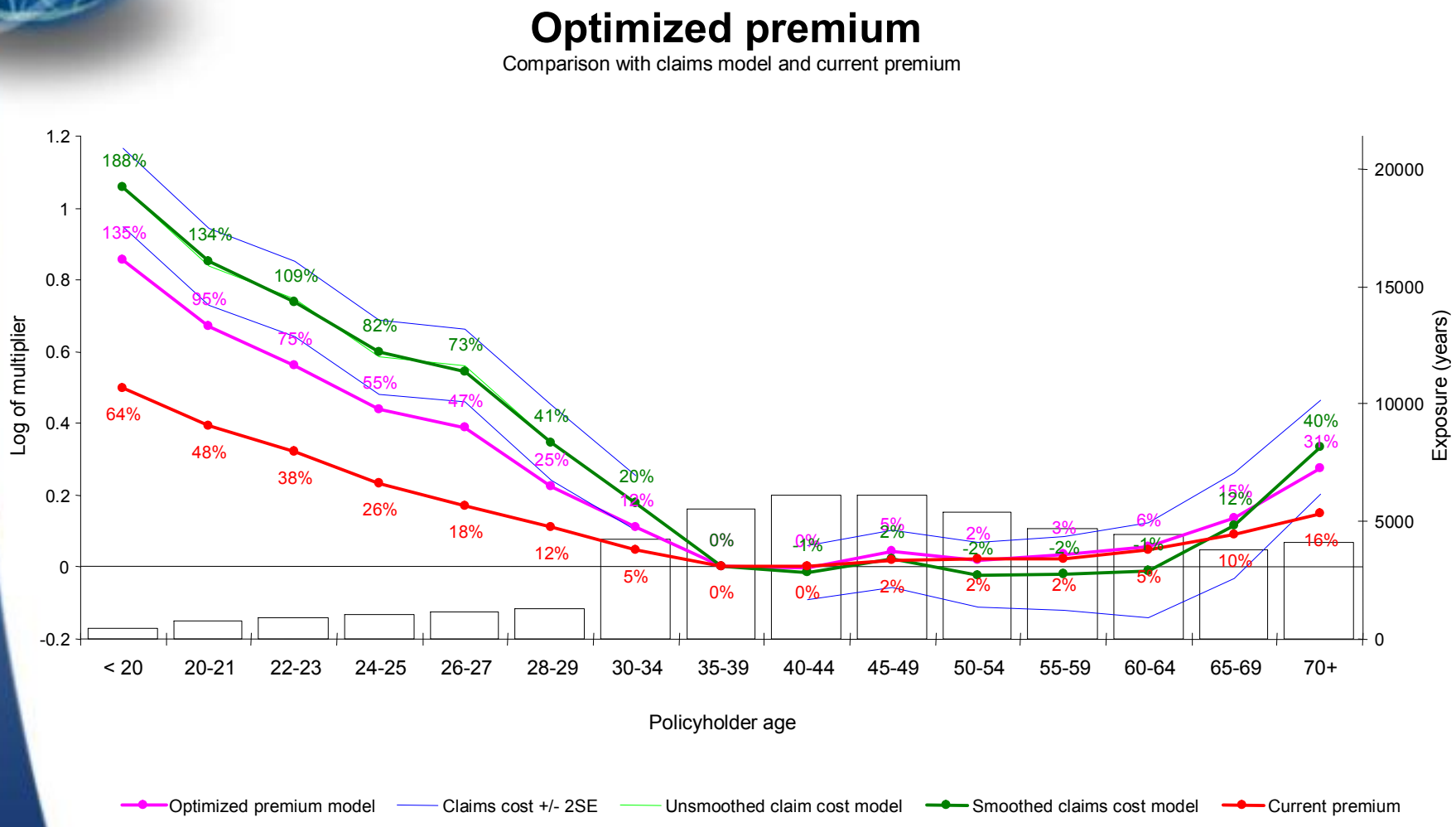
# More details...

- Specified global constraints, eg minimum business volume, can be incorporated in optimization algorithm
- For a given policy, the best action next year is interdependent with the action the following year(s) - embedded/looped optimizations allow consideration of actions in the future (which will need revisiting next year)
- Value of cross-sell can be included within optimization
- Point of sale optimisation

# Optimization - issues

- IT administration constraints
  - speed / point of sale competitor data
- Will ruthlessly penalize errors in risk models, in particular categorisations
- Do not leave unattended!
- Constraints from marketing messages / distribution issues
- Not "inadequate", "excessive", "unfairly discriminatory"…

# Example of full optimisation



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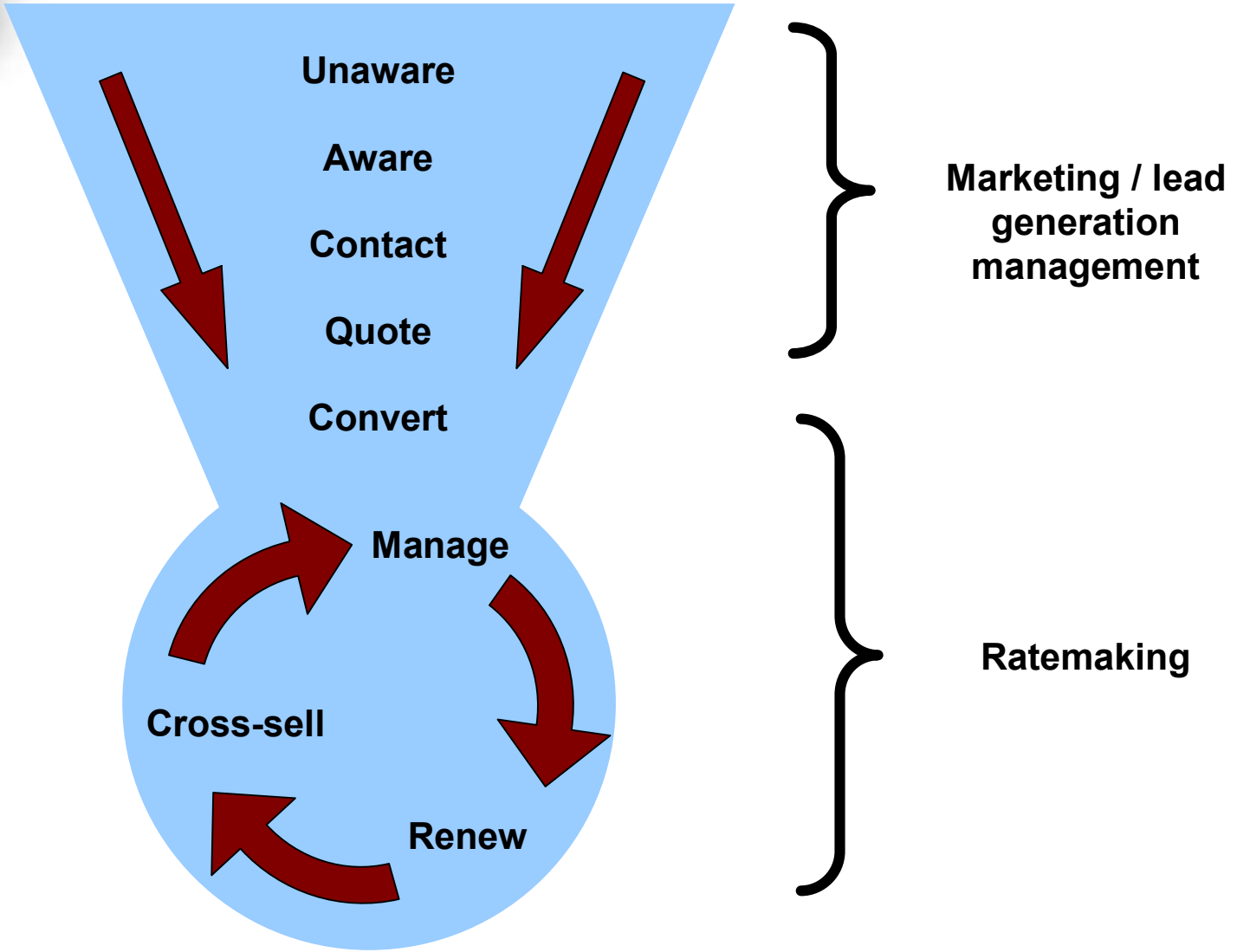

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