Price Optimization for the U.S. Market: Techniques and Implementation Strategies

CAS Ratemaking and Product Management Seminar

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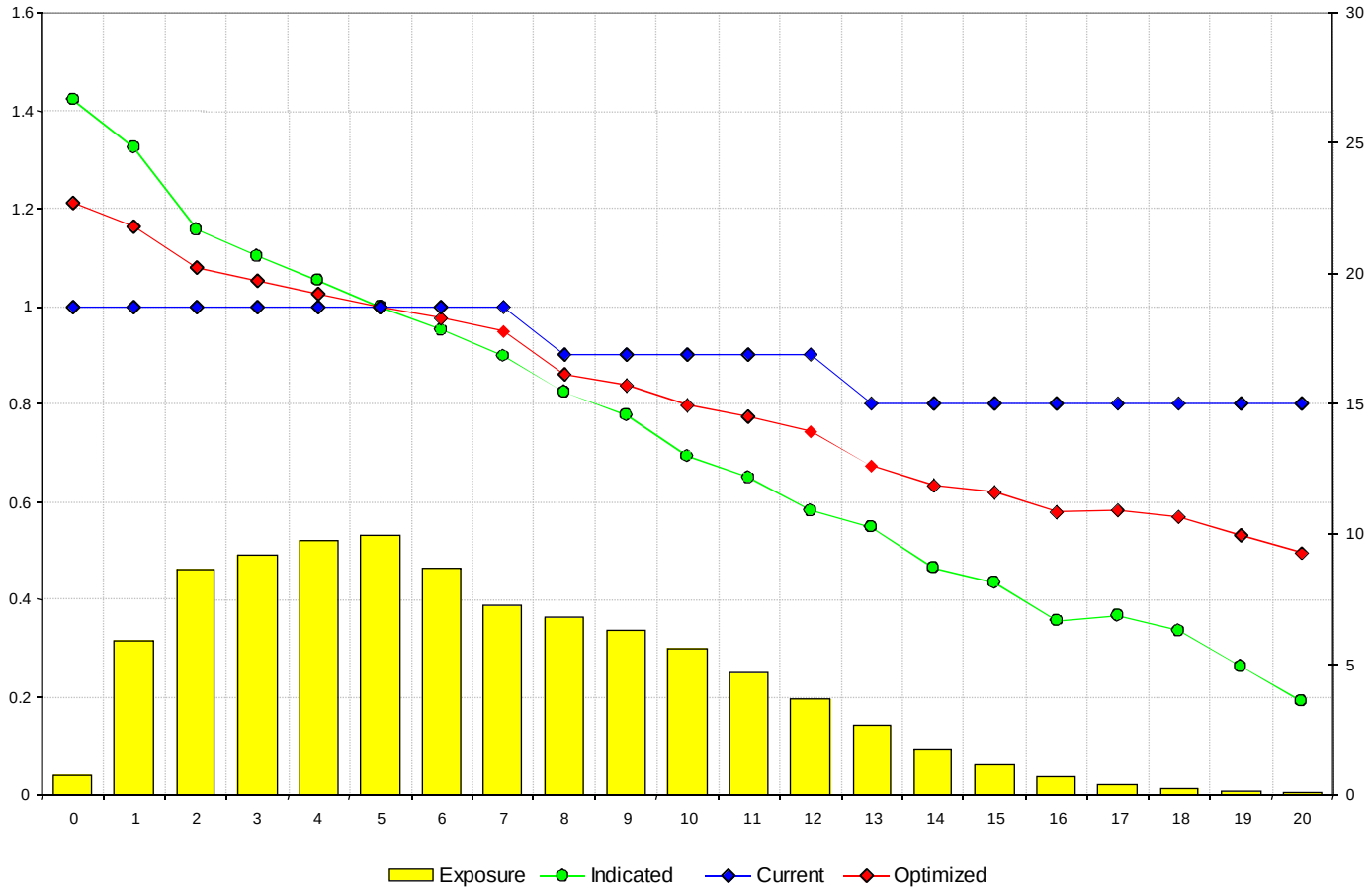
March 31, 2014

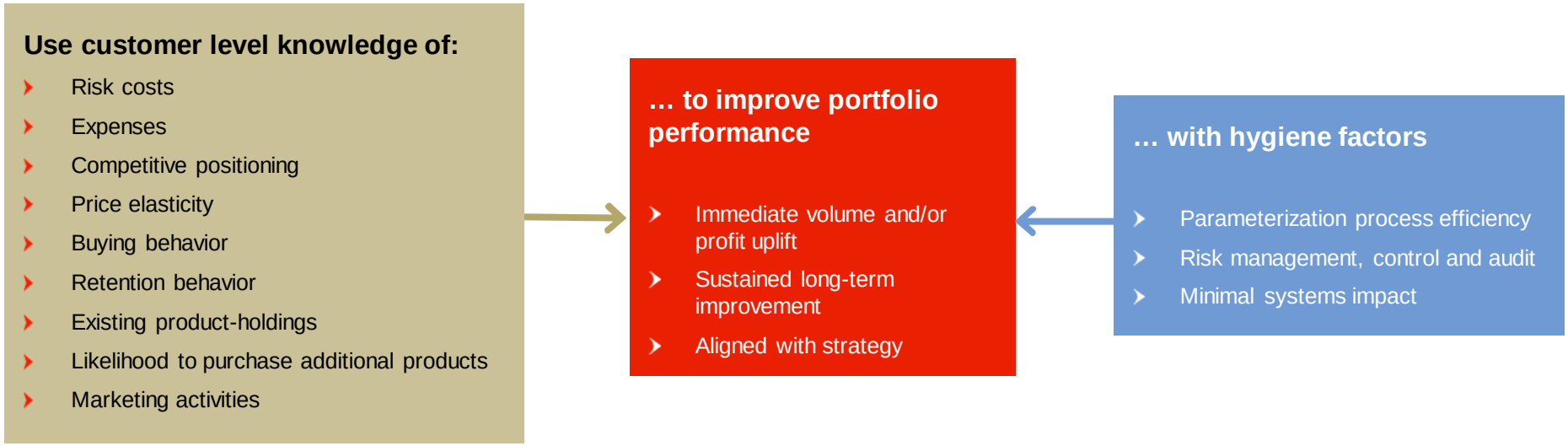
Agenda

- What is price optimization?
- Key aspects
  - inputs
  - algorithm
  - implementation
- Business benefits and wider implications

What is price optimization?



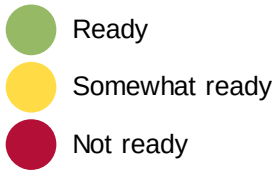
What is price optimization?



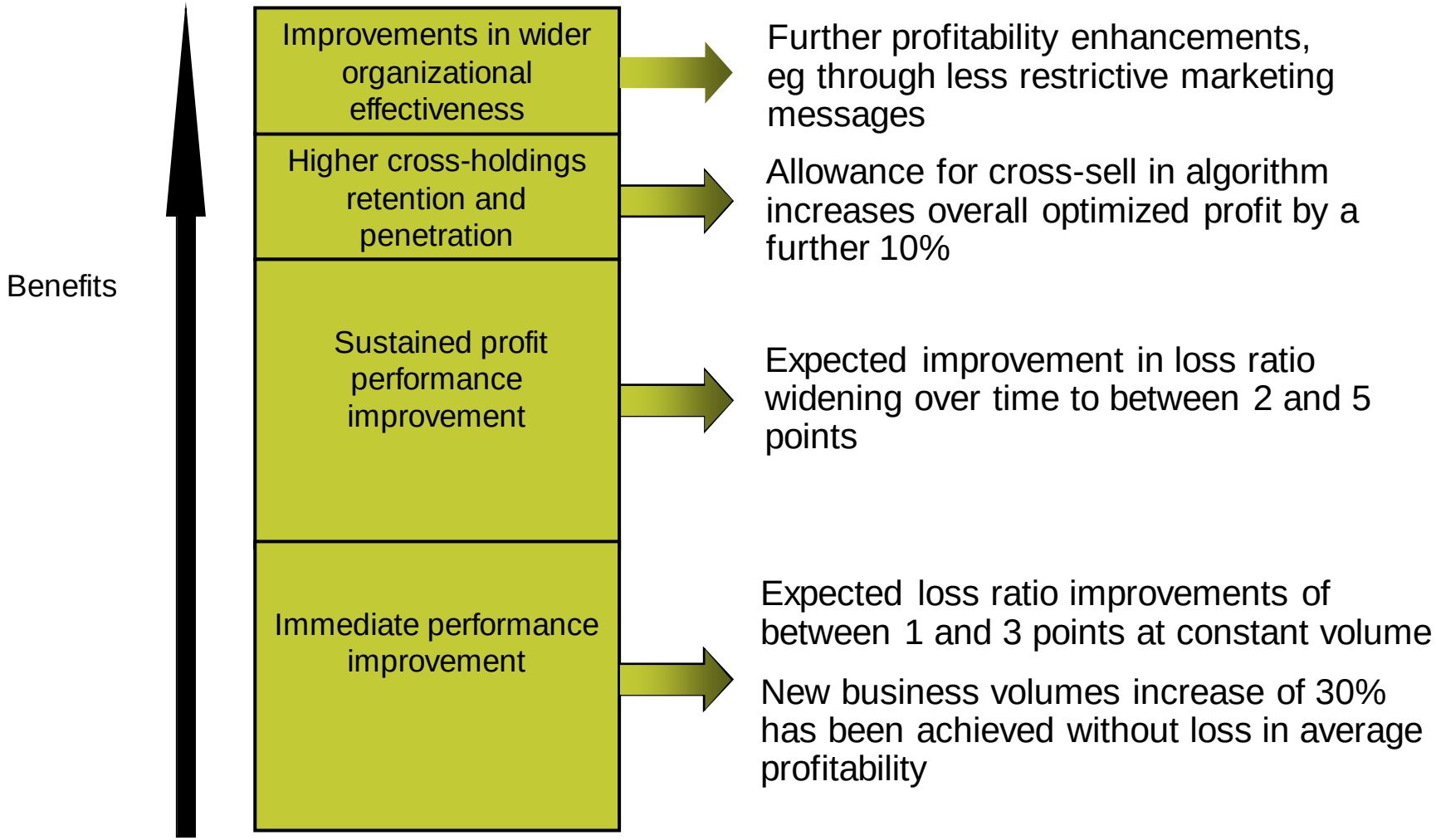
Price optimization

- Pricing performance scorecard for the insurance industry?

Task	Ability
Aggregate loss costs	
Granular loss costs	
Price competitive position	
Regulatory challenges	
Policyholder reaction to price	
Bringing it all together	



Benefits


Benefits
Improvements in wider organizational effectiveness
Higher cross-holdings retention and penetration
Sustained profit performance improvement
Immediate performance improvement
Further profitability enhancements, eg through less restrictive marketing messages
Allowance for cross-sell in algorithm increases overall optimized profit by a further 10%
Expected improvement in loss ratio widening over time to between 2 and 5 points
Expected loss ratio improvements of between 1 and 3 points at constant volume
New business volumes increase of 30% has been achieved without loss in average profitability

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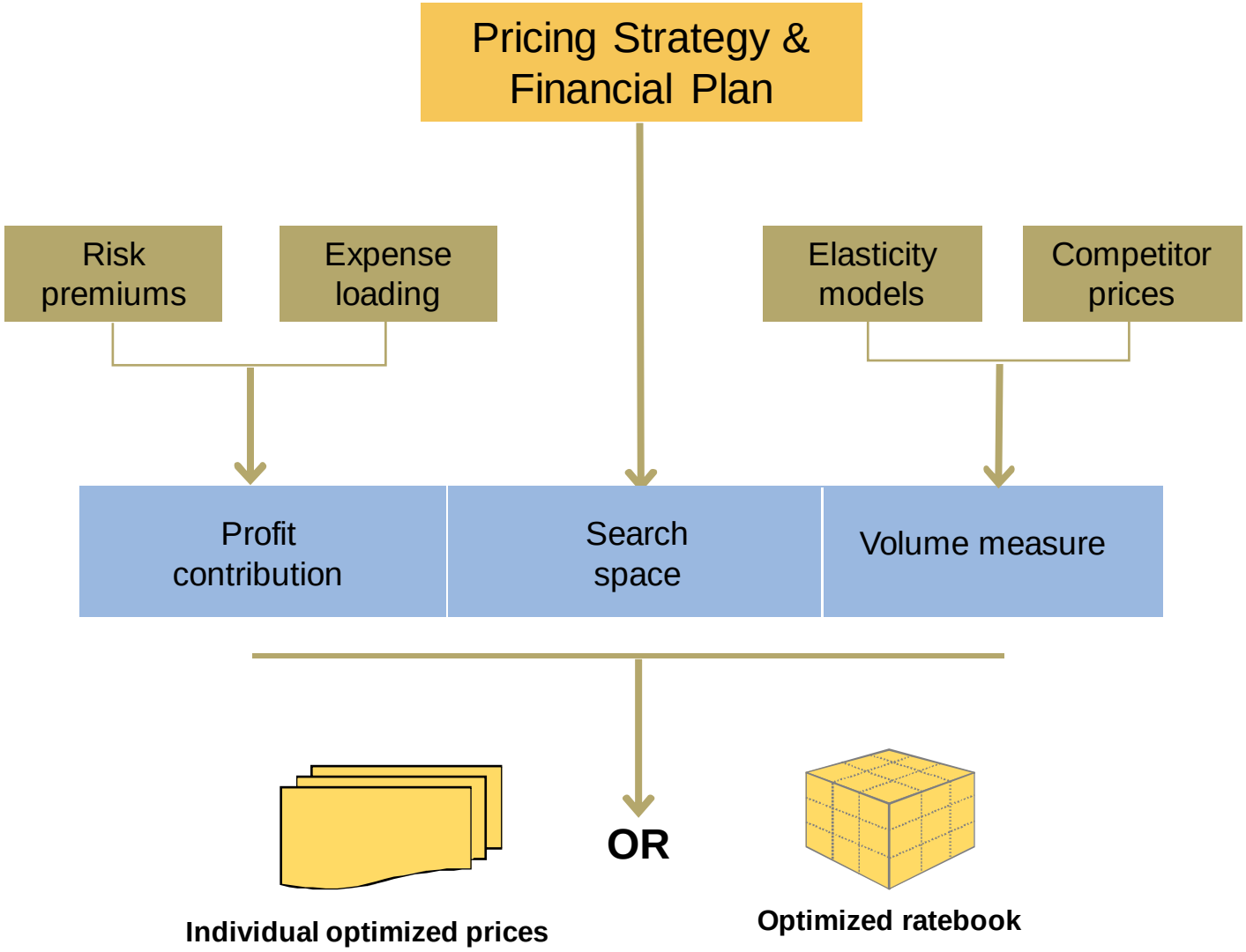
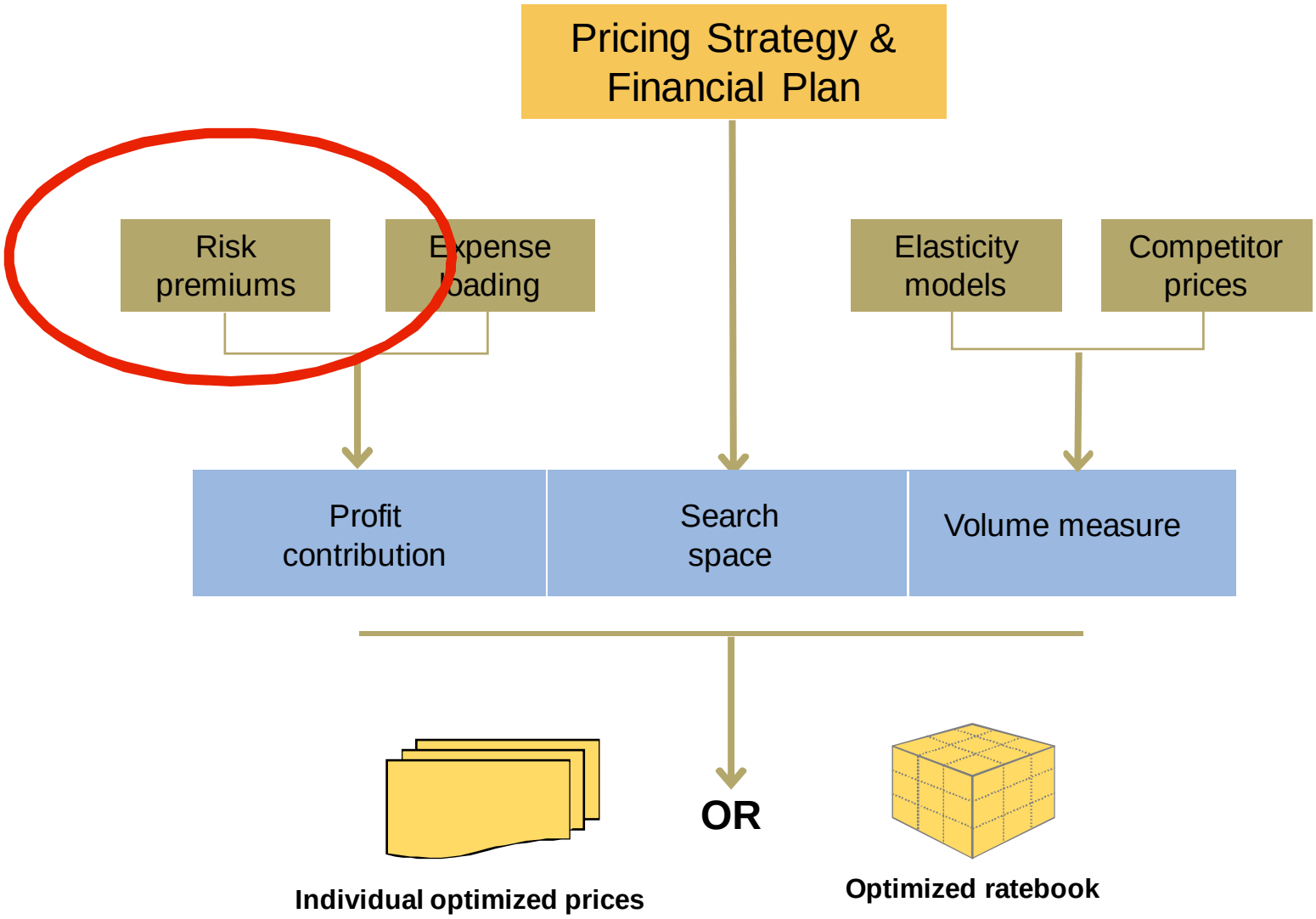
Price optimization



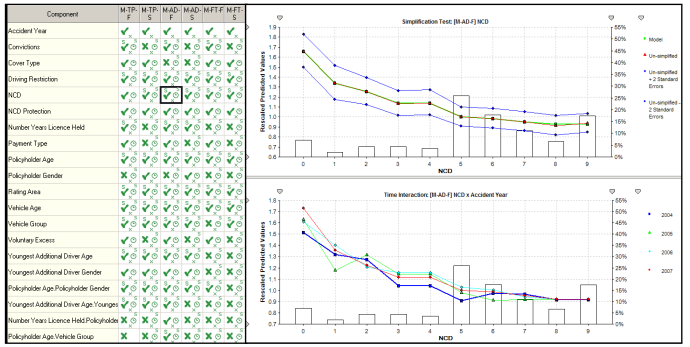
Price optimization

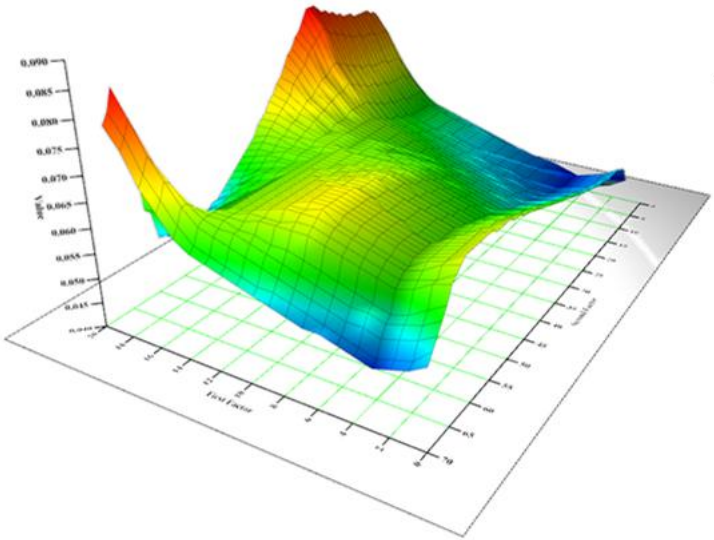
Inputs	Sound inputs are critical
Optimization Algorithm	Important to have practical optimization approach which pays due regard to long term value
Outputs	Practical and phased implementation

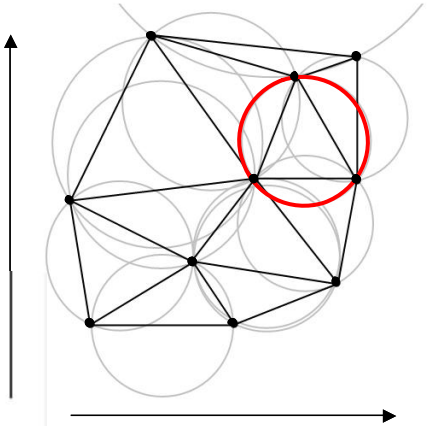
Price optimization

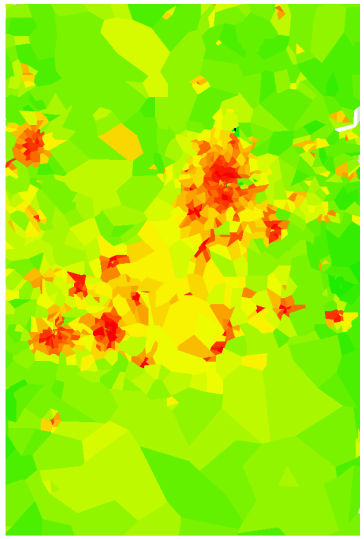


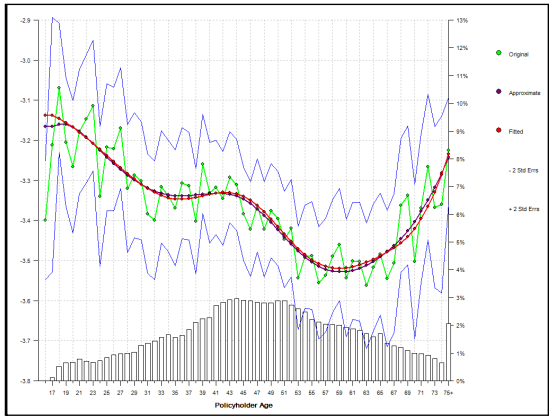
Risk models


Component
Accident Year
Convictions
Cover Type
Driving Restriction
NCD
NCD Protection
Number Years Licence Held
Payment Type
Policyholder Age
Policyholder Gender
Rating Area
Vehicle Age
Vehicle Group
Voluntary Excess
Youngest Additional Driver Age
Youngest Additional Driver Gender
Policyholder Age.Policyholder Gender
Youngest Additional Driver Age.Youngest
Number Years Licence Held.Policyholder
Policyholder Age.Vehicle Group
Simplification Test: [M-AD-F] NCD
Rescaled Predicted Values
NCD
Time Interaction: [M-AD-F] NCD x Accident Year
Rescaled Predicted Values
NCD

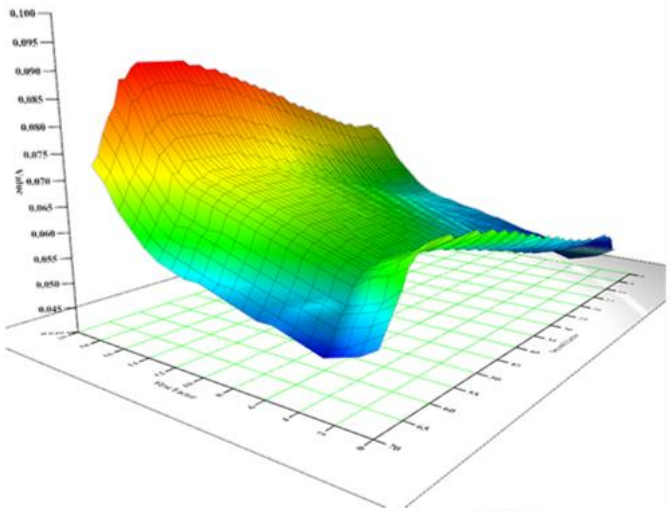


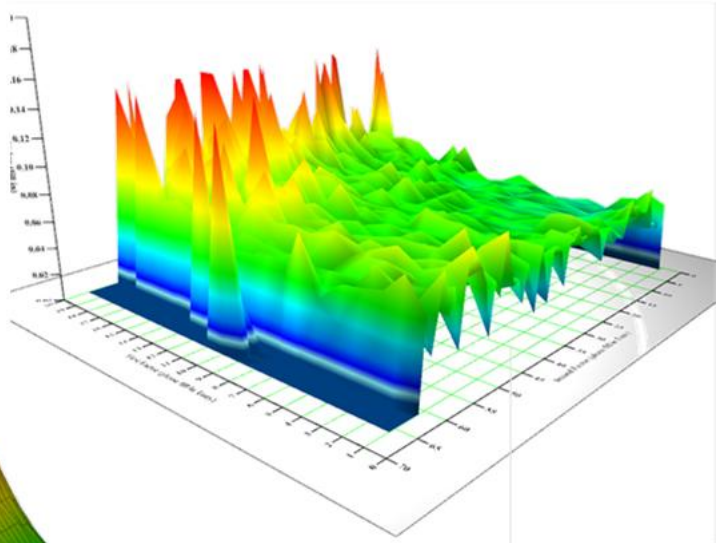


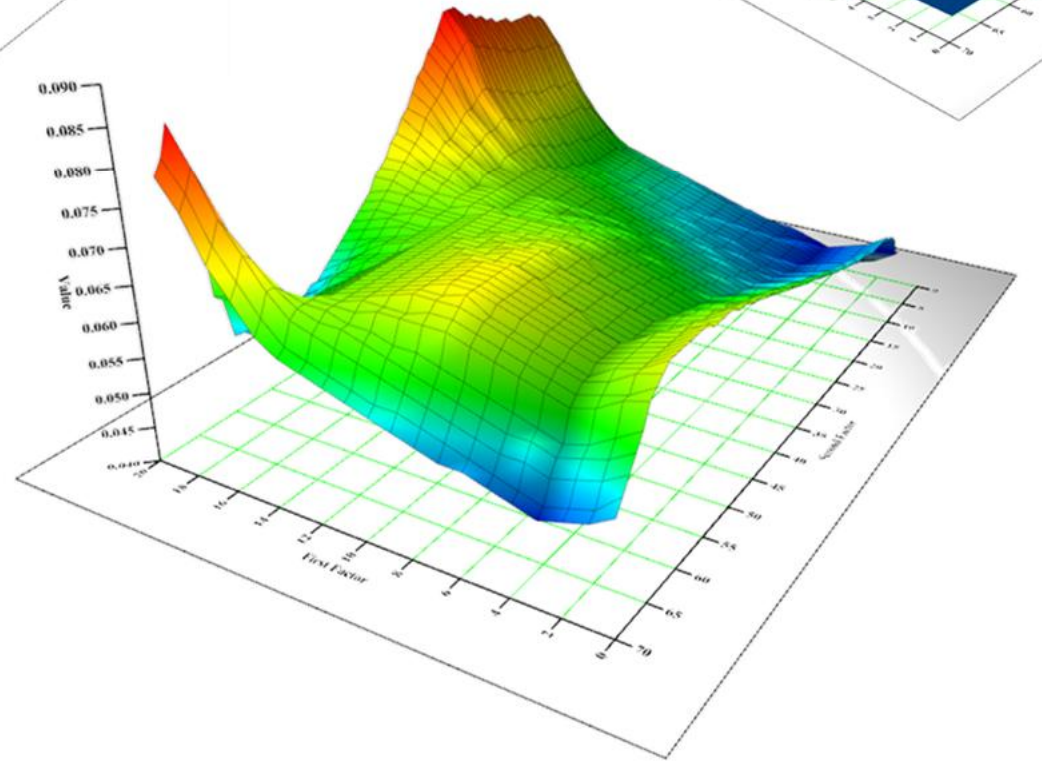



Original
Approximate
Fitted
- 2 Std Errs
+ 2 Std Errs
Policyholder Age

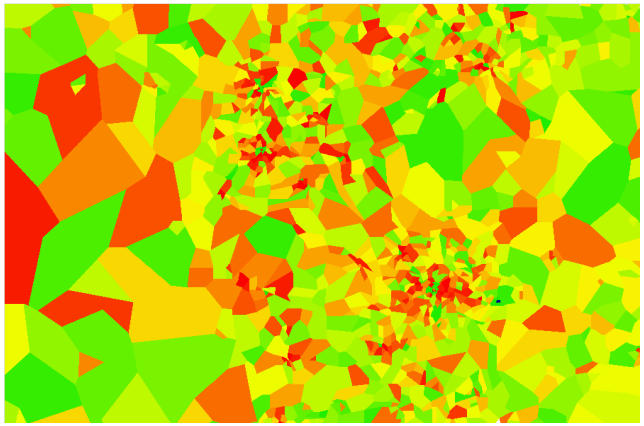
Interactions



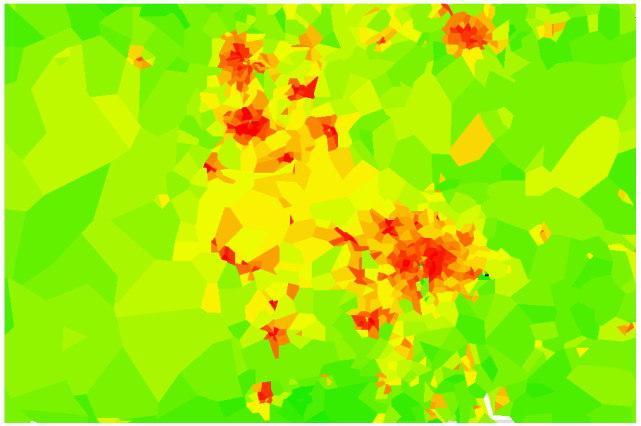




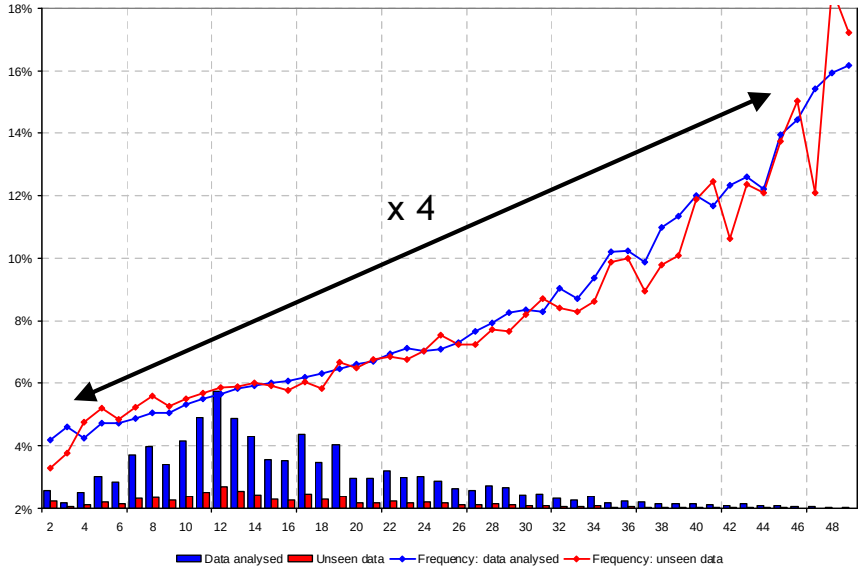
Spatial smoothing



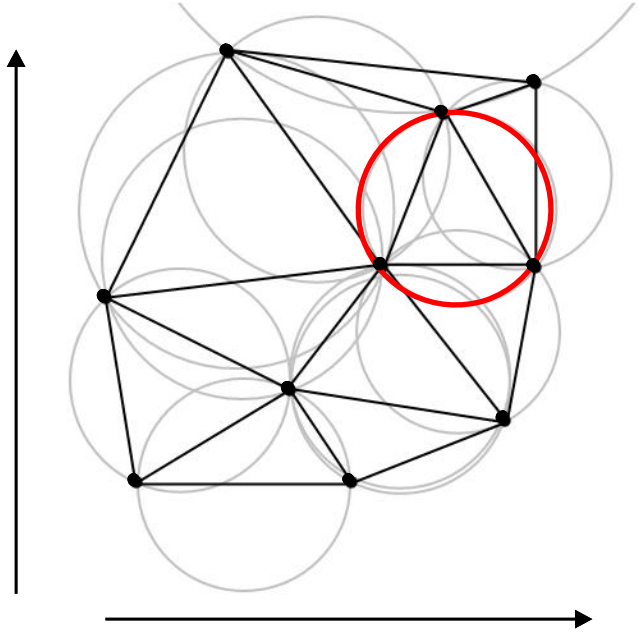
Unsmoothed

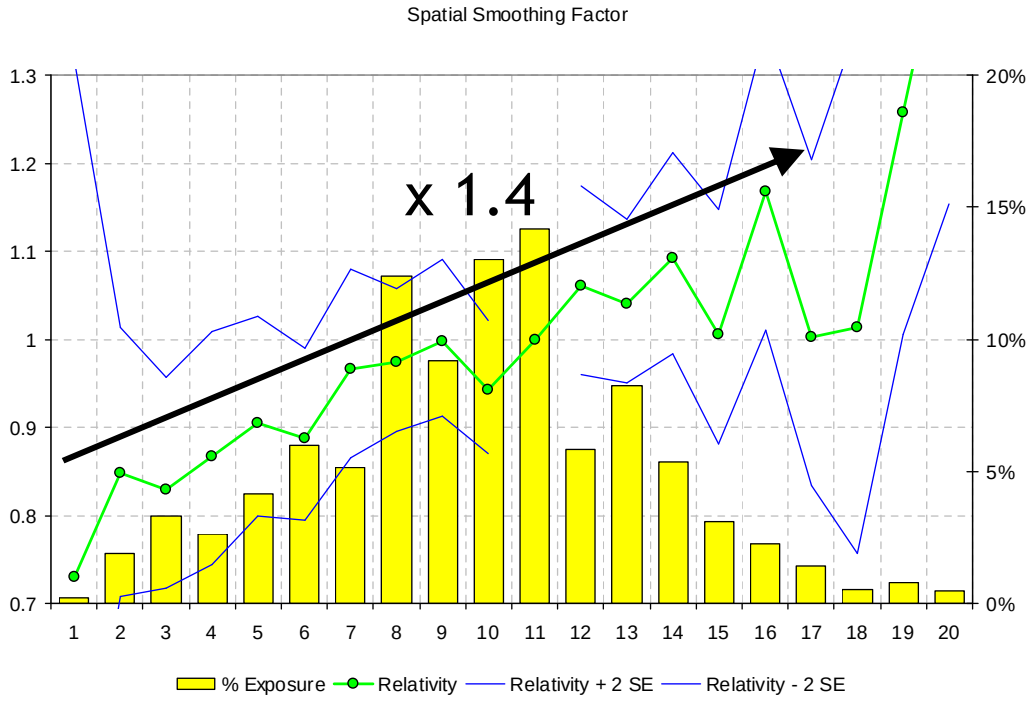


Smoothed

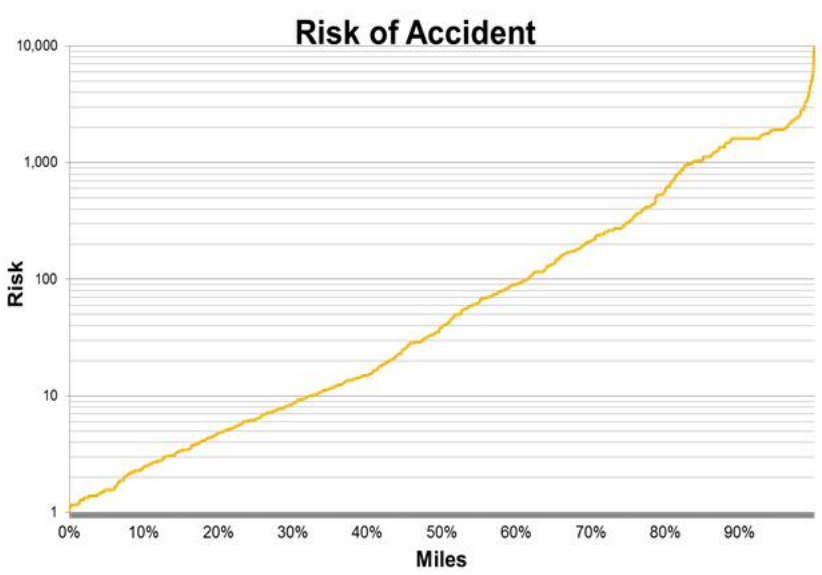


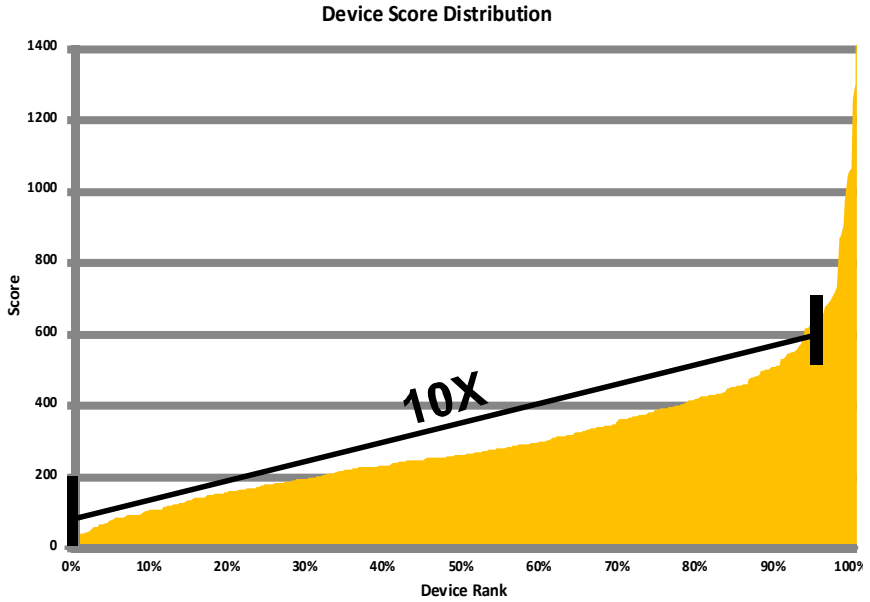
Analogous vehicle groupings techniques



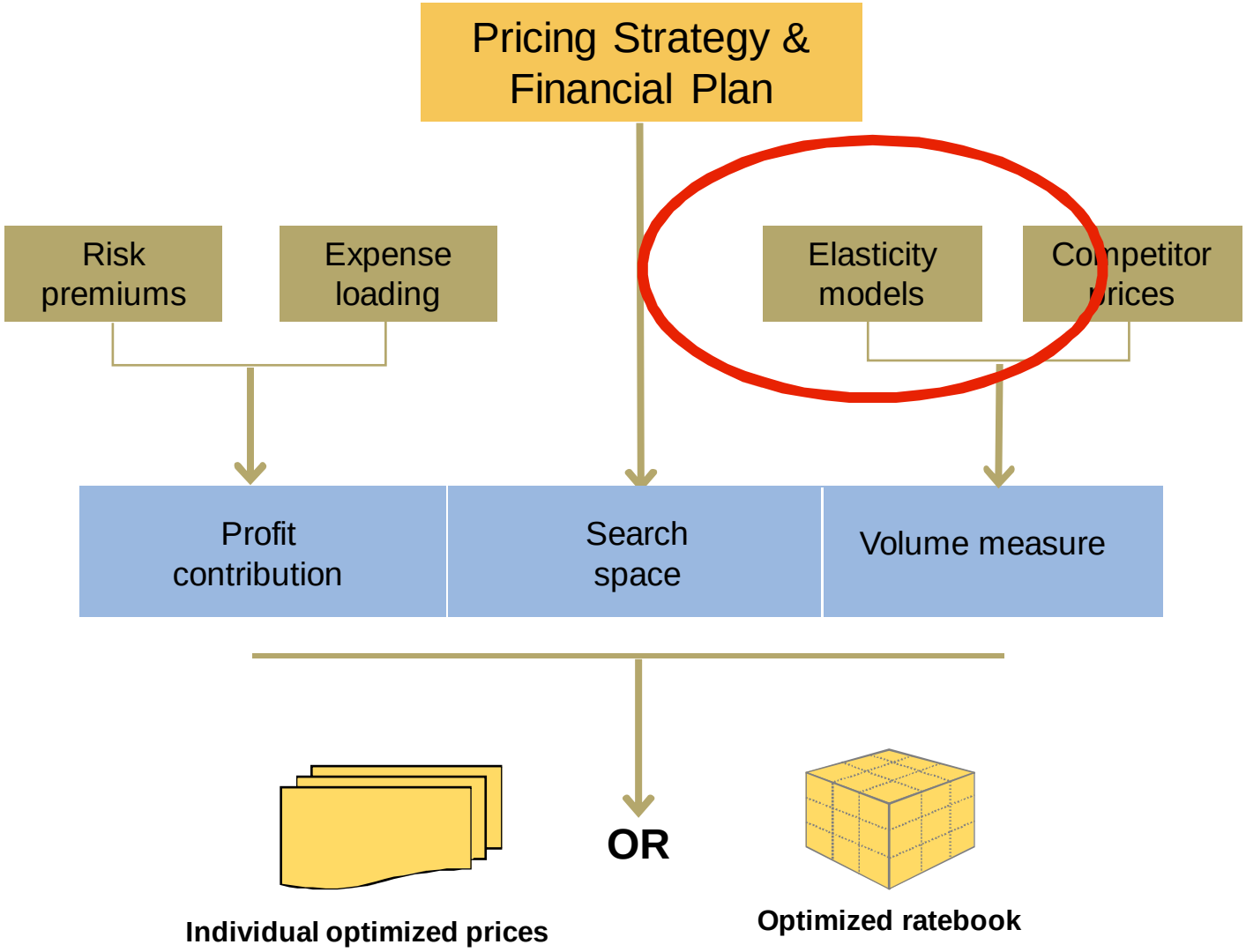


Usage Based Insurance

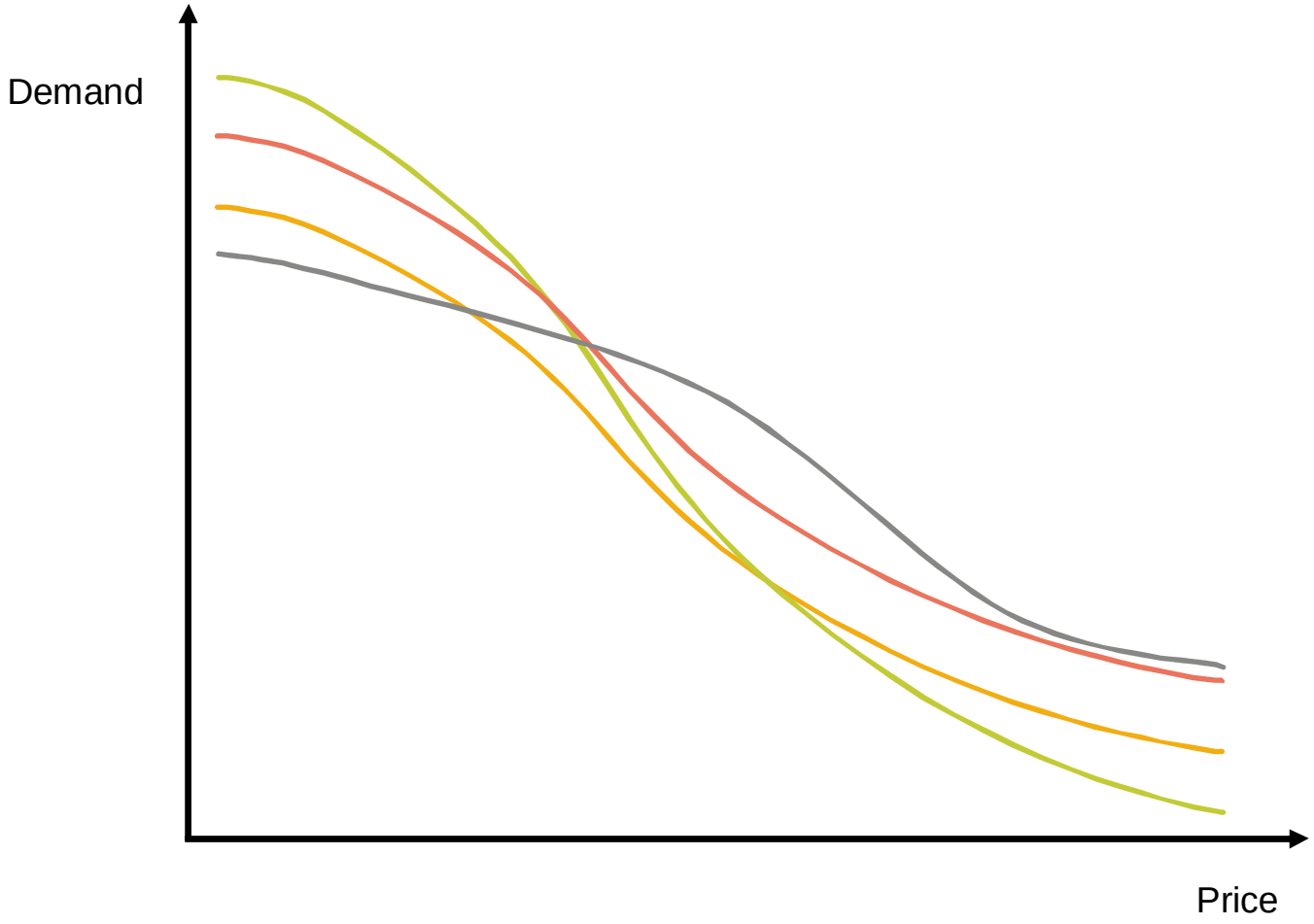




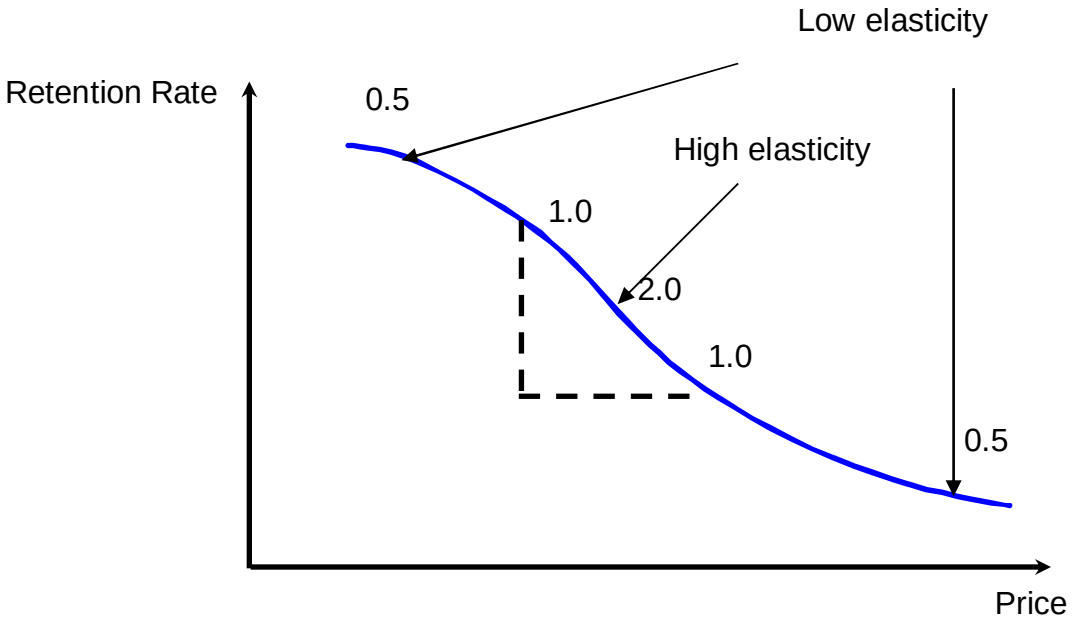
Price optimization



Price demand elasticity

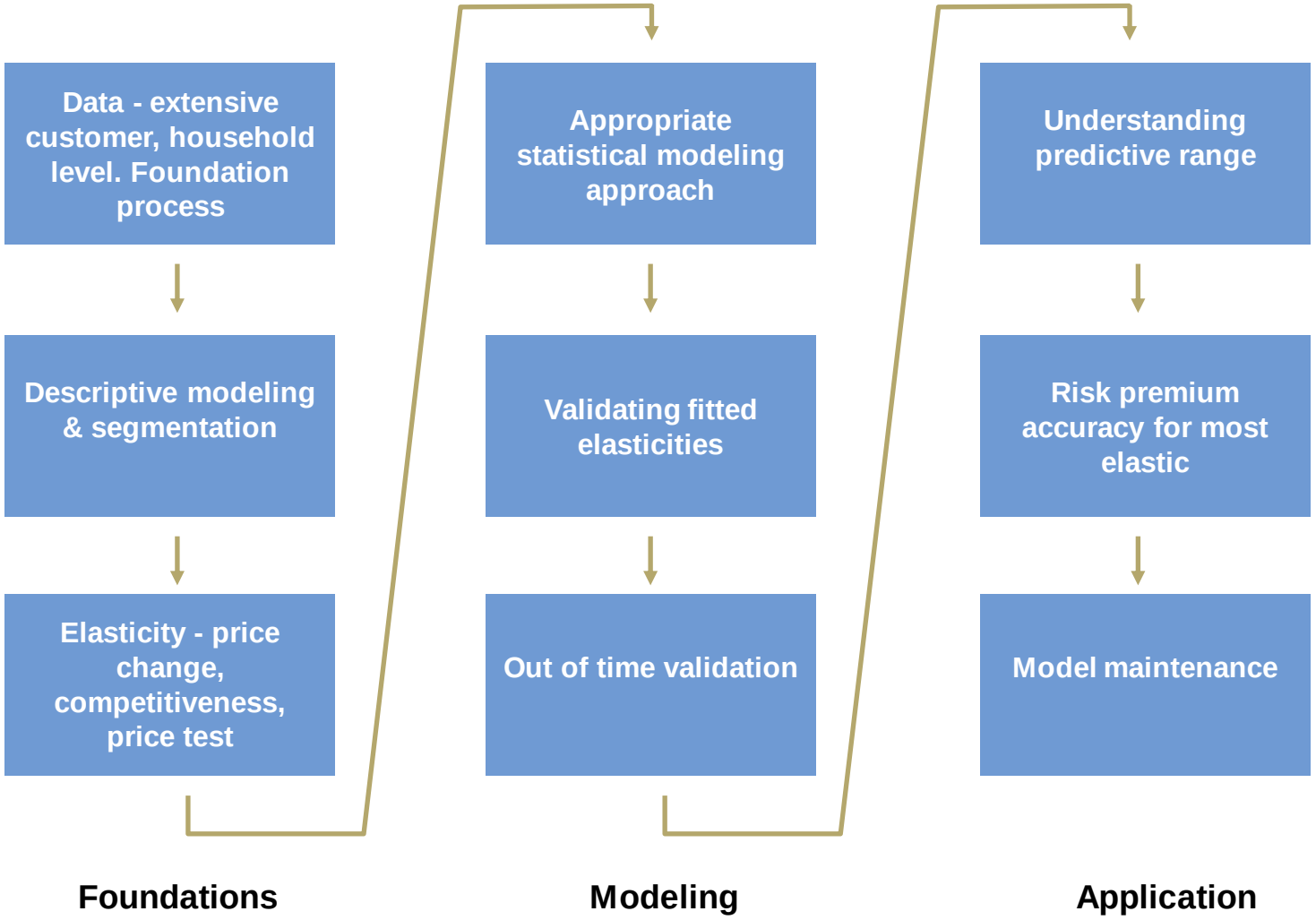


Elasticity



- There are different definitions of elasticity
- Common definition is % change in demand for % change in price
- Price elasticity varies by price:
  - "Policyholder X has elasticity Y" ✖
  - Be wary of assuming straight lines (even in linear predictor space)

Elasticity modeling - a rigorous approach



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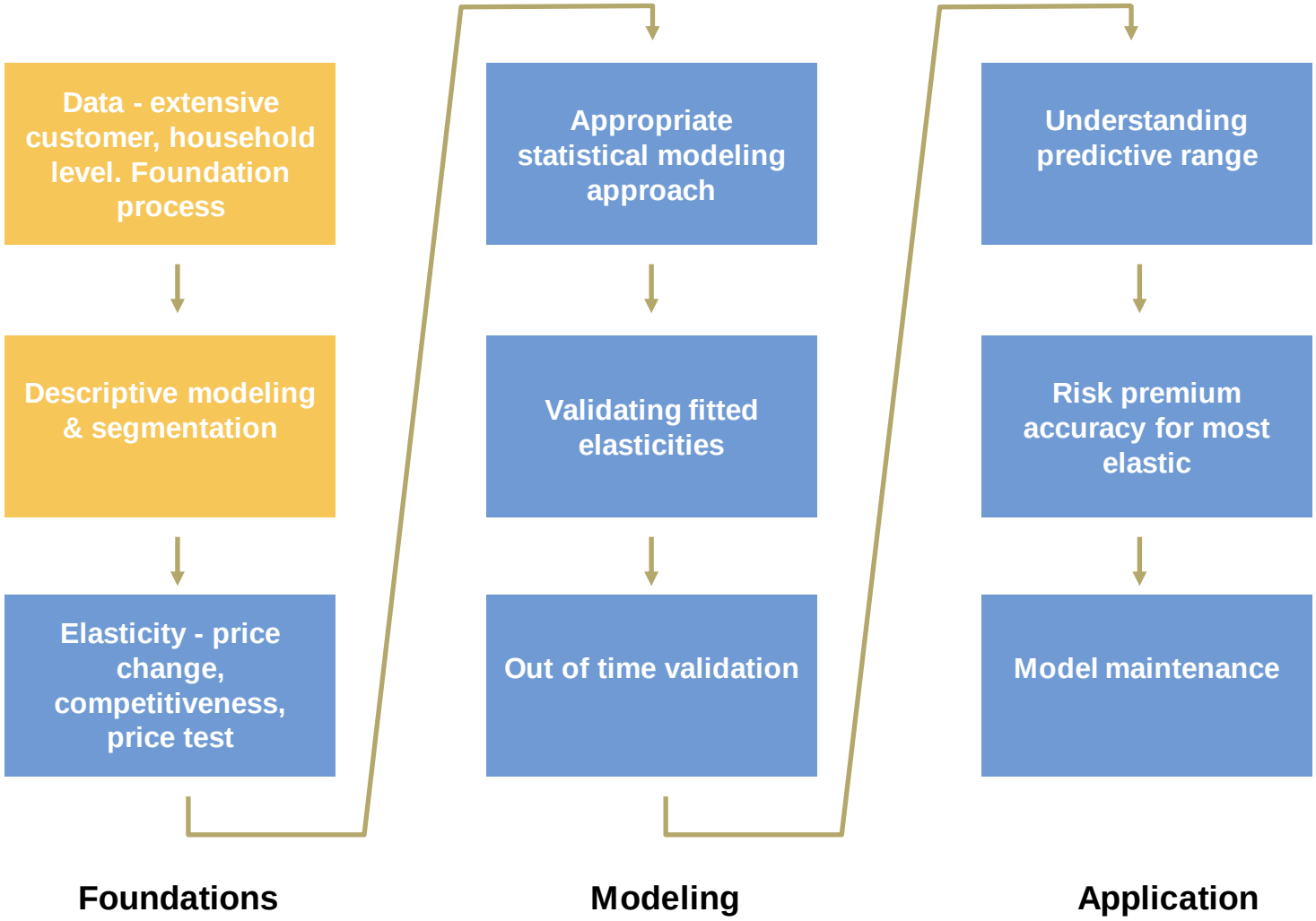
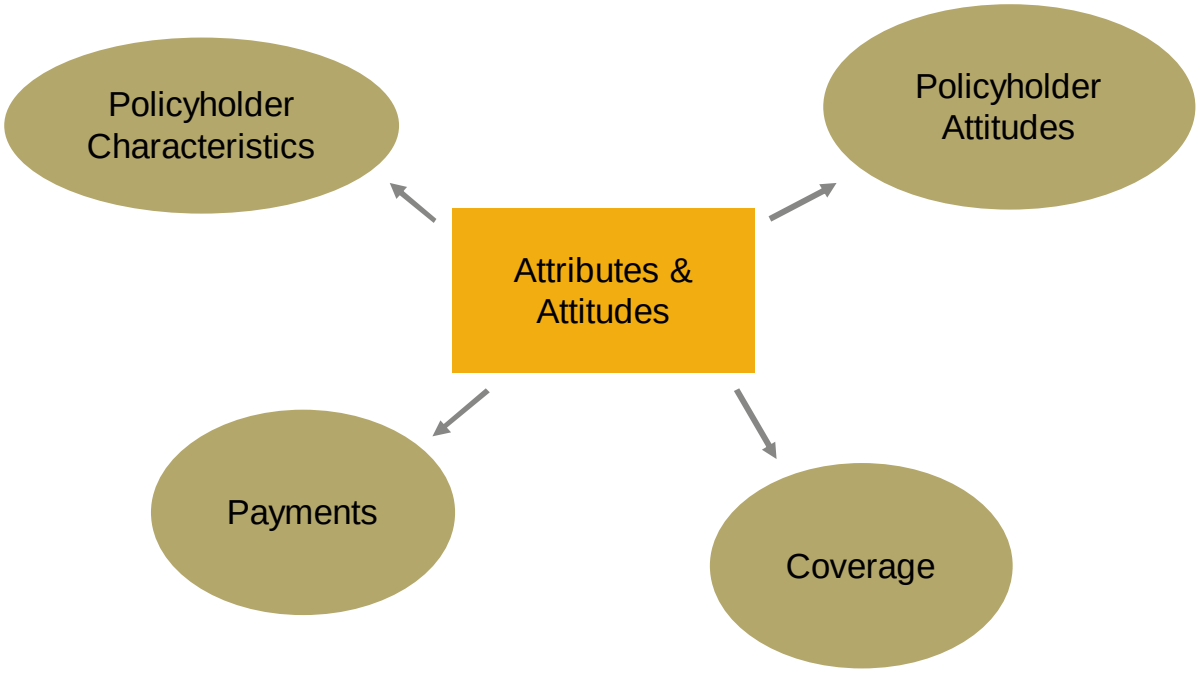
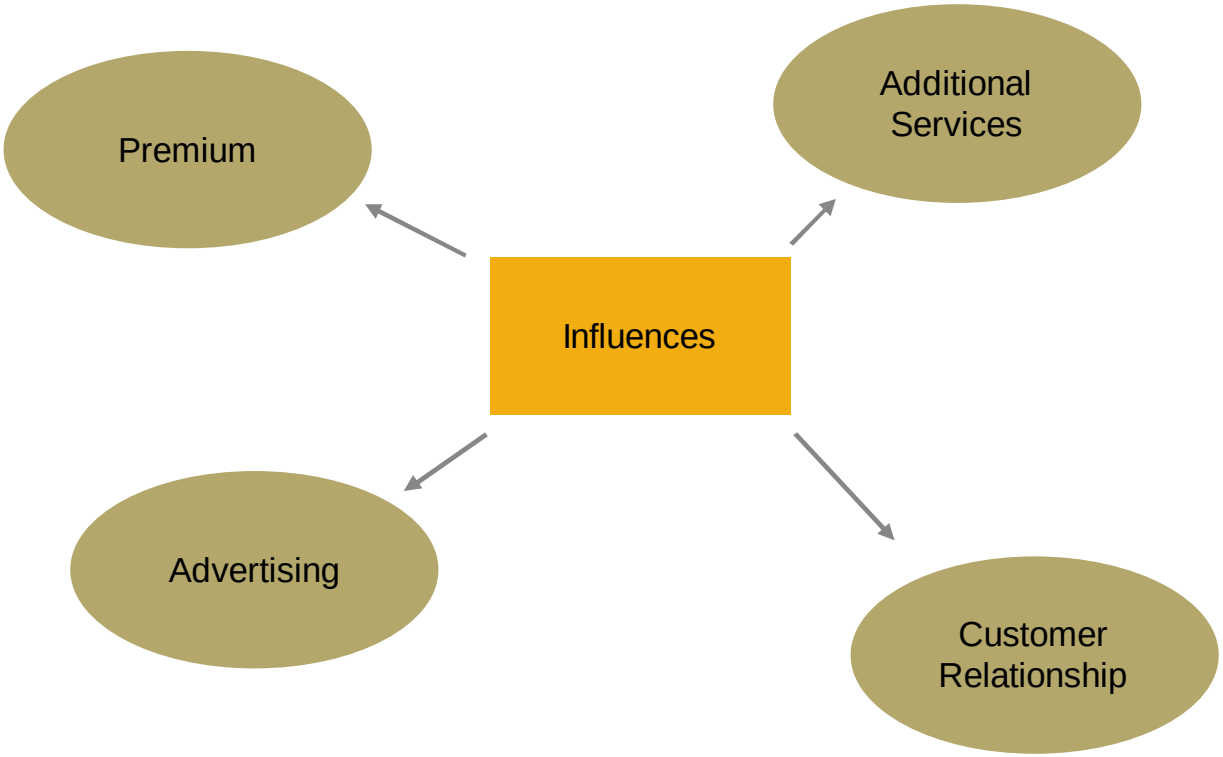


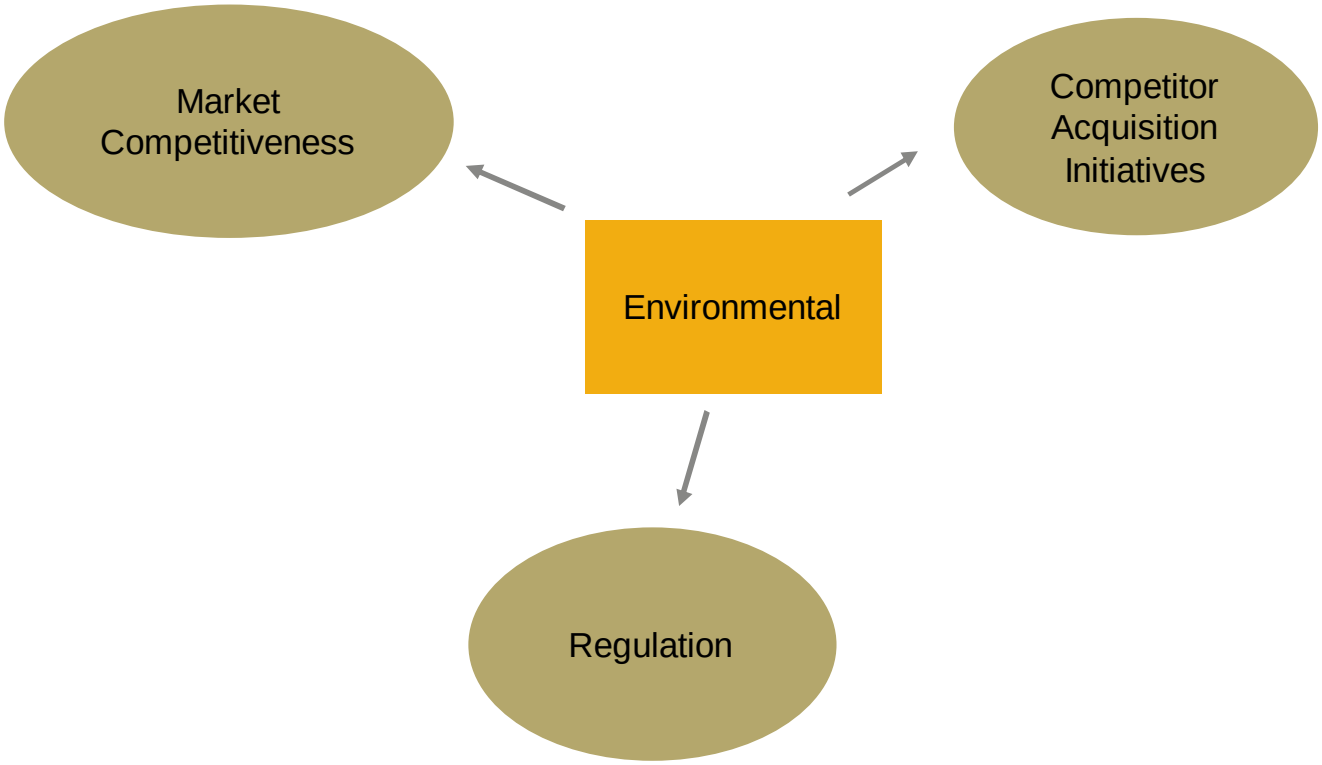
Customer characteristics



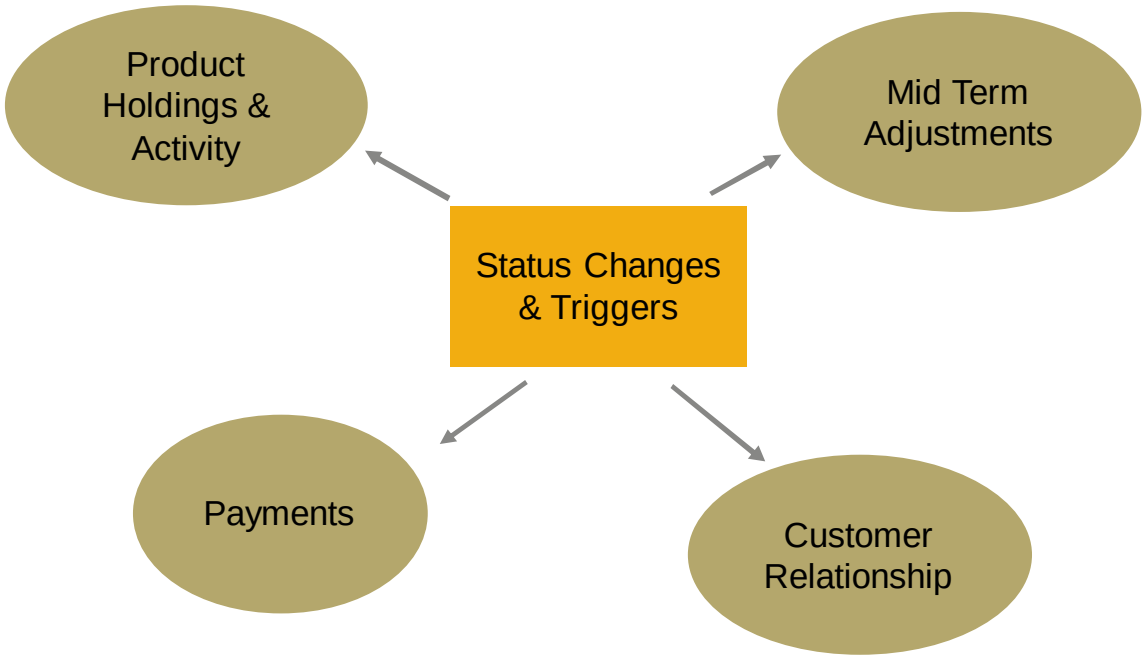
Company triggered changes



External influences

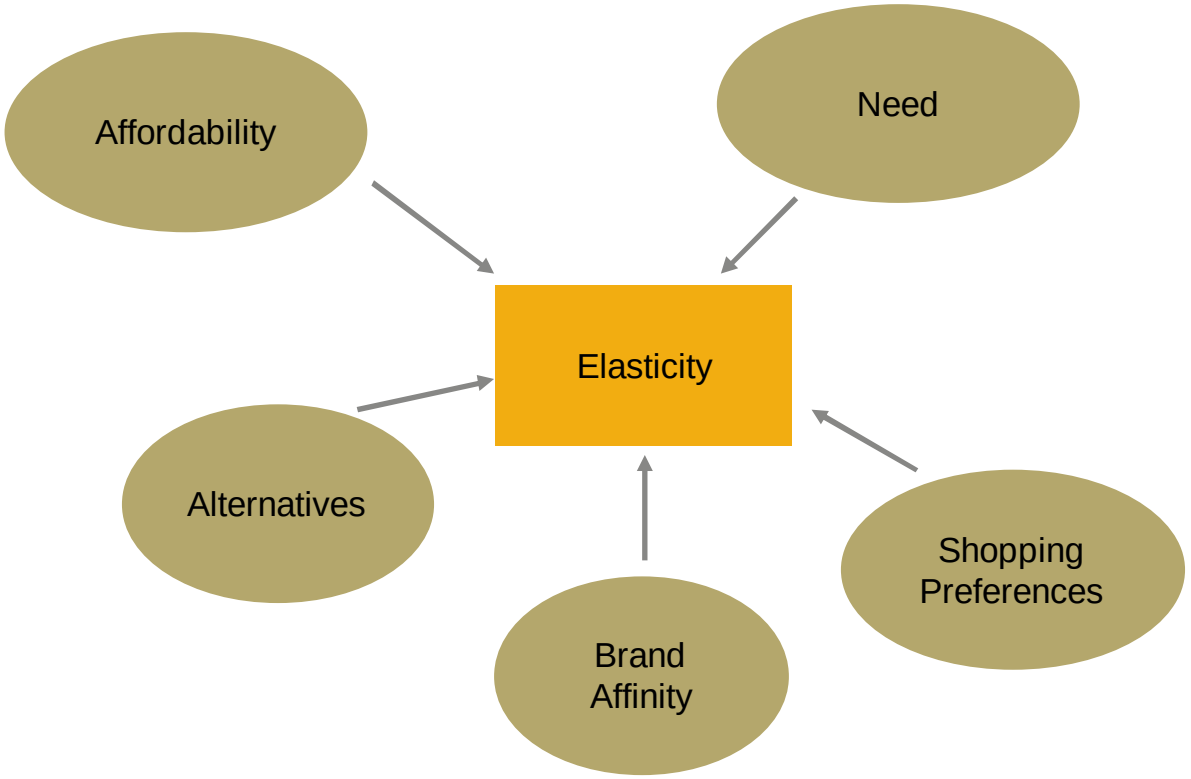


Customer triggered changes



An alternative view of elasticity drivers

Return to basic economic theory



Brand

(Actual results cannot be disclosed in handouts)

Behavioural analysis and customer profiling

(Actual results cannot be disclosed in handouts)

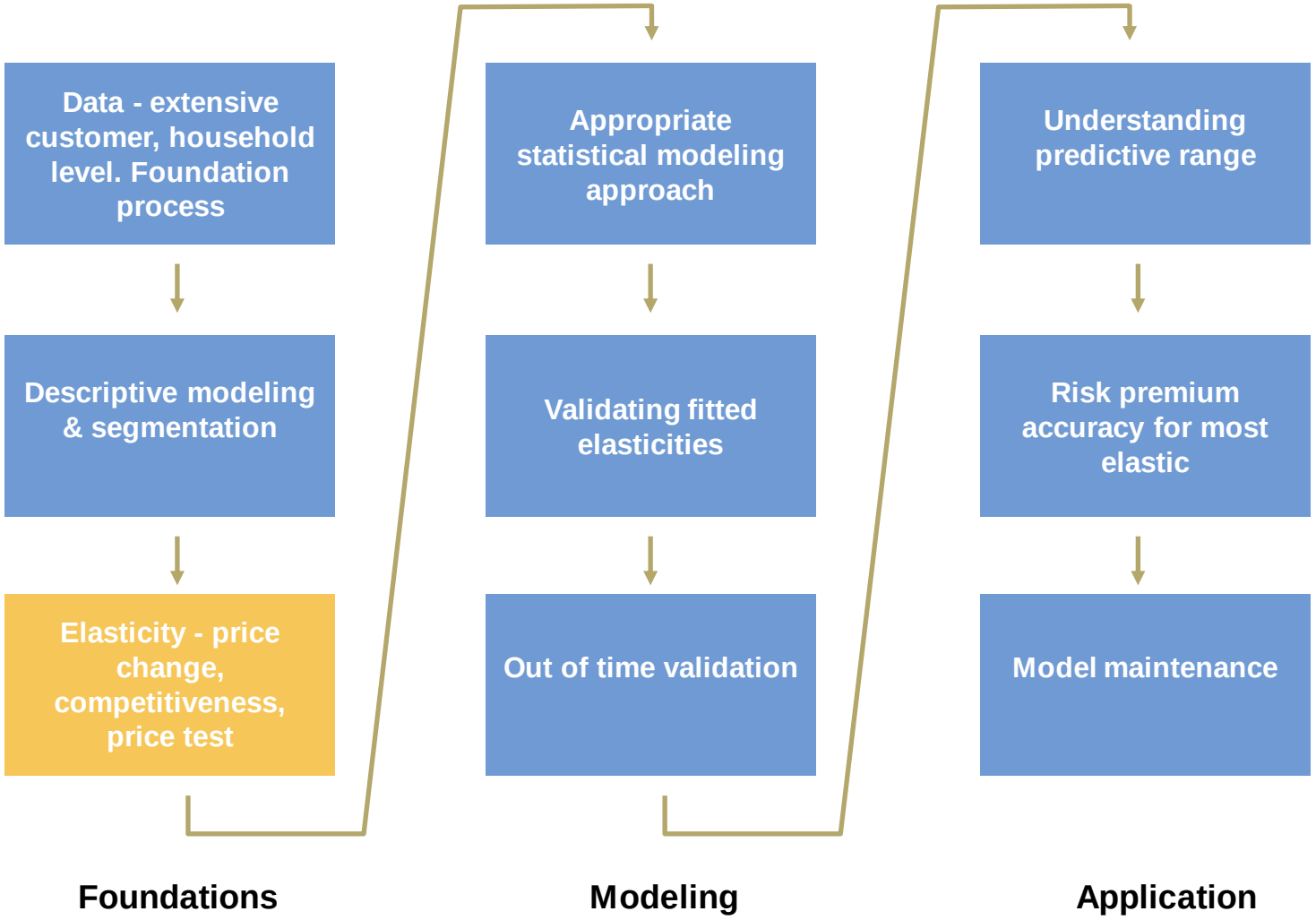
Behavioural factors

(Actual results cannot be disclosed in handouts)

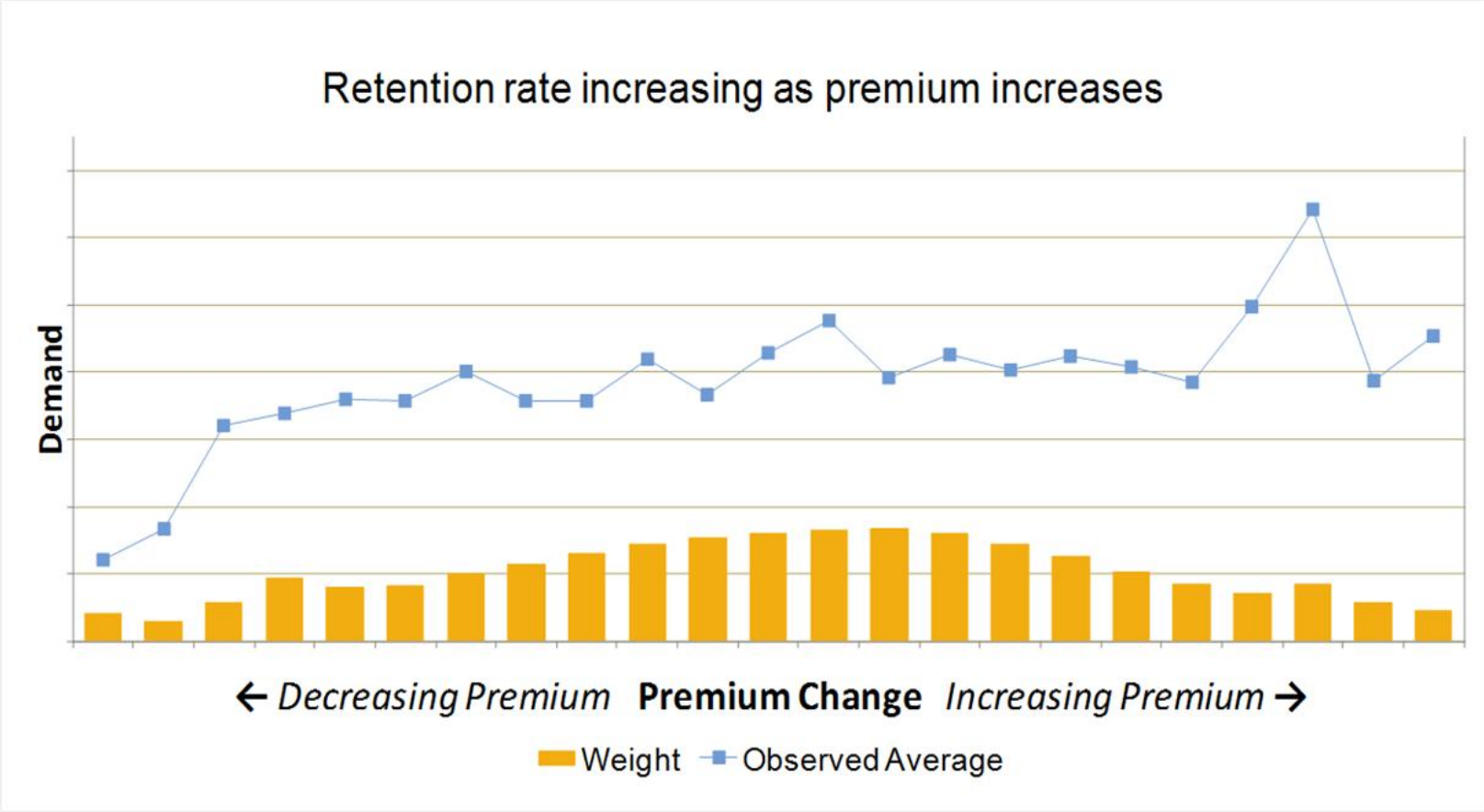
Affluence

(Actual results cannot be disclosed in handouts)

Elasticity modeling - a rigorous approach

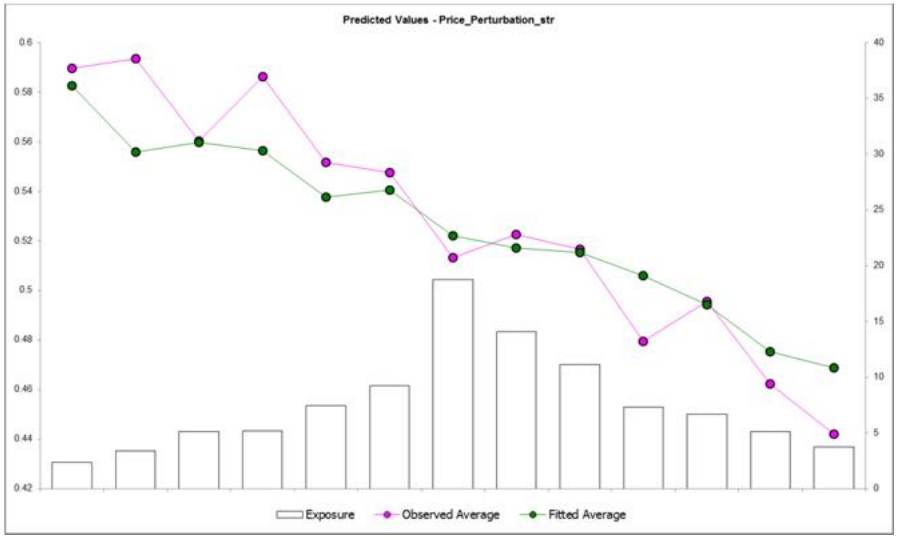


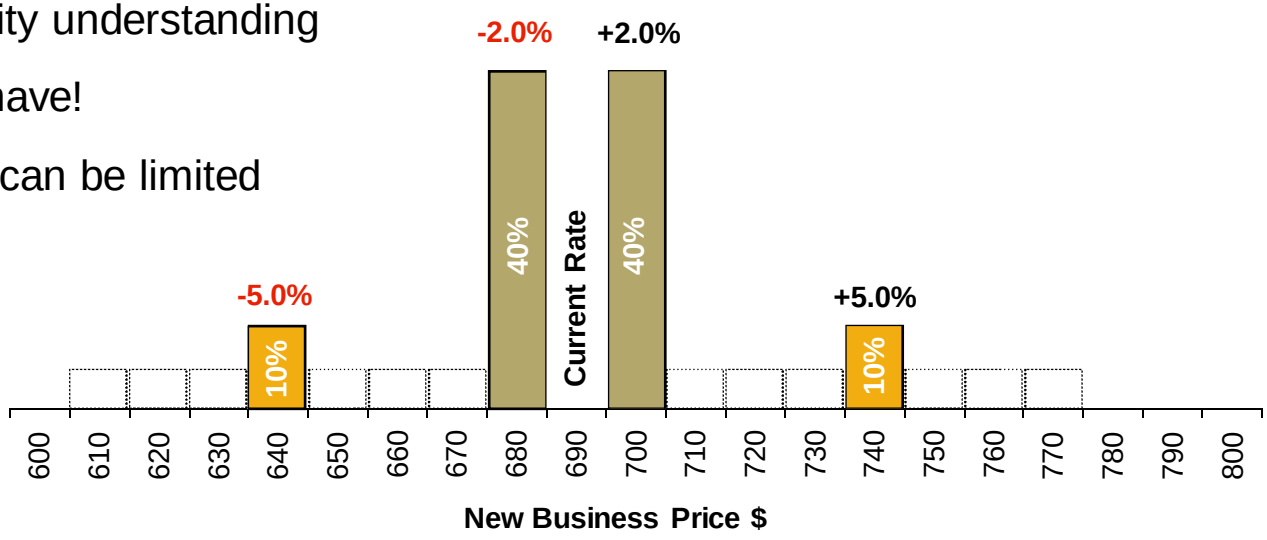
Risks


Retention rate increasing as premium increases
Demand
← Decreasing Premium
Premium Change
Increasing Premium →
Weight
Observed Average

Price trials

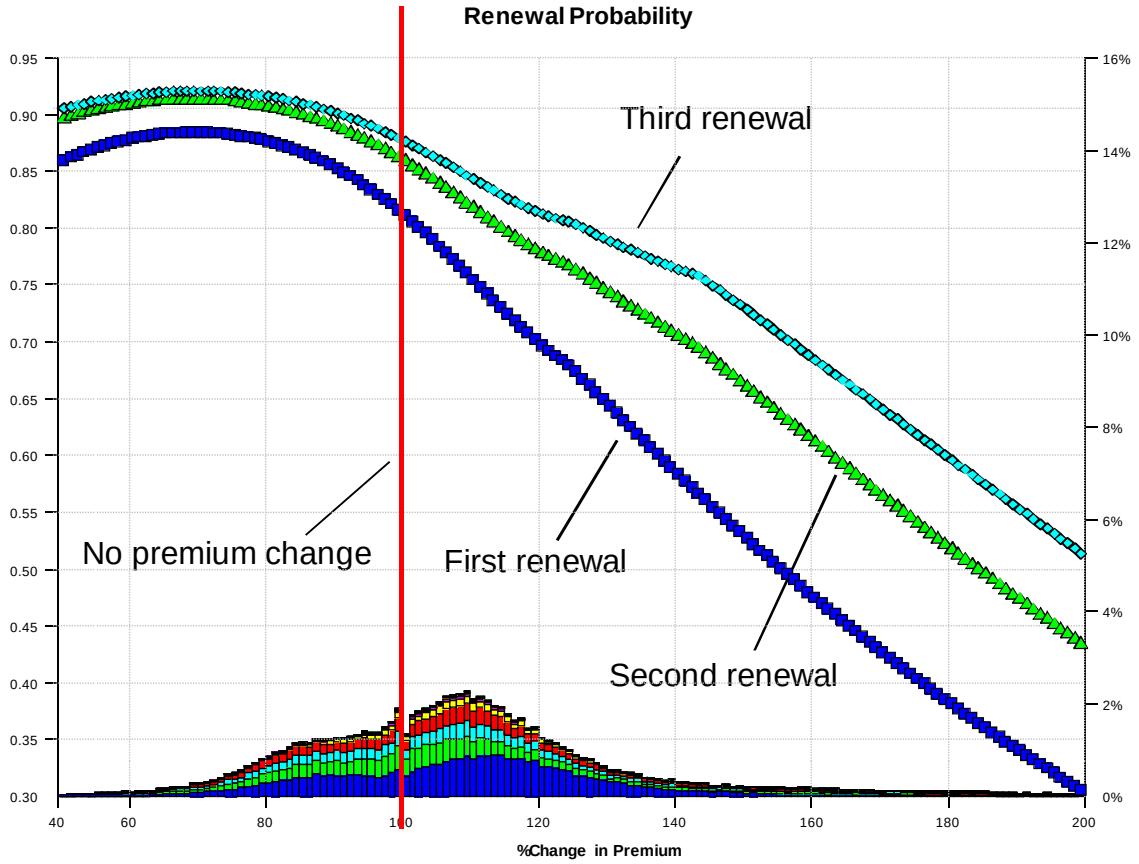
- In deregulated markets, ideally vary random sample of quotes on an ongoing basis
- In regulated markets, other standard rate changes need to act as a proxy
- Best to decorrelate from other factors as much as possible
- Geographical or vehicle reclassification can yield valuable elasticity understanding
- But, you have what you have!
- If range is limited, scope can be limited





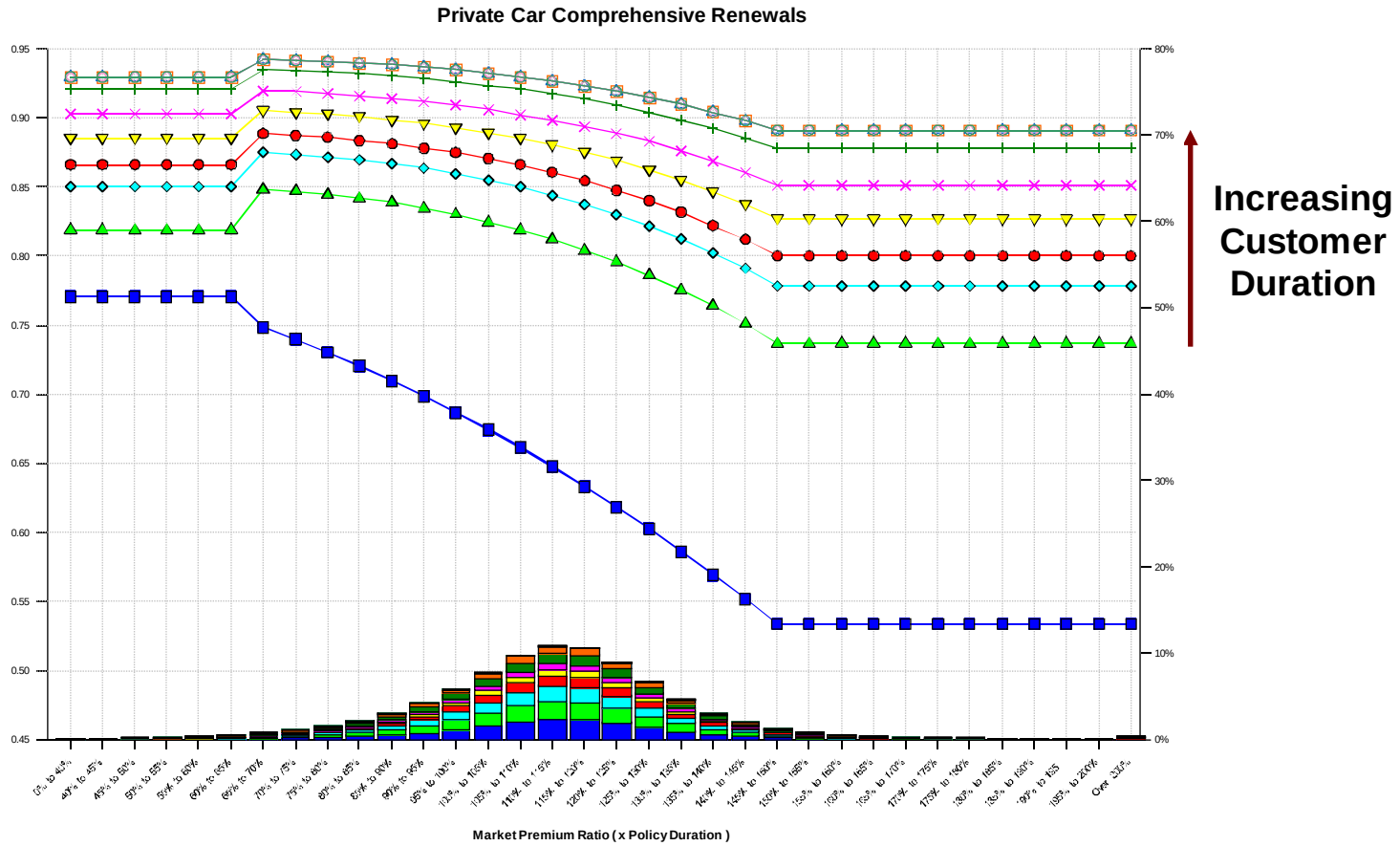
Elasticity modelling without price tests

- It is possible to capture some elasticity variation just from undesigned historic price changes



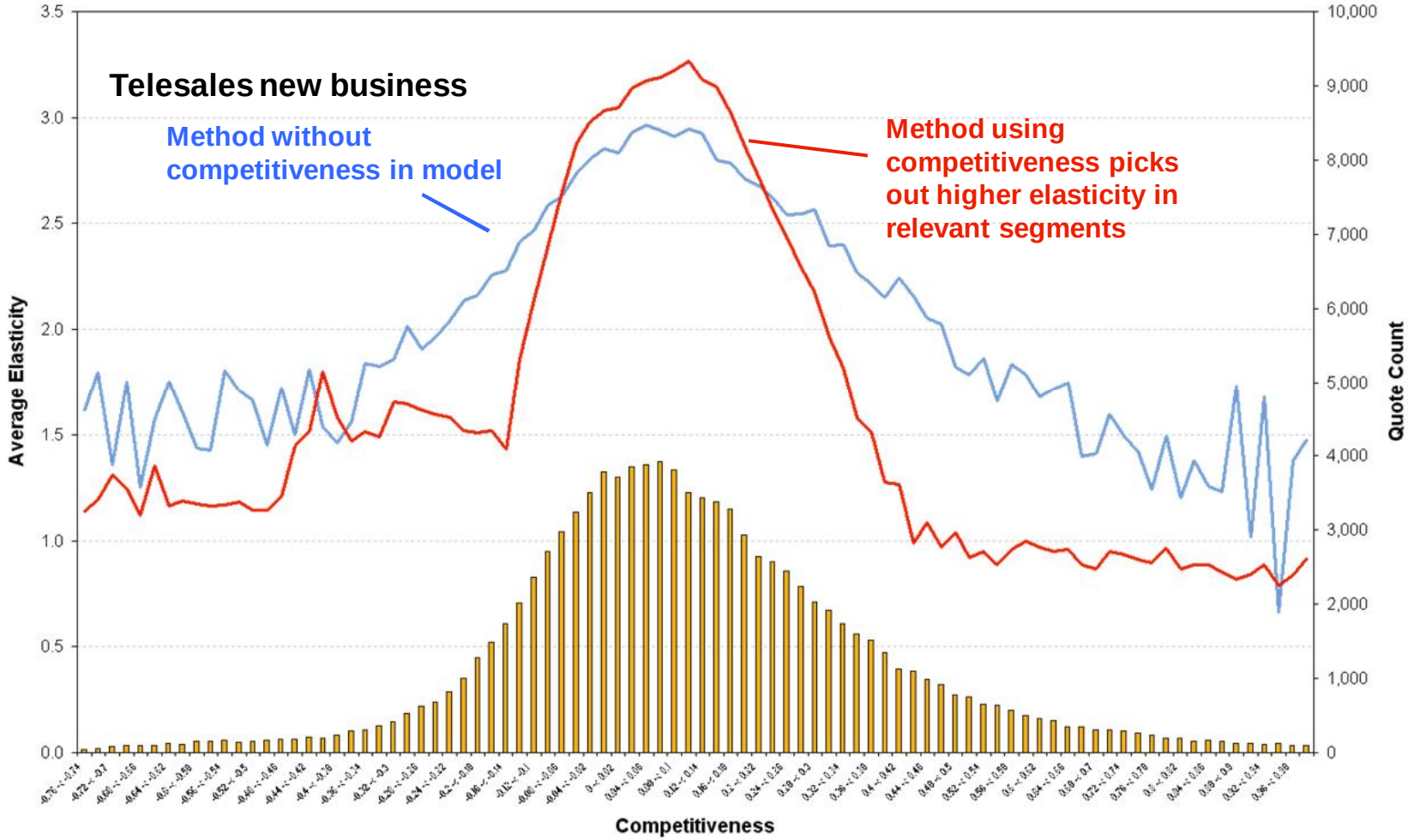
Elasticity modelling without price tests

- It is possible to capture some elasticity* variation just from undesigned historic price changes



* Elasticity estimated by calculating change in demand in response to small changes in price

Competitiveness measures



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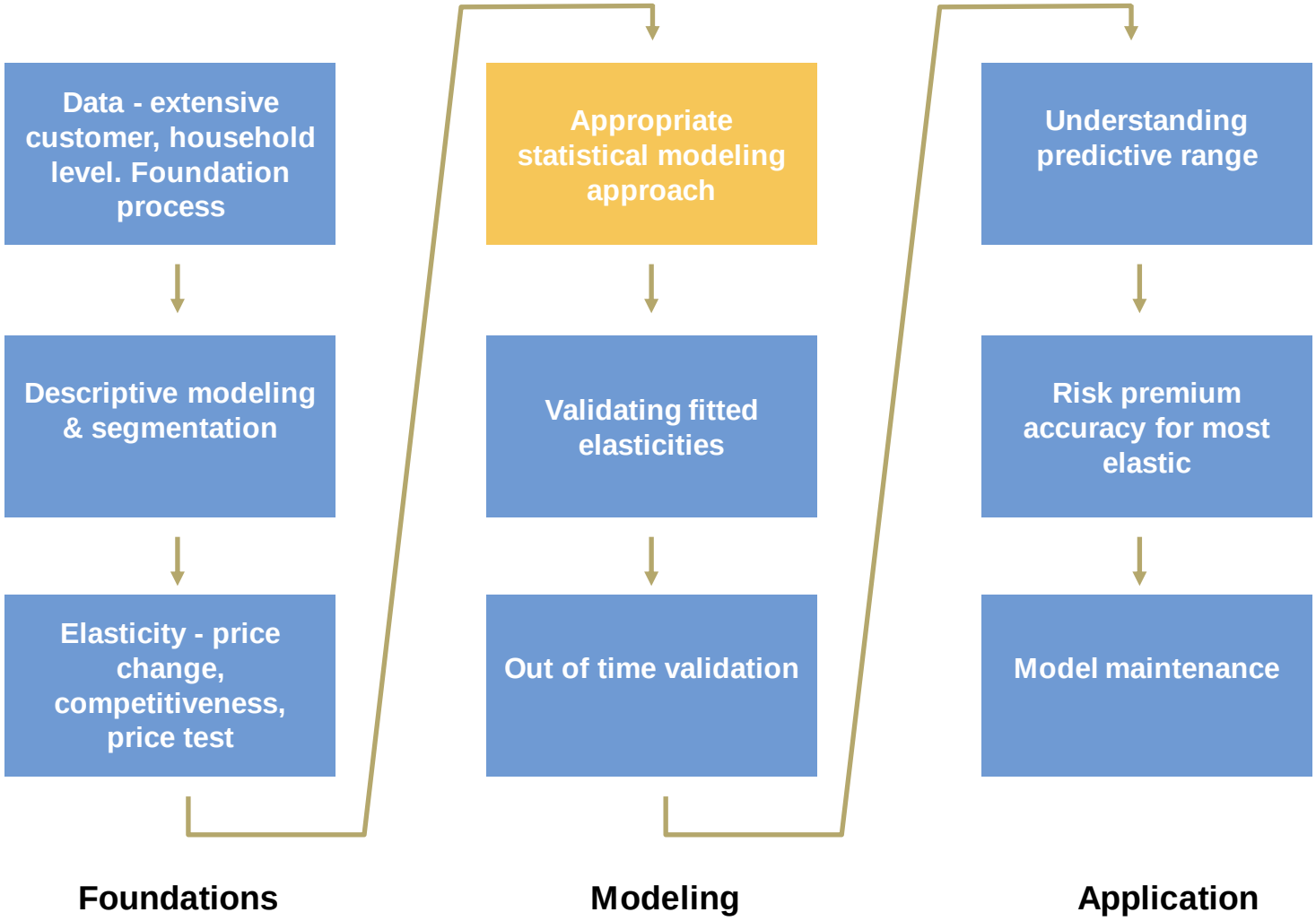
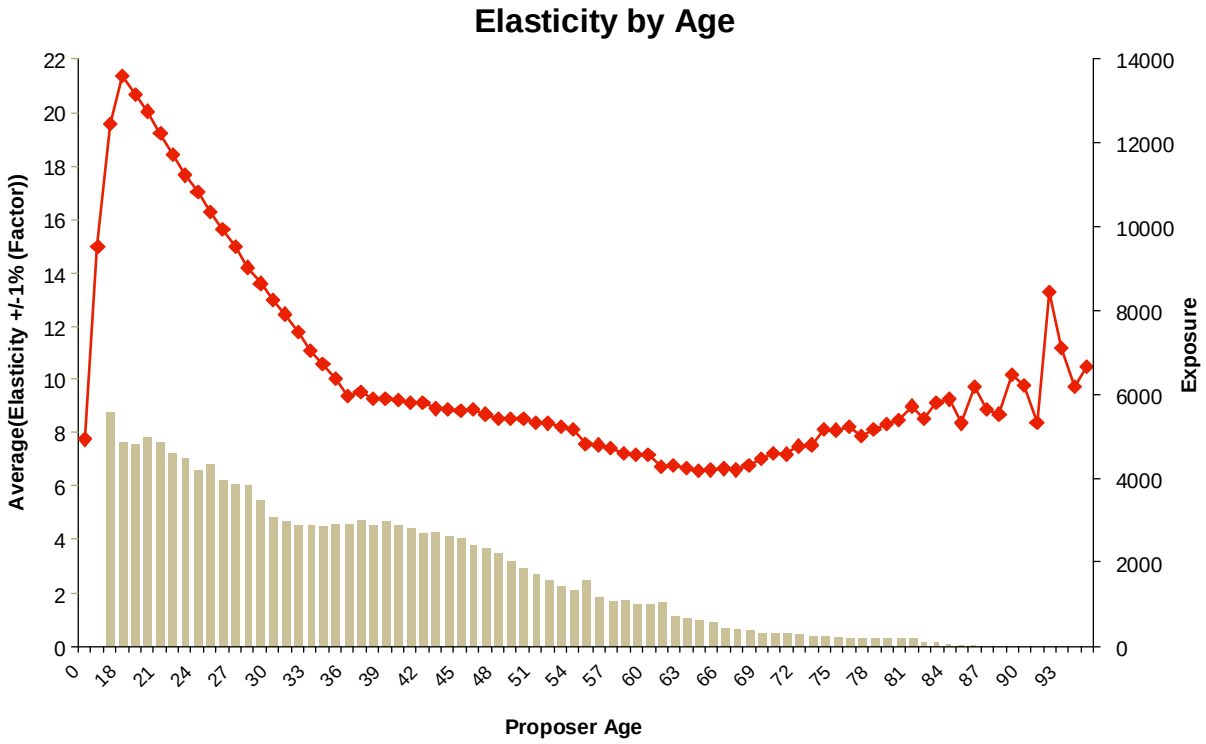


Modeling elasticity vs demand

- Y-variate still "did they buy, yes/no"
- Focus on price related explanatory variables different
- Can re-express as elasticity by wobbling price explanatory variables after fitting model



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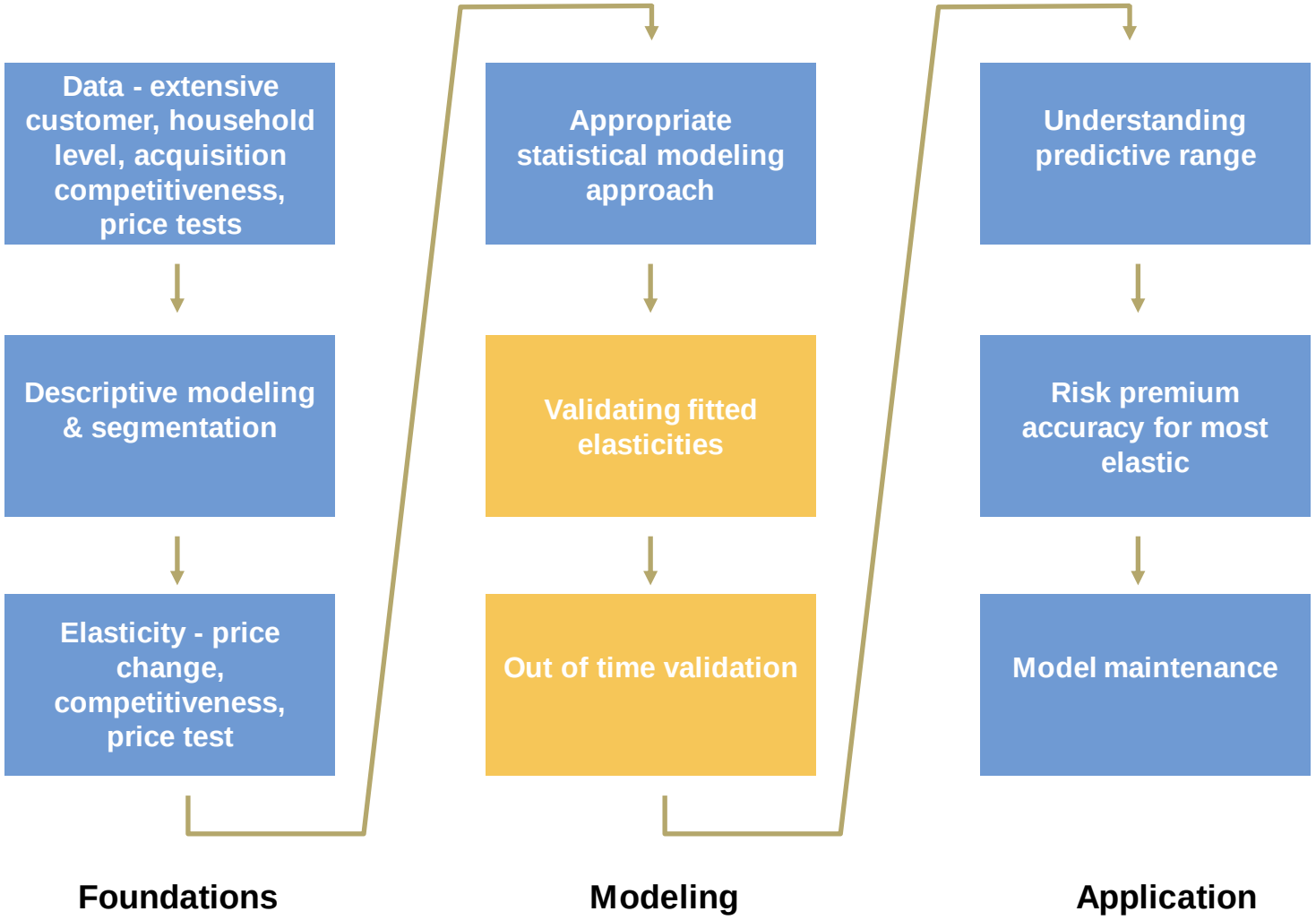
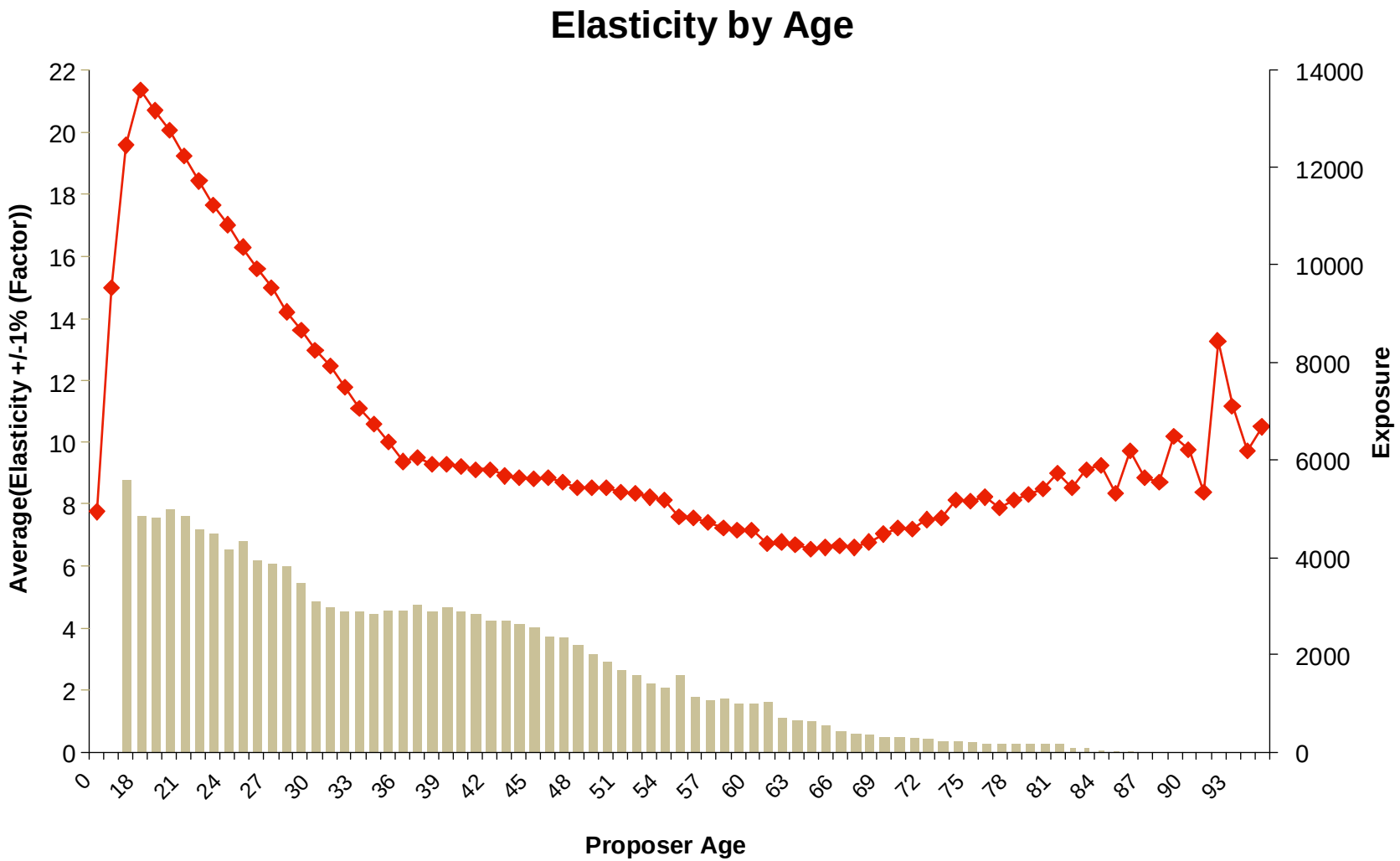
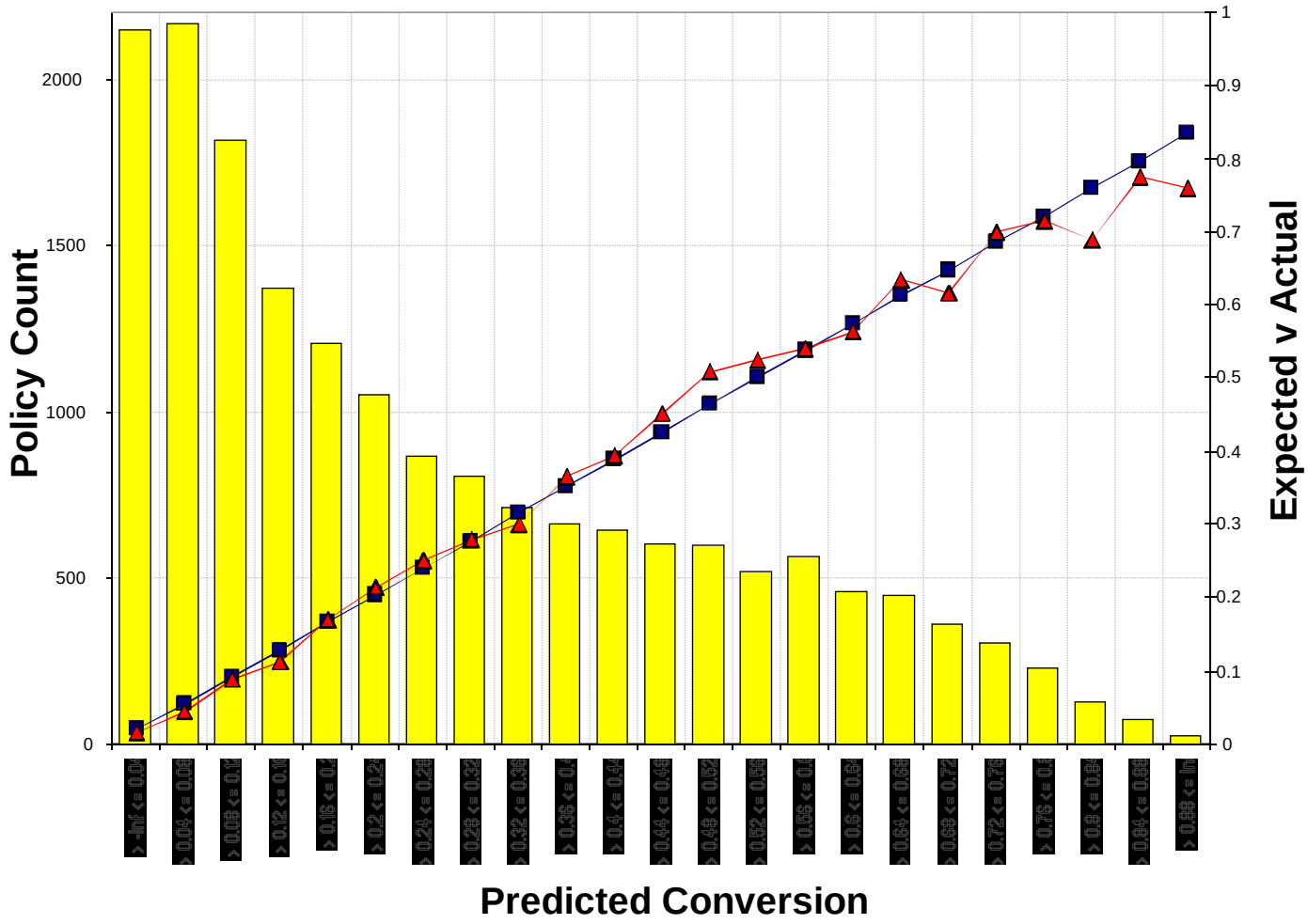


Checking modeled elasticity

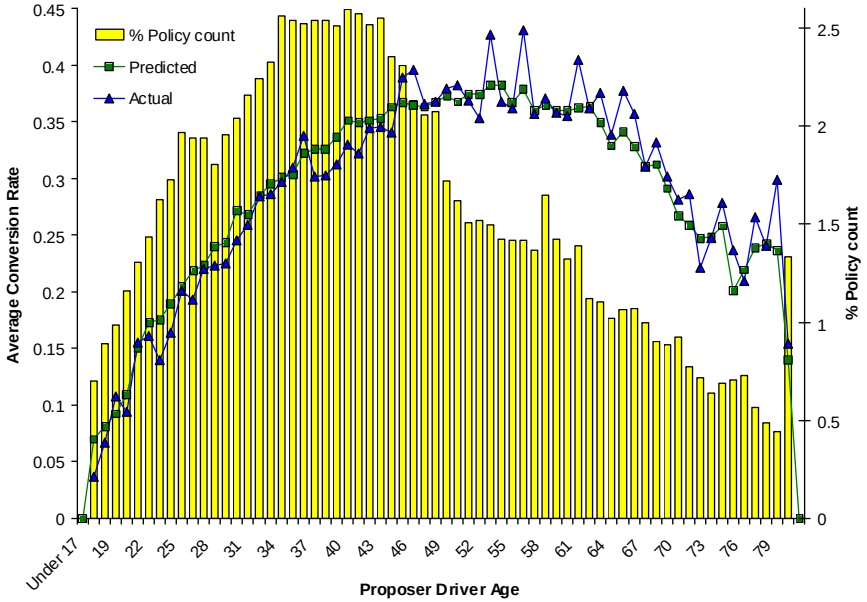


New business - out of time validation

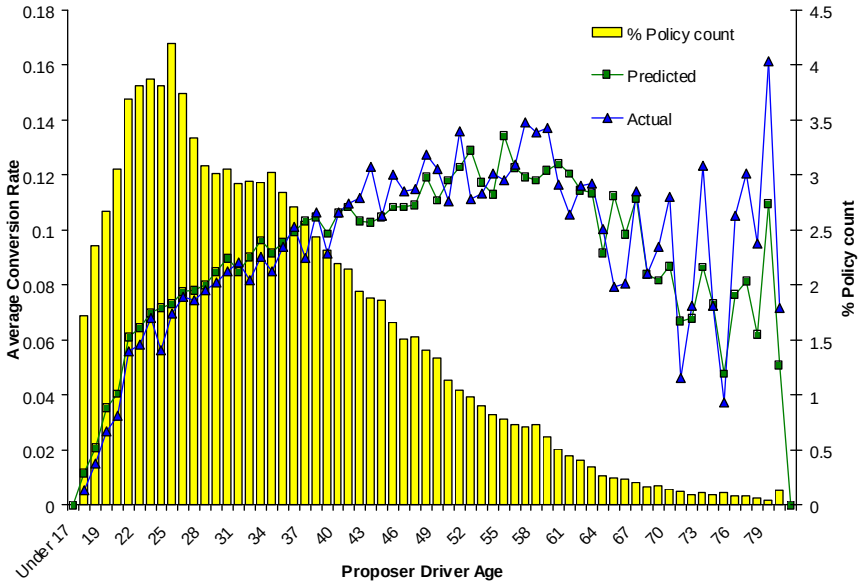


New business - out of time validation

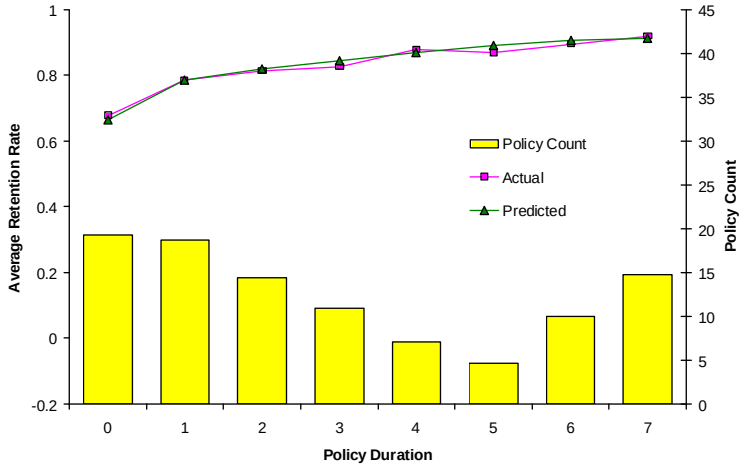
Phone

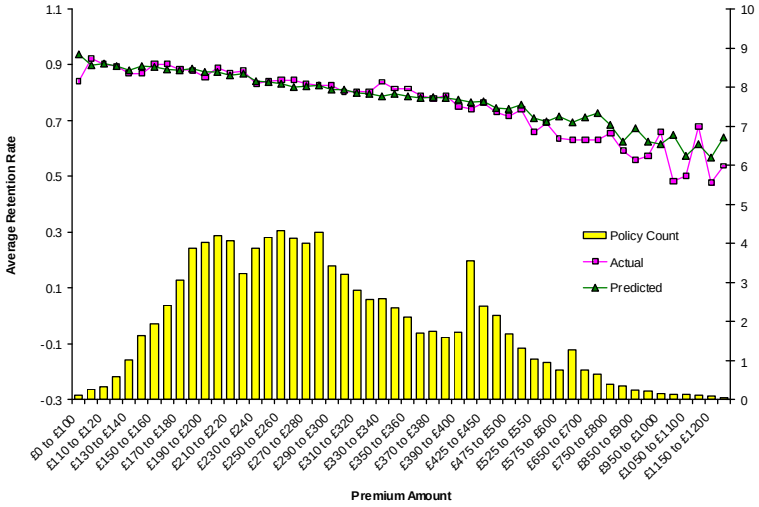


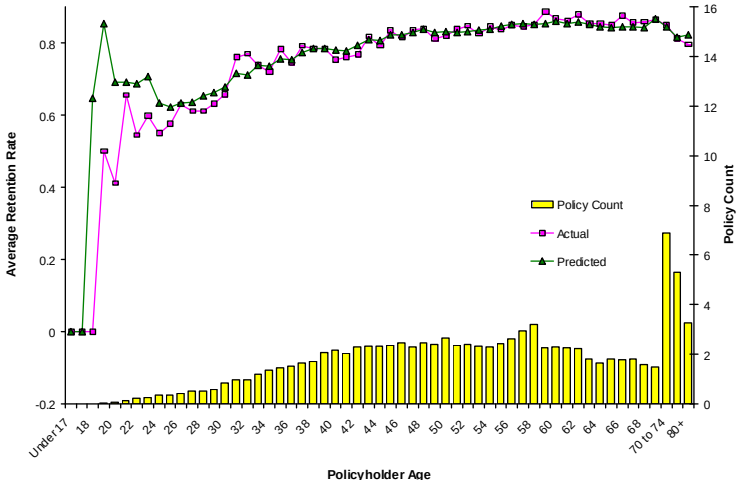
Web

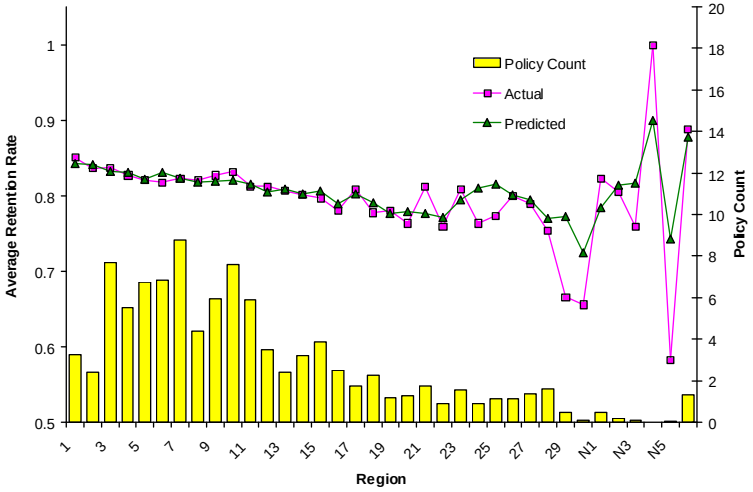


Renewals - out of time validation

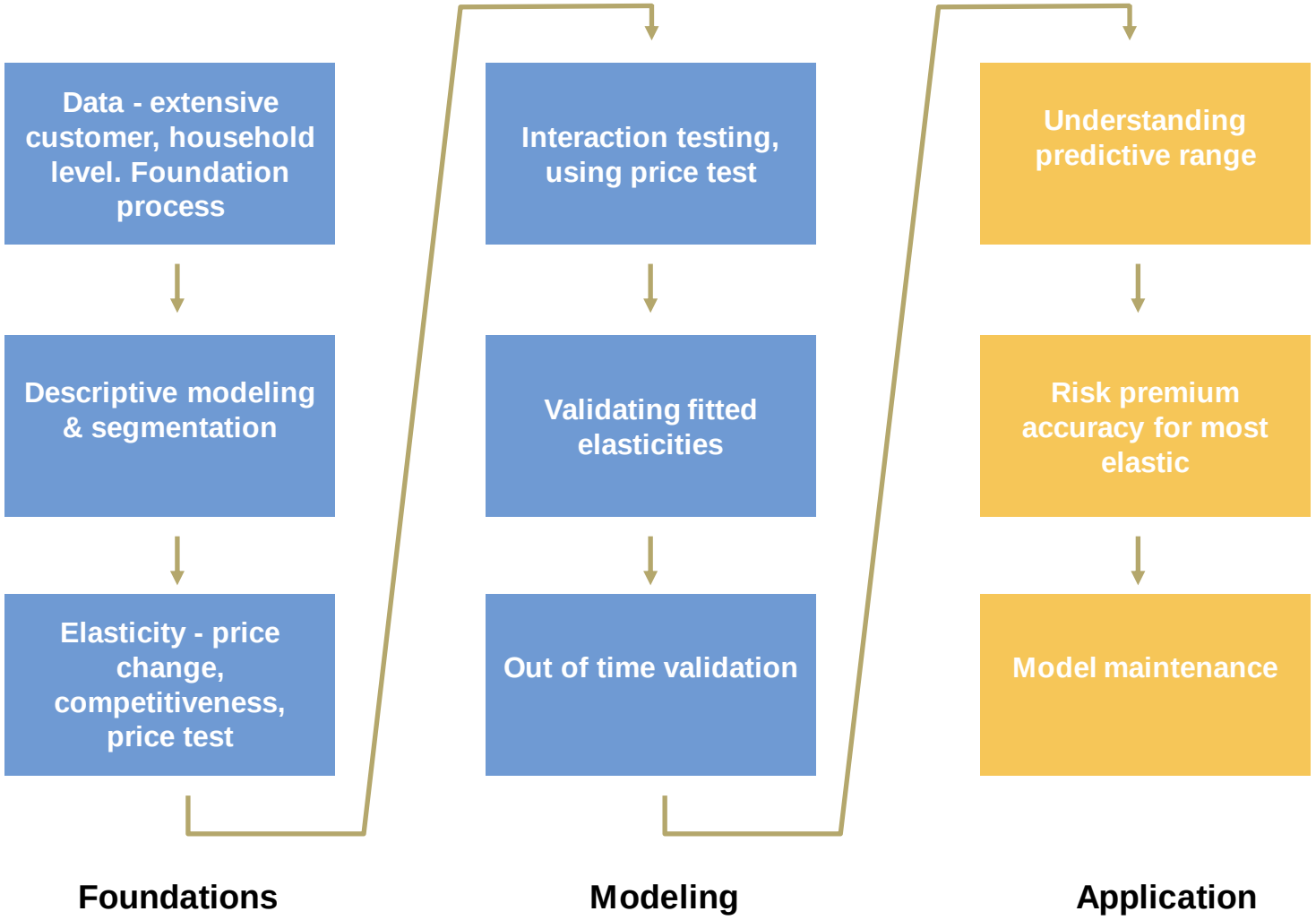




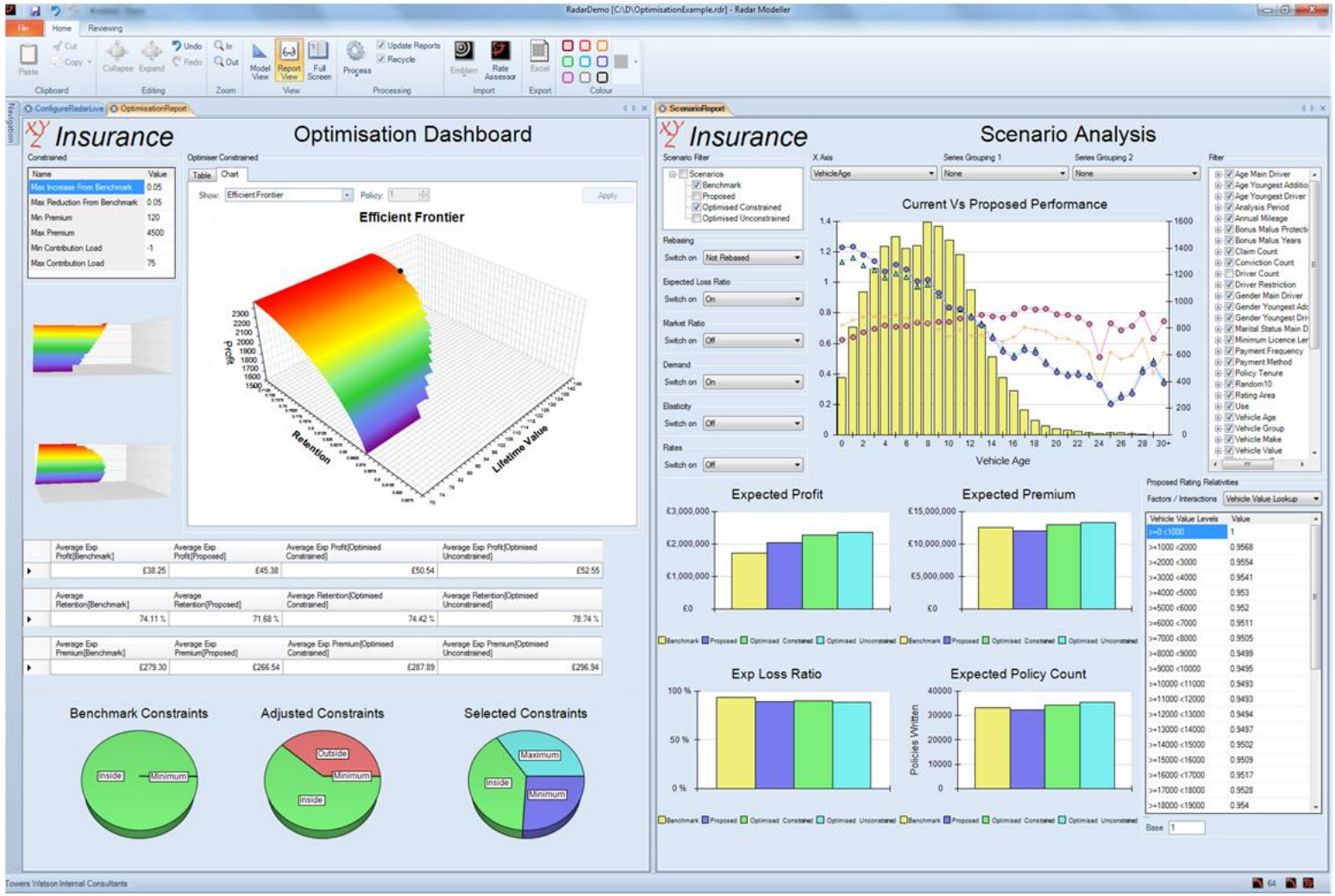




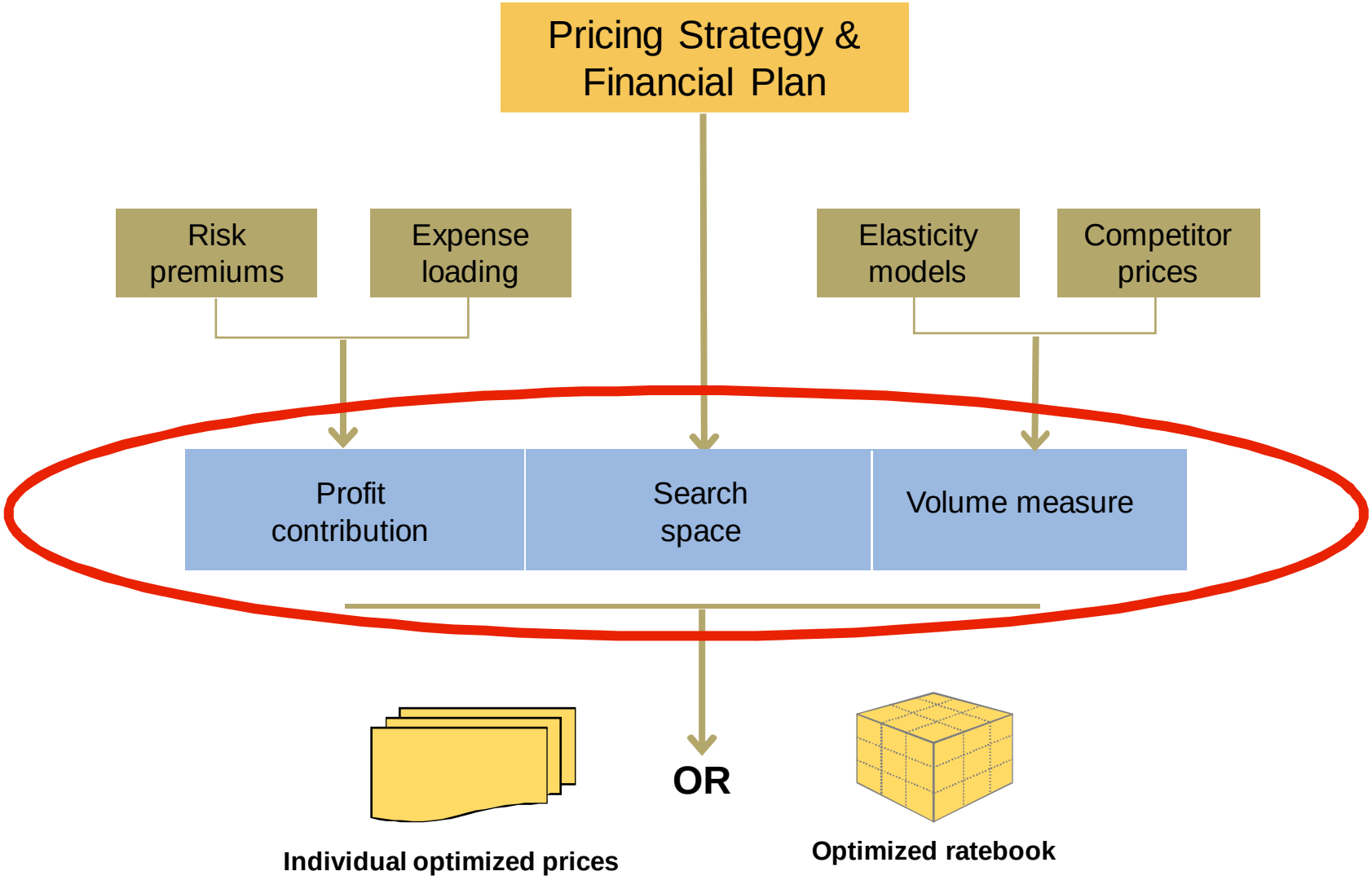
Elasticity modeling - a rigorous approach



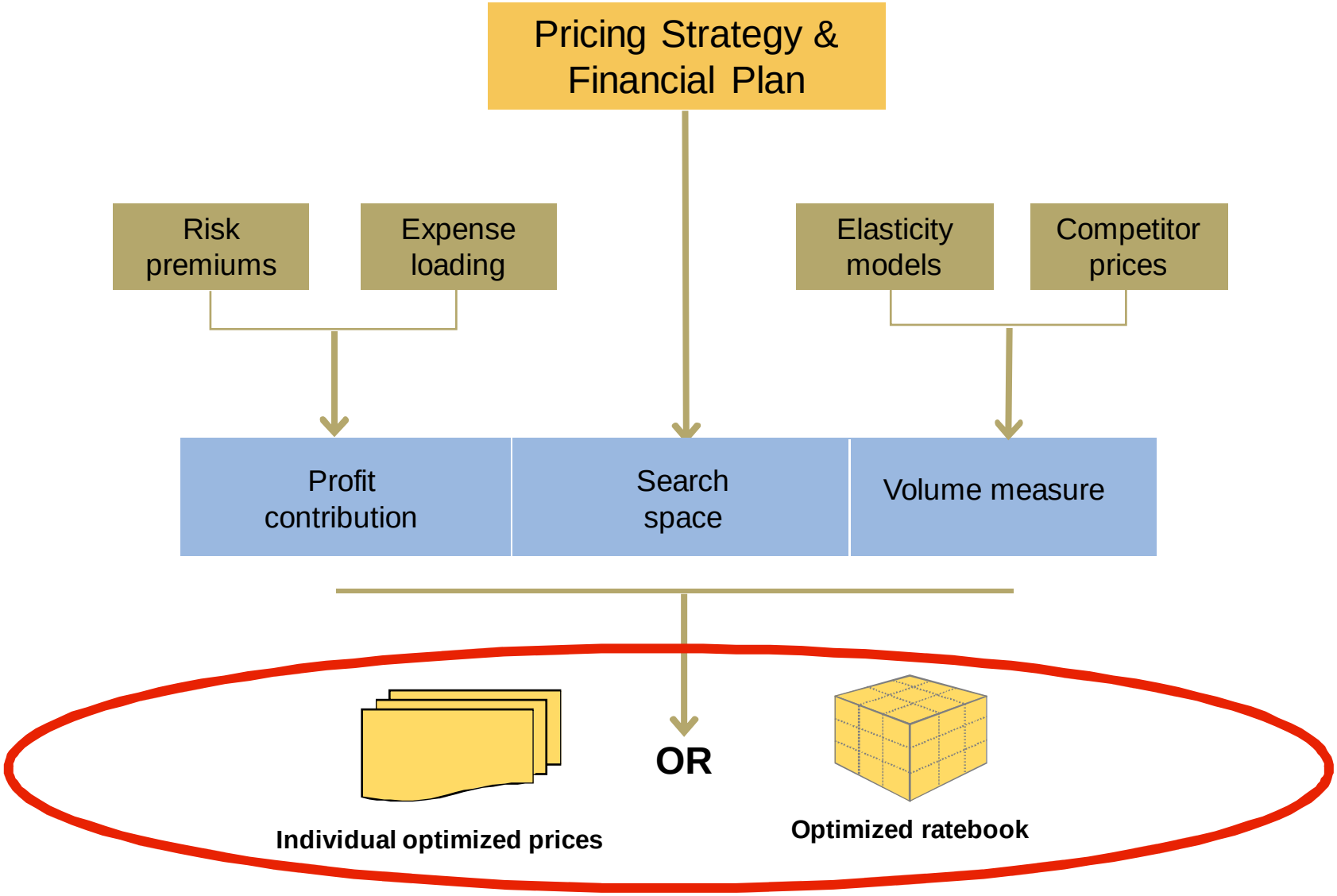
Monitoring


RadarDemo [C:\D\OptimisationExample.rdr] - Radar Modeller
Optimisation Dashboard
Efficient Frontier
Benchmark Constraints
Adjusted Constraints
Selected Constraints
Scenario Analysis
Current Vs Proposed Performance
Vehicle Age
Expected Profit
Expected Premium
Exp Loss Ratio
Expected Policy Count

Price optimization



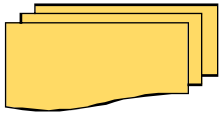
Price optimization



Four options for optimization

1. Individual policy optimization ✗
2. Individual policy optimization re-expressed in ratebook form ✓
3. Direct ratebook optimization ✓
4. Real time optimization ✗

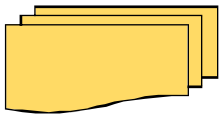
1 - Individual policy optimization



Individual optimized prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
XTB008693907	175
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
ZJY528736252	372
VRF026498810	647
BIN297260627	555
SXT608697514	203
JAE716278042	163
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

2 - Individual policy optimization re-expressed in ratebook form



Individual optimized prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
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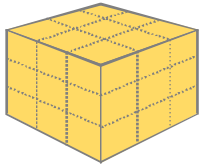
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

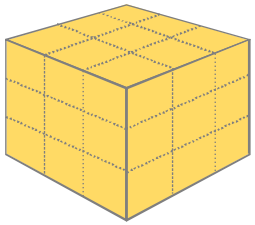
Fit model to results to yield traditional rating structure

Model



Traditional ratebook structure

3 - Direct ratebook optimization



Traditional ratebook structure

Base $445

Age	
16	1.89
17	1.78
18	1.65
19	1.54
20	1.43
21	1.30
22	1.28
23	1.16
24	1.10
25	1.05
26	1.04
27	1.03
…	

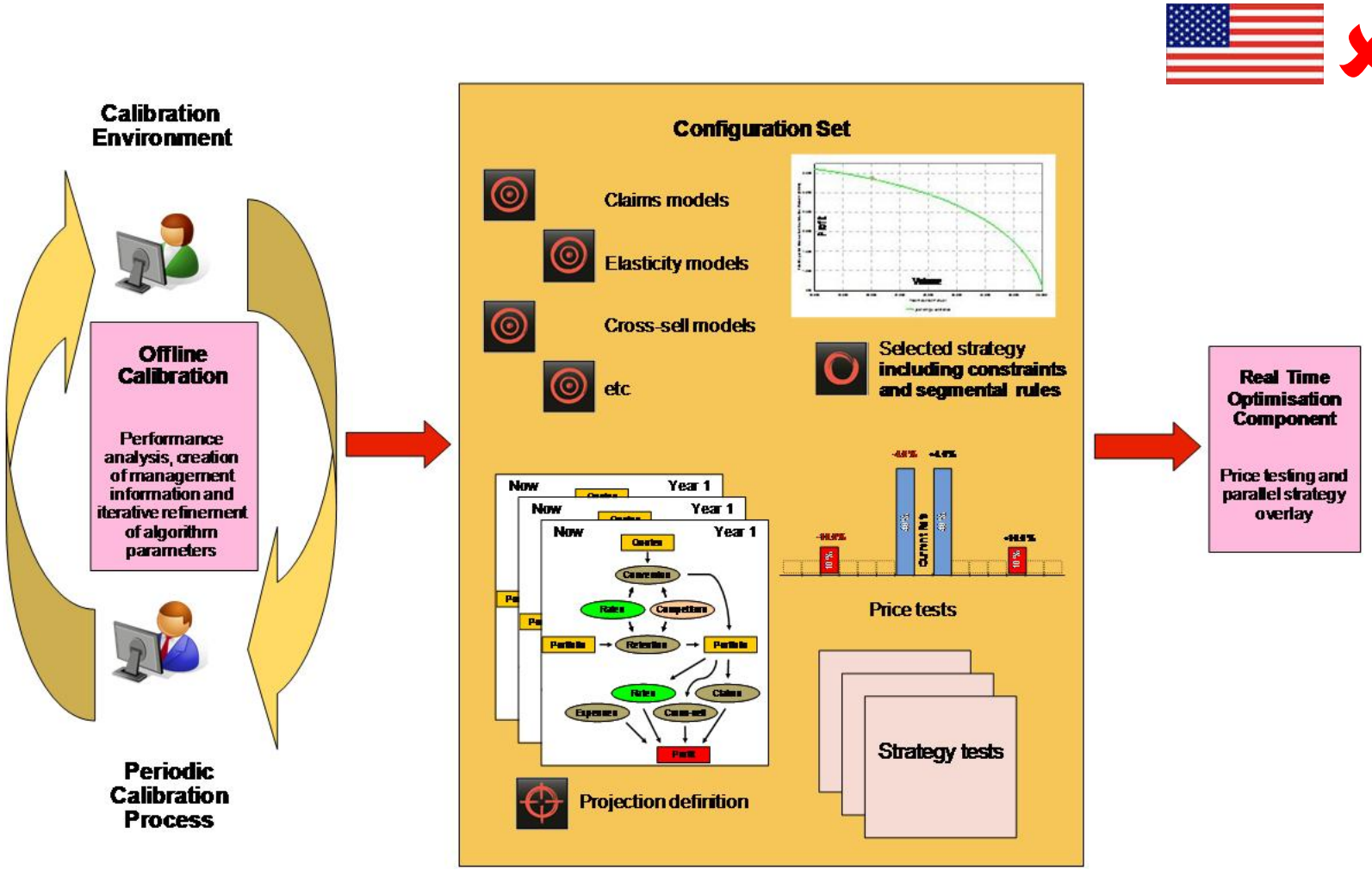
Vehicle	
1	0.56
2	0.68
3	0.82
4	0.91
5	0.98
6	1.00
7	1.11
8	1.16
9	1.19
10	1.25
11	1.34
12	1.43
…	

Area	
1	0.46
2	0.58
3	0.72
4	0.81
5	0.90
6	0.95
7	1.01
8	1.11
9	1.18
10	1.21
11	1.33
12	1.49
…	

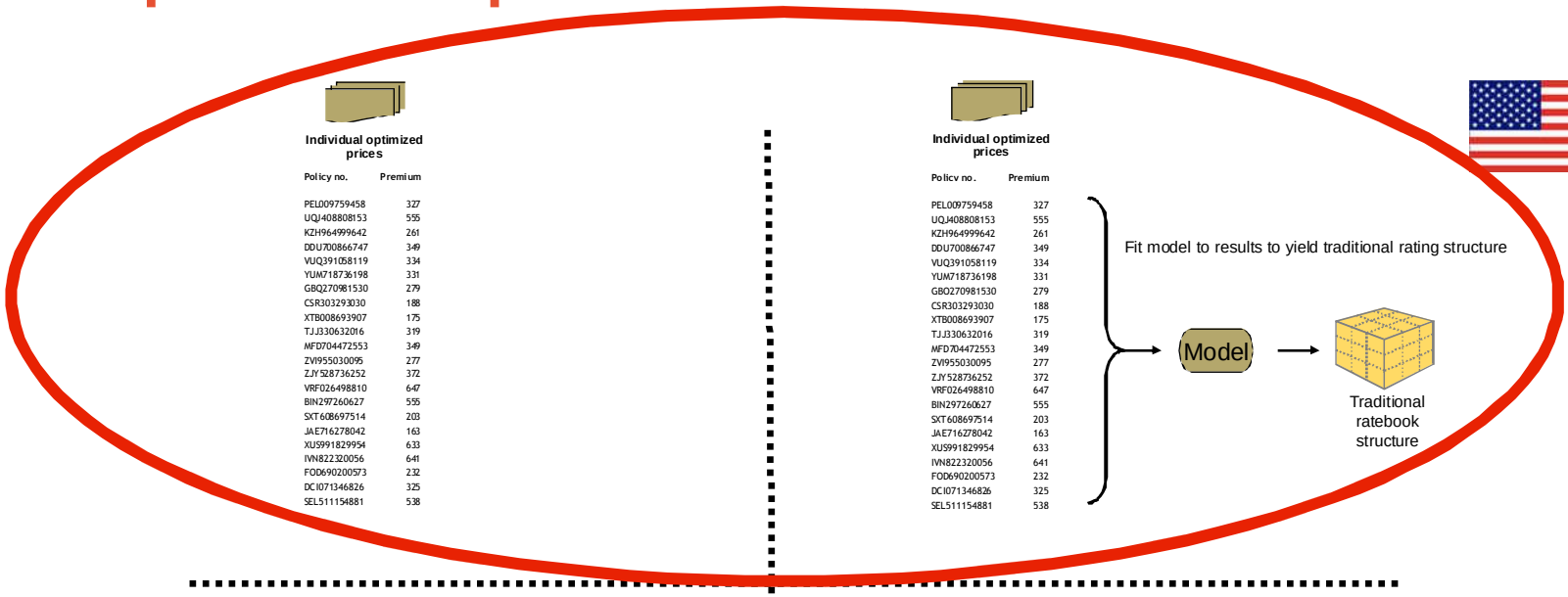
Etc.
…

Etc.
…

4 - Real Time Optimization

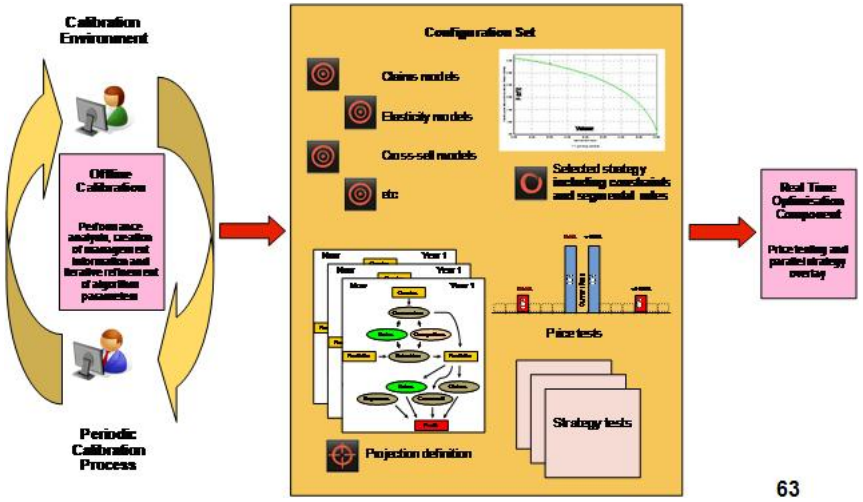


Four options for optimization

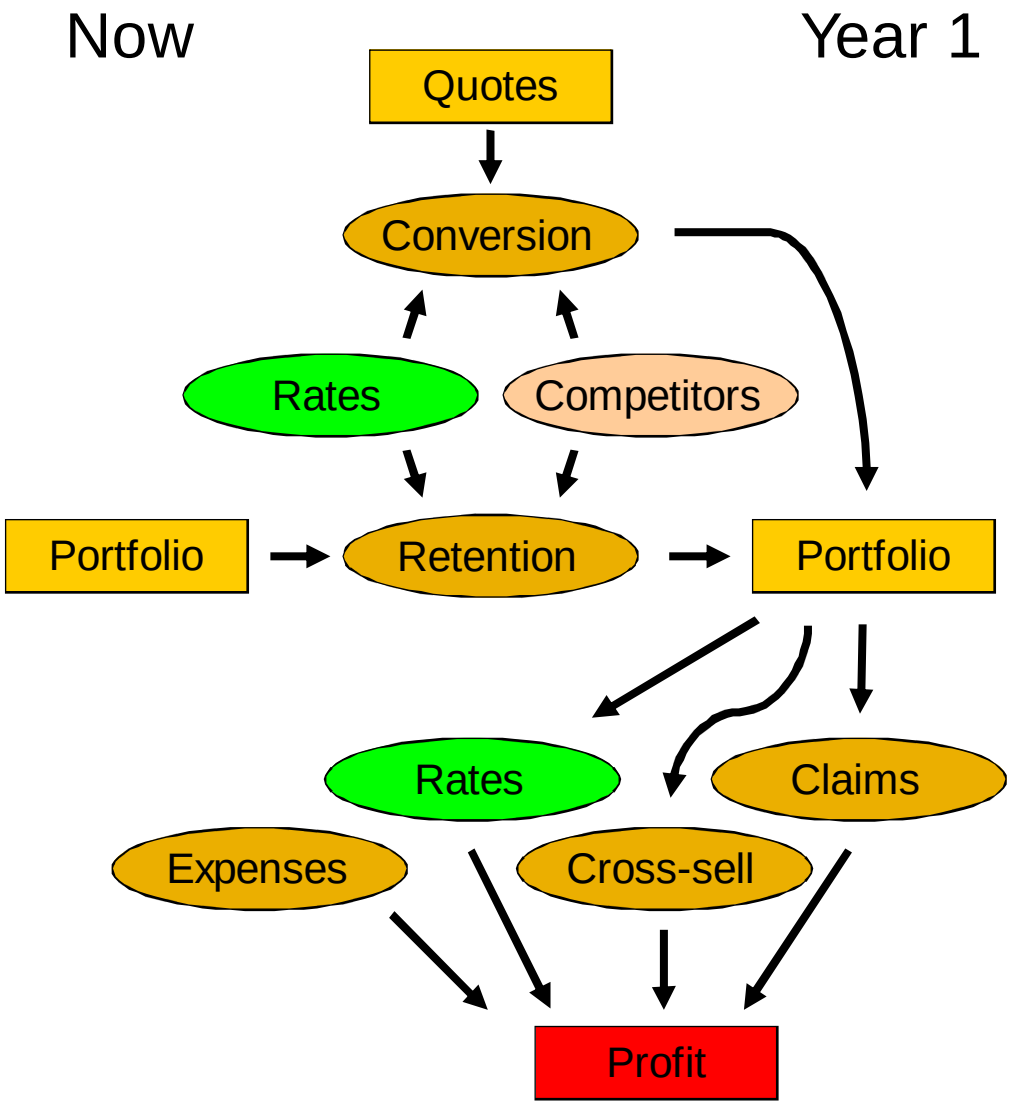


Traditional ratebook structure

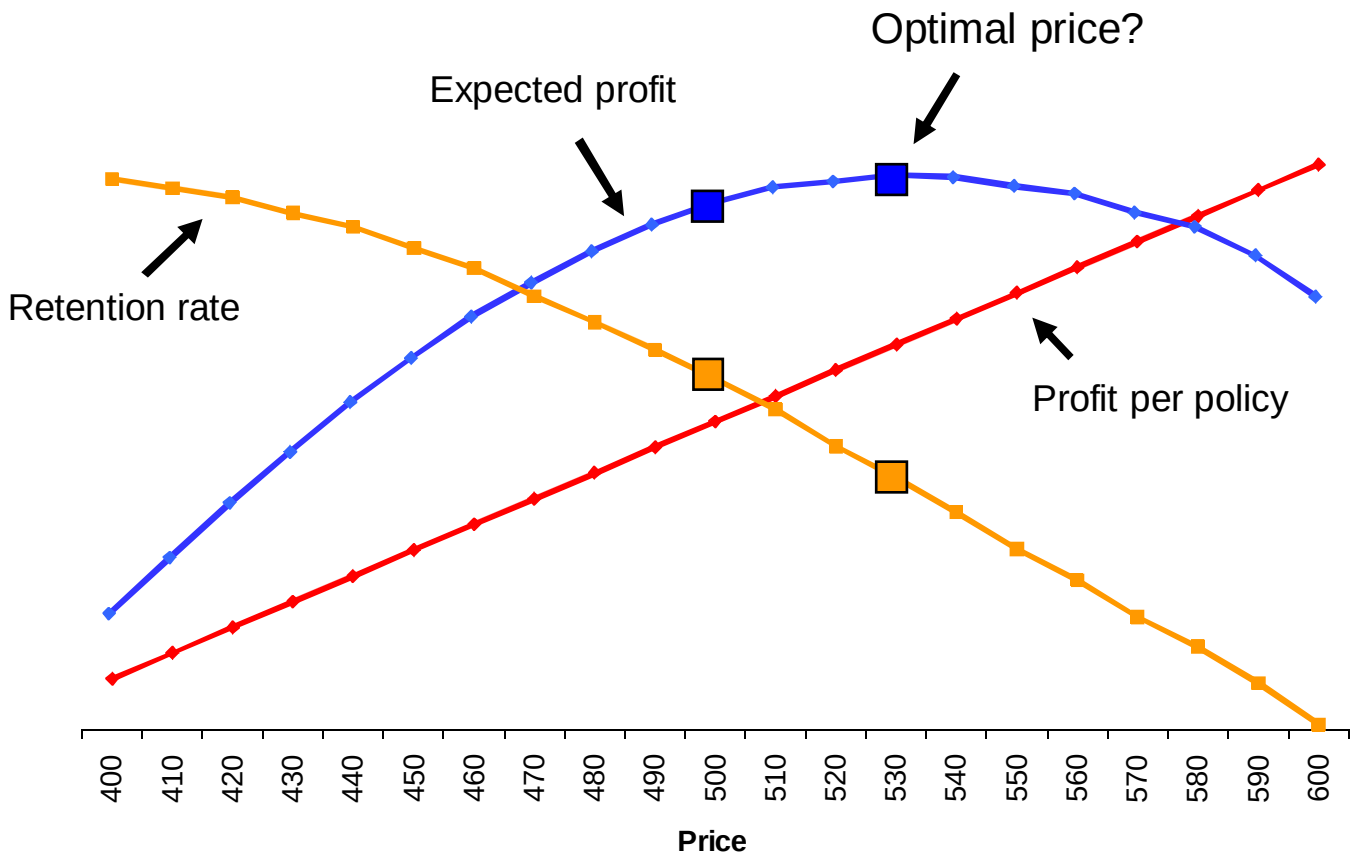
Base $445									
Age		Vehicle		Area		Etc	Etc
16	1.89	1	0.56	1	0.46	…	…
17	1.78	2	0.68	2	0.58		
18	1.65	3	0.82	3	0.72		
19	1.54	4	0.91	4	0.81		
20	1.43	5	0.98	5	0.90		
21	1.30	6	1.00	6	0.95		
22	1.28	7	1.11	7	1.01		
23	1.16	8	1.16	8	1.11		
24	1.10	9	1.19	9	1.18		
25	1.05	10	1.25	10	1.21		
26	1.04	11	1.34	11	1.33		
27	1.03	12	1.43	12	1.49		
…		…		…			



Projection

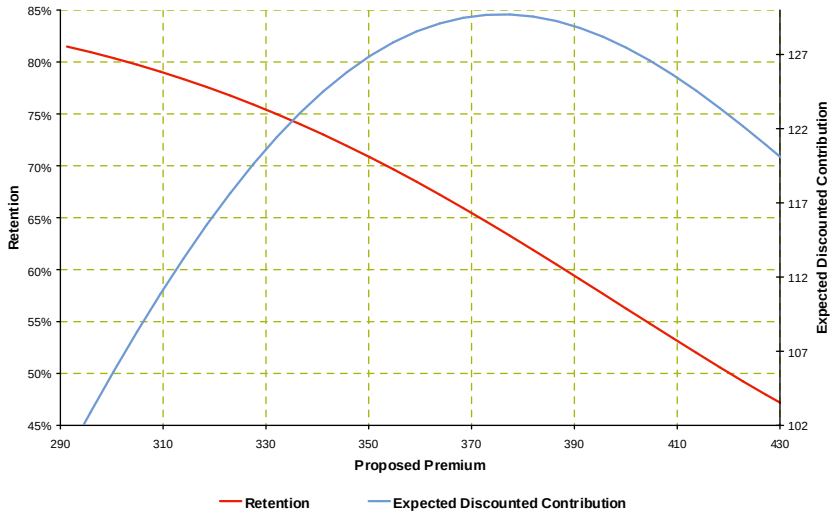

Now
Year 1
Quotes
Conversion
Rates
Competitors
Portfolio
Retention
Portfolio
Rates
Claims
Expenses
Cross-sell
Profit

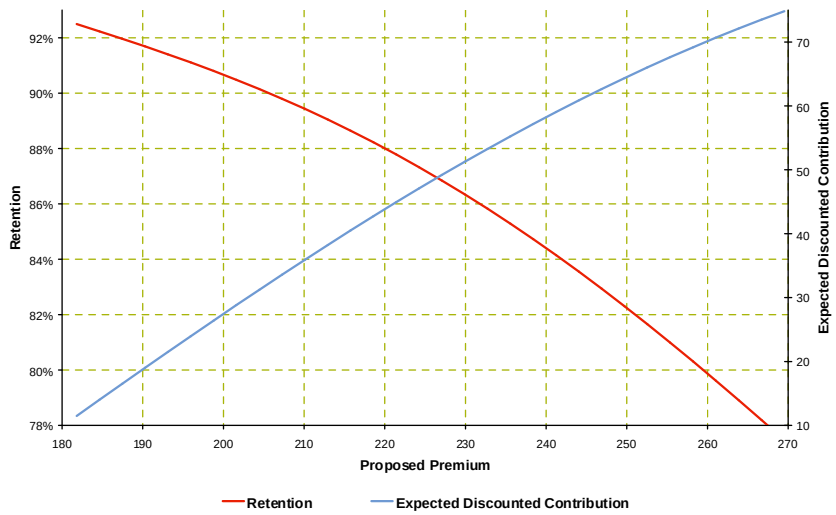
Results for one policy

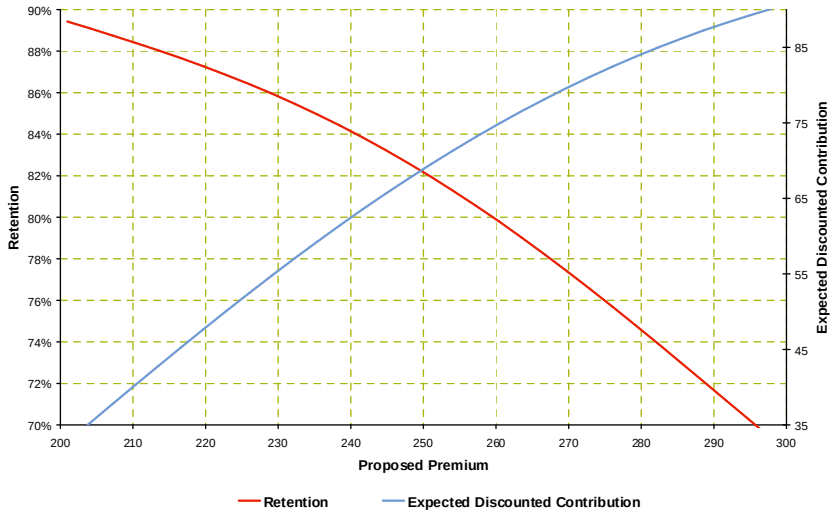


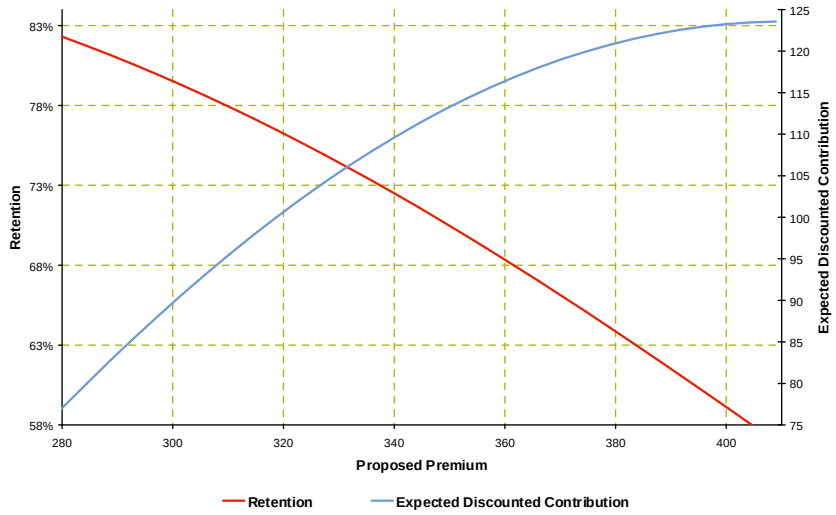
Premium for policy in question

Results for four policies







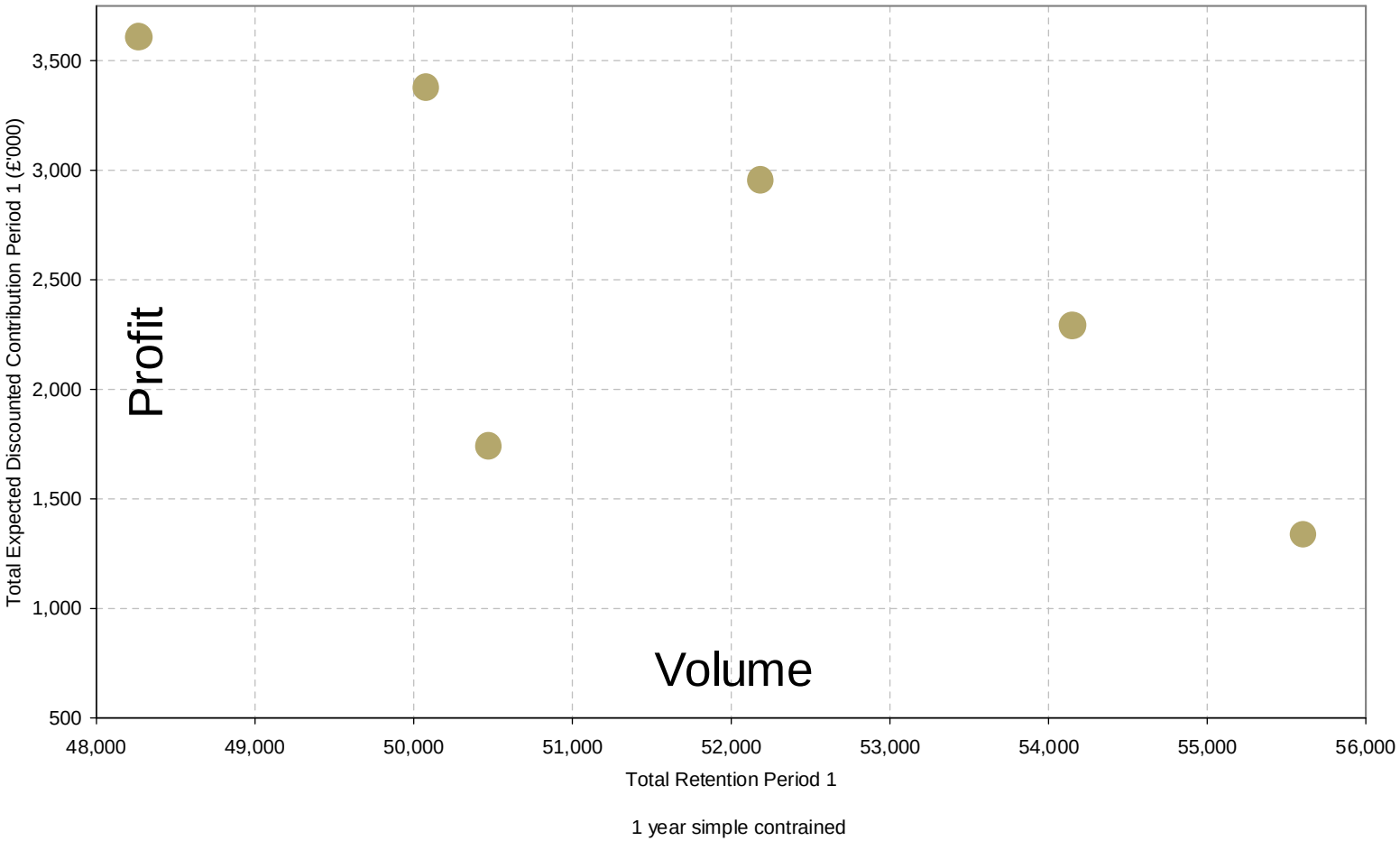


Balancing profit and volume

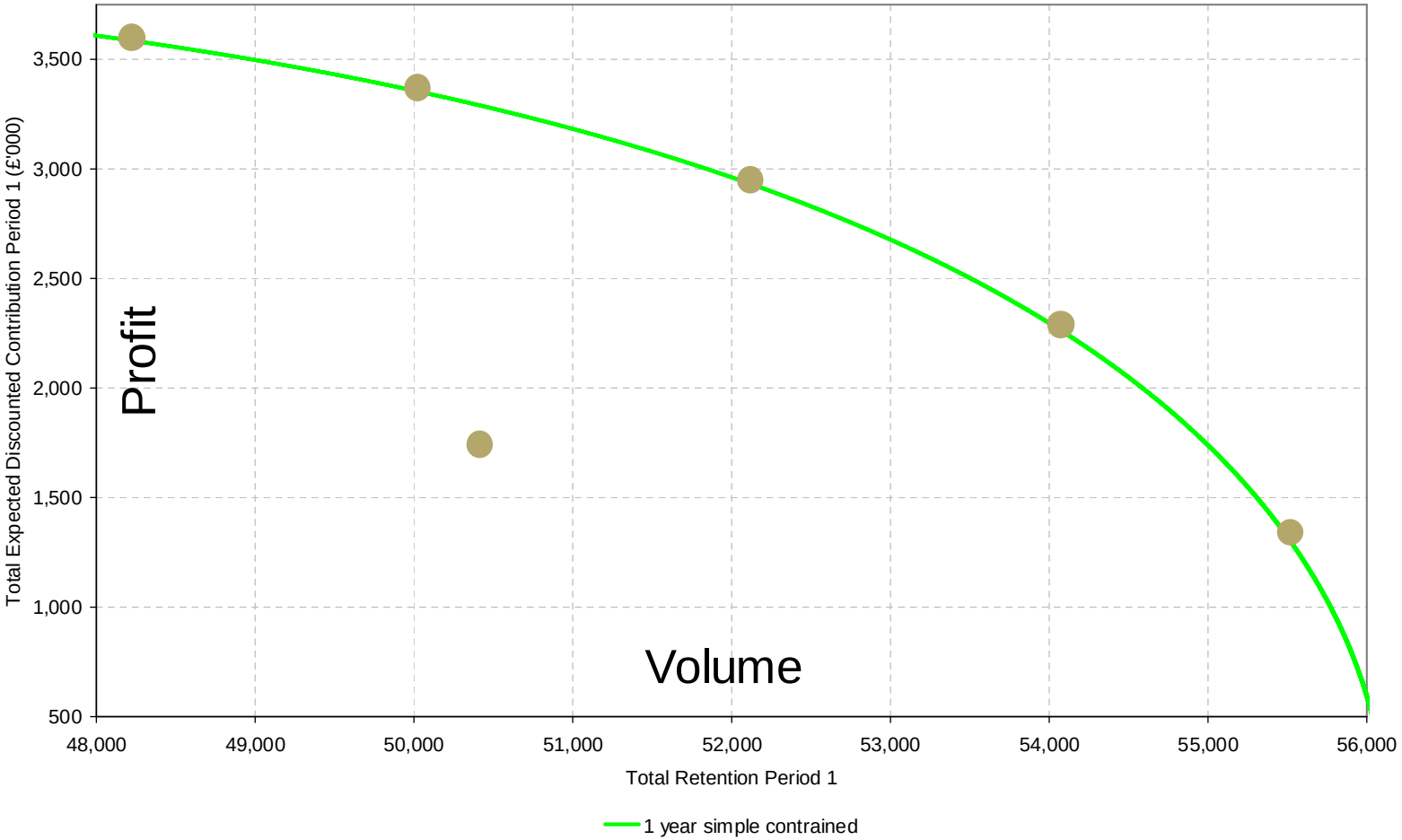
- Can optimize
  - profit for a particular volume, or
  - volume for a particular profit

  over a defined time horizon
- Maximise (Profit + λ . Volume)
- Try different values of λ to understand different balances available
- Generates efficient frontier which aids understanding of target selection

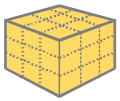
One year efficient frontier



One year efficient frontier



Four options for optimization



Traditional ratebook structure

Base $445									
Age		Vehicle		Area		Etc	Etc
16	1.89	1	0.56	1	0.46	…	…
17	1.78	2	0.68	2	0.58		
18	1.65	3	0.82	3	0.72		
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26	1.04	11	1.34	11	1.33		
27	1.03	12	1.43	12	1.49		
…		…		…			

Individual optimized prices

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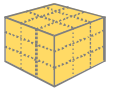
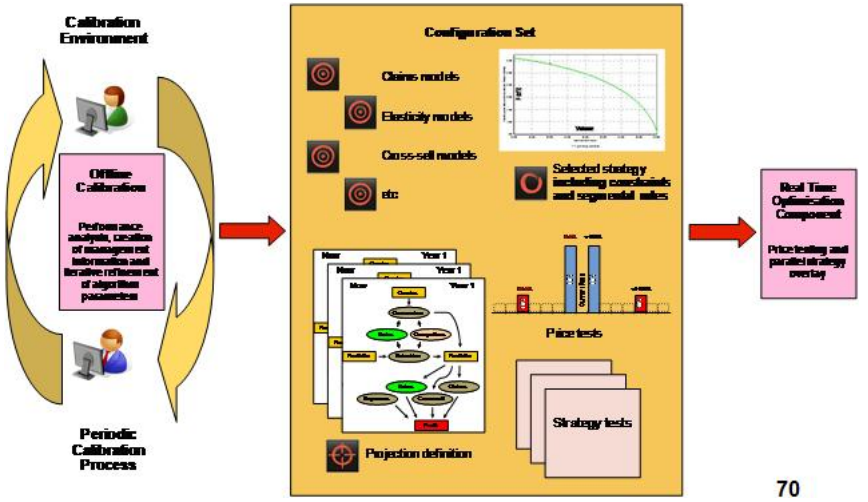
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

Fit model to results to yield traditional rating structure

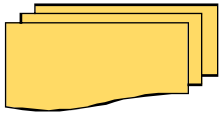
Model



Traditional ratebook structure



Re-expressing in ratebook form



Individual optimized prices

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XTB008693907	175
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XUS991829954	633
IVN822320056	641
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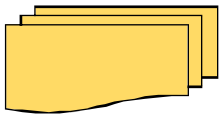
Re-expressing in ratebook form



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KZH964999642	261
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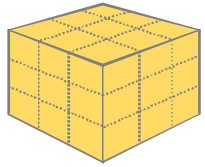
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

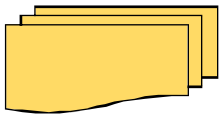
Can fit GLM to results to yield multiplicative structure using standard rating factors

GLM



Multiplicative structure

Re-expressing in ratebook form



Individual optimized Prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
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XUS991829954	633
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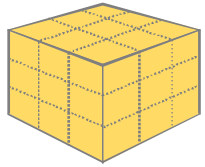
FOD690200573	232
DCI071346826	325
SEL511154881	538

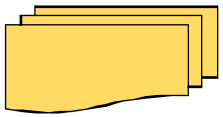
Can fit GLM to results to yield multiplicative structure using standard rating factors **plus alternative factors**

GLM



Multiplicative structure with extra factors

Re-expressing in ratebook form



Individual optimized Prices

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YUM718736198	331
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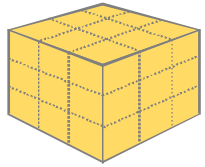
JAE716278042	163
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

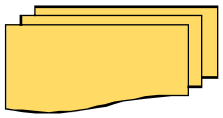
Can use moderators (caps and floors) in conjunction with multiplicative structure

Model



Multiplicative structure with moderator

Re-expressing in ratebook form



Individual optimized Prices

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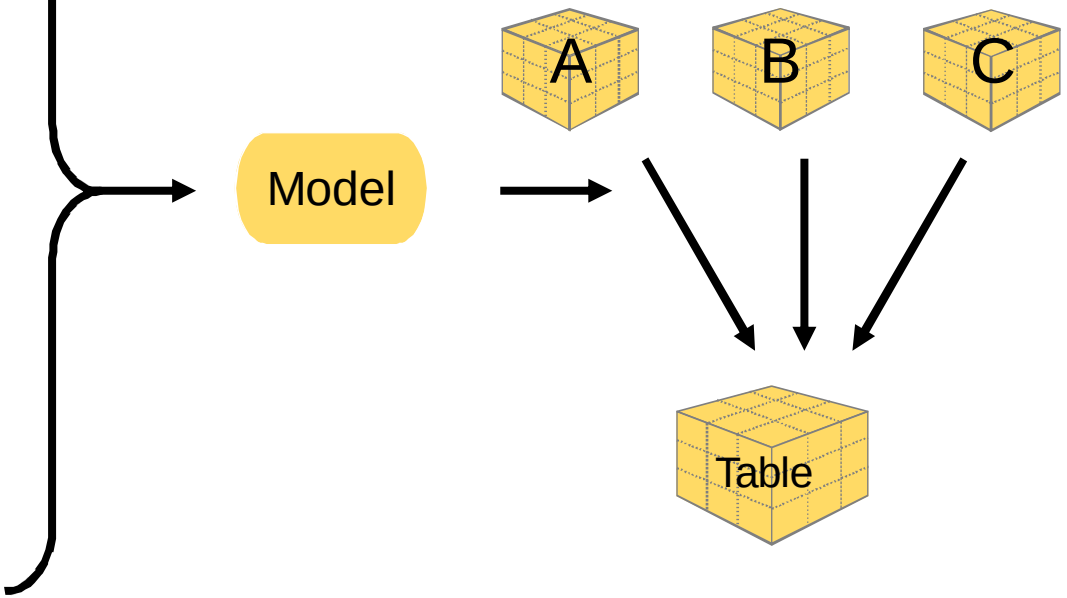
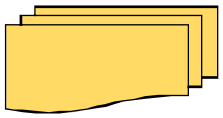
JAE716278042	163
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

Can use factors in combination, or secondary models, to derive score factors which feed into traditional table form



Re-expressing in ratebook form



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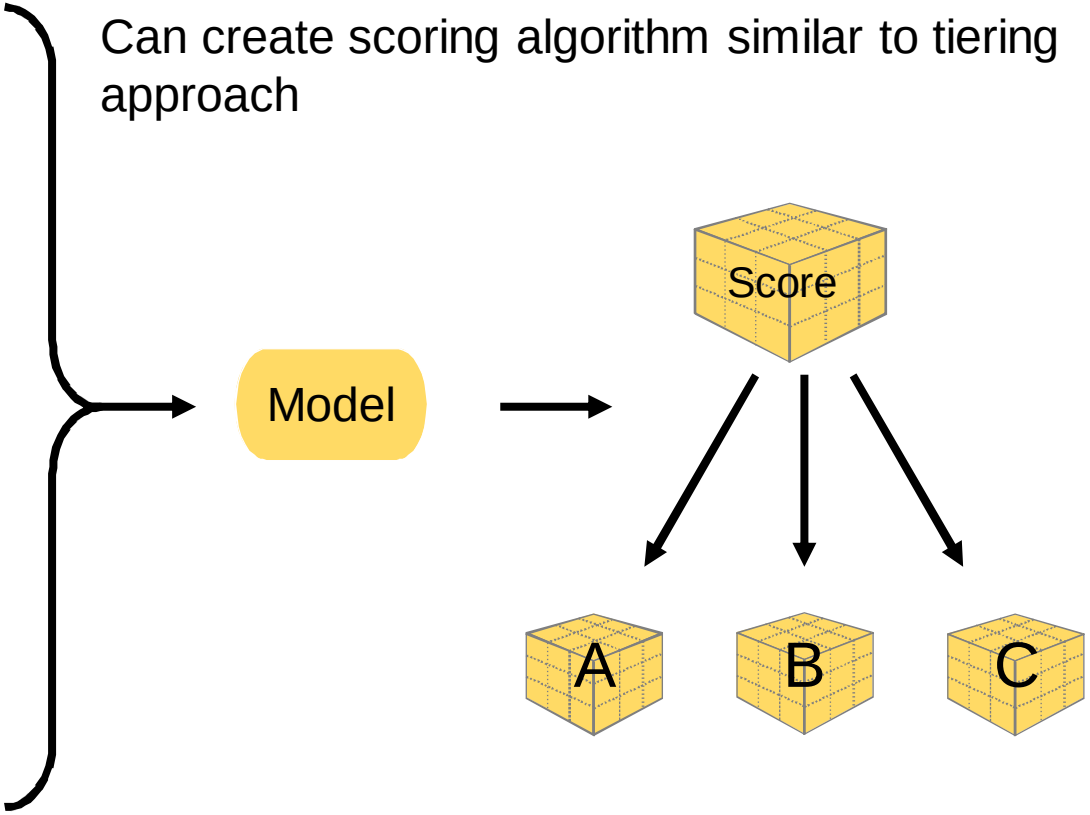
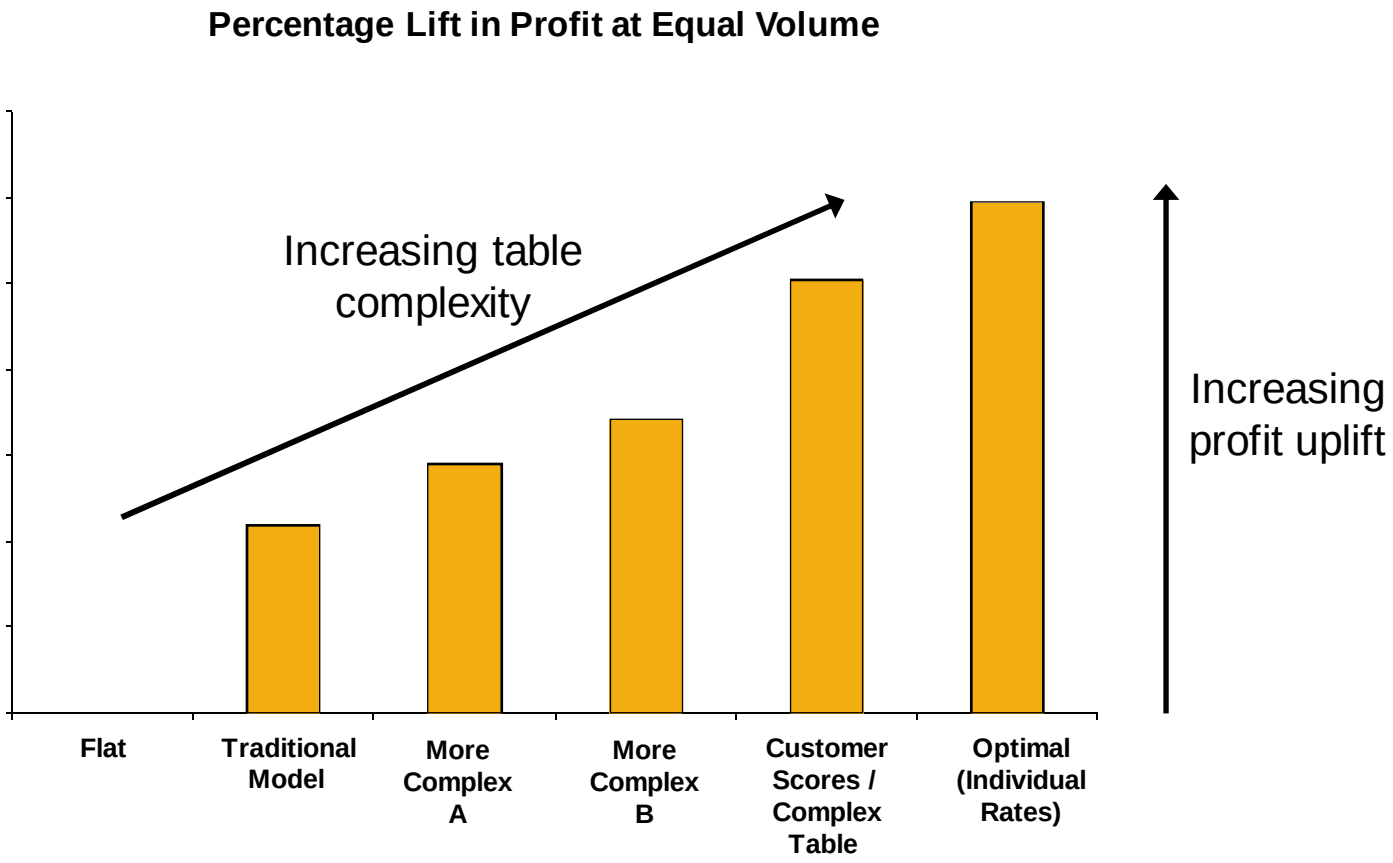
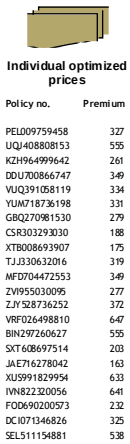
Can create scoring algorithm similar to tiering approach



Profit uplift comparison
Real example (UK motor renewals optimization)



Four options for optimization



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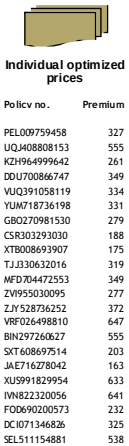
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
ZJY528736252	372
VRF026498810	647
BIN297260627	555
SXT608697514	203
JAE716278042	163
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538



Individual optimized prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
XTB008693907	175
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
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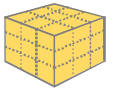
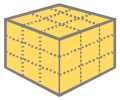
JAE716278042	163
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

Fit model to results to yield traditional rating structure



Traditional ratebook structure



Traditional ratebook structure

Base $445

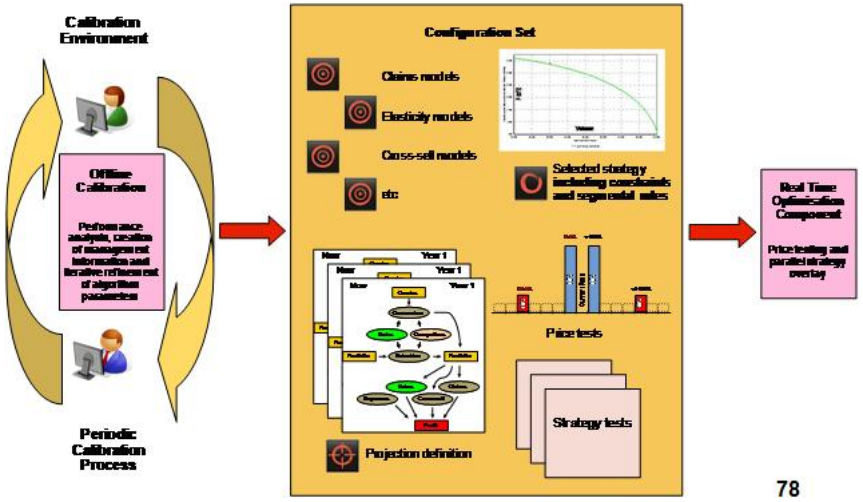
Age	
16	1.89
17	1.78
18	1.65
19	1.54
20	1.43
21	1.30
22	1.28
23	1.16
24	1.10
25	1.05
26	1.04
27	1.03
…	

Vehicle	
1	0.56
2	0.68
3	0.82
4	0.91
5	0.98
6	1.00
7	1.11
8	1.16
9	1.19
10	1.25
11	1.34
12	1.43
…	

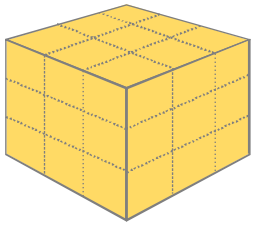
Area	
1	0.46
2	0.58
3	0.72
4	0.81
5	0.90
6	0.95
7	1.01
8	1.11
9	1.18
10	1.21
11	1.33
12	1.49
…	

Etc
…

Etc
…



3 - Direct ratebook optimization



Traditional ratebook structure

Base $445

Age	
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17	1.78
18	1.65
19	1.54
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21	1.30
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…	

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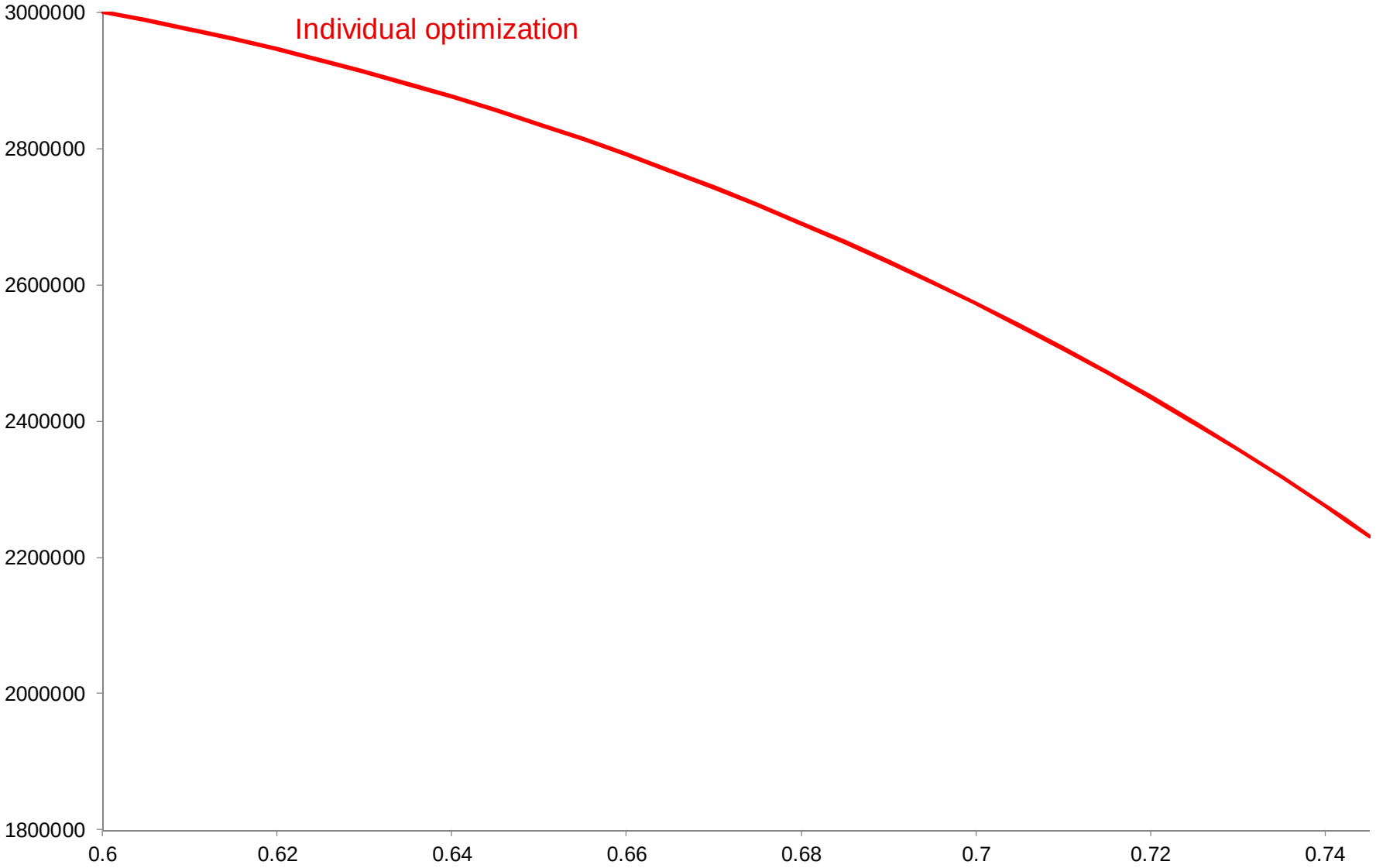
6	0.95
7	1.01
8	1.11
9	1.18
10	1.21
11	1.33
12	1.49
…	

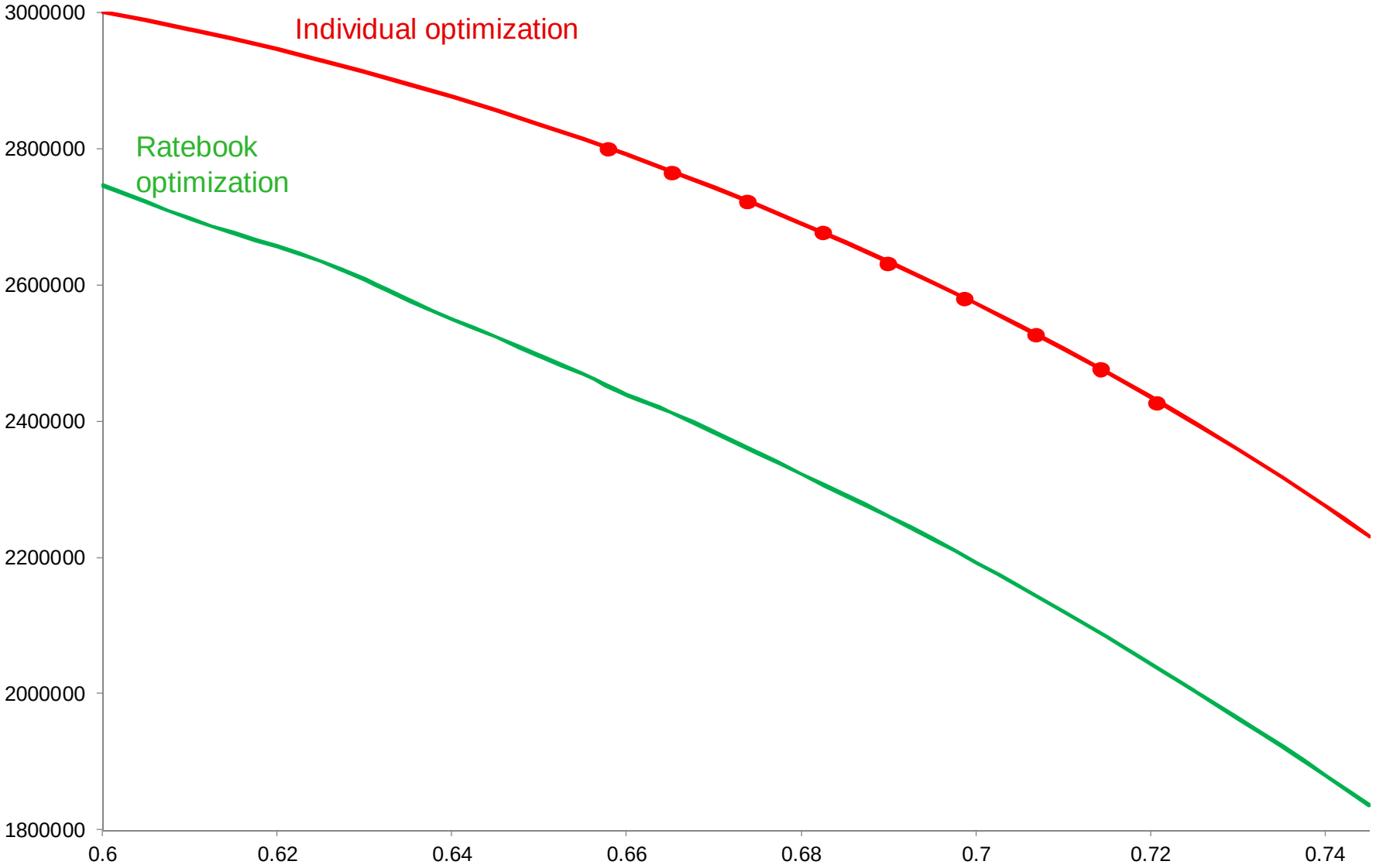
Etc.
…

Etc.
…

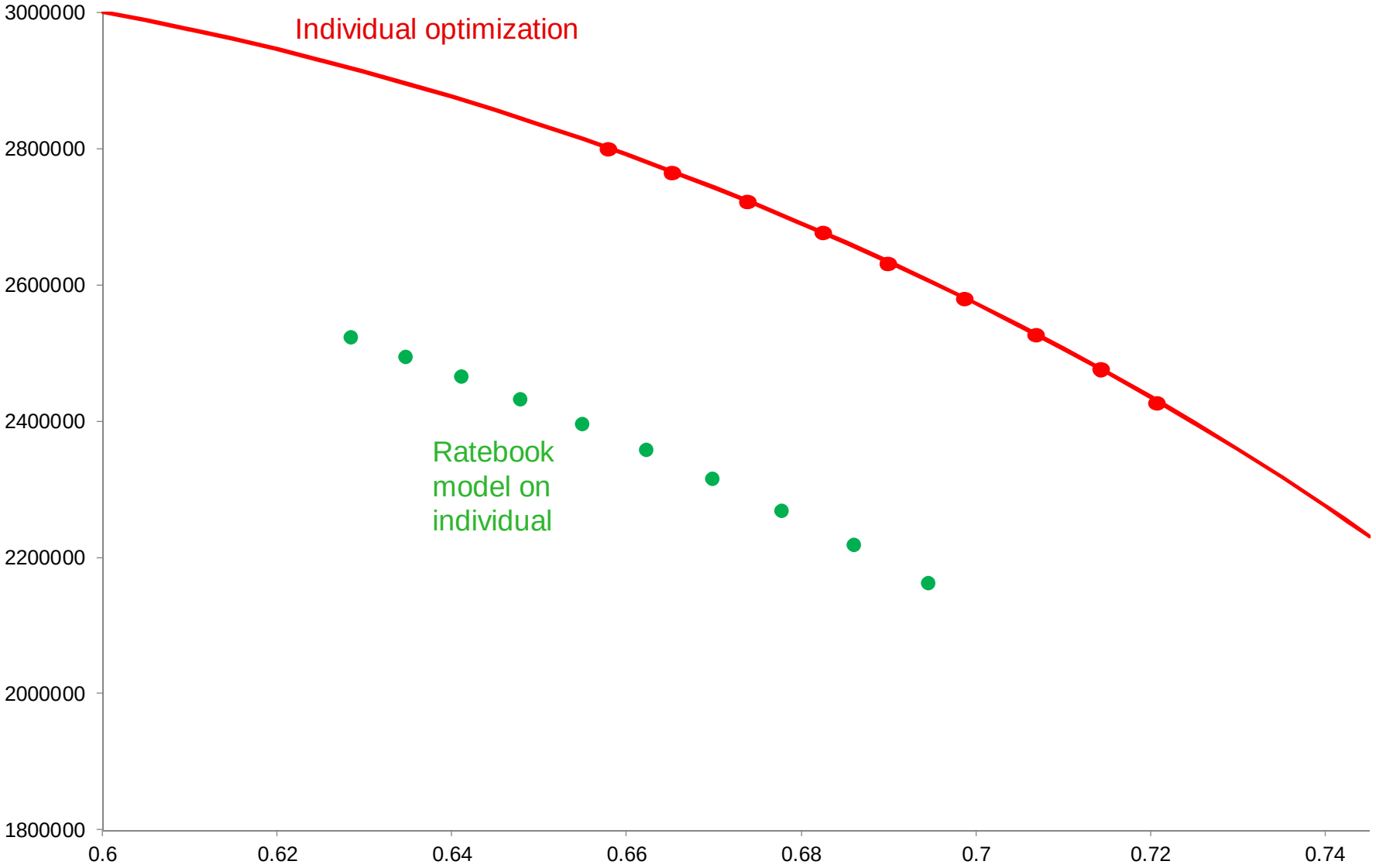
Ratebook vs individual optimization



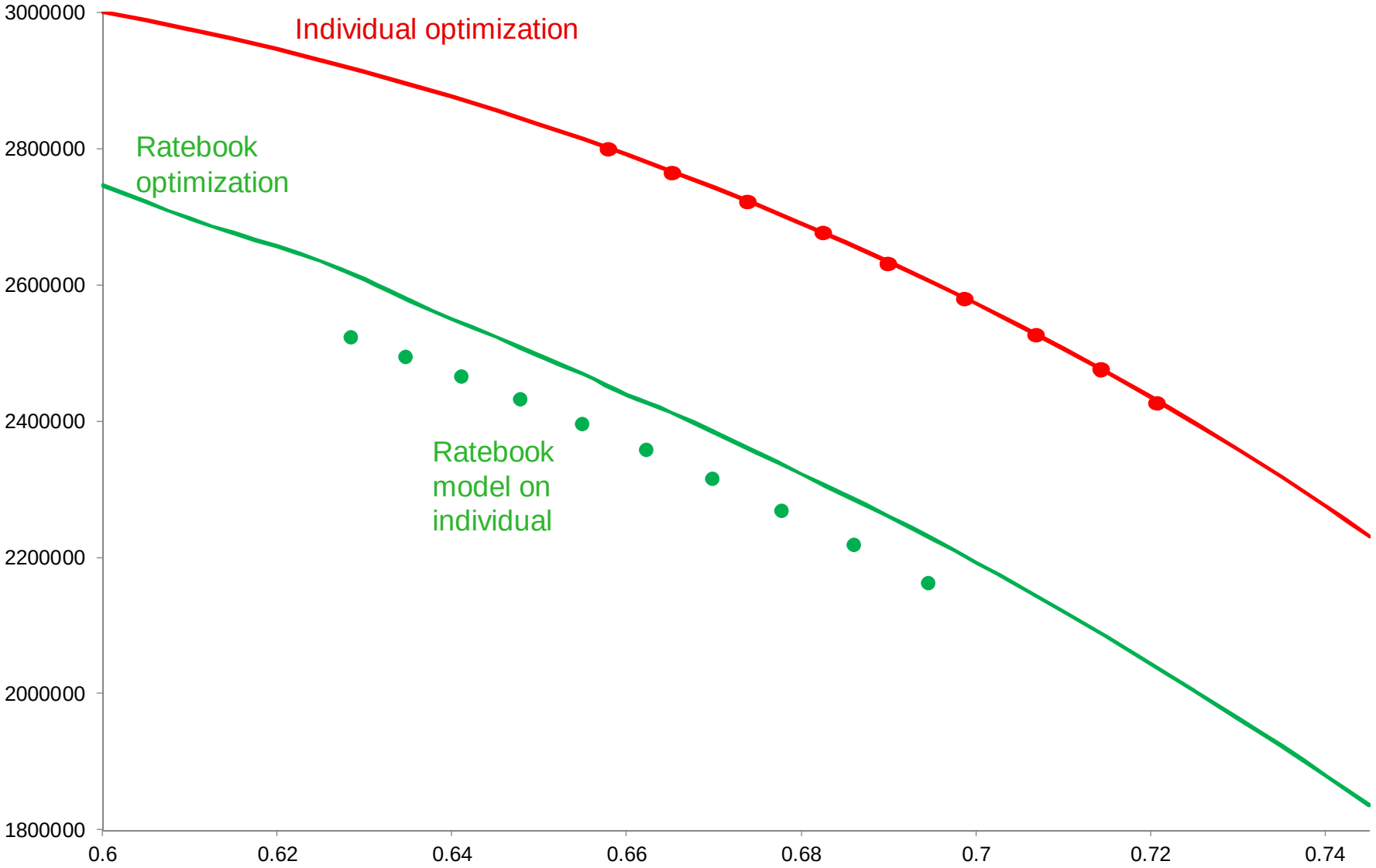
Ratebook vs individual optimization



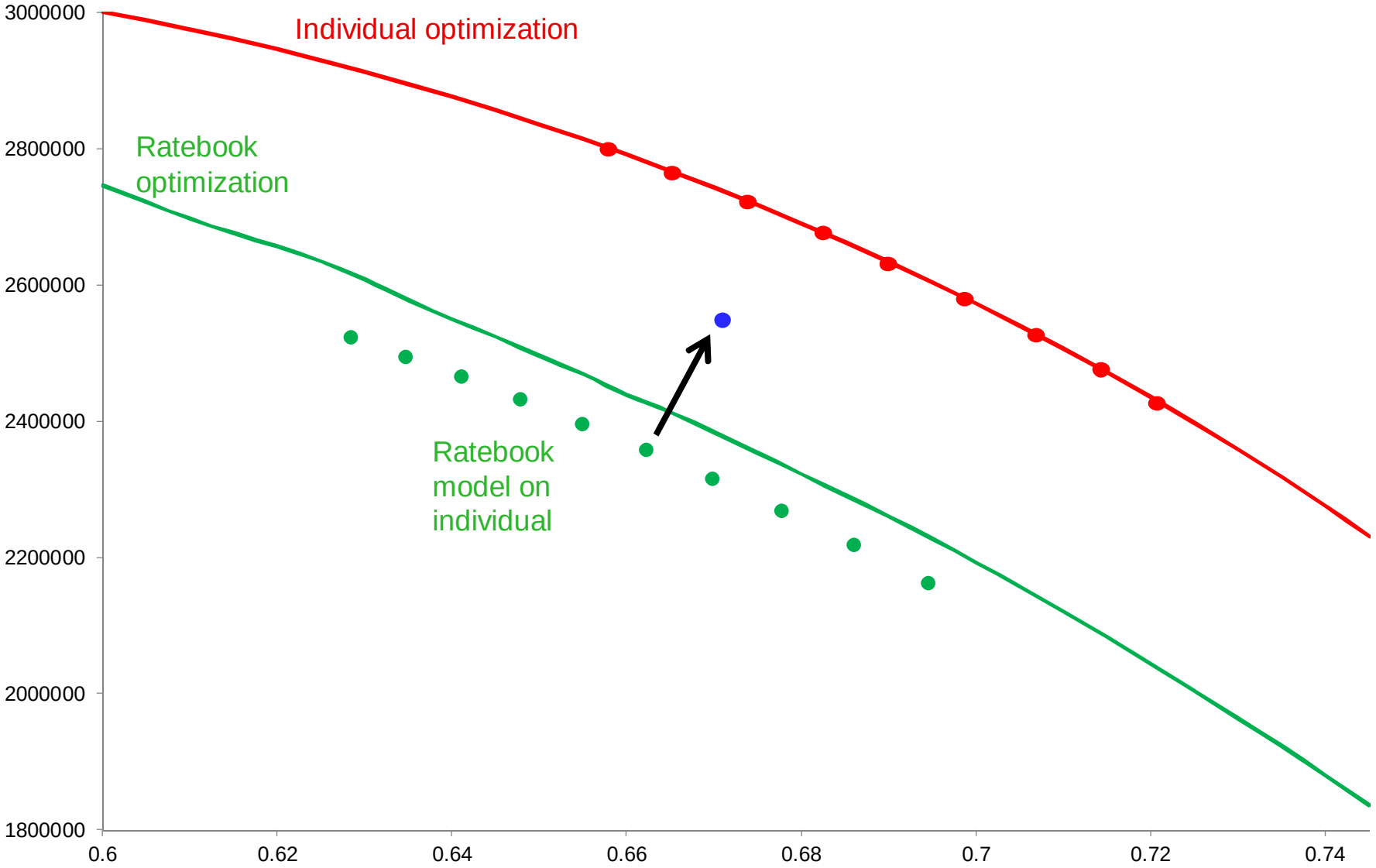
Ratebook vs individual optimization



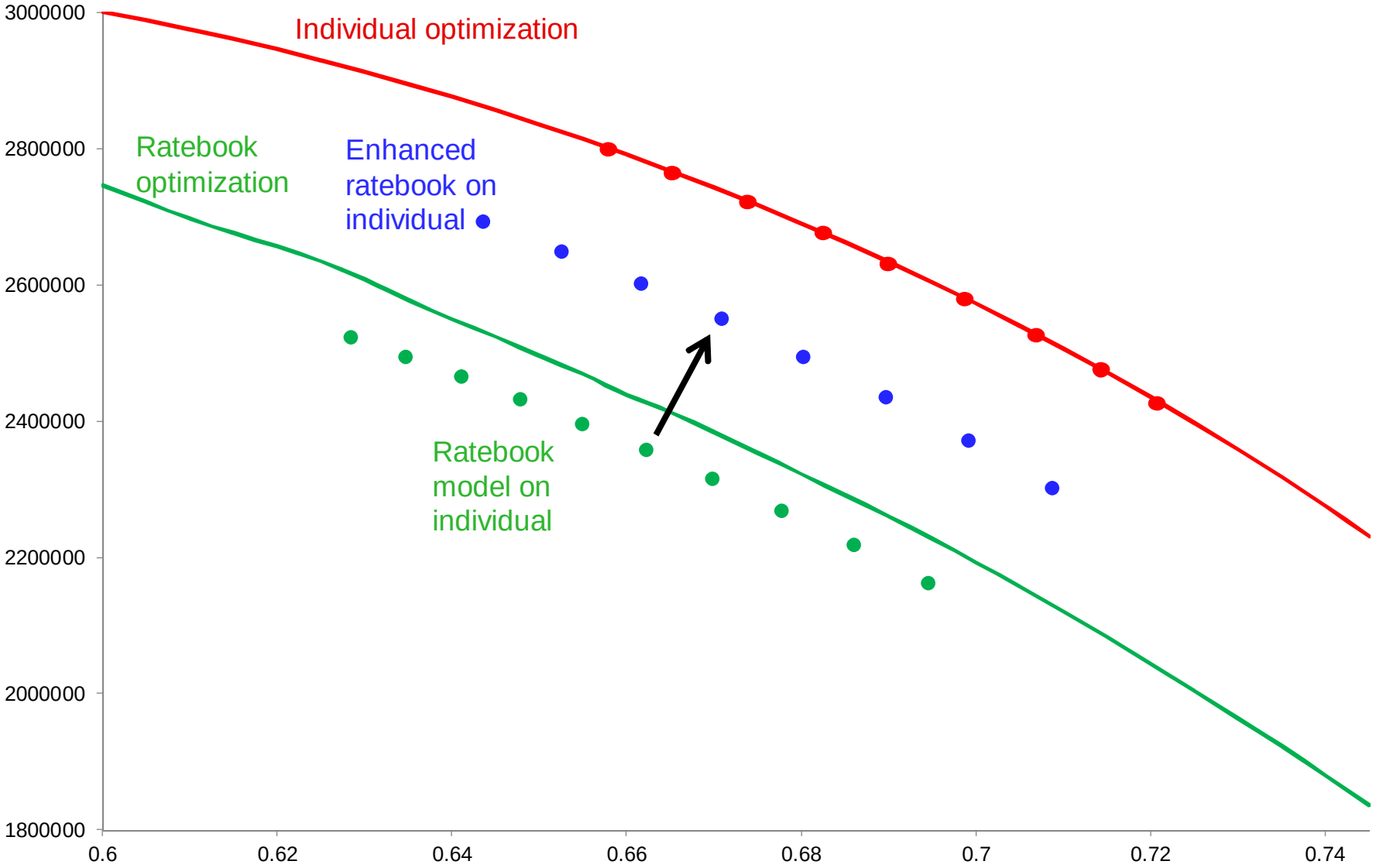
Ratebook vs individual optimization



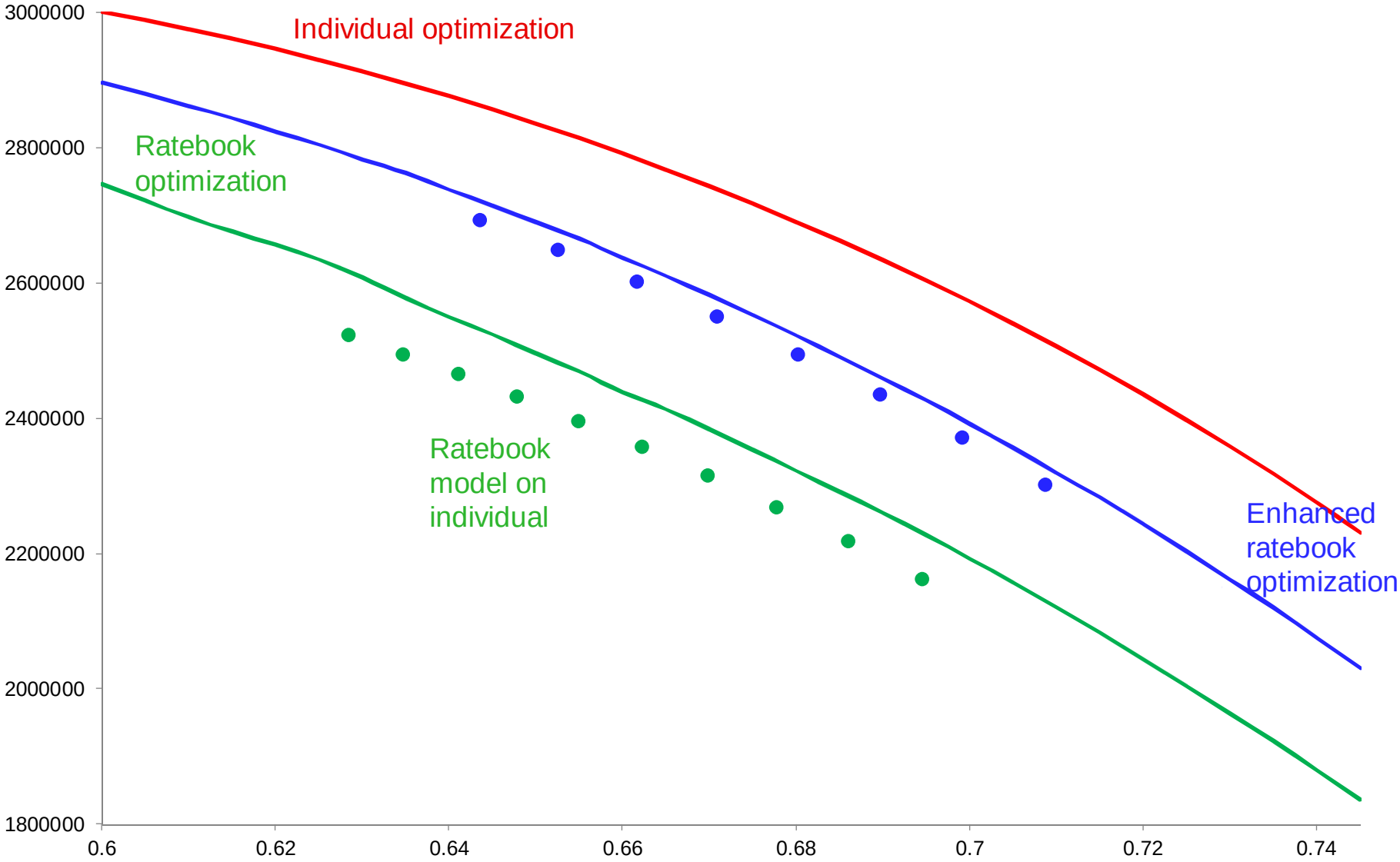
Ratebook vs individual optimization



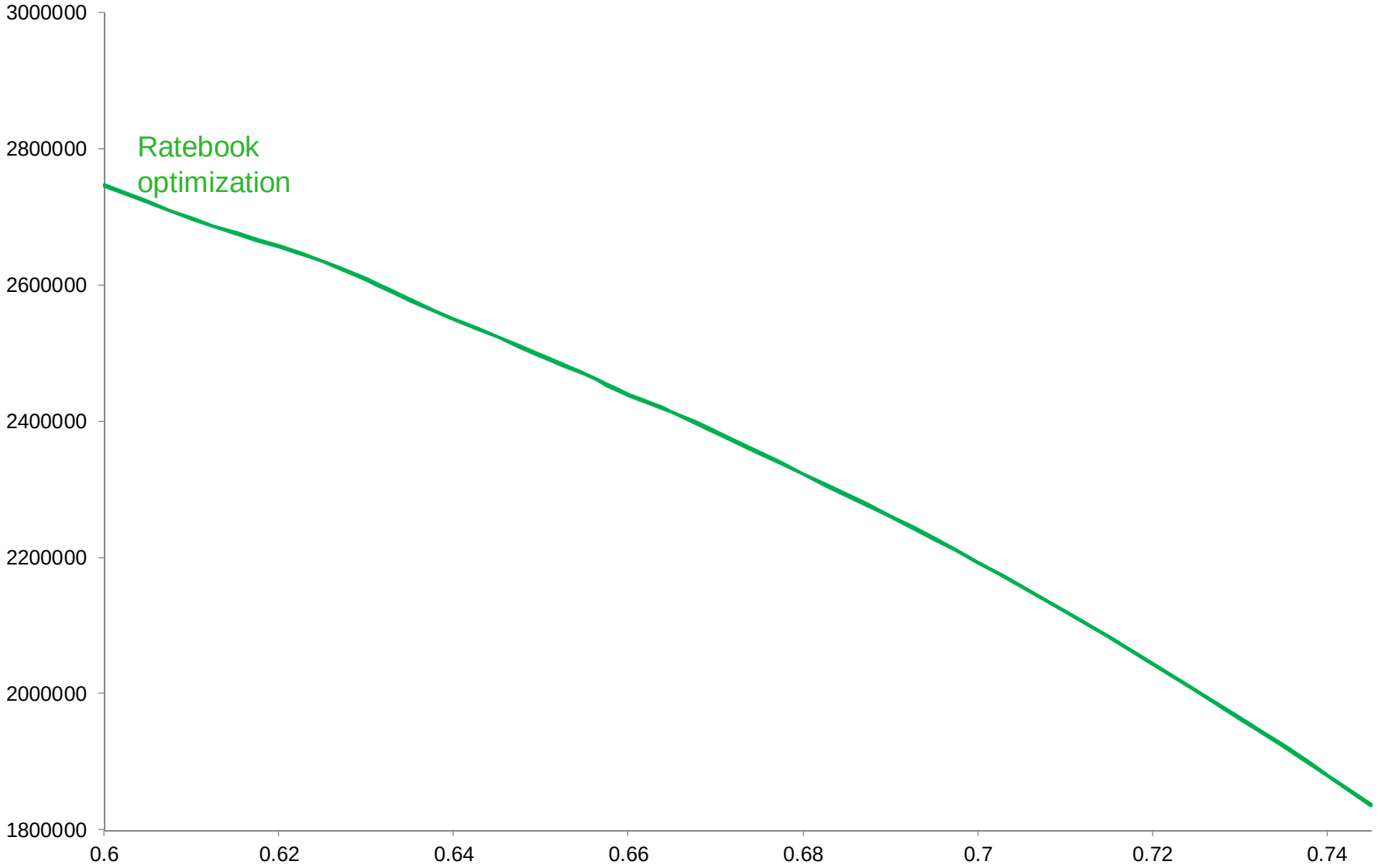
Ratebook vs individual optimization



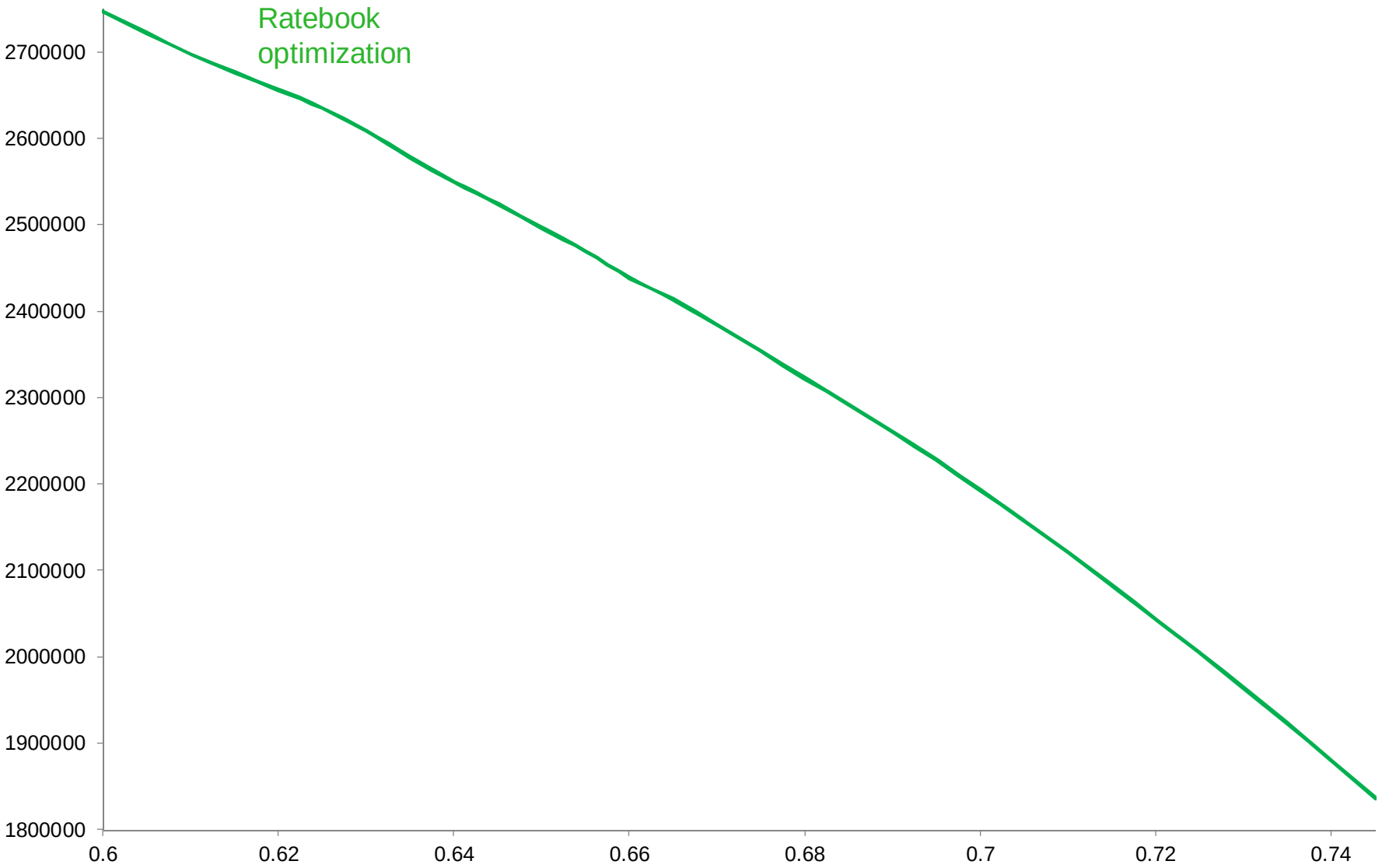
Ratebook vs individual optimization



Ratebook vs individual optimization



Ratebook vs individual optimization

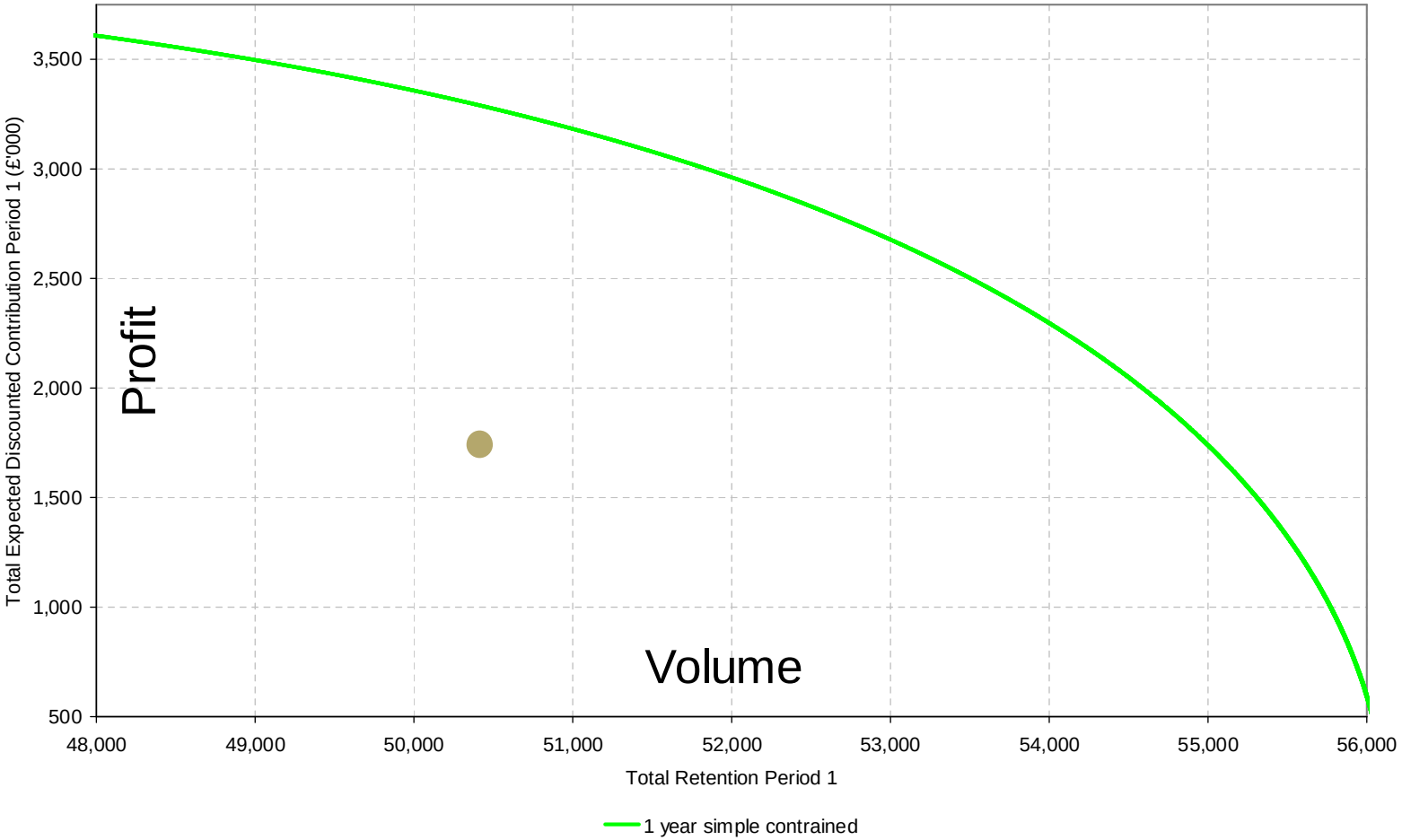


Ratebook optimization vs. Individual optimization

	Pros	Cons
Individual Optimization	• Entire universe of achievable outcomes is identified • Active modeling offers flexibility	• Reverse-engineering process can be hard to automate • Output ratebook is one of many possibilities
Ratebook Optimization	• Process is smoother, quick and convenient	• Constrained by chosen structure • Not all structures qualify

- Individual optimization shows target frontier
- Modelling individual optimization gets enhanced rating structure form more quickly

Time horizons



Time horizons

Advantages

More certain short-term profitability

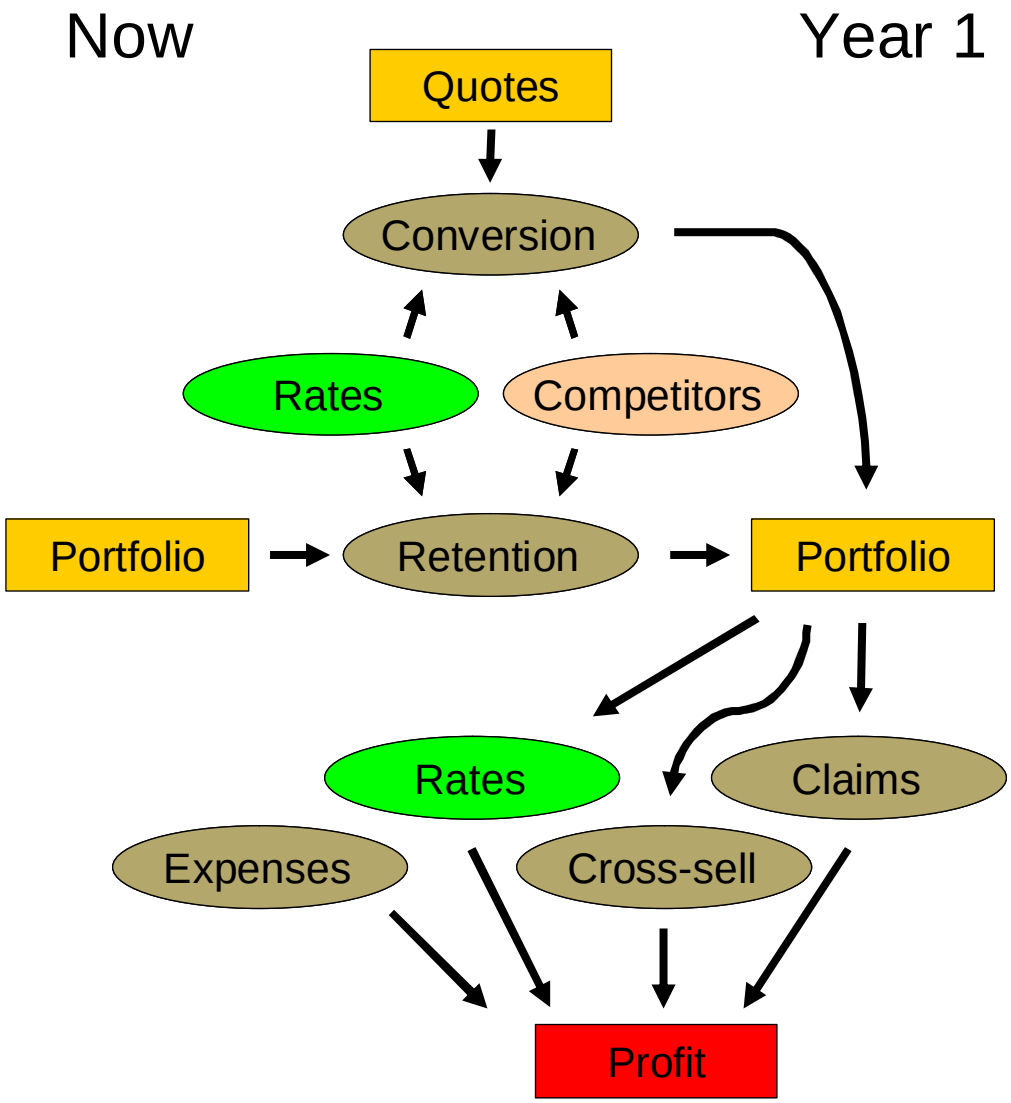
Protects long-standing customers

Disadvantages

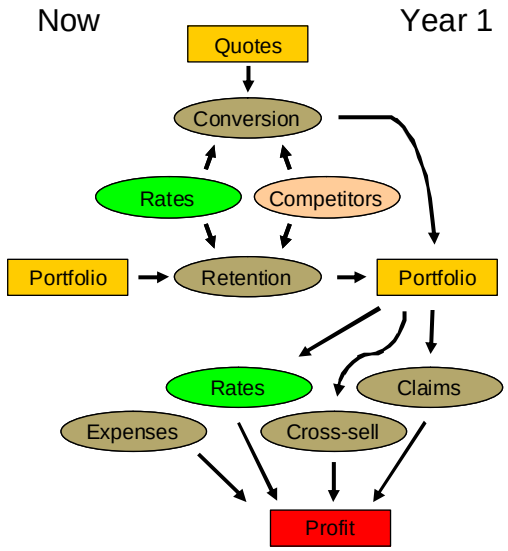
"Milks" the most inelastic customers leads to a reducing quality portfolio

Profits anticipated in future years may be "illusory" (predicting future market prices?)

Projection


Now
Year 1
Quotes
Conversion
Rates
Competitors
Portfolio
Retention
Portfolio
Rates
Claims
Expenses
Cross-sell
Profit

Projection


Now
Year 1
Quotes
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Competitors
Portfolio
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Portfolio
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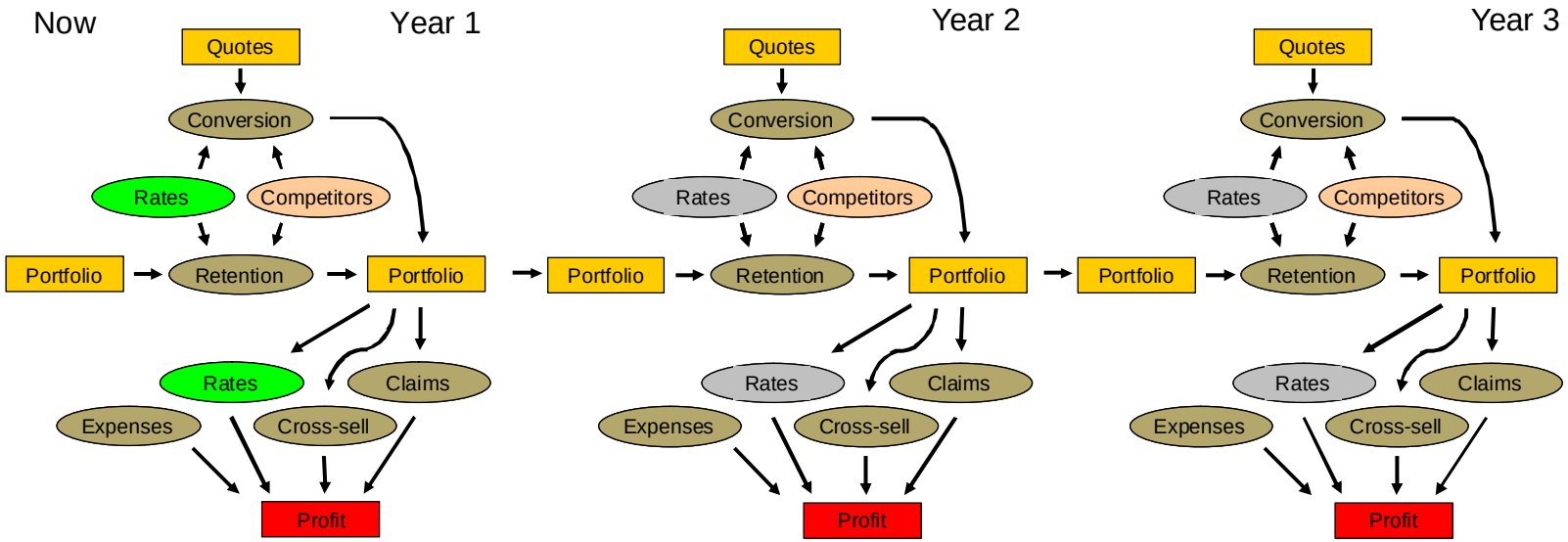
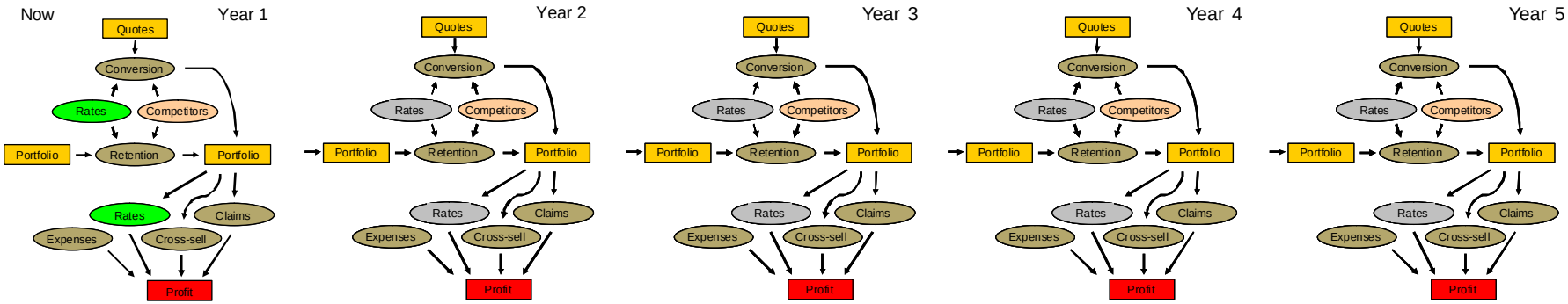
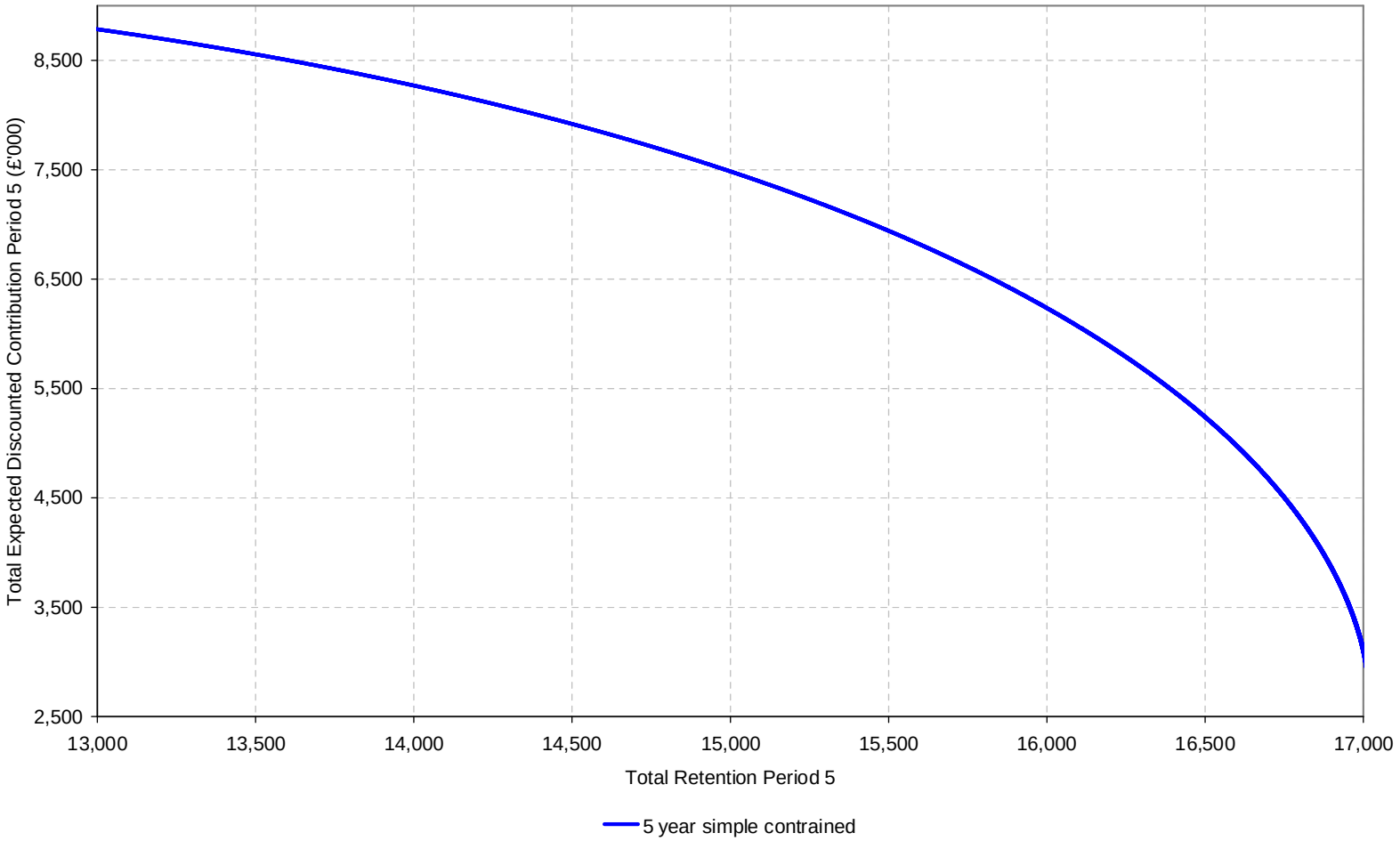
Projection


Now
Year 1
Year 2
Year 3
Quotes
Conversion
Rates
Competitors
Portfolio
Retention
Portfolio
Rates
Claims
Expenses
Cross-sell
Profit

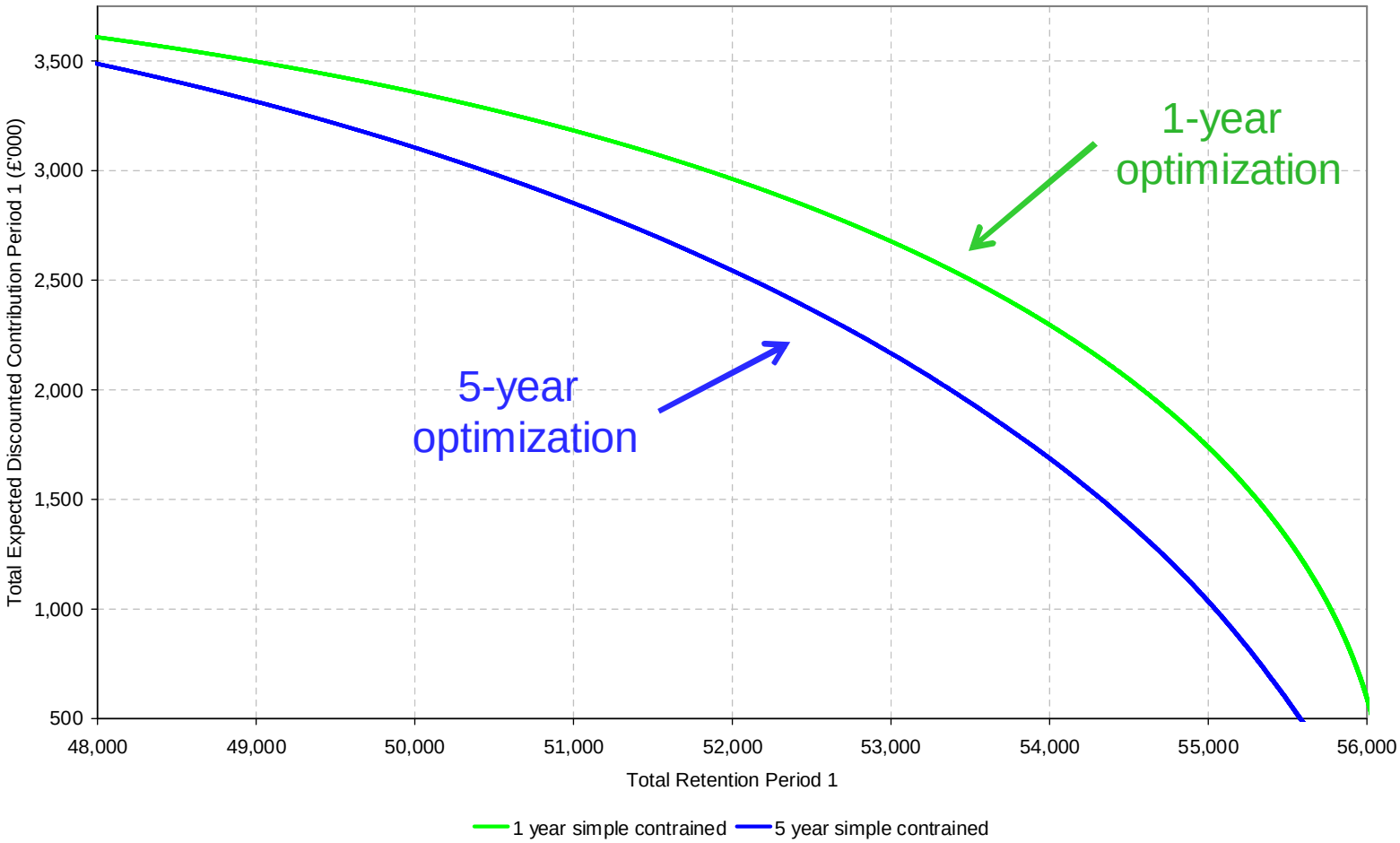
Projection


Now
Year 1
Year 2
Year 3
Year 4
Year 5
Quotes
Conversion
Rates
Competitors
Portfolio
Retention
Portfolio
Rates
Claims
Expenses
Cross-sell
Profit

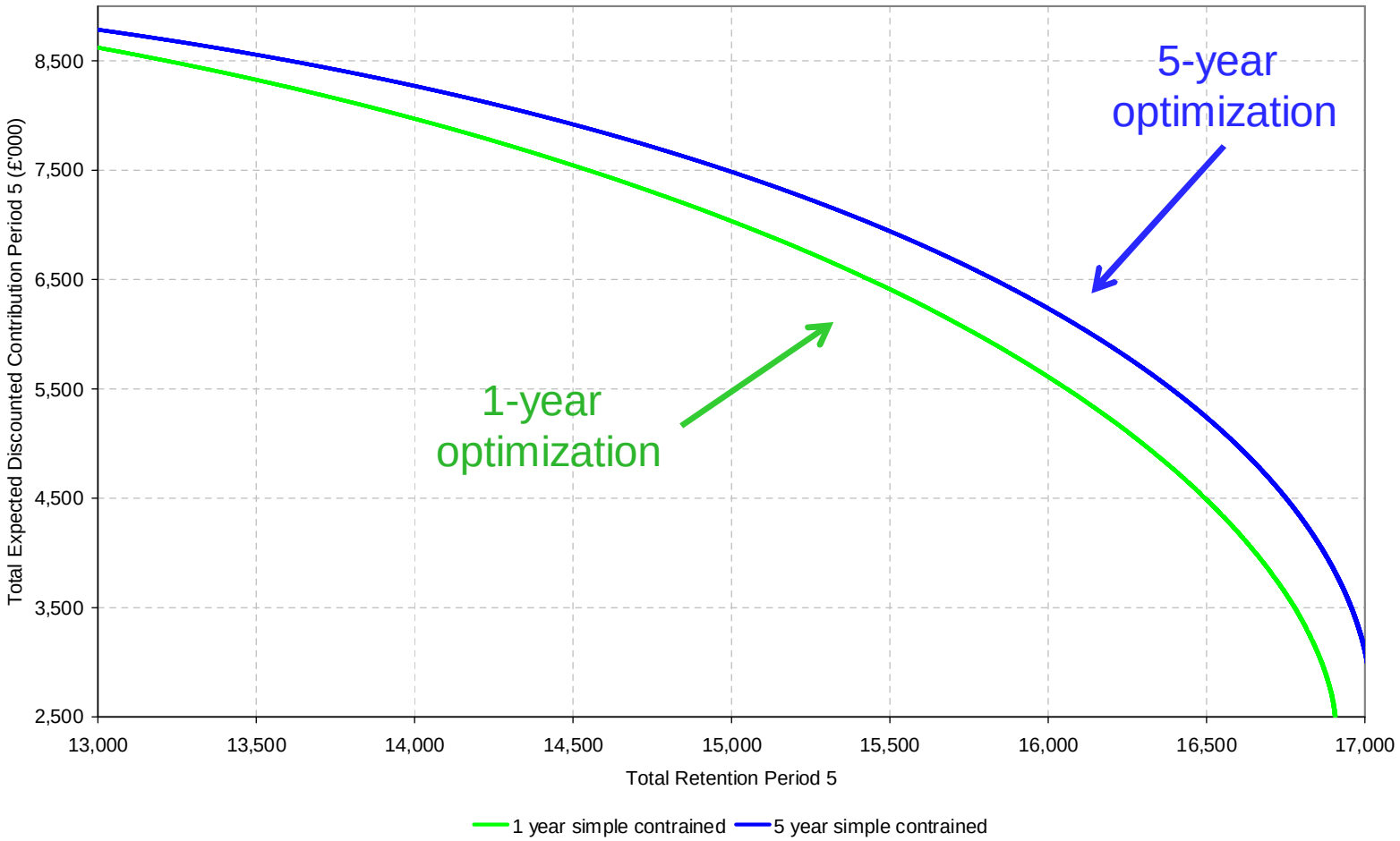
Five year efficient frontier



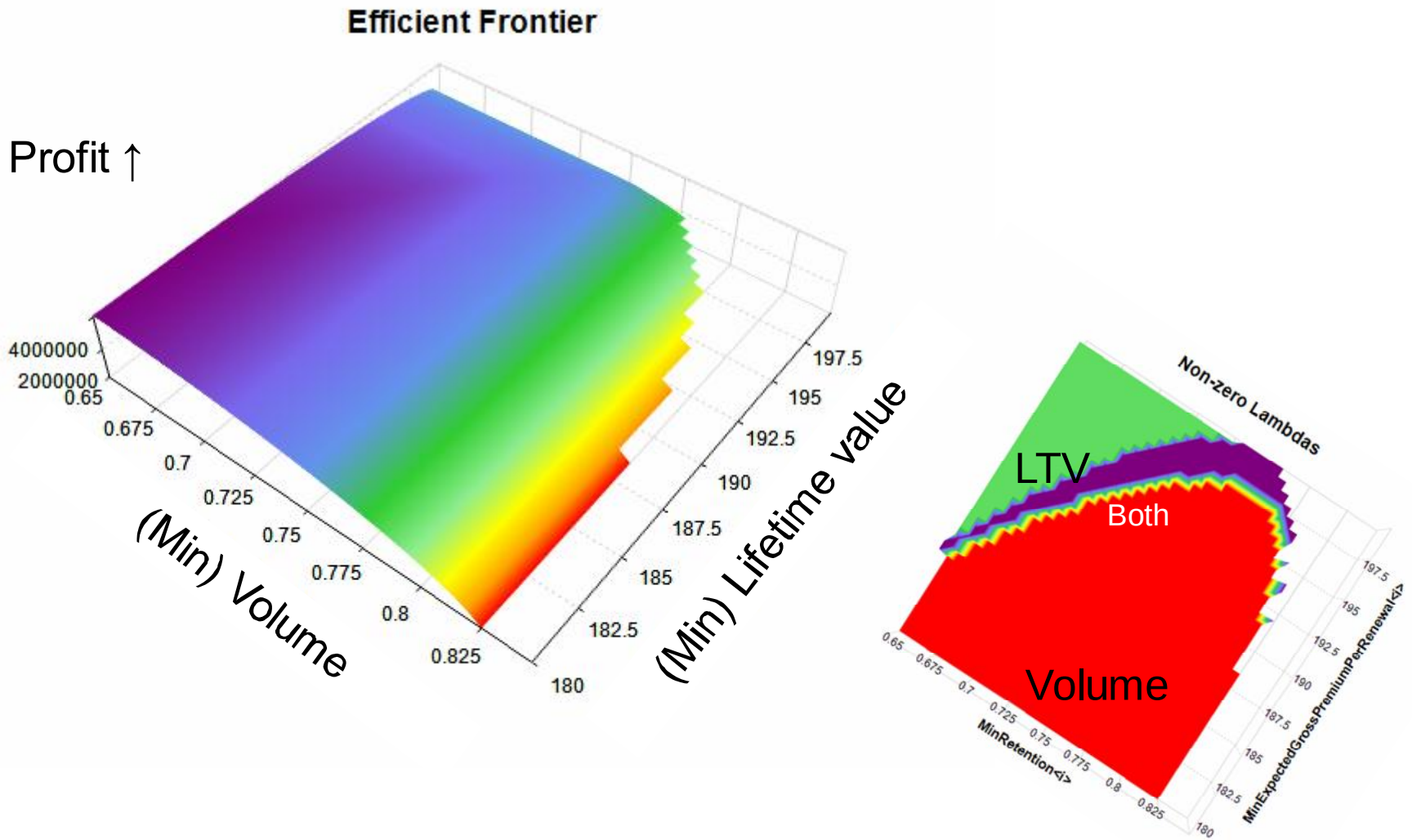
One year efficient frontier



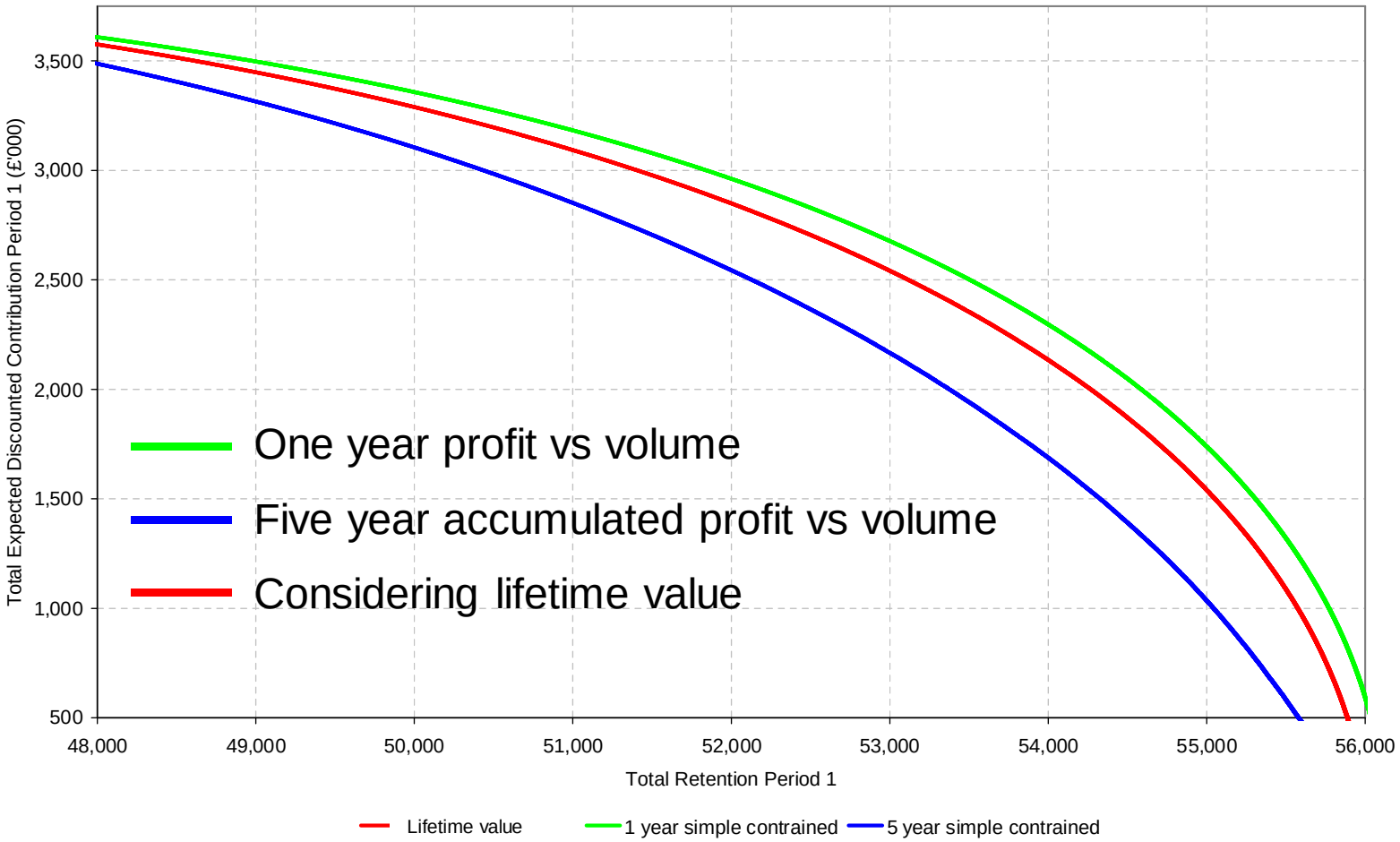
Five year efficient frontier



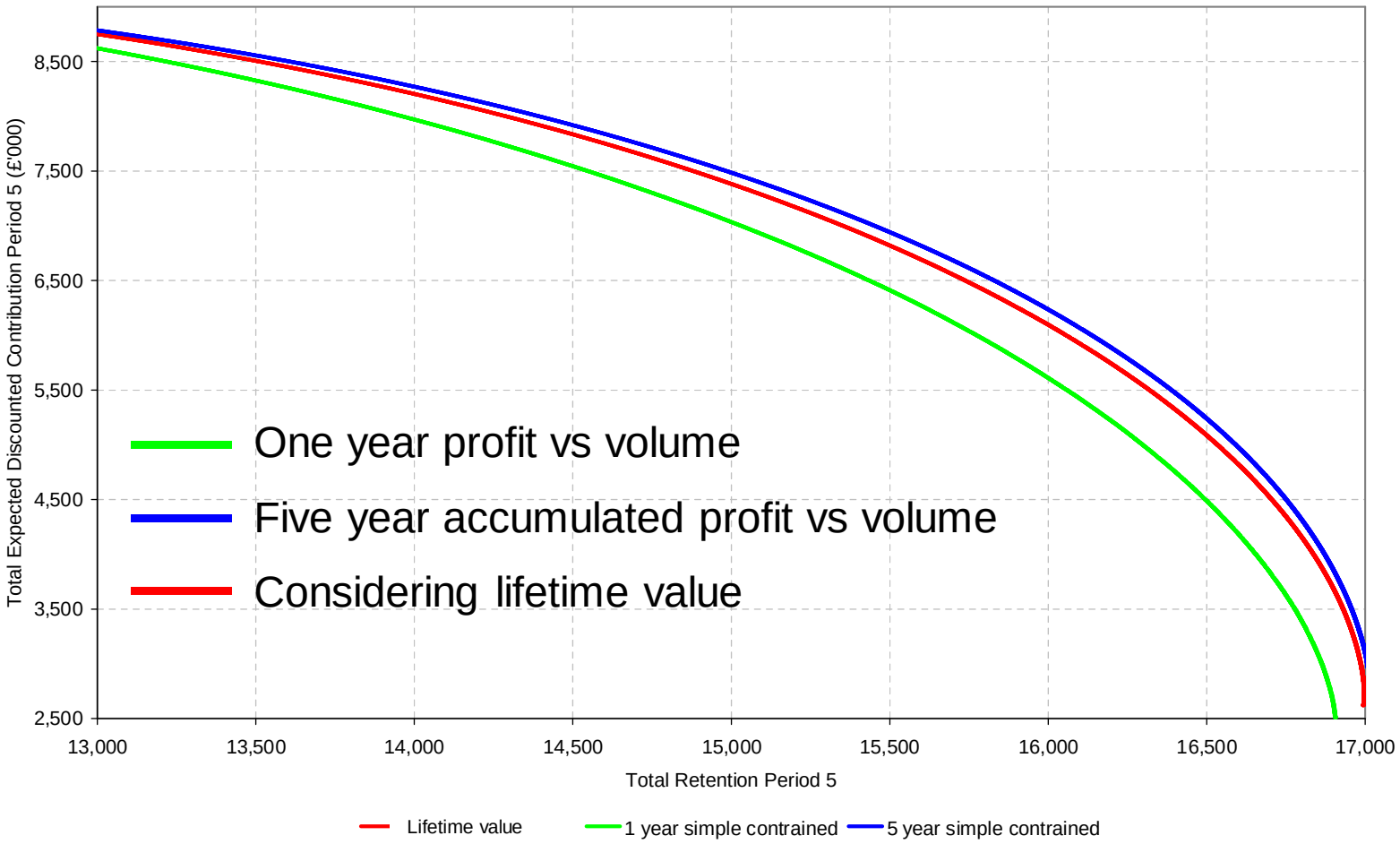
Multidimensional Optimization



One year efficient frontier



Five year efficient frontier

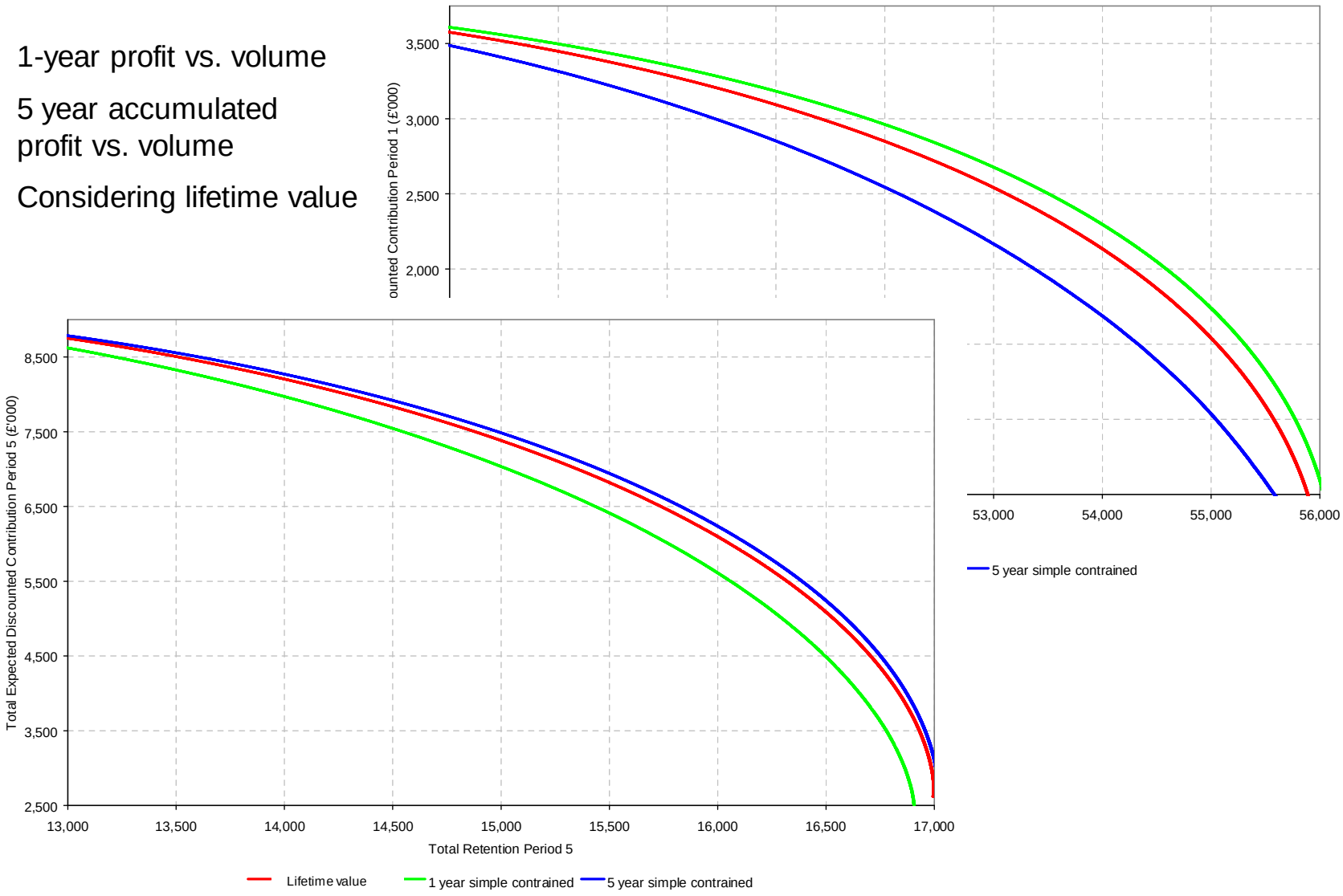


Almost the best of both worlds

1-year profit vs. volume

5 year accumulated profit vs. volume

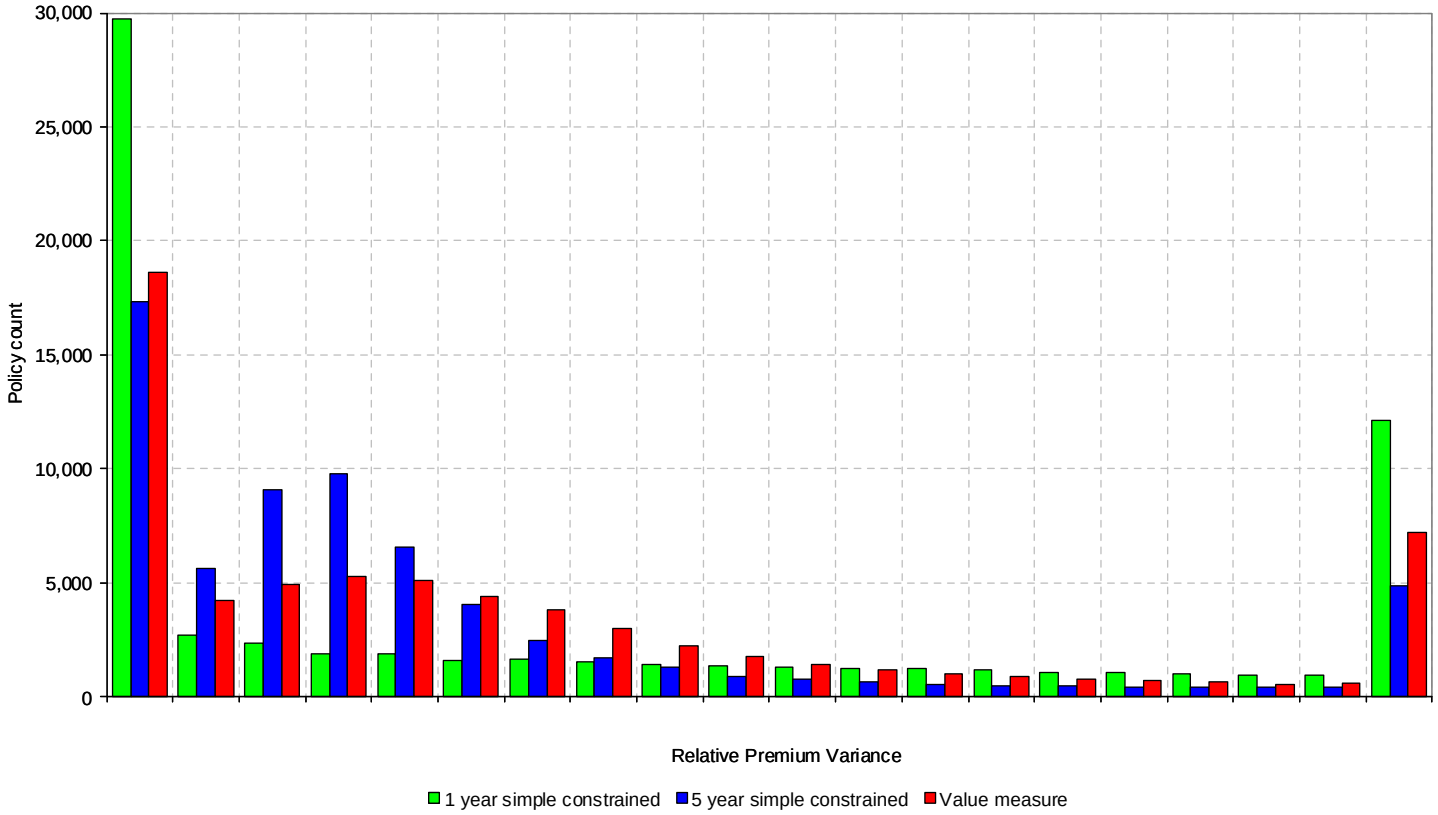
Considering lifetime value



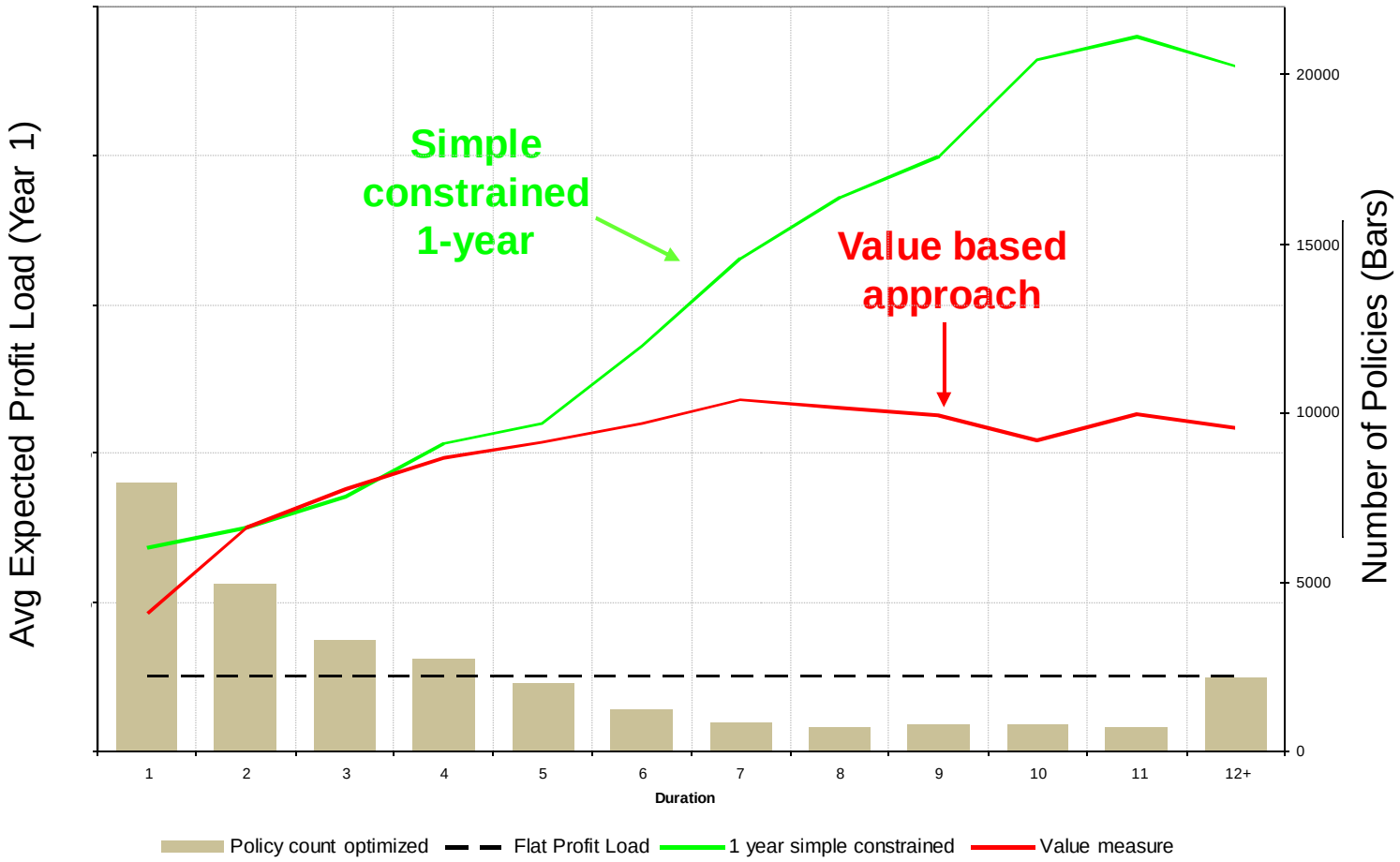
Value based approach - premium variances

Value based approach avoids concentration of profit loads at extreme values which…

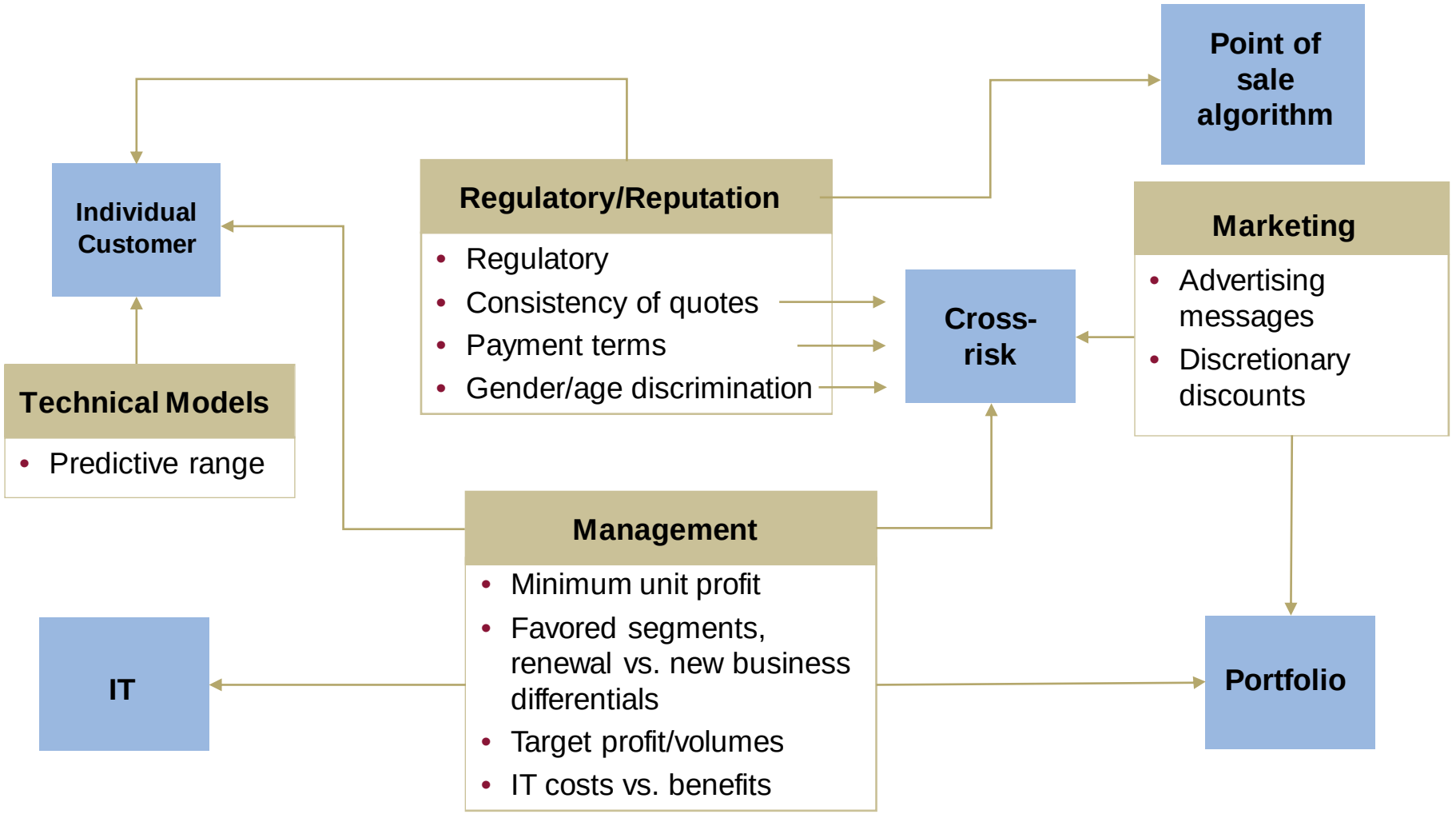
- Extracts large profits from a small customer group
- Maximizes degree of price differentiation
- Relies on predictive accuracy of models at their extremes



Value based approach - premium variances by tenure



Constraints



Example marketing messages constraints

Discount for Combined Cover

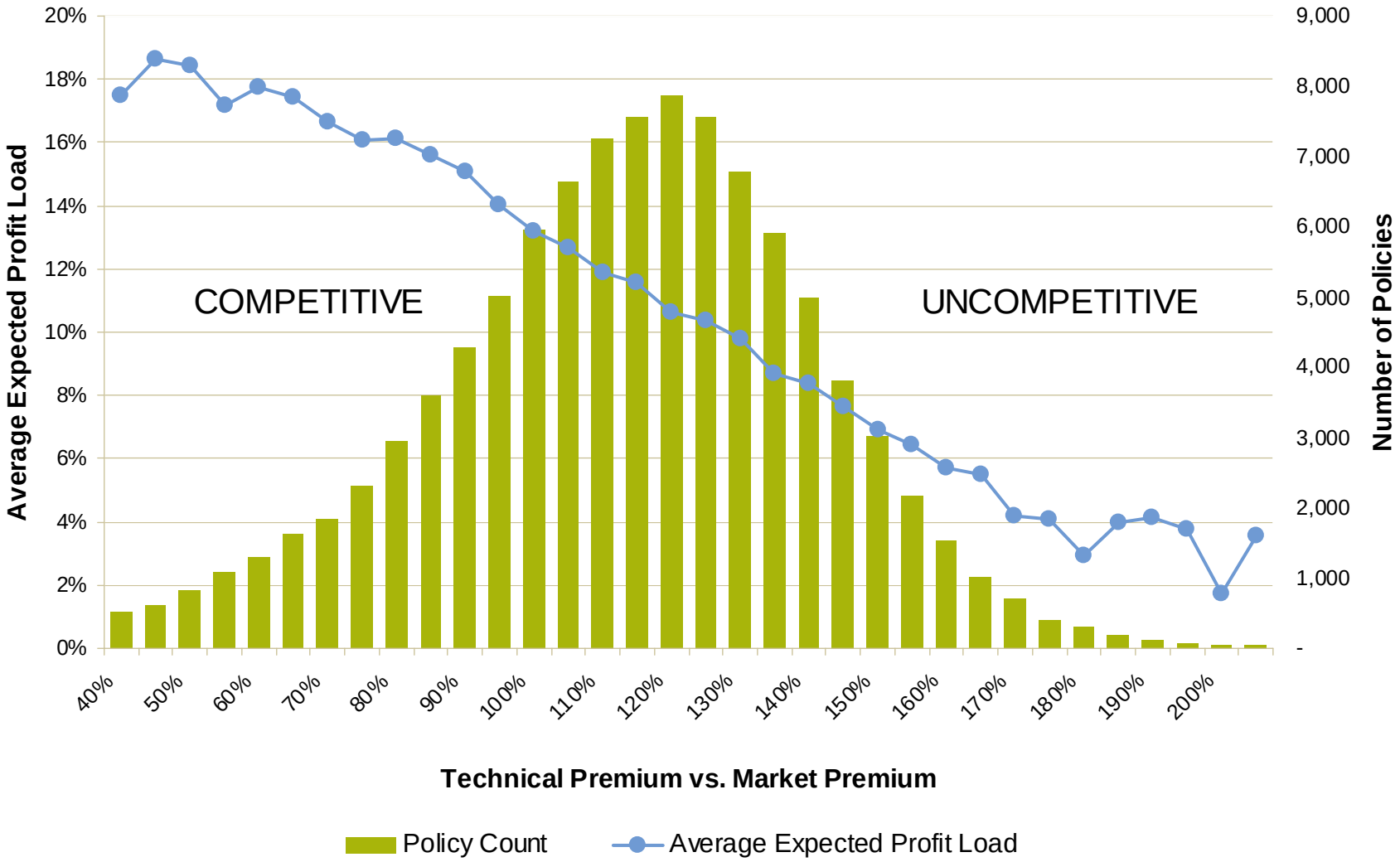
(Actual results cannot be disclosed in handouts)

Example marketing messages constraints

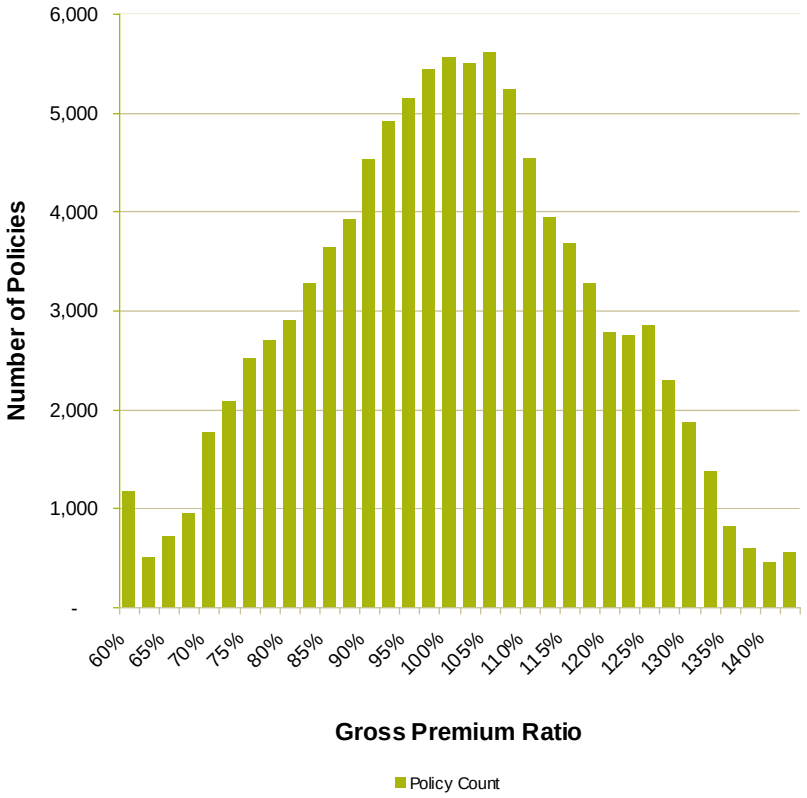
‘Buy Buildings, Get Contents Half Price’

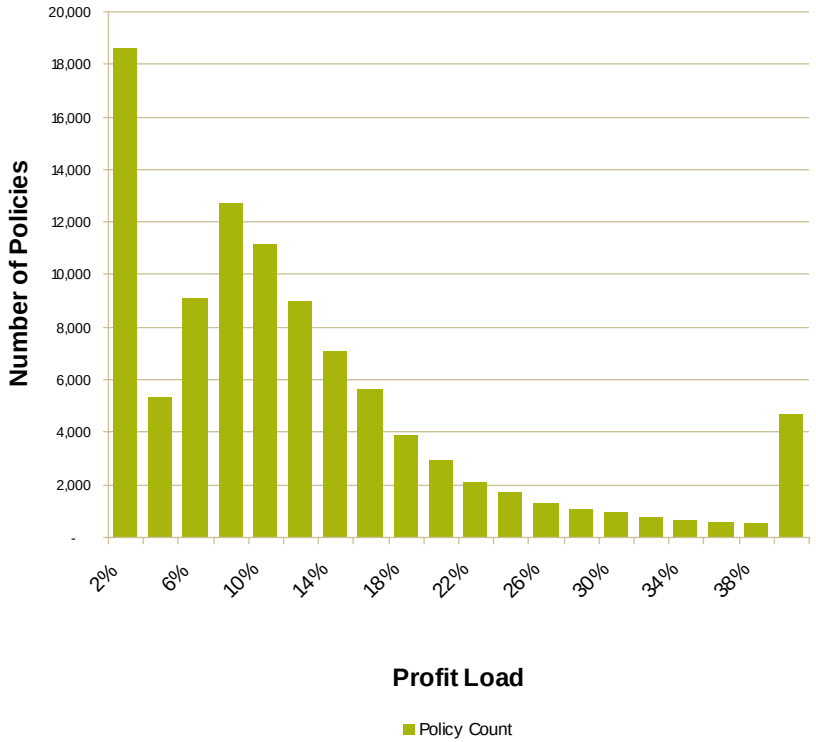
(Actual results cannot be disclosed in handouts)

Example diagnostics



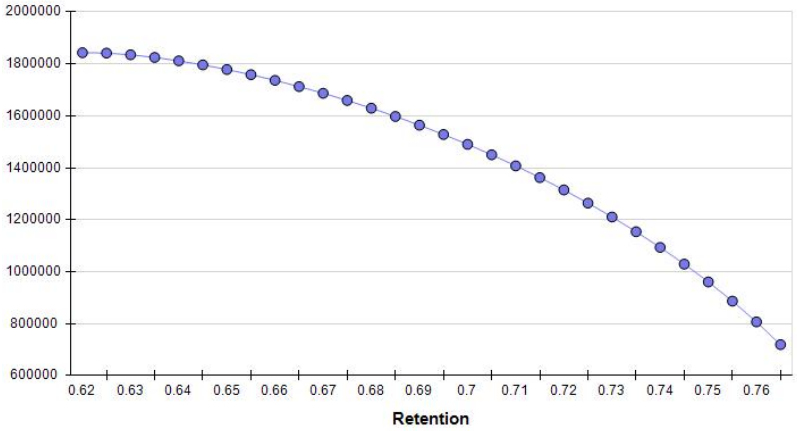
Example diagnostics

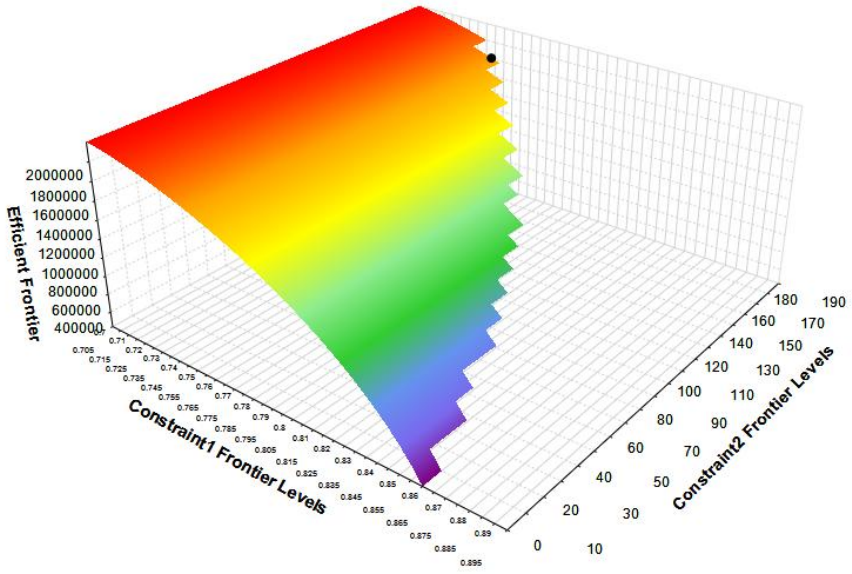




Advanced uses — Multiple constraints and alternative metrics

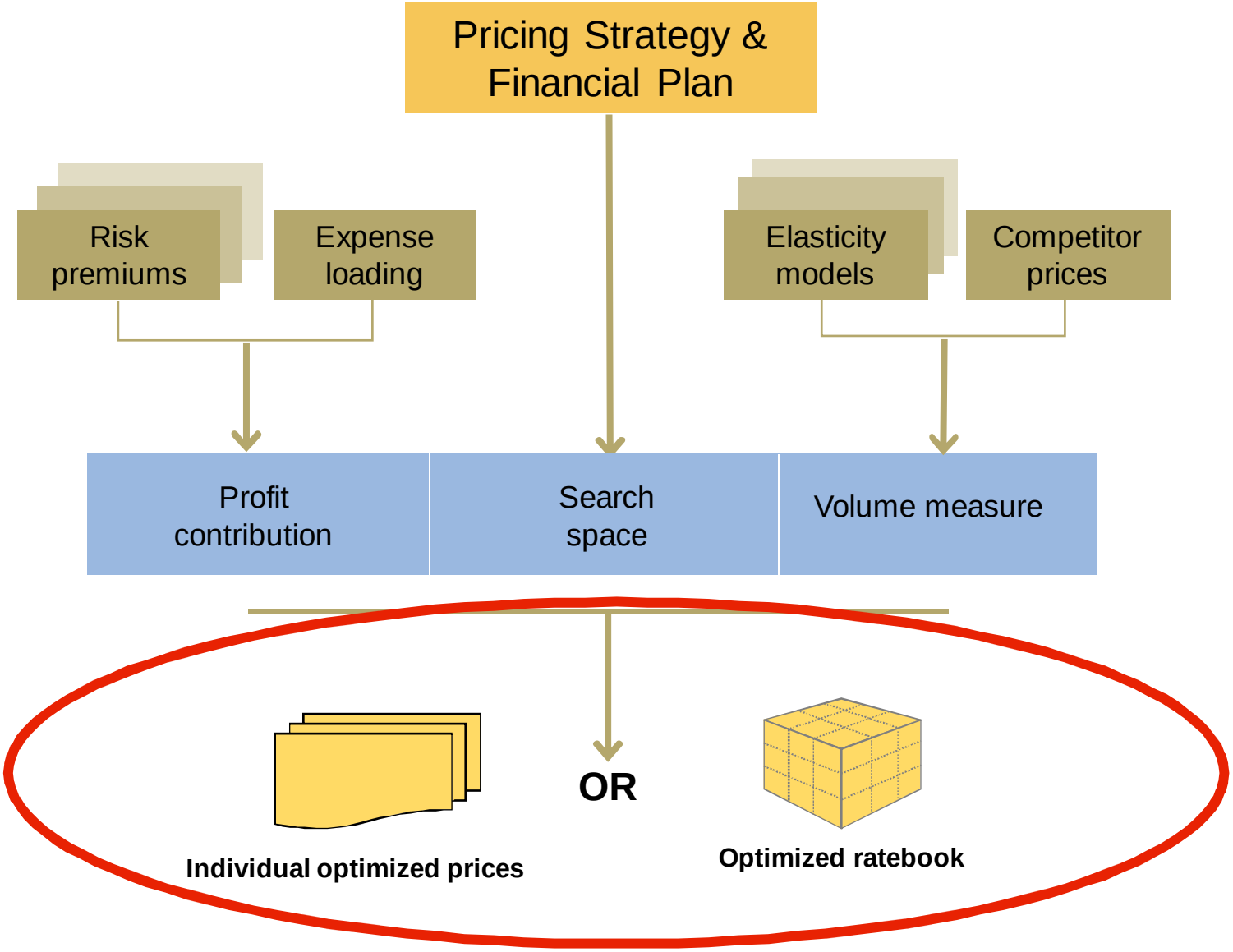
- Standard goal is to seek maximum profit given a set retention rate





- Other constraints can be added
- A wealth of alternative metrics
- Helps to achieve a more refined selection

Price optimization



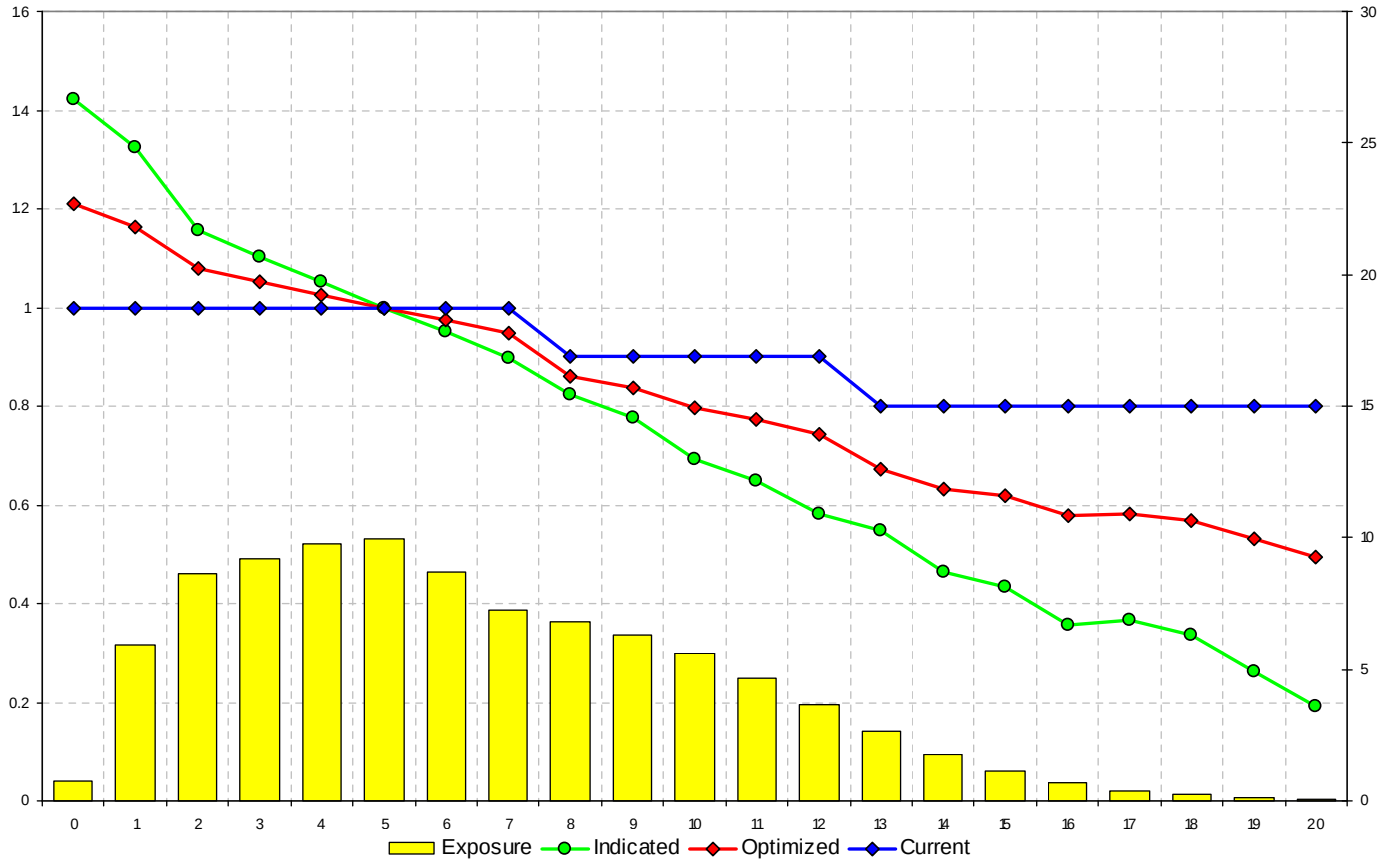
Implementing an Optimized Structure - Internal

- Balance Company Goals
  - Growth, Profit, Segments
- Address Concerns
  - Actuarial and Other
- Appeal to Management
  - Quick Wins

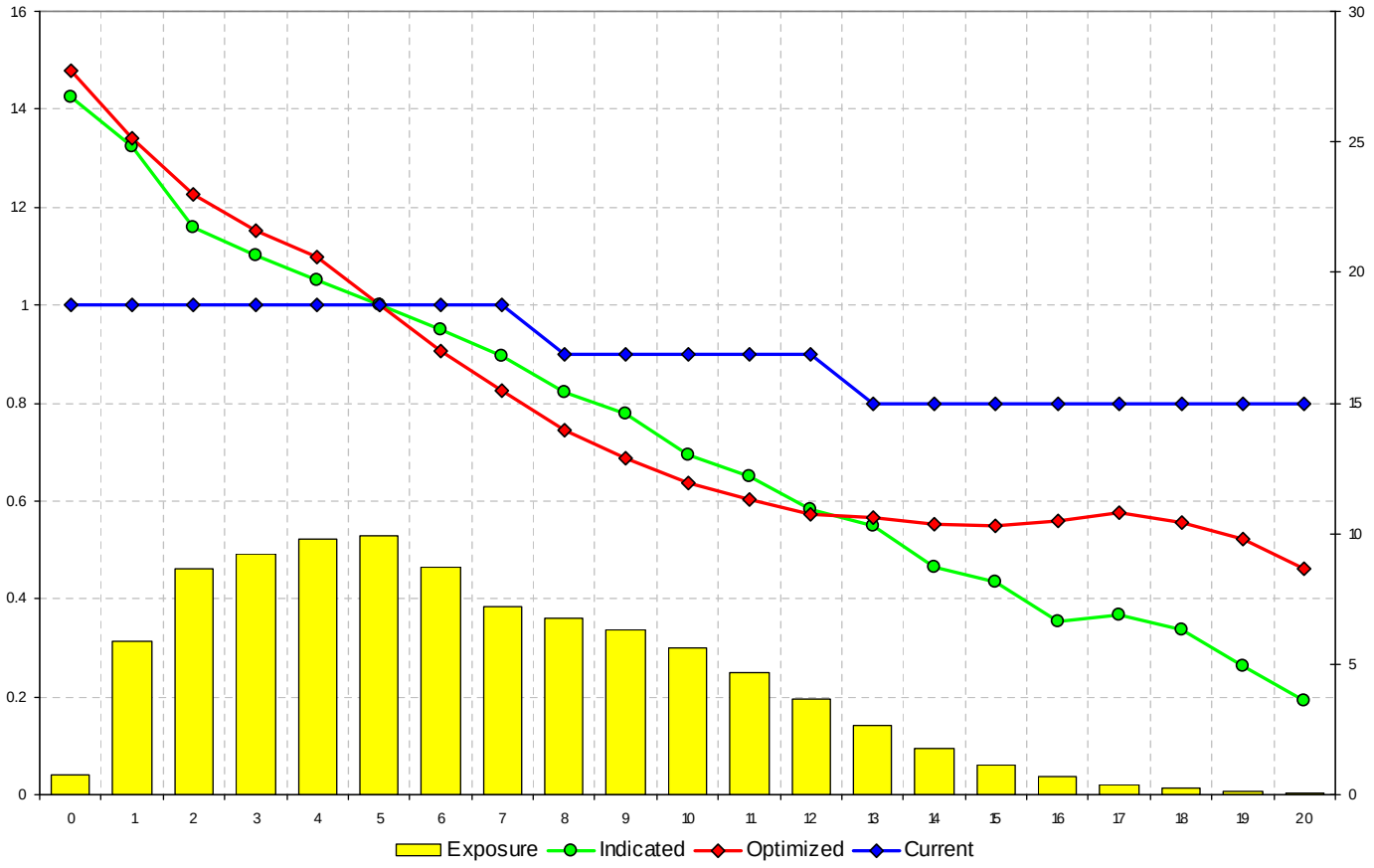
Implementing an Optimized Structure - External

- USA Regulatory Considerations
  - Environment varies by state
  - Requirements differ by line
- Ratemaking Principles
  - A rate is an estimate of the expected value of future costs
  - Rates shall not be excessive, inadequate, or unfairly discriminatory
  - **Reasonable Range**

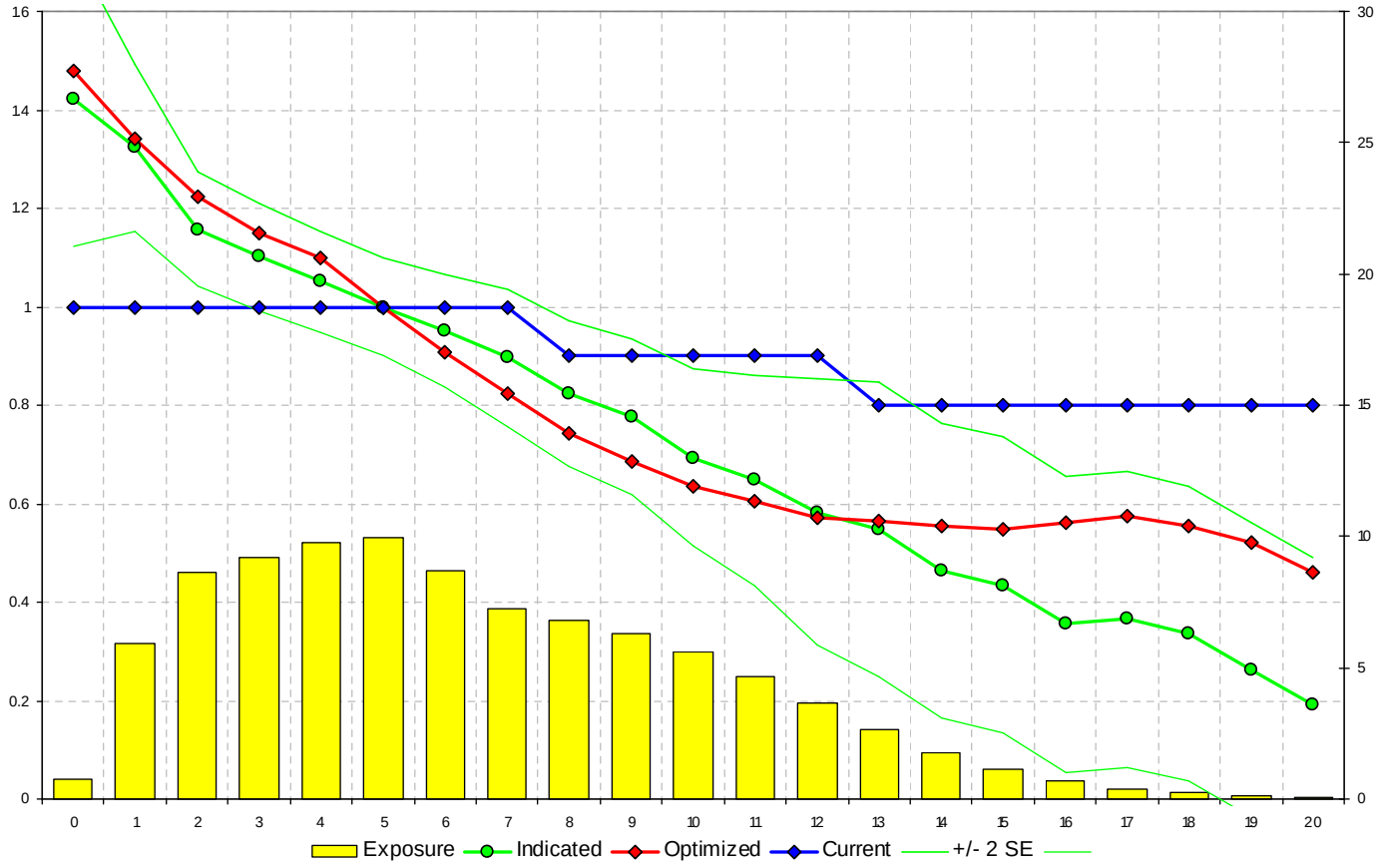
Effect of Regulatory Constraints on “Optimized” Factors



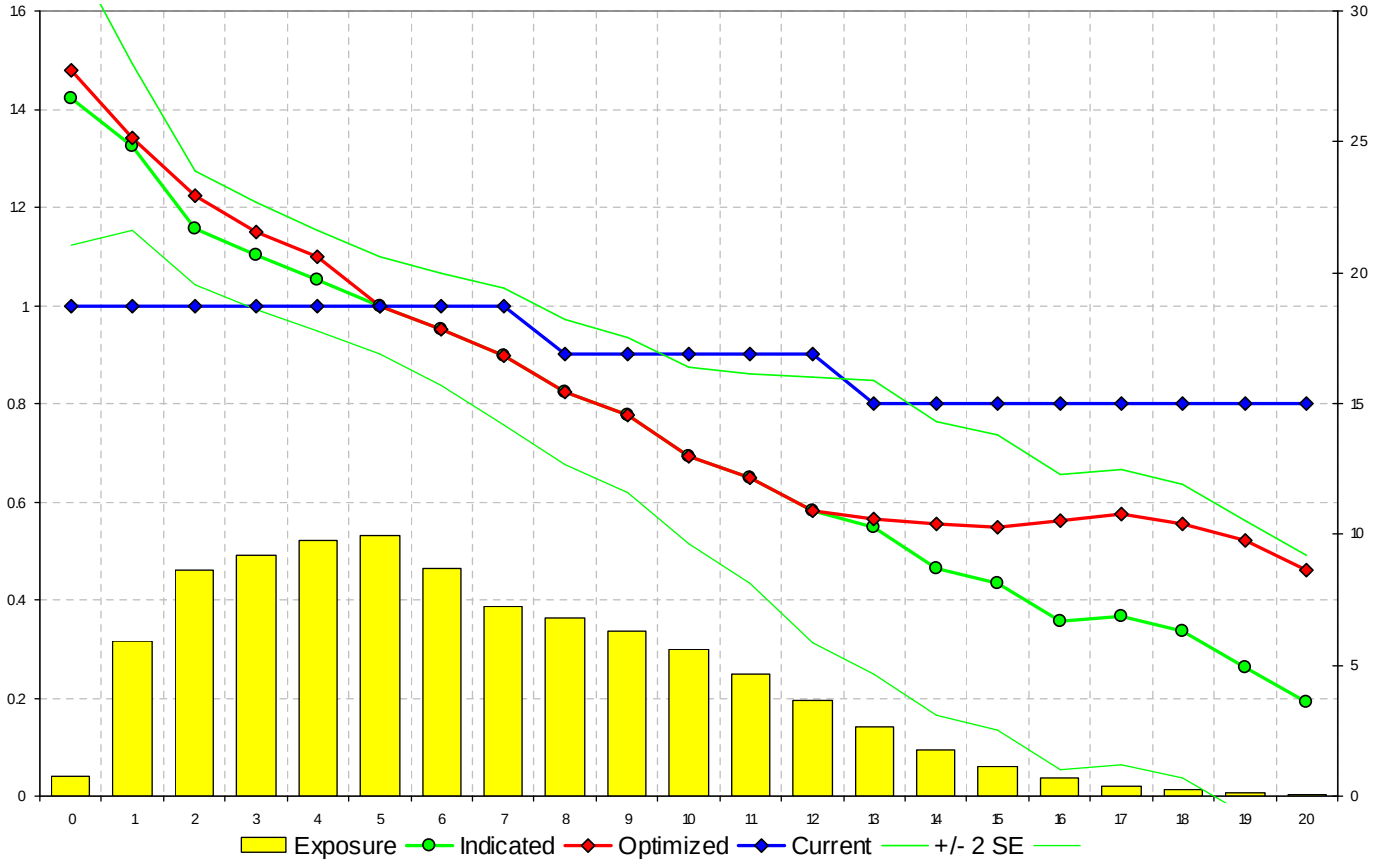
Effect of Regulatory Constraints on “Optimized” Factors



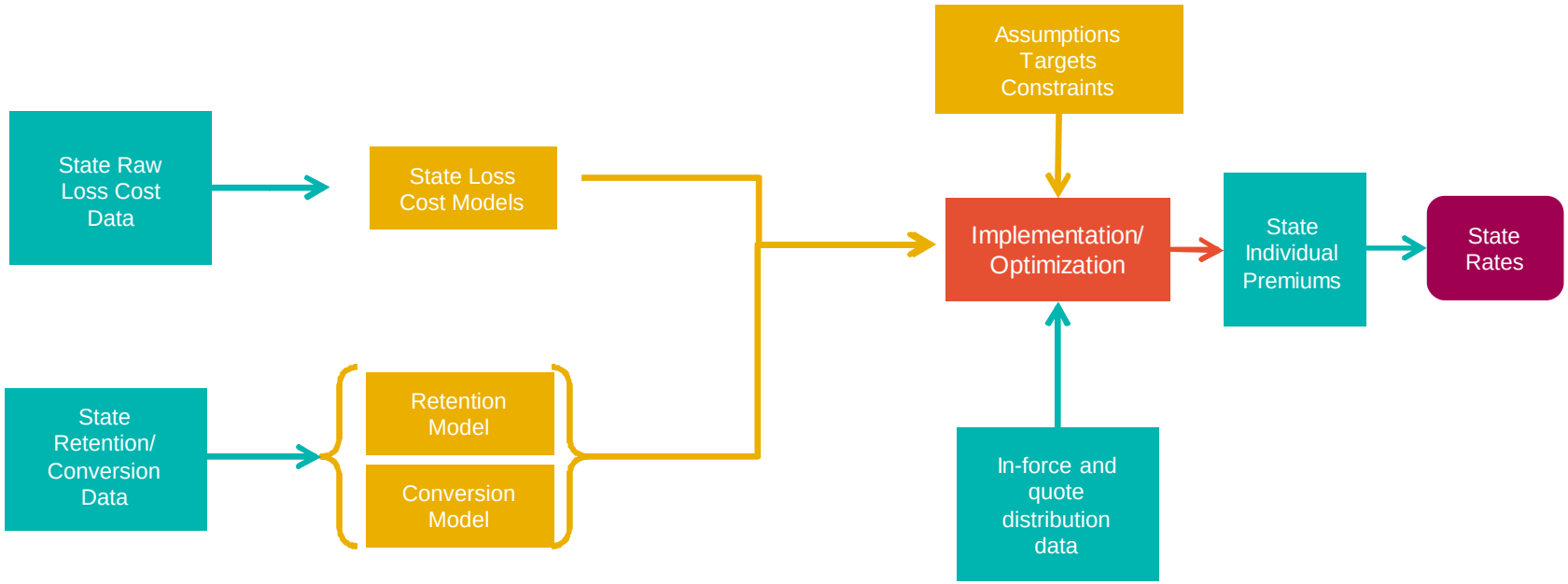
Effect of Regulatory Constraints on “Optimized” Factors



Effect of Regulatory Constraints on “Optimized” Factors



Integrated pricing process



Agenda

- What is price optimization?
- Key aspects
  - inputs
  - algorithm
  - implementation
- Business benefits and wider implications

Price Optimization for the U.S. Market: Techniques and Implementation Strategies

CAS Ratemaking and Product Management Seminar

Mark Chamberlain
Yves Colomb

March 31, 2014