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

CAS Ratemaking and Product Management Seminar

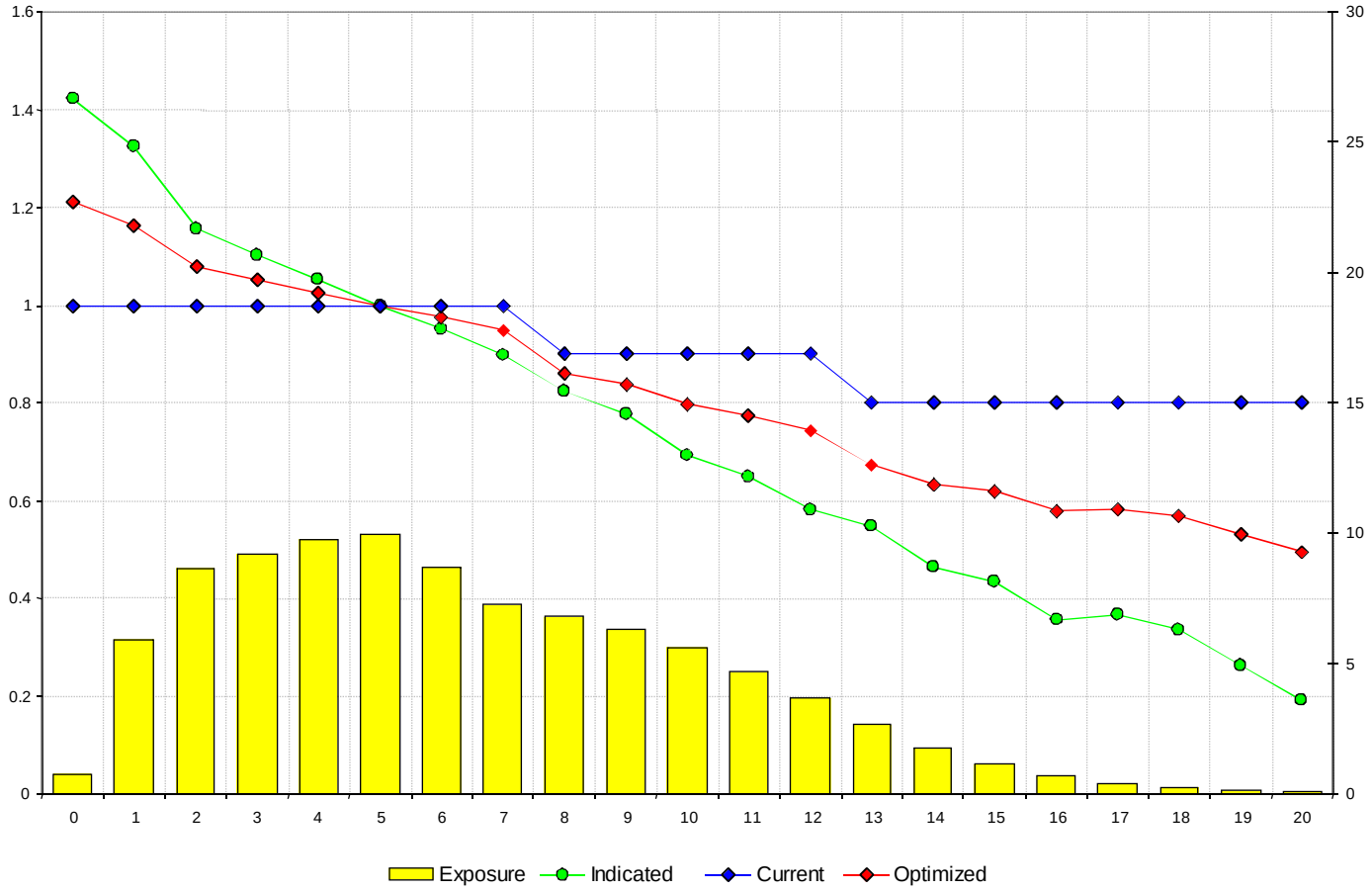
Duncan Anderson
Michael McPhail

March 12, 2013

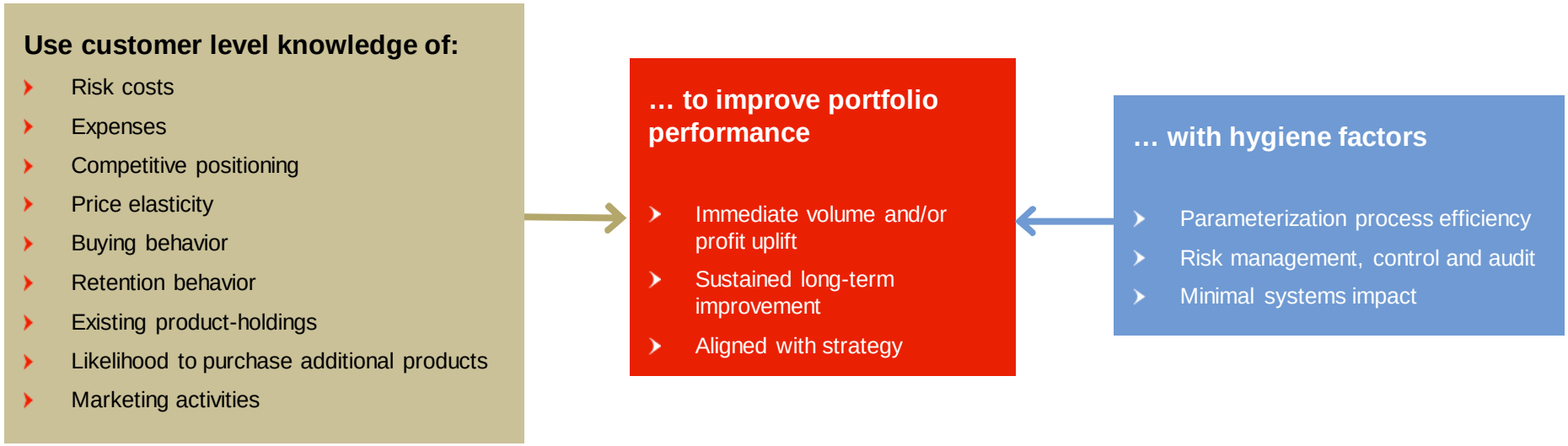
Agenda

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

What is price optimization?



What is price optimization?

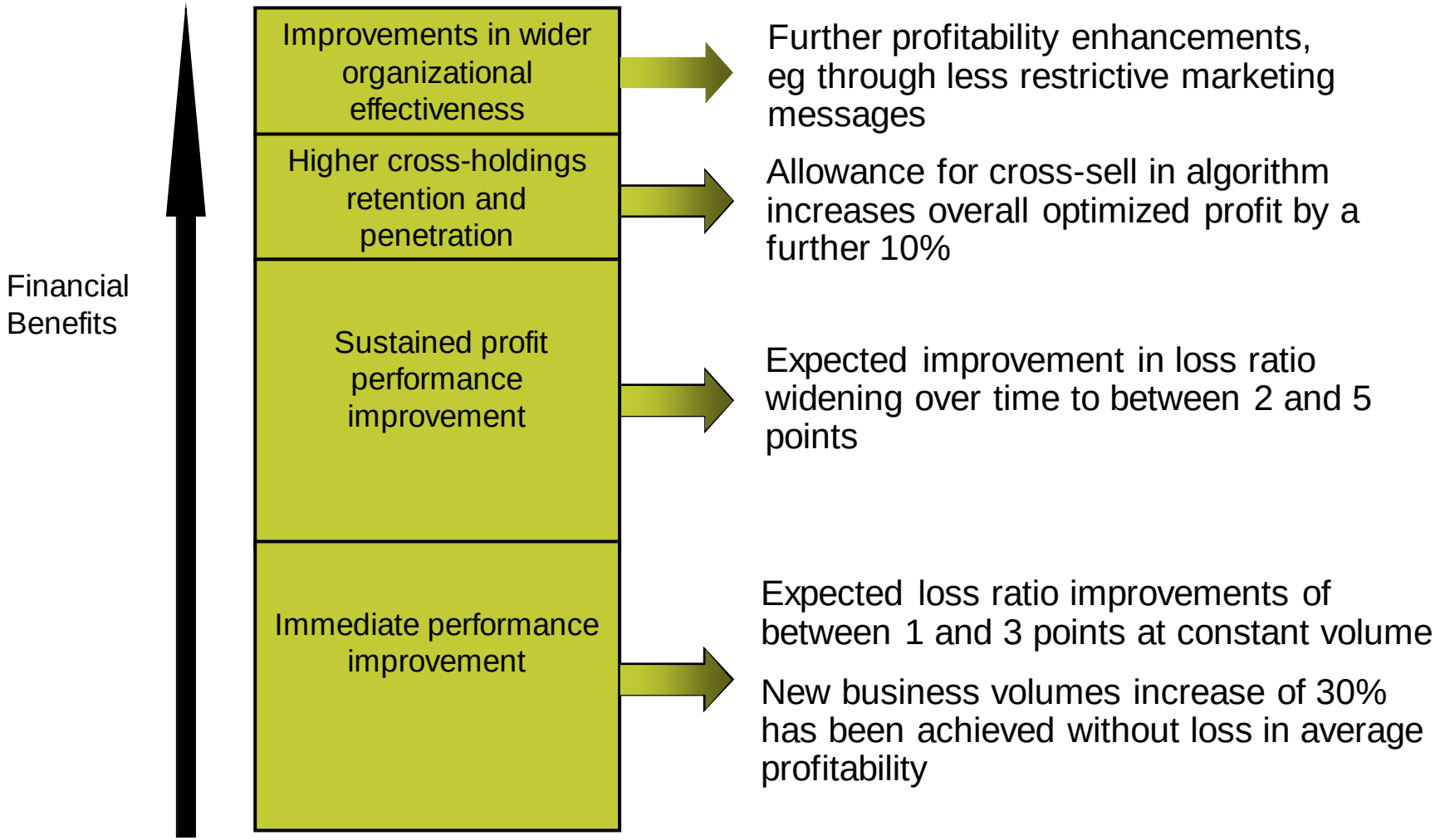


Price optimization

- 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	

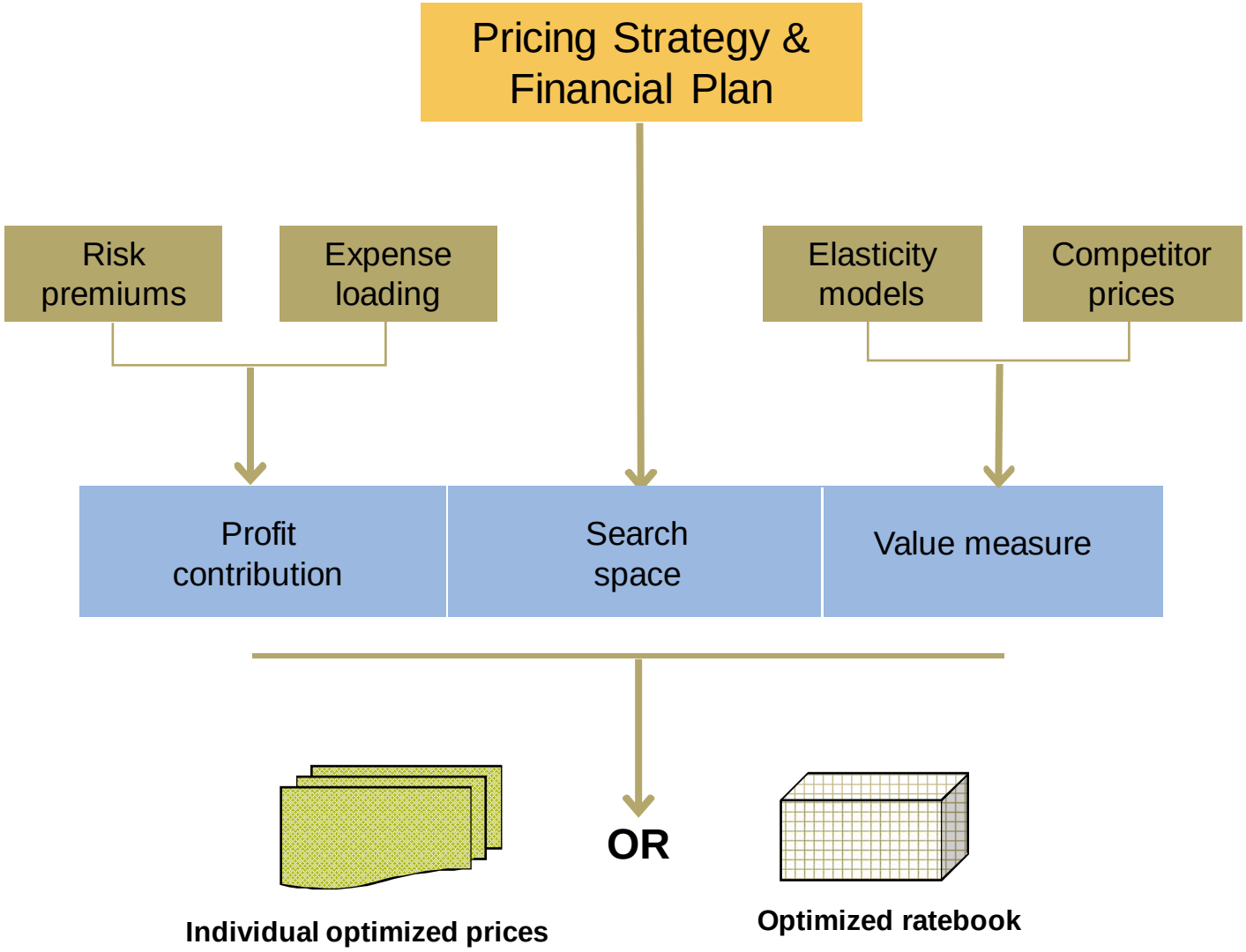
Financial benefits



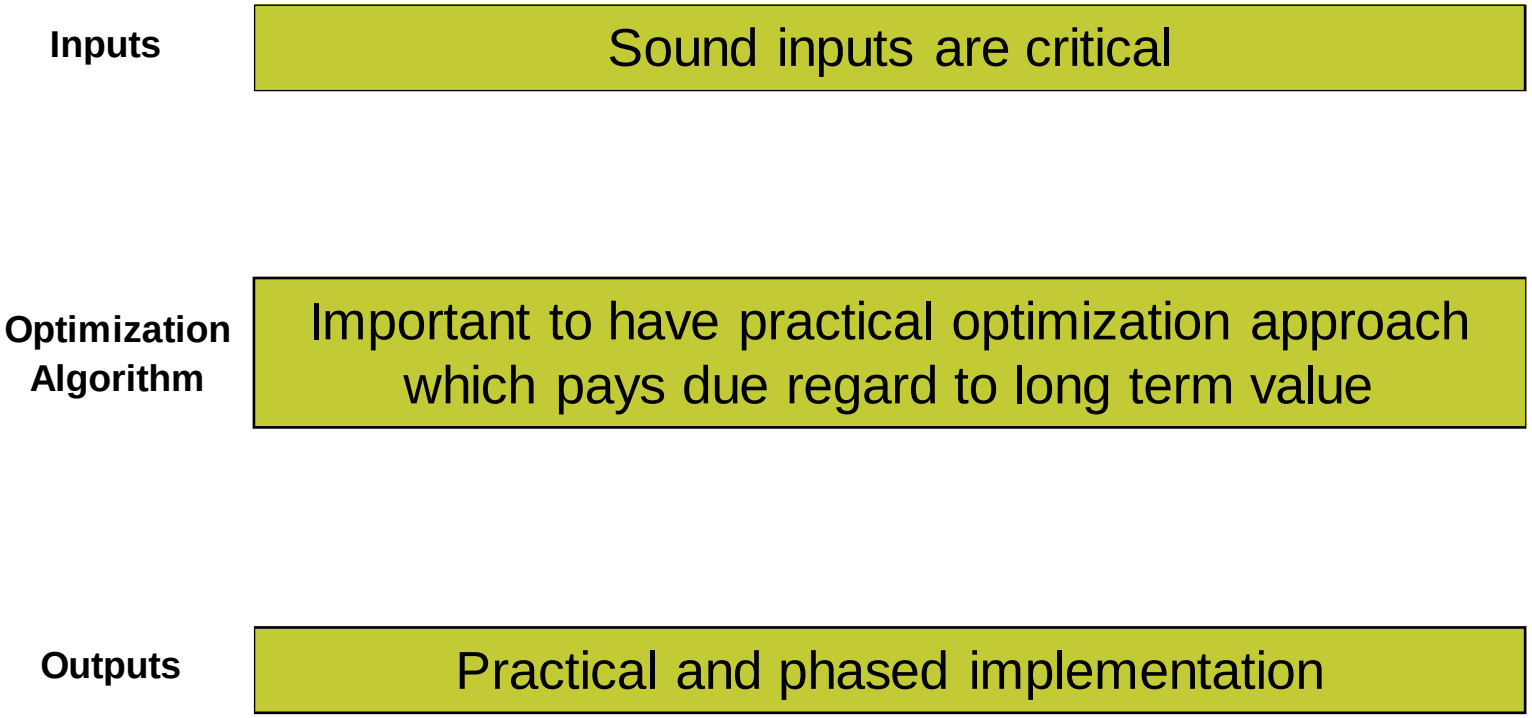
Agenda

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

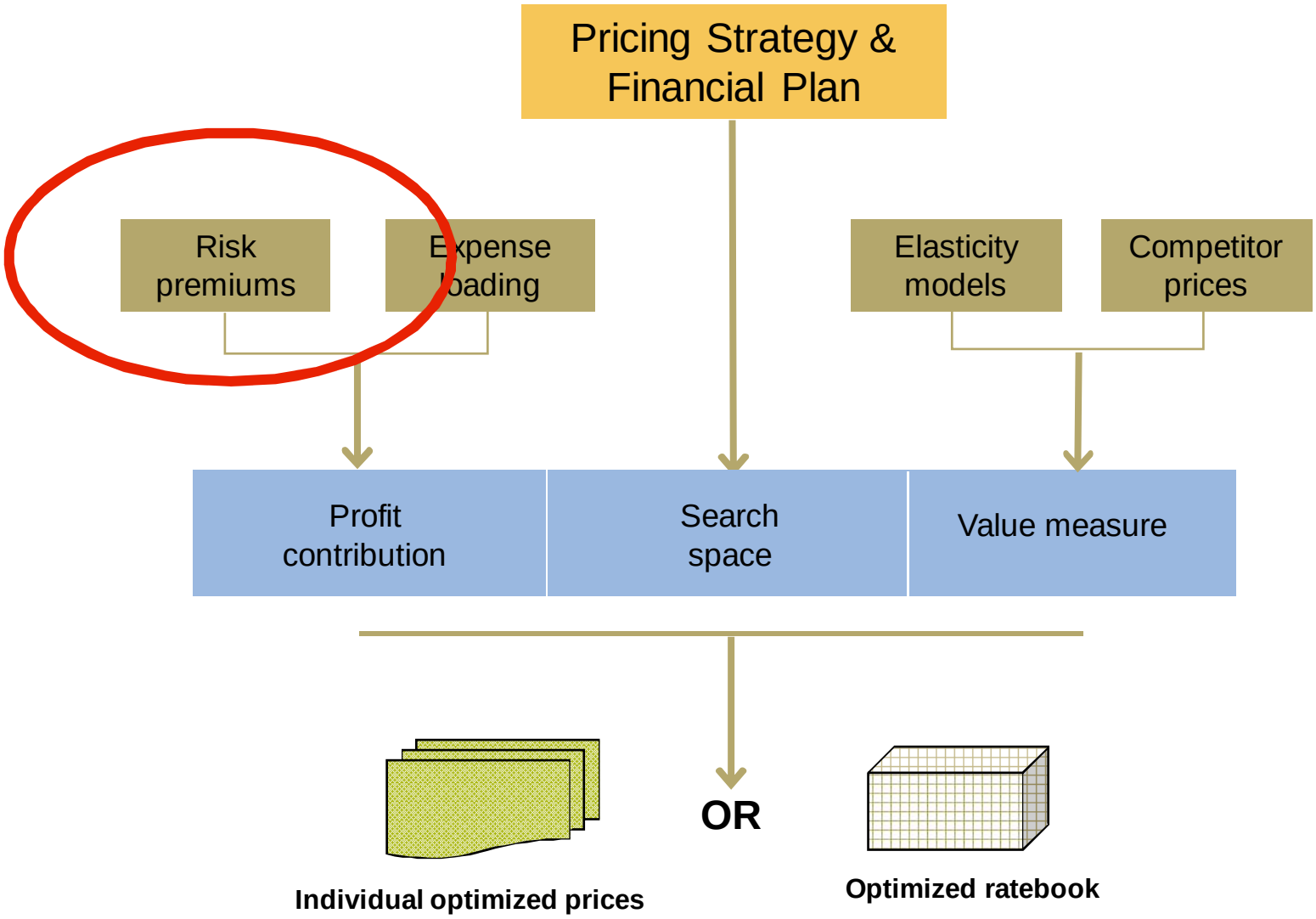
Price optimization



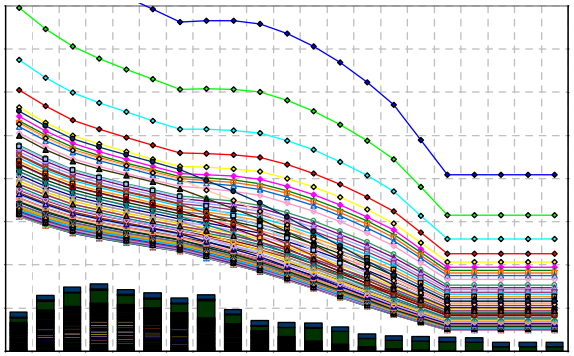
Price optimization

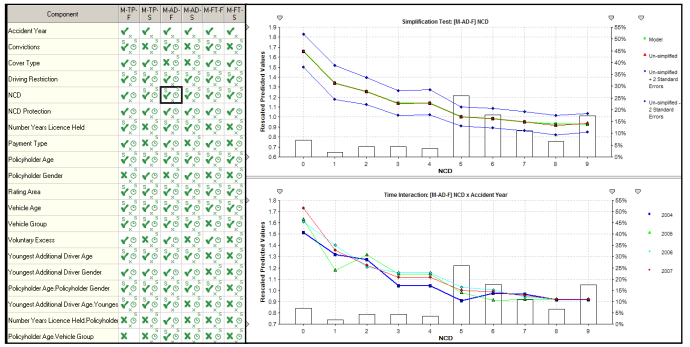


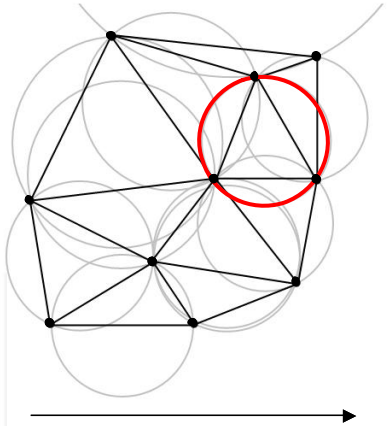
Price optimization

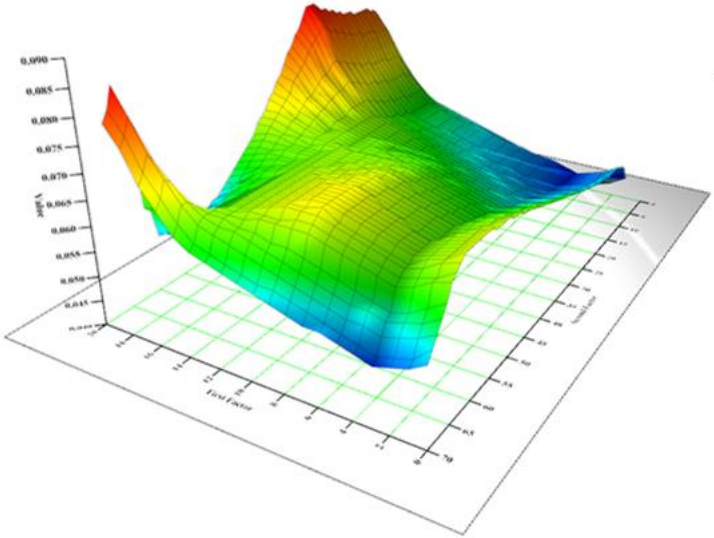


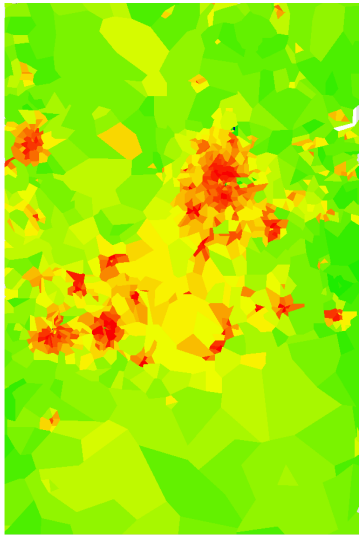
Risk models

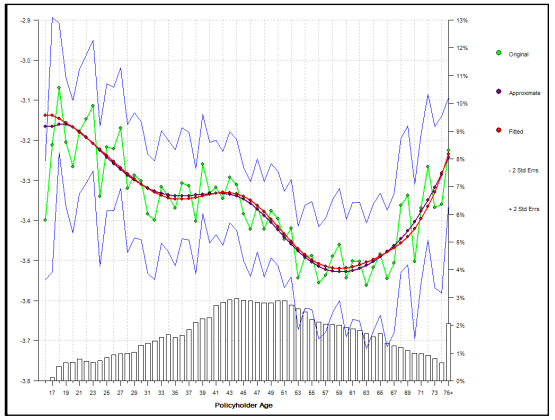



Component
Accident Year
Convictions
Cover Type
Driving Restriction
NCD
NCD Protection
Number Years Licence Held
Payment Type
Policyholder Age
Policyholder Gender
Rating Area
Vehicle Age
Vehicle Group
Voluntary Excess
Youngest Additional Driver Age
Youngest Additional Driver Gender
Policyholder Age.Policyholder 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
2004
2005
2006
2007

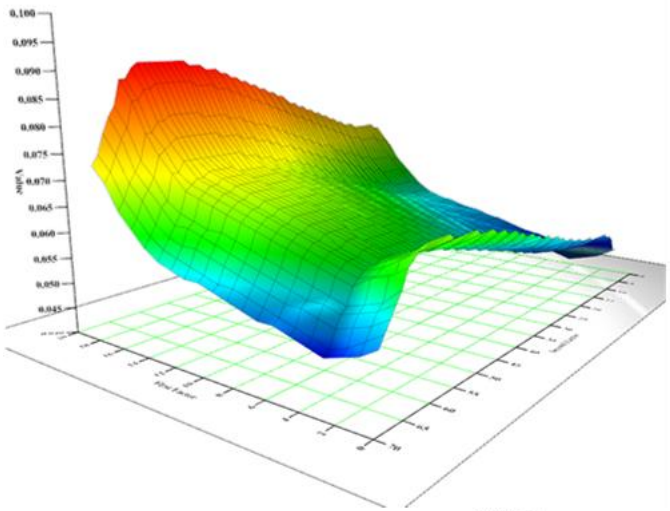


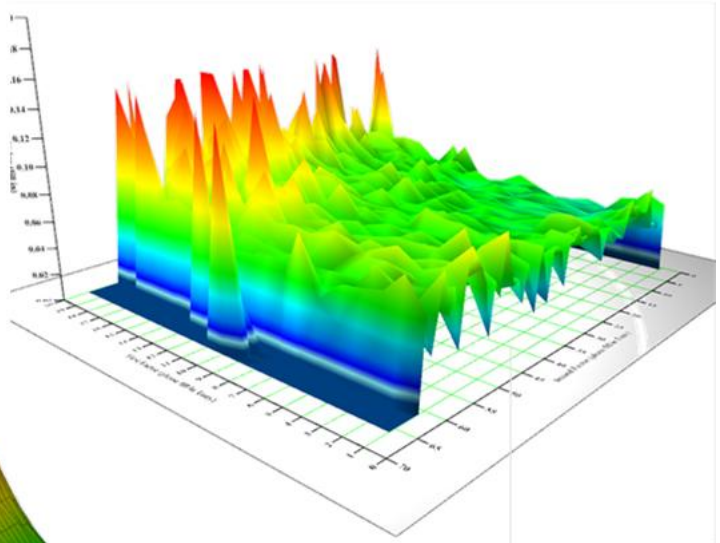


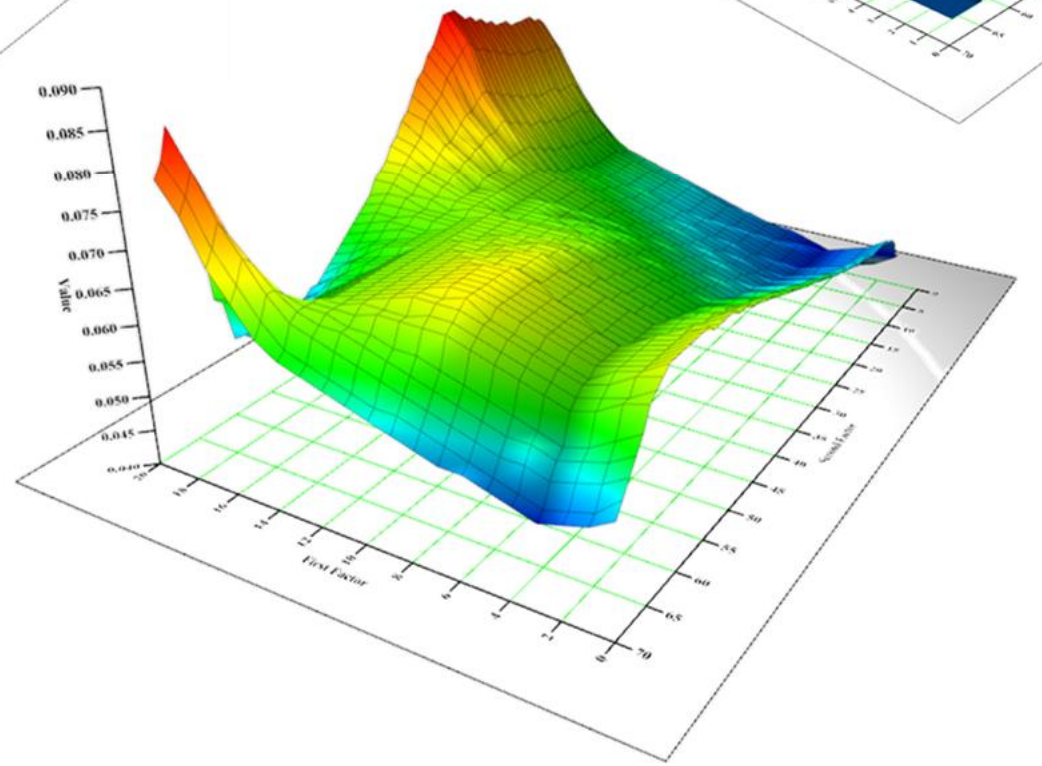



Original
Approximate
Fitted
- 2 Std Errs
+ 2 Std Errs
Policyholder Age

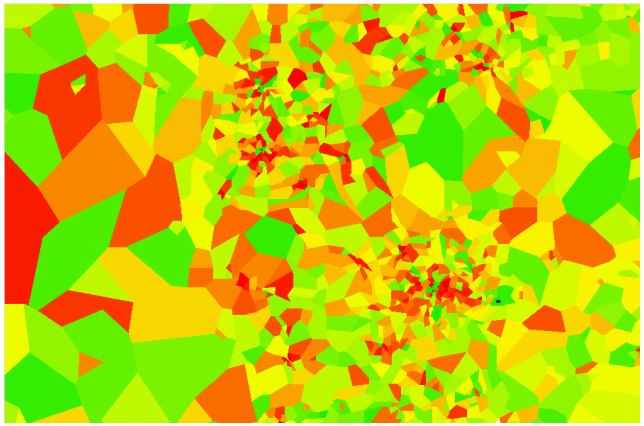
Interactions



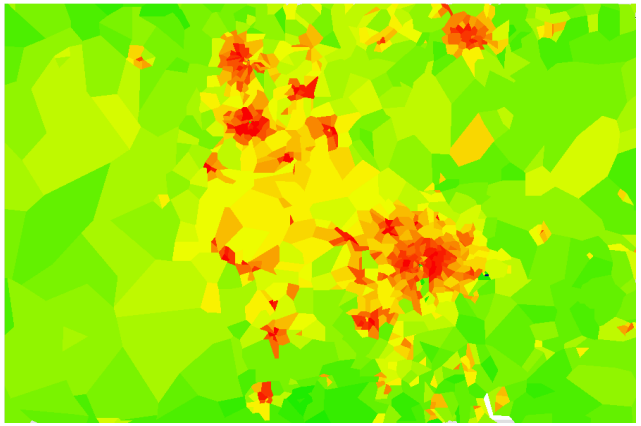




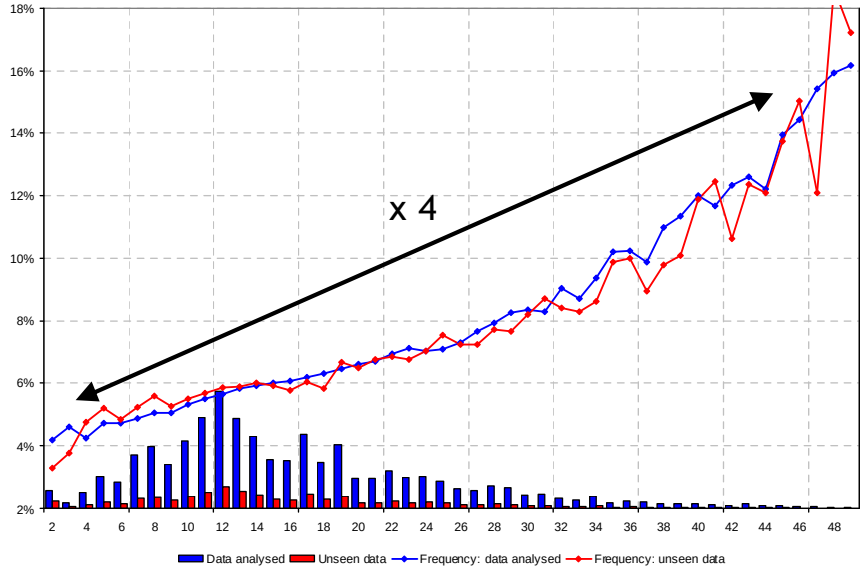
Spatial smoothing



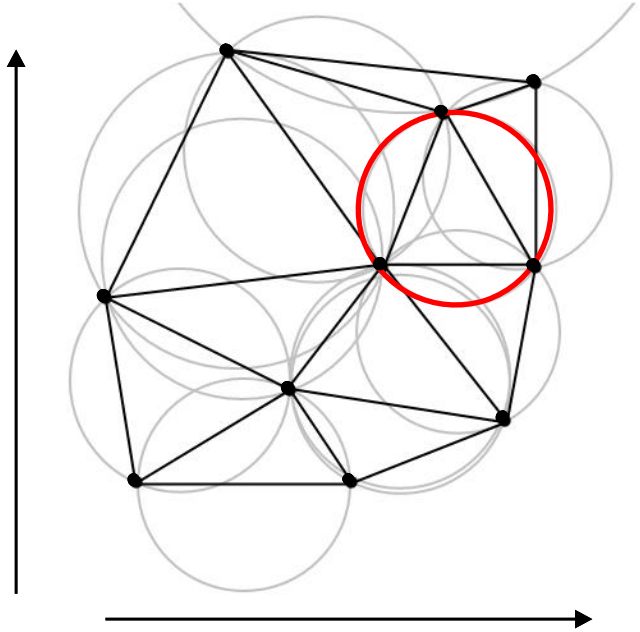
Unsmoothed

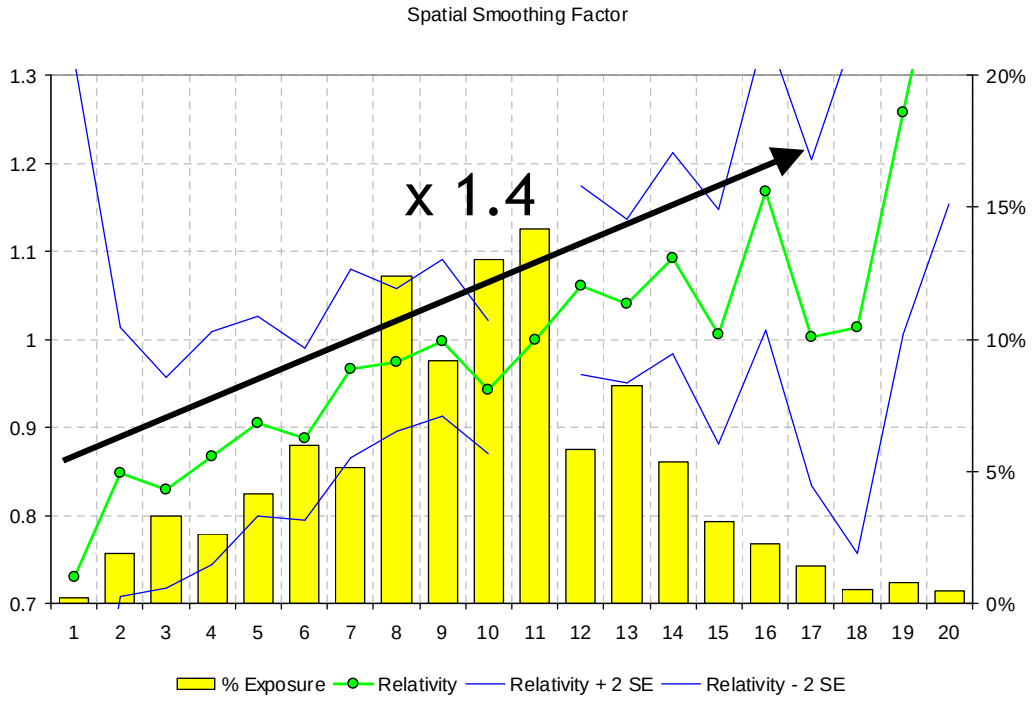


Smoothed

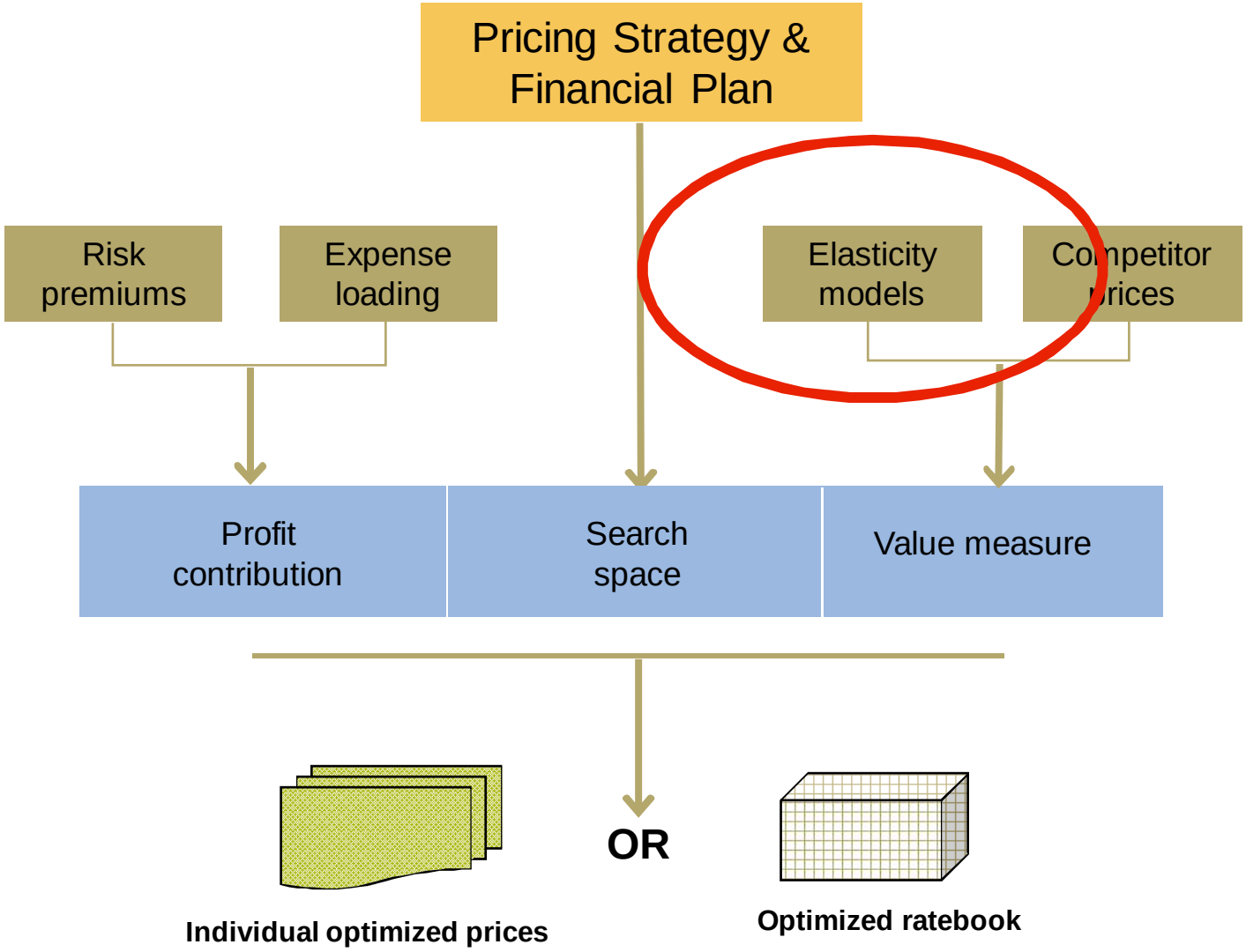


Analogous vehicle groupings techniques

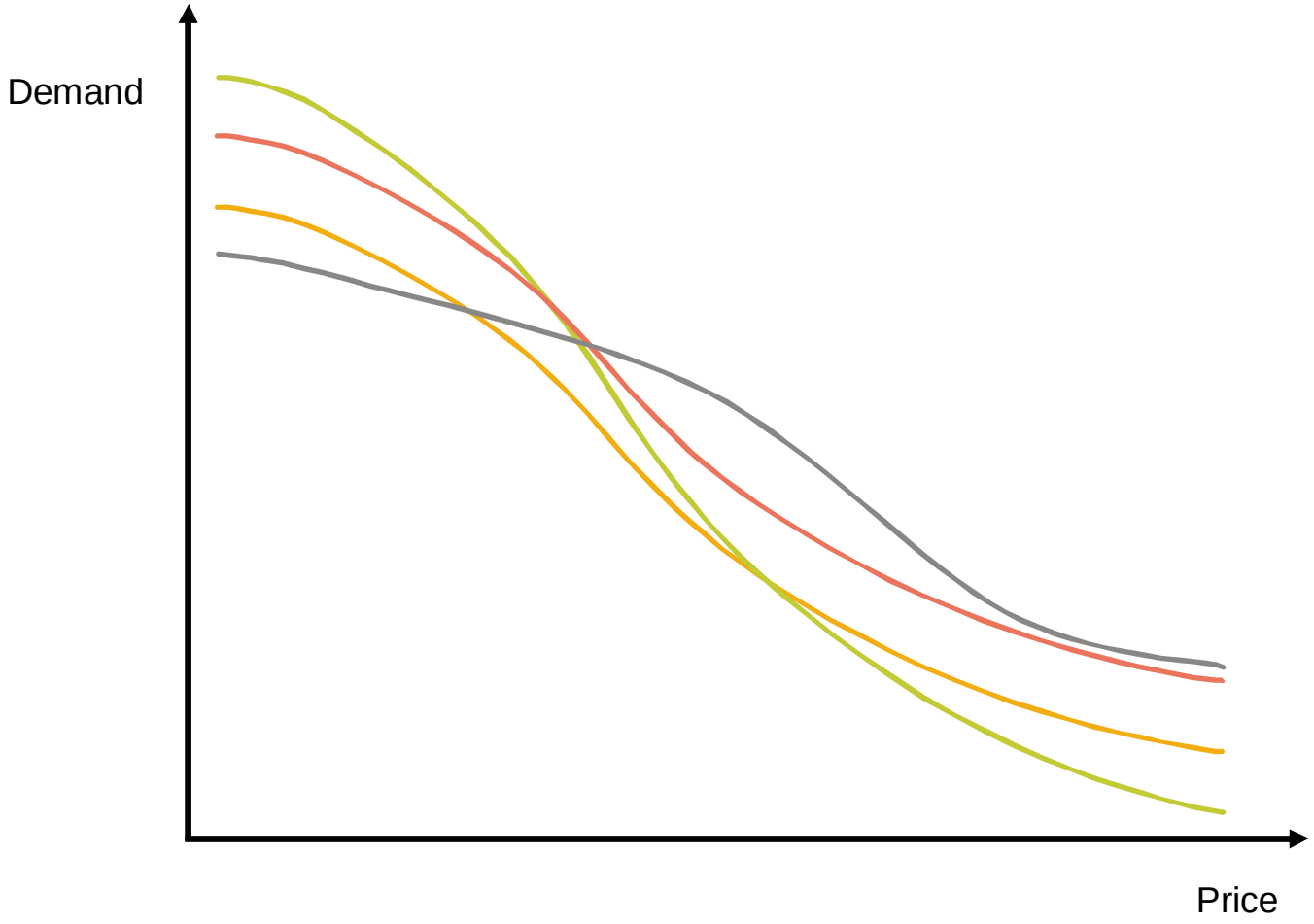




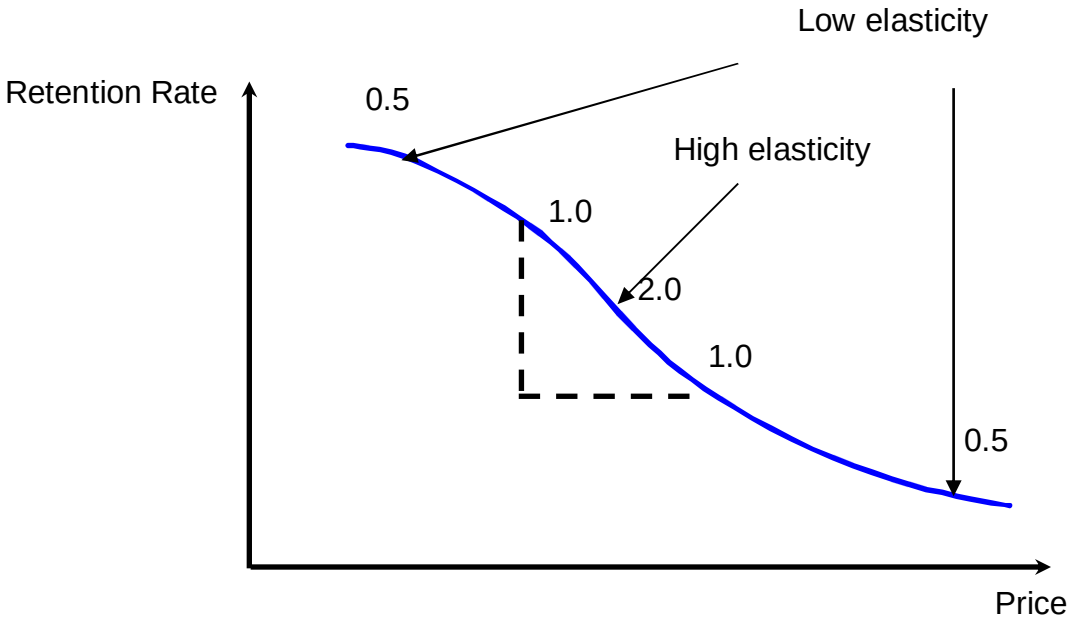
Price optimization



Price demand elasticity

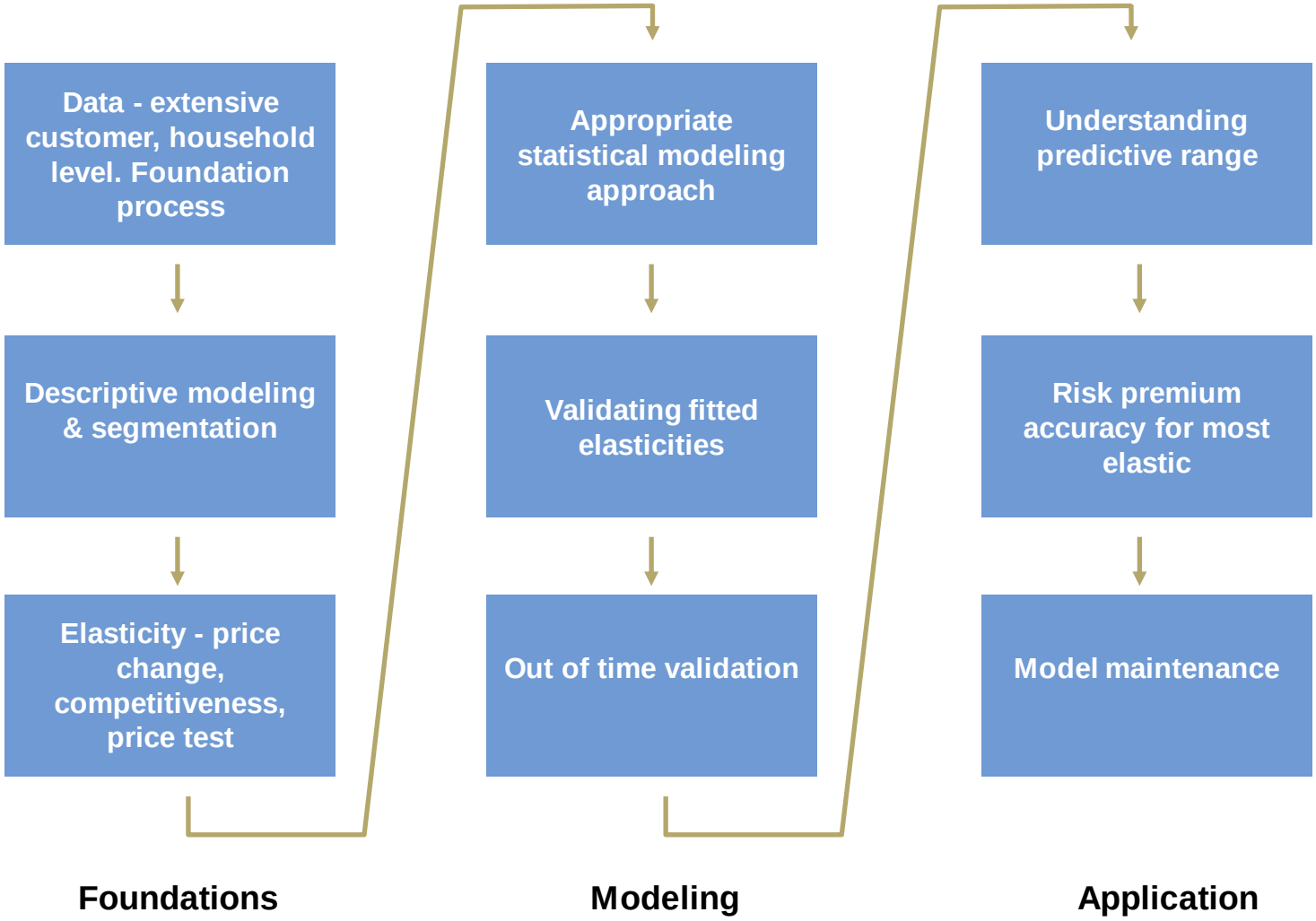


Elasticity

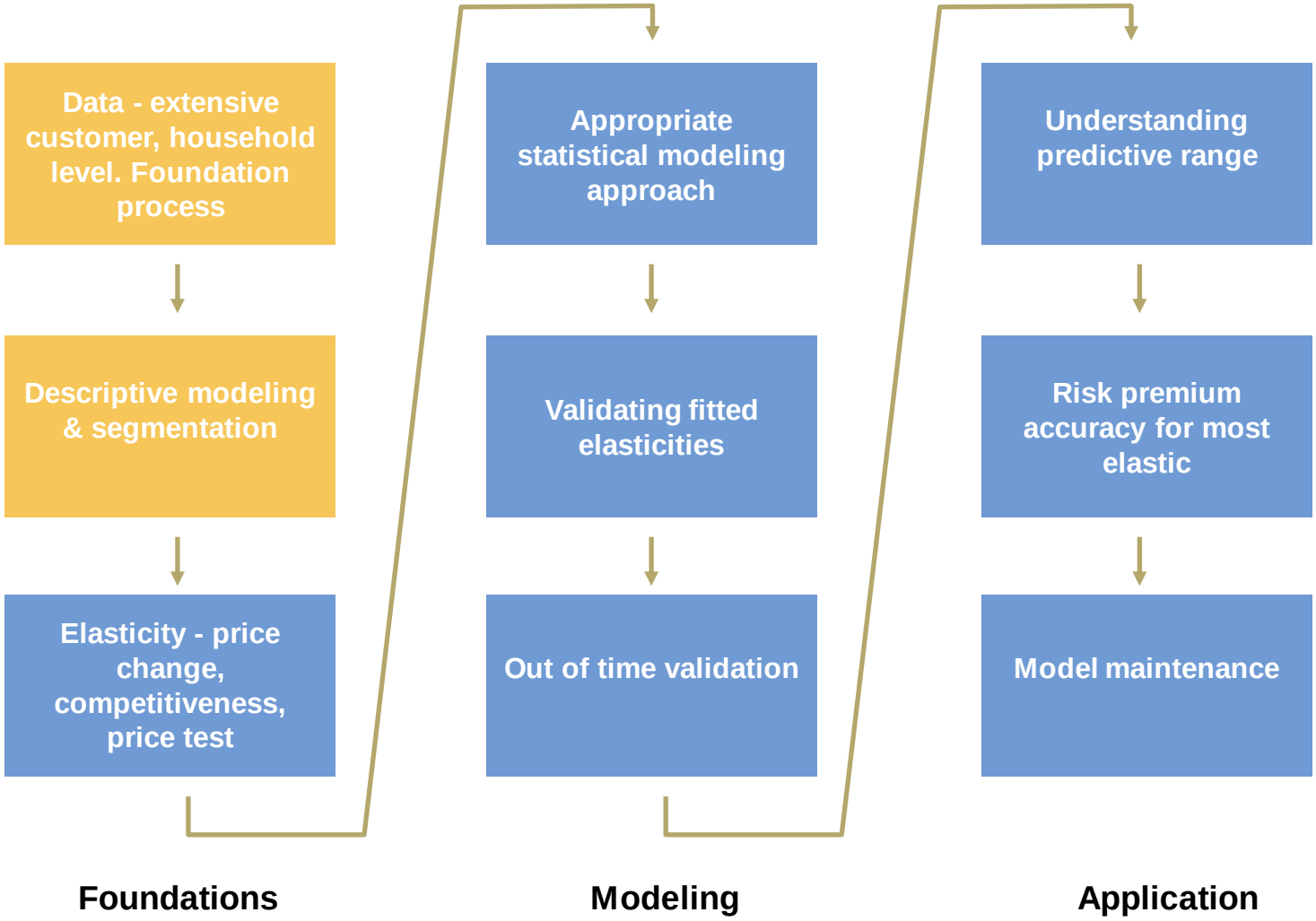


- There are different definitions of elasticity
- Common definition is % change in demand for % change in price
- Price elasticity varies by price:
  - "Policyholder X has elasticity Y" ✖
  - Be wary of assuming straight lines (even in linear predictor space)

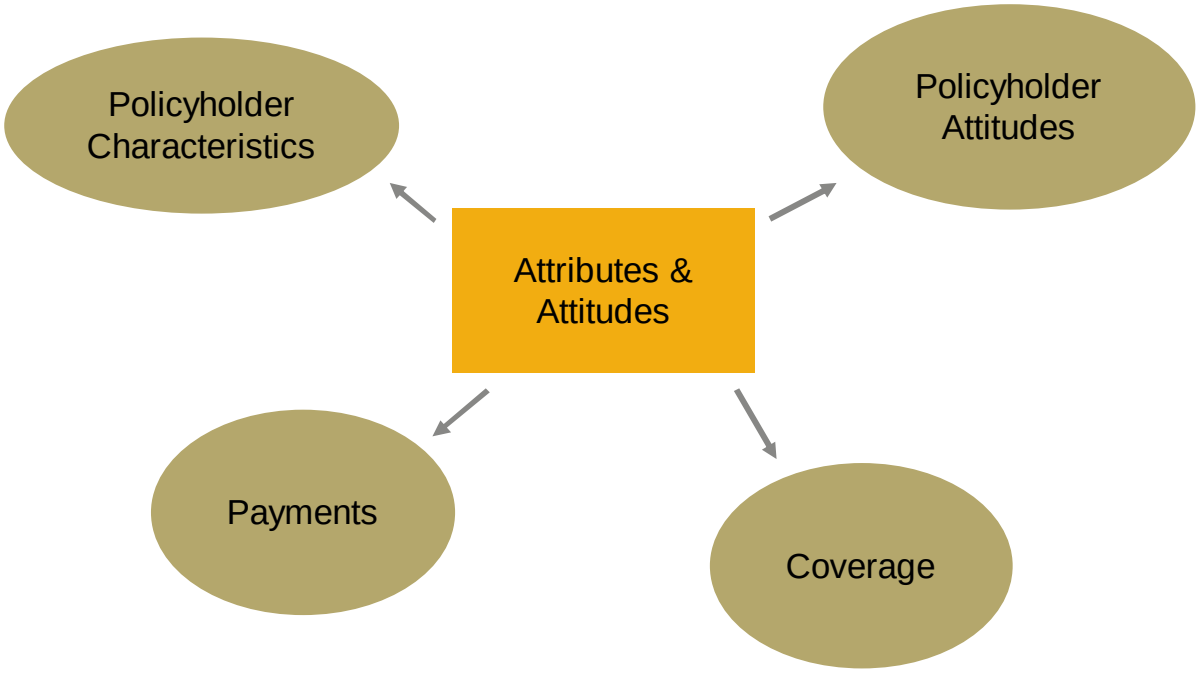
Elasticity modeling - a rigorous approach



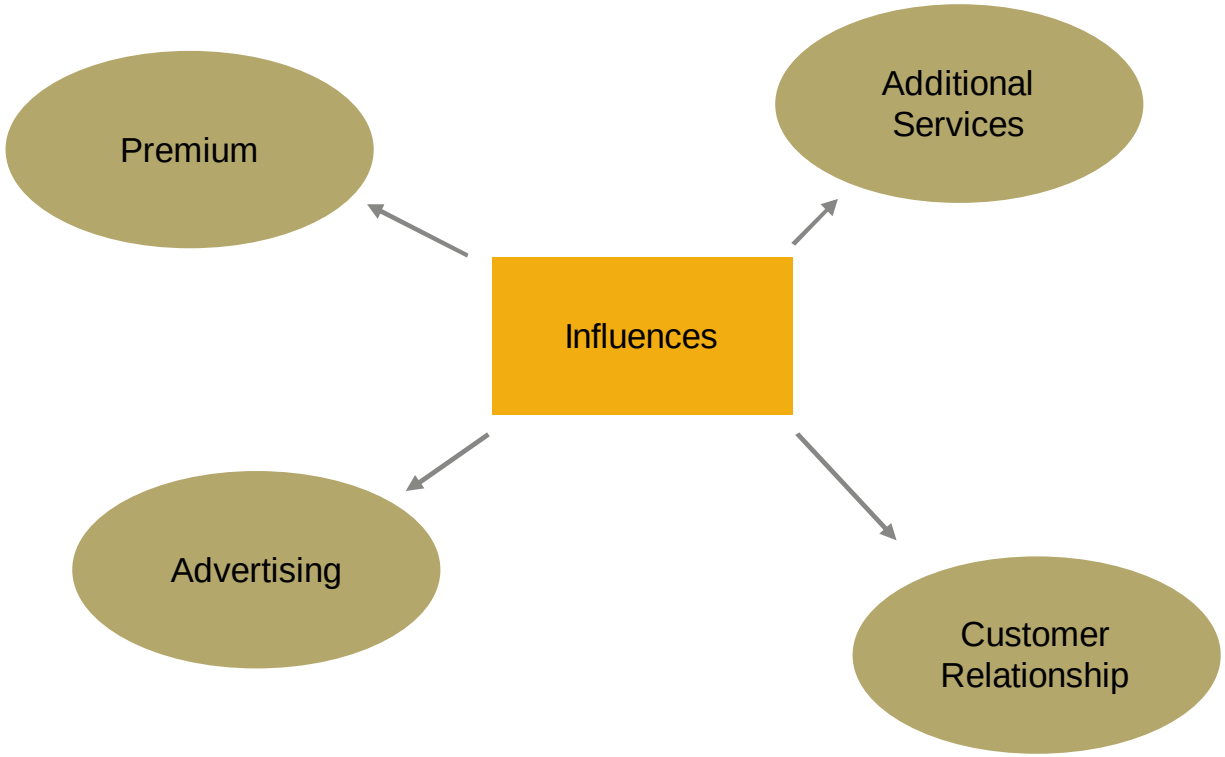
Elasticity modeling - a rigorous approach



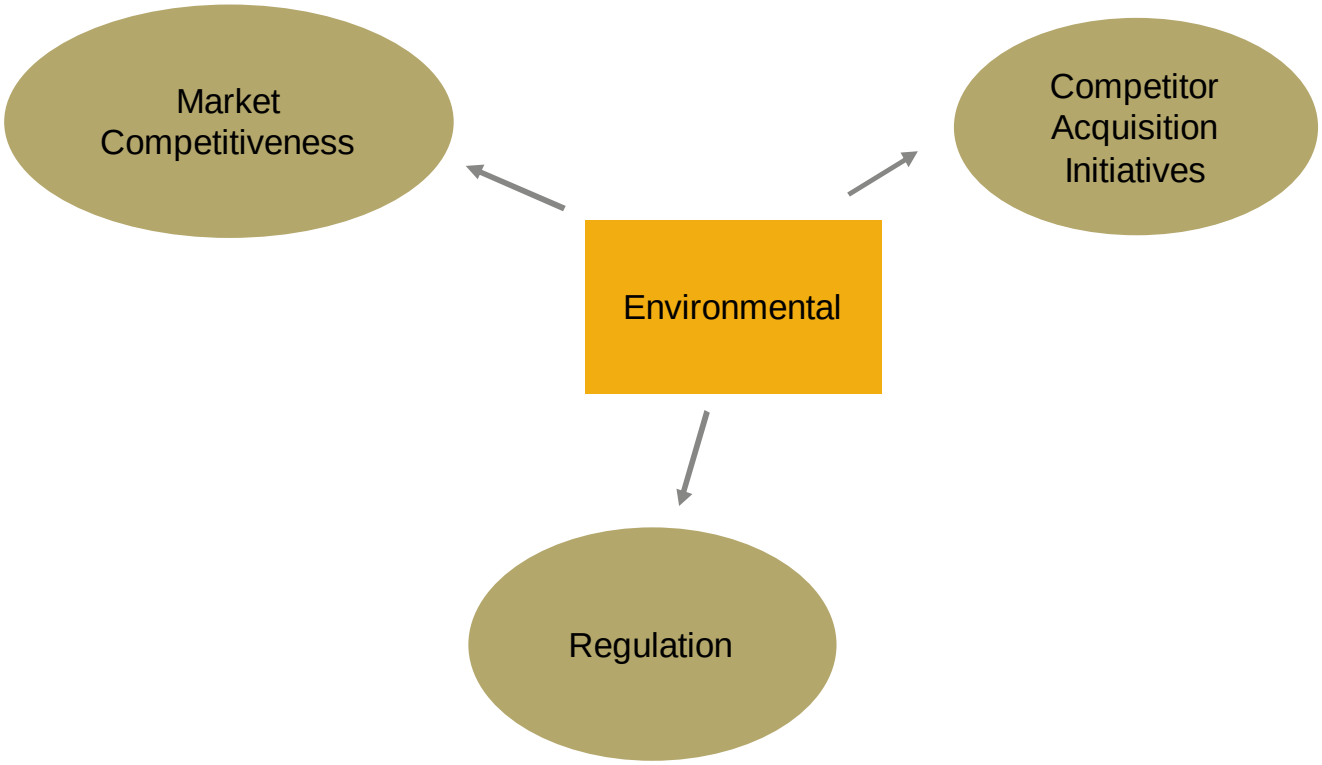
Customer characteristics



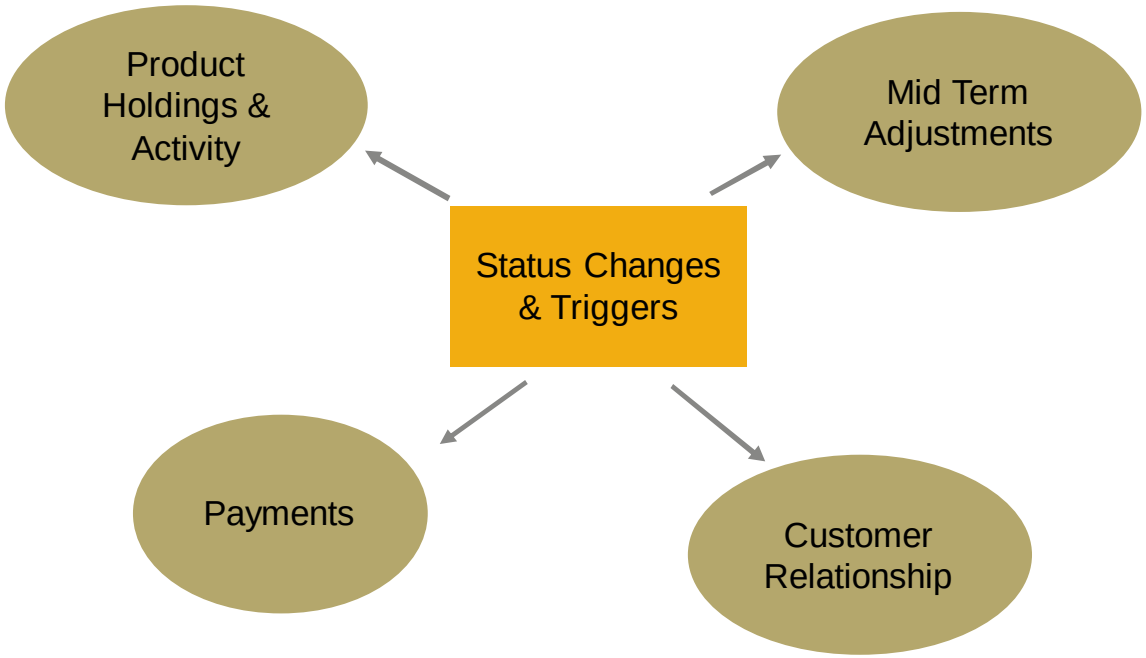
Company triggered changes



External influences

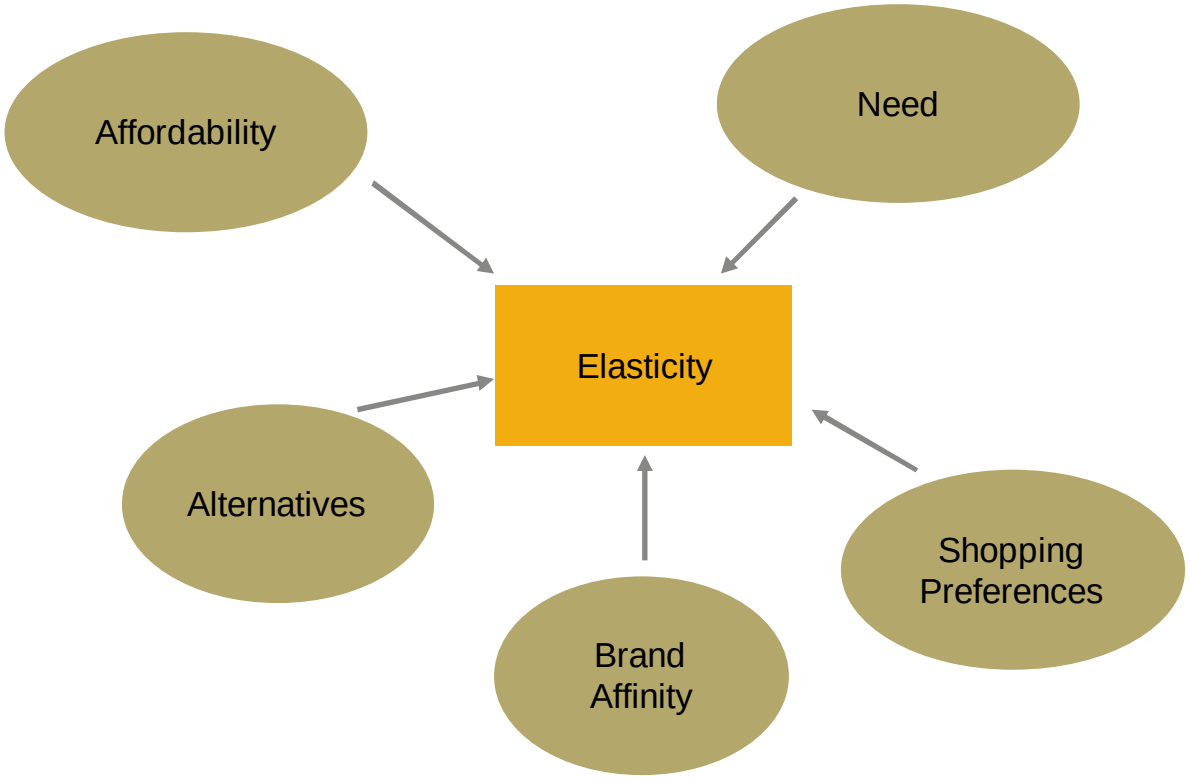


Customer triggered changes



An alternative view of elasticity drivers

Return to basic economic theory



Brand

(Actual result cannot be disclosed in handout)

Behavioural analysis and customer profiling

(Actual result cannot be disclosed in handout)

Behavioural factors

(Actual result cannot be disclosed in handout)

Affluence

(Actual result cannot be disclosed in handout)

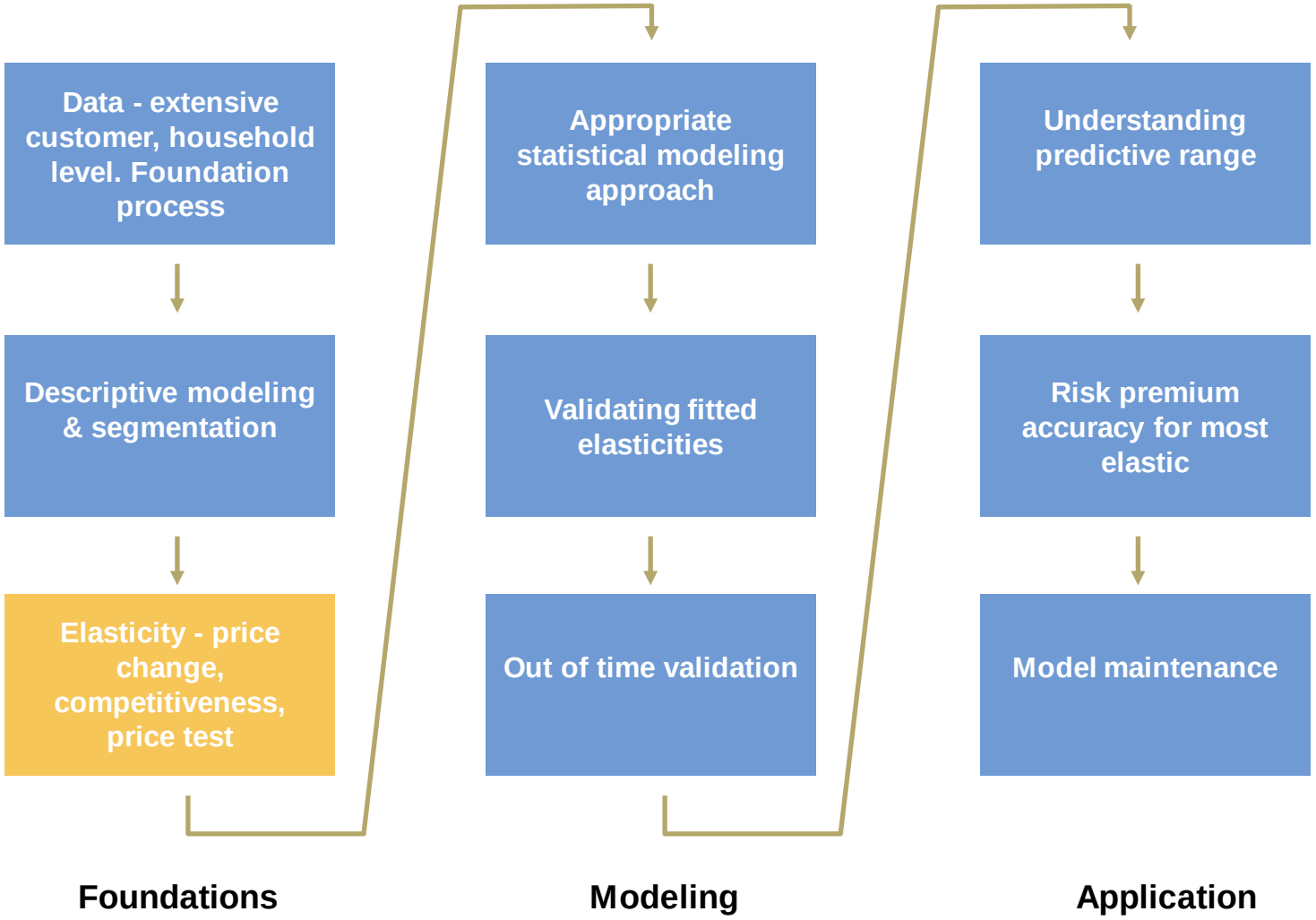
More unusual factors

(Actual result cannot be disclosed in handout)

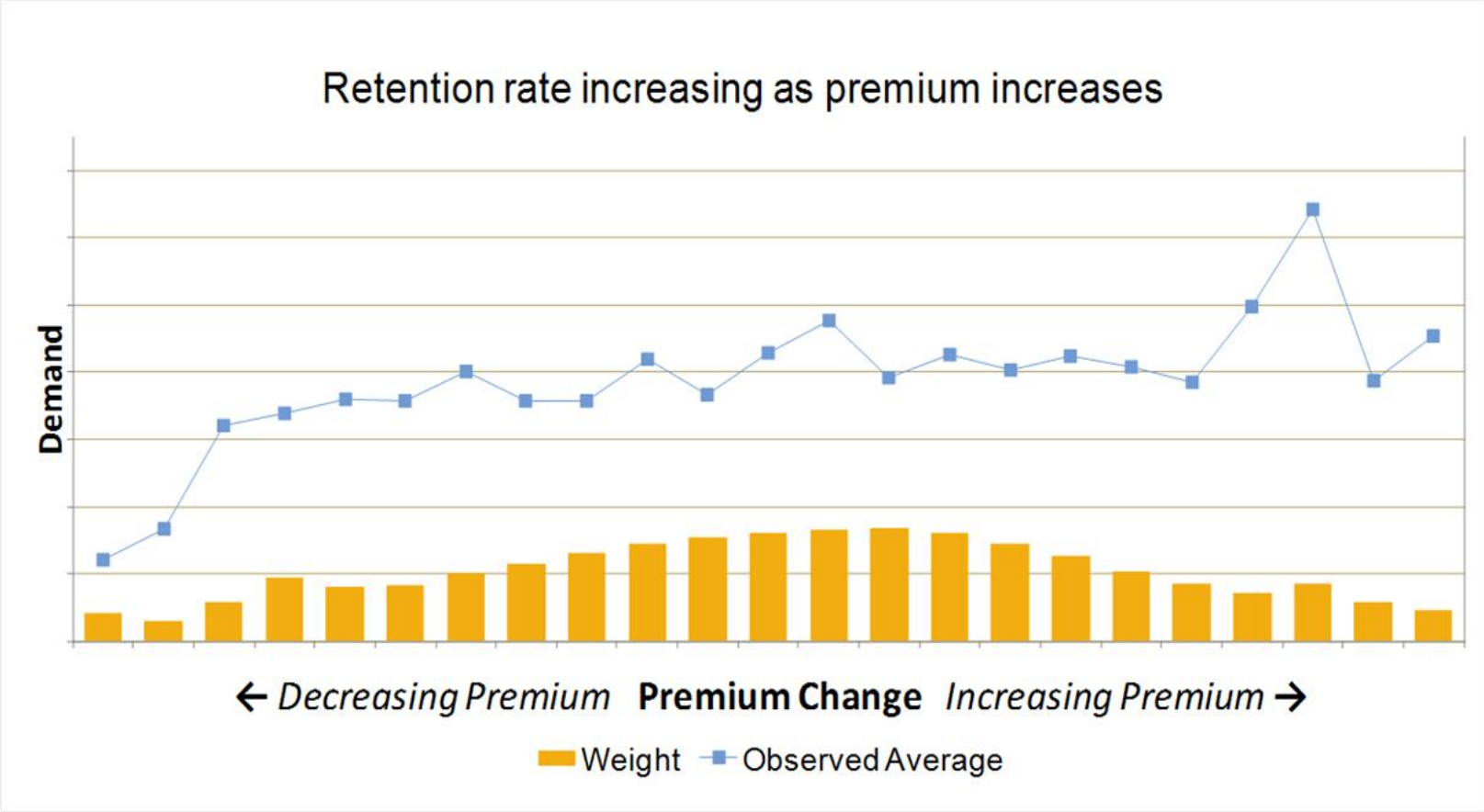
Add-on propensity

(Actual result cannot be disclosed in handout)

Elasticity modeling - a rigorous approach

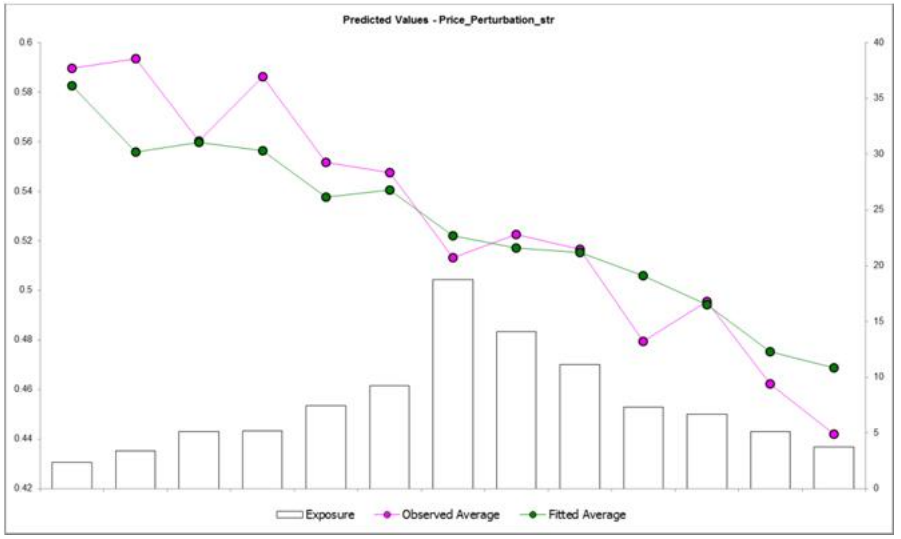


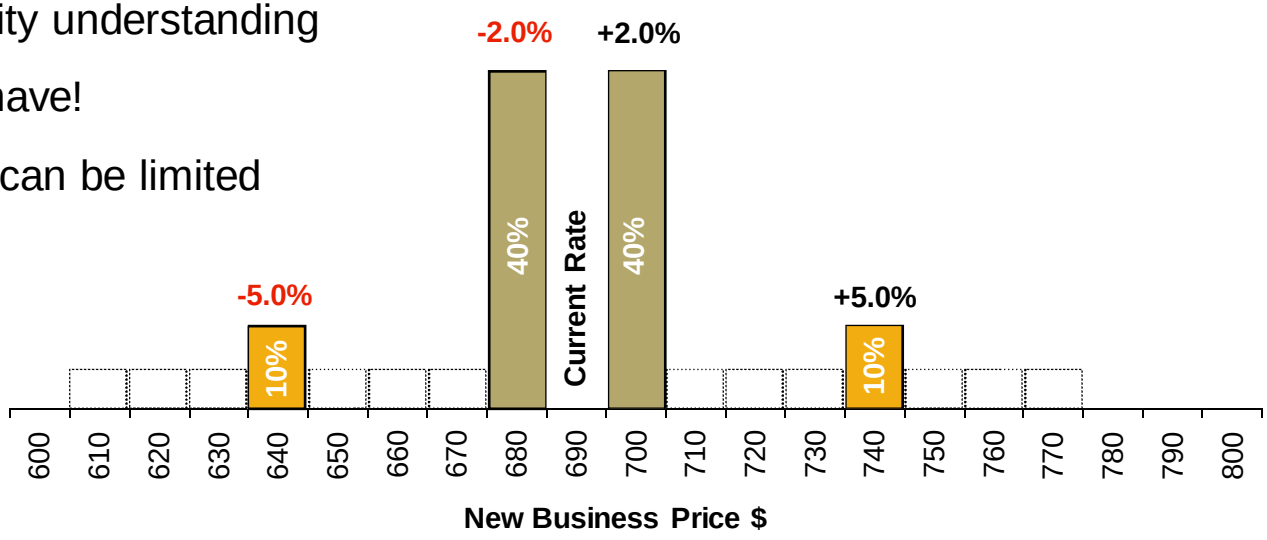
Risks


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

Price trials

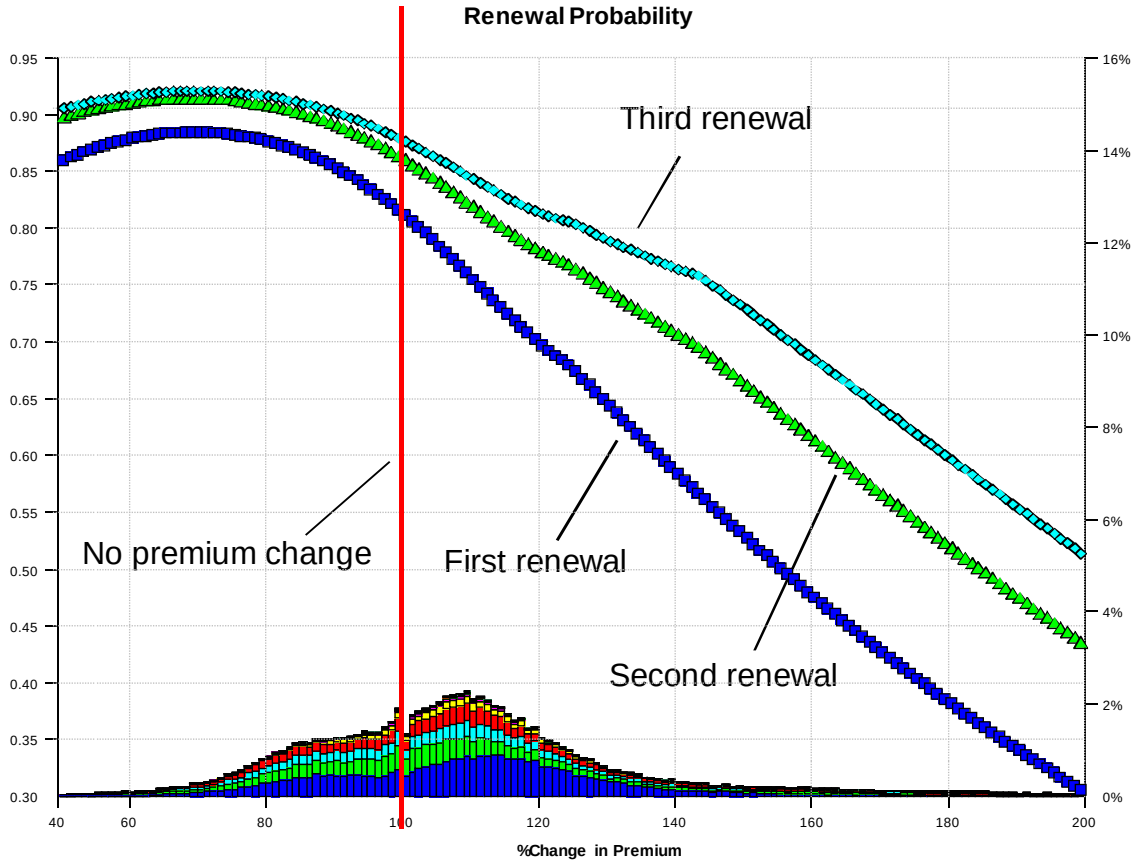
- In deregulated markets, ideally vary random sample of quotes on an ongoing basis
- In regulated markets, other standard rate changes need to act as a proxy
- Best to decorrelate from other factors as much as possible
- Geographical or vehicle reclassification can yield valuable elasticity understanding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





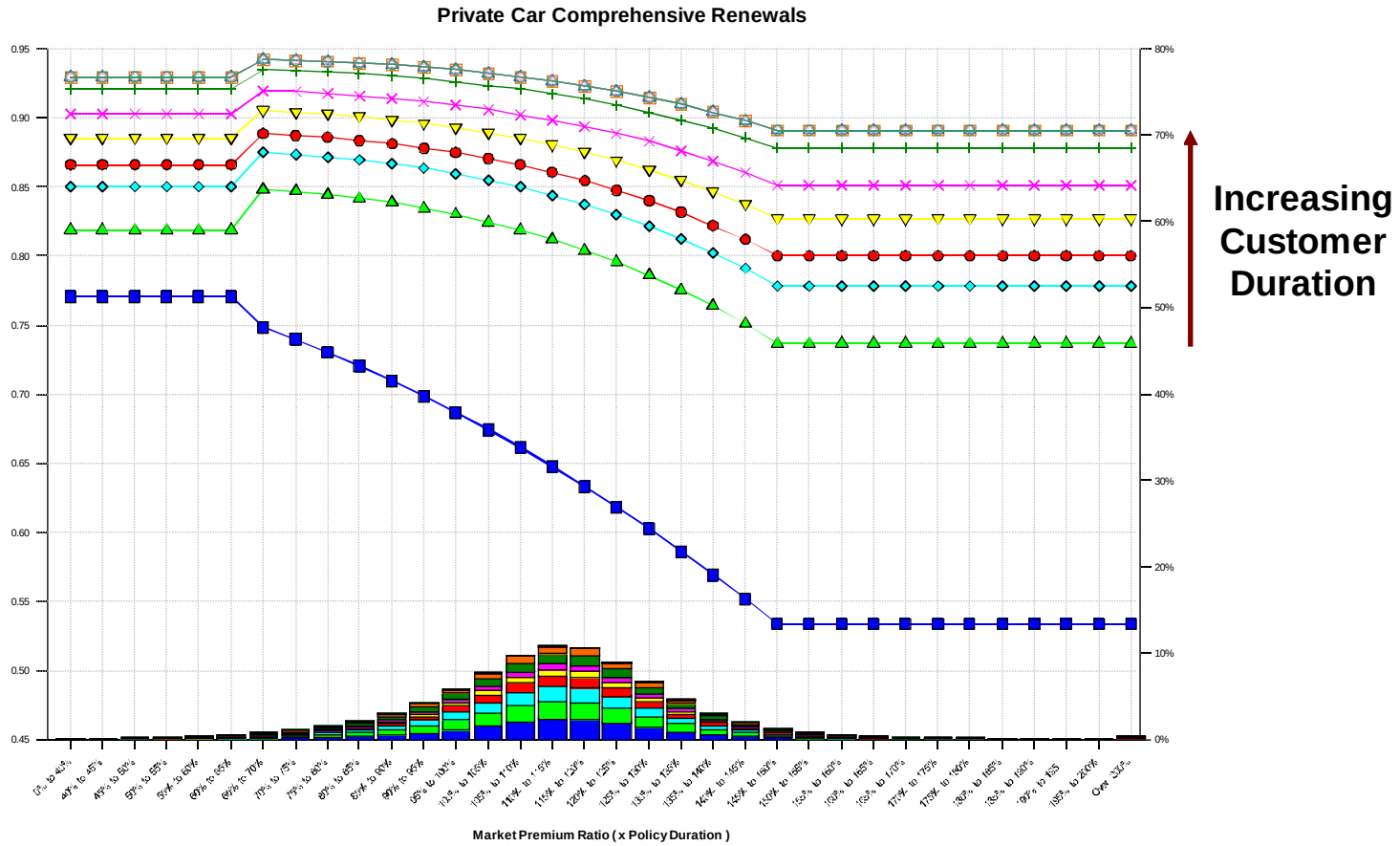
Elasticity modelling without price tests

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

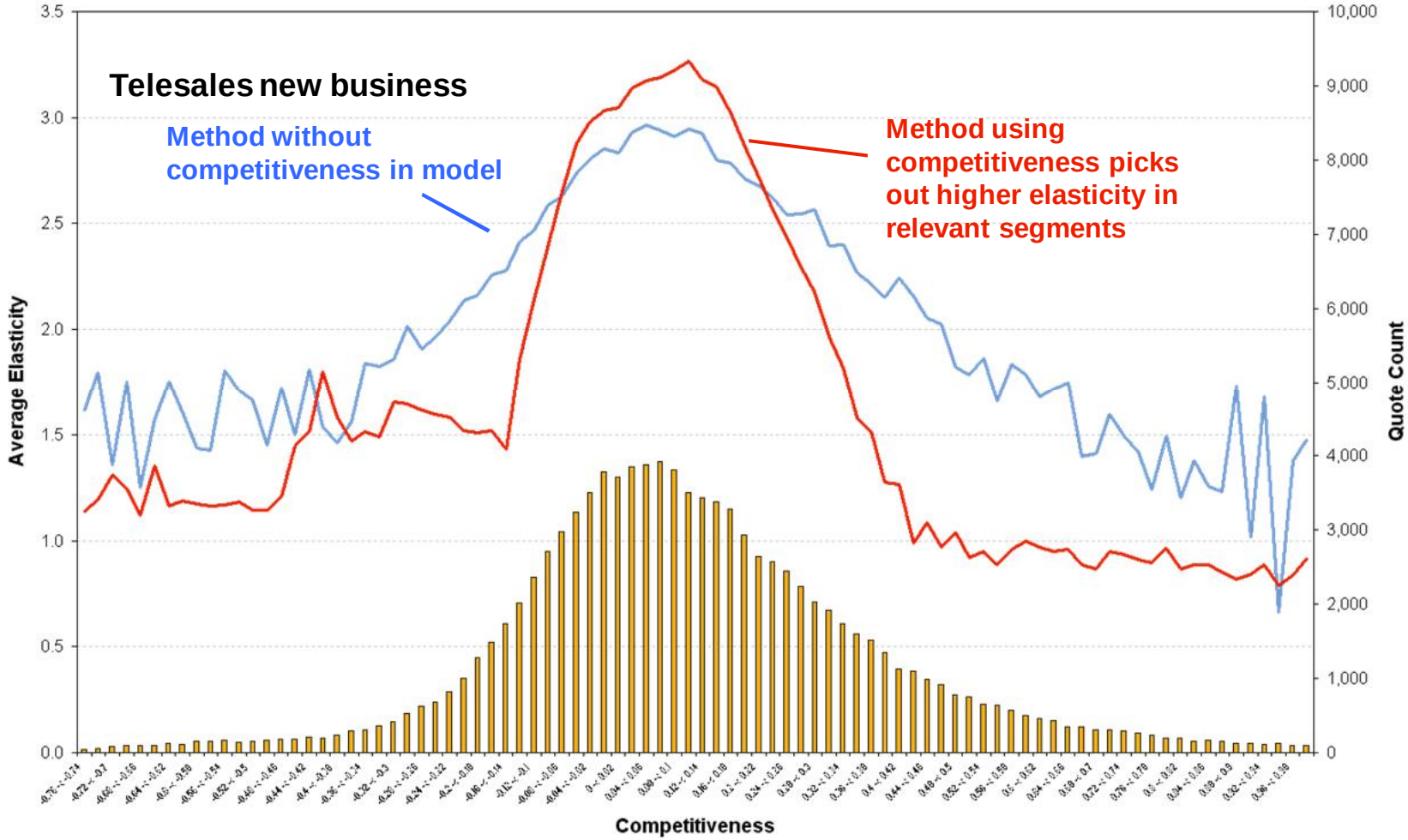


Elasticity modelling without price tests

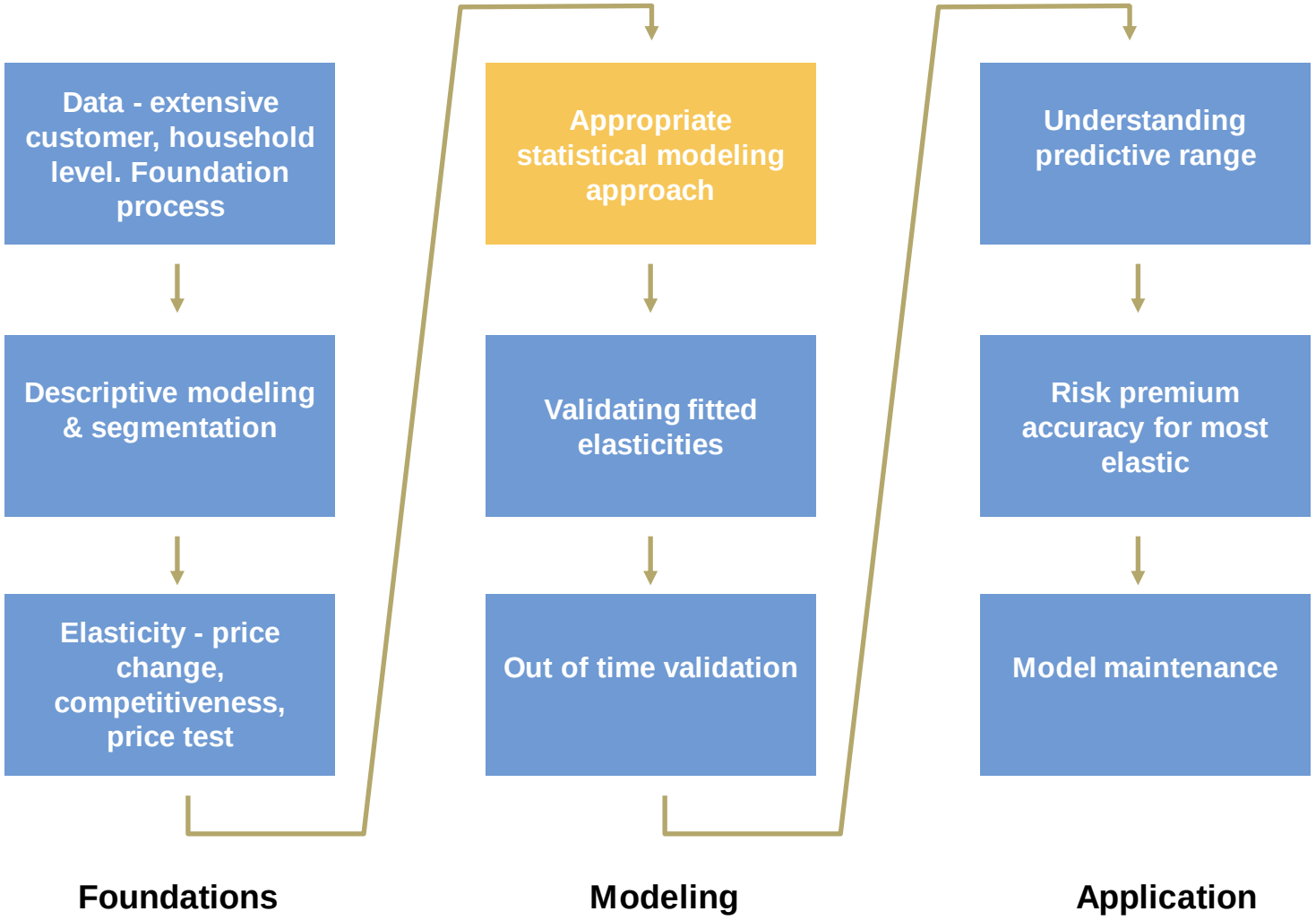
- It is possible to capture some elasticity variation just from undesigned historic price changes



Competitiveness measures

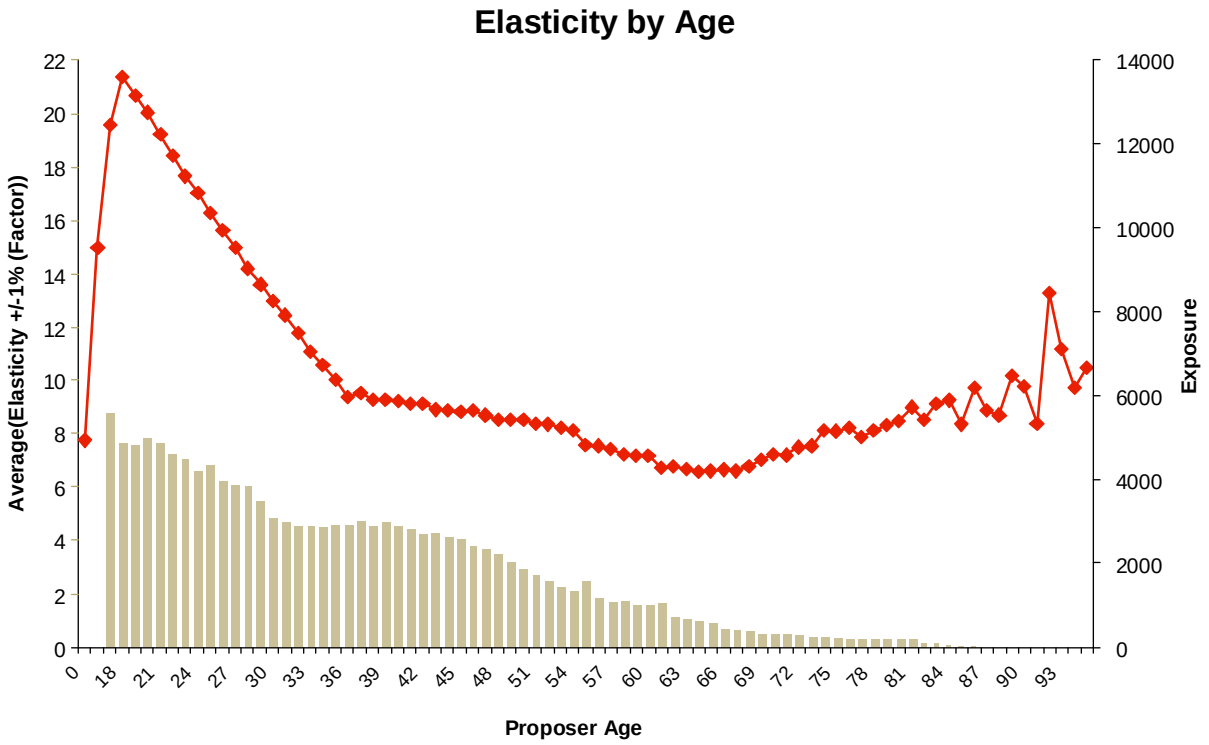


Elasticity modeling - a rigorous approach

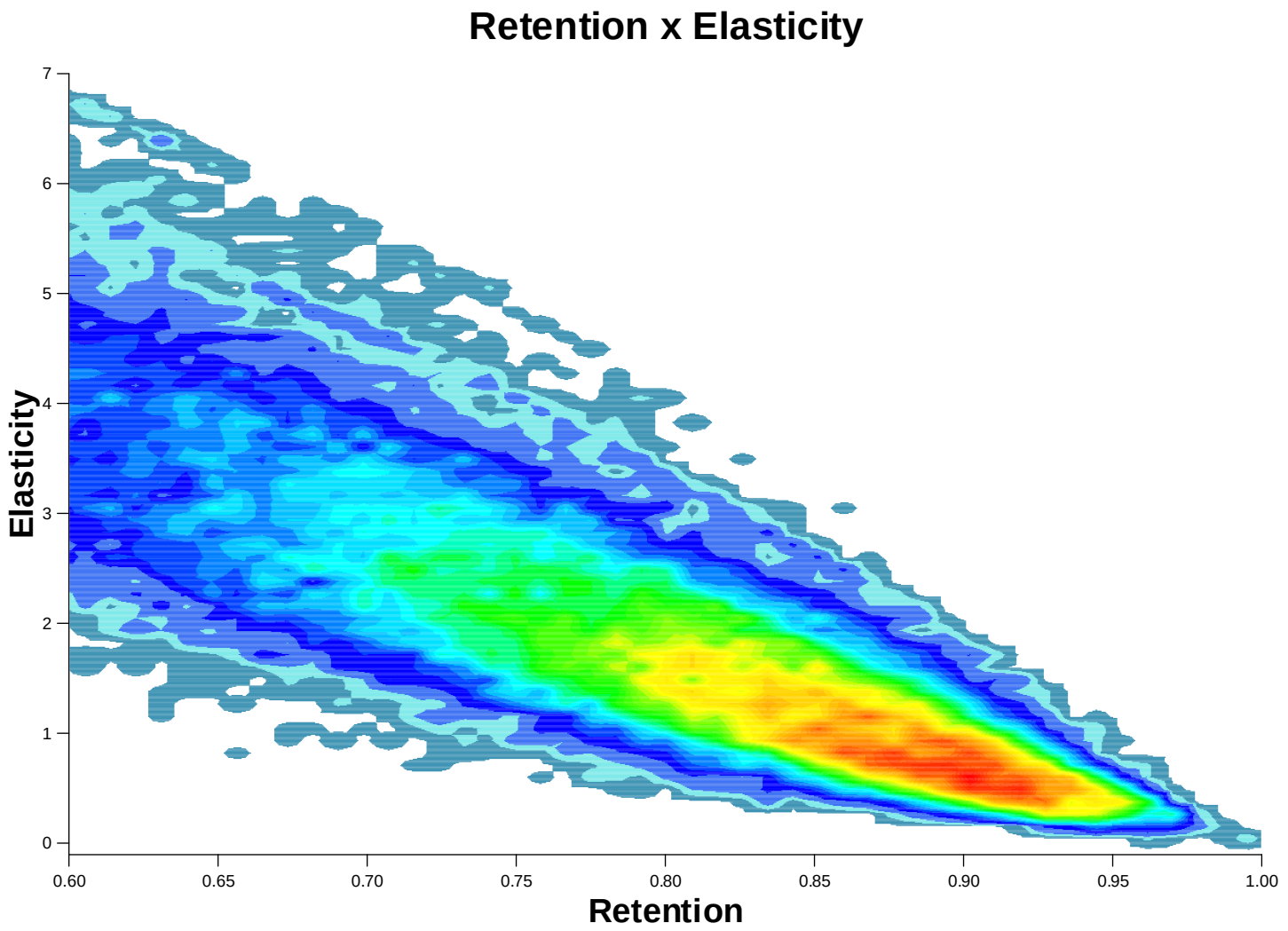


Modeling elasticity vs demand

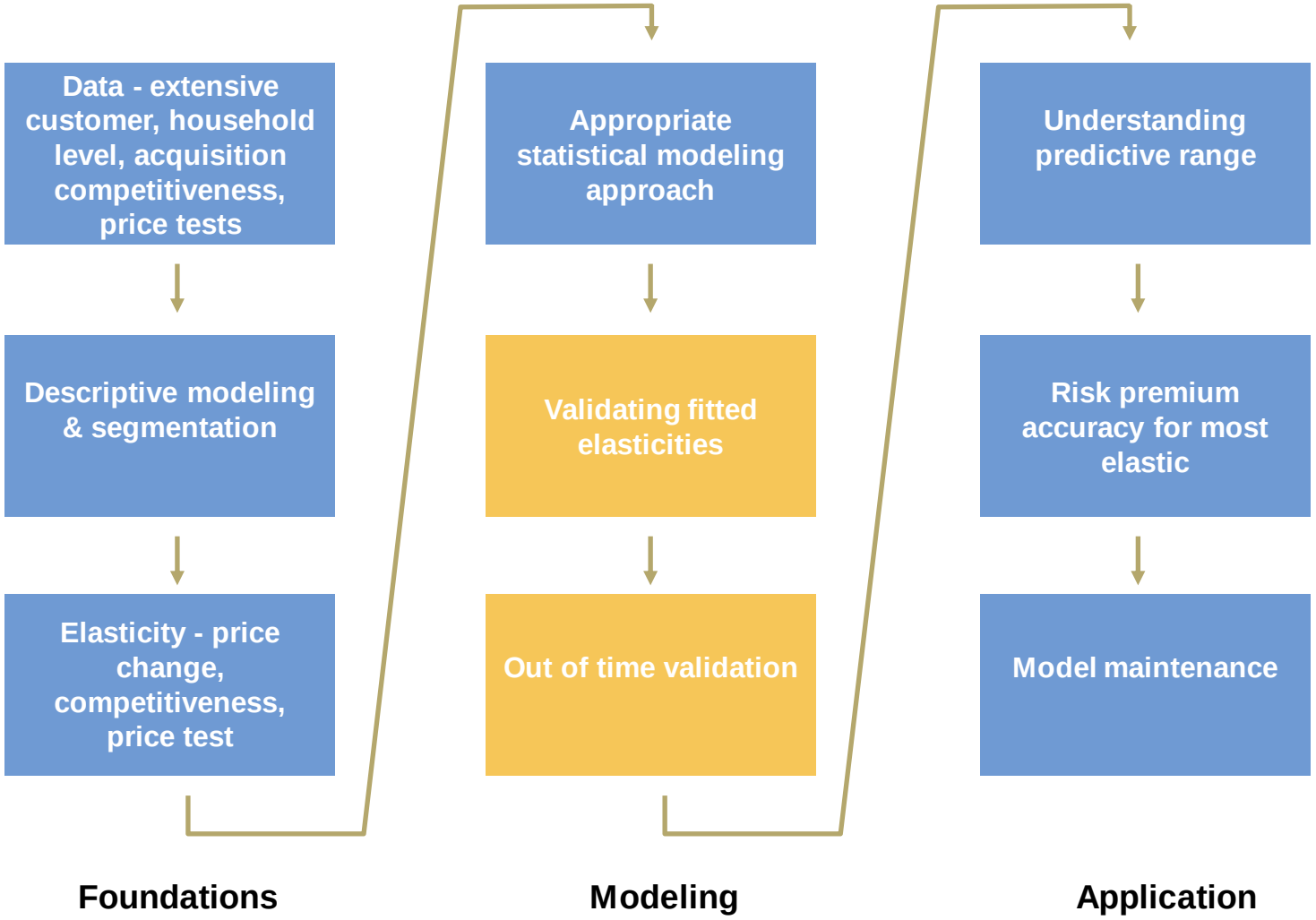
- Y-variate still "did they buy, yes/no"
- Focus on price related explanatory variables different
- Can re-express as elasticity by wobbling price explanatory variables after fitting model



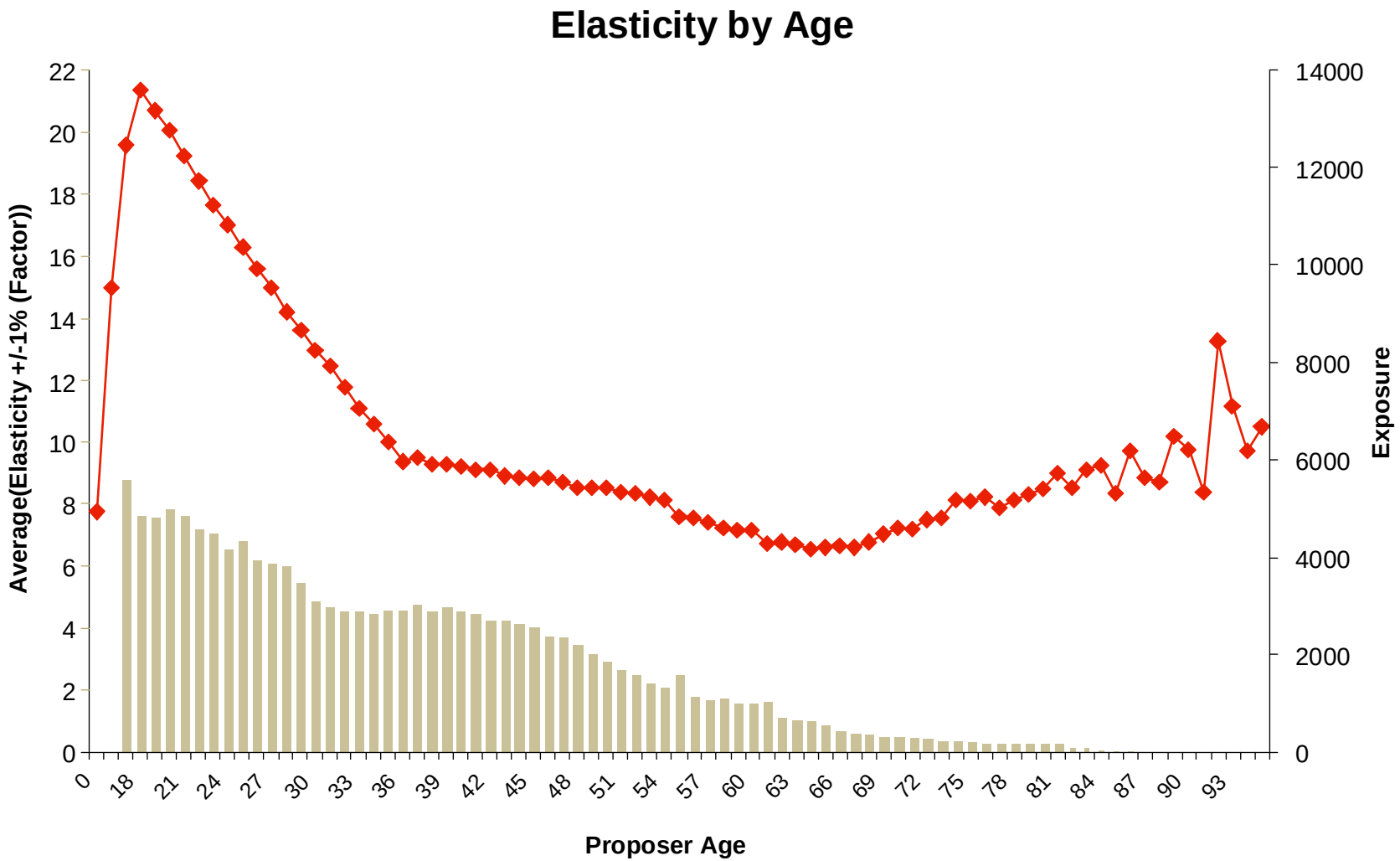
Classical elasticity and lapse rate – example XY plot



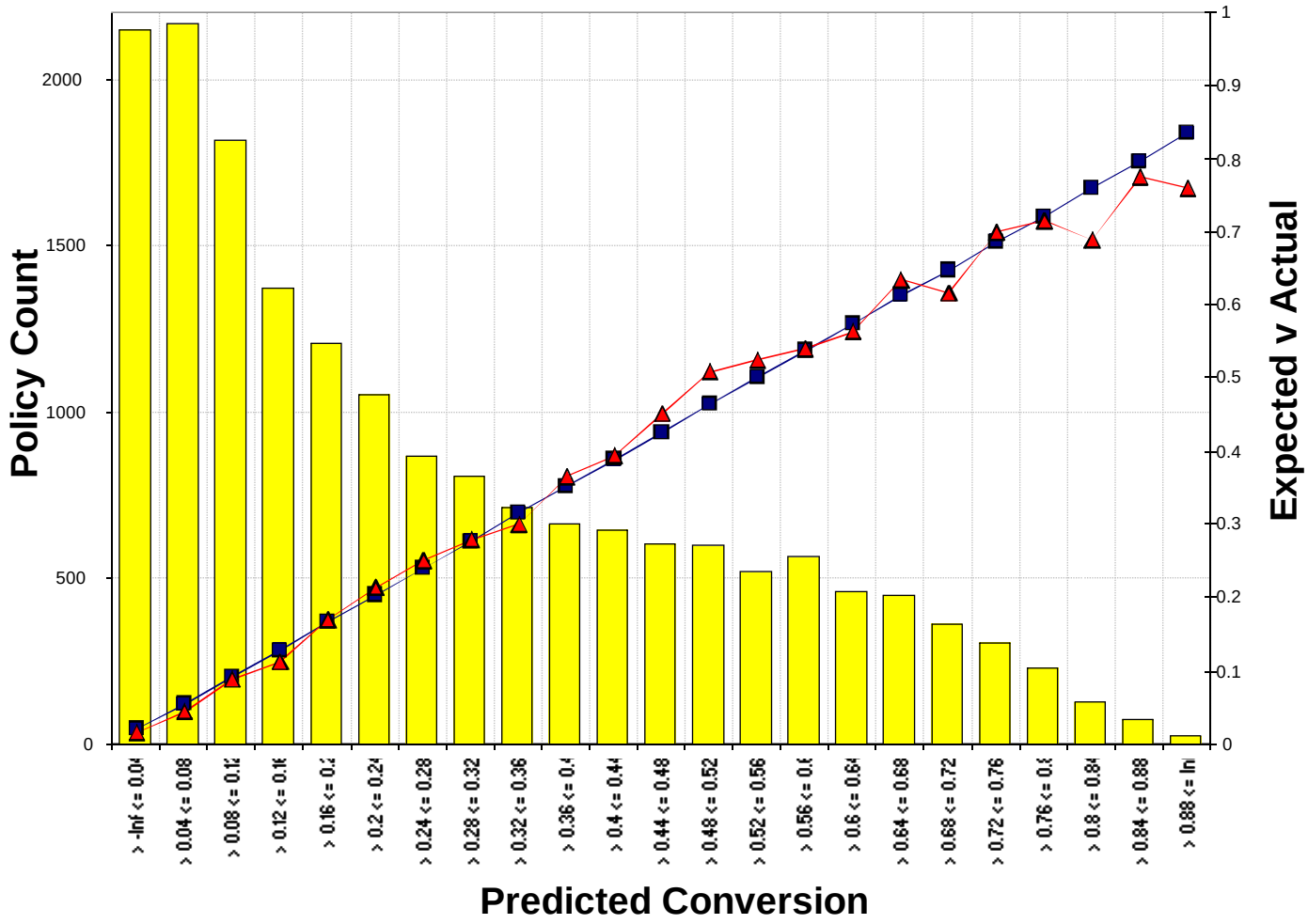
Elasticity modeling - a rigorous approach



Checking modeled elasticity

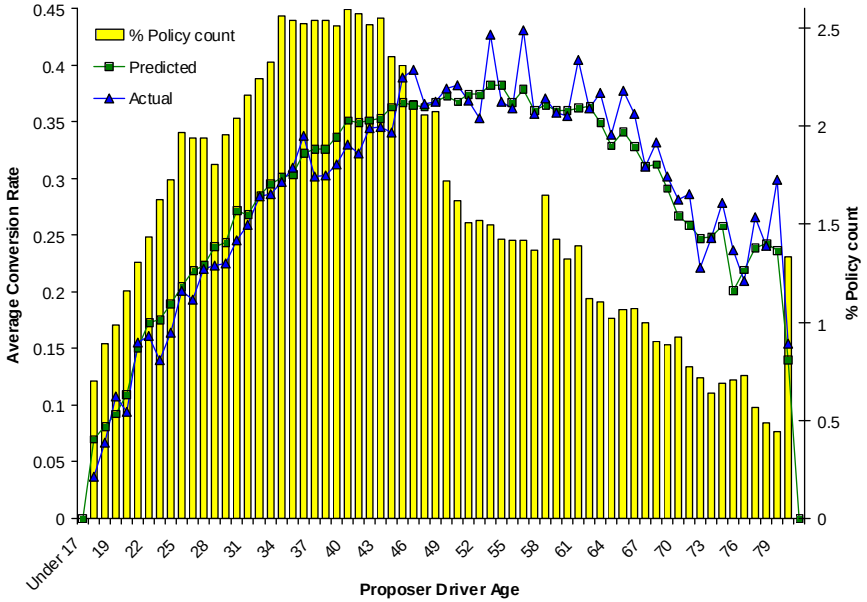


New business - out of time validation

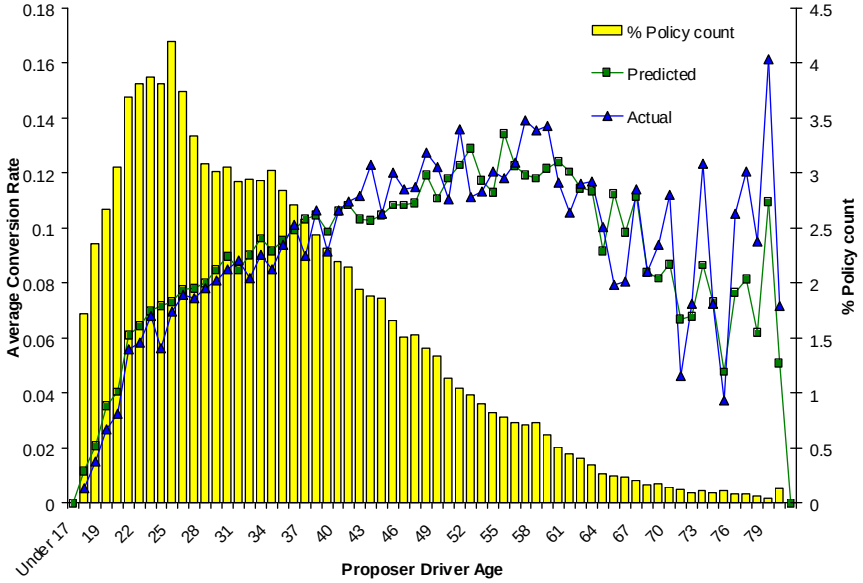


New business - out of time validation

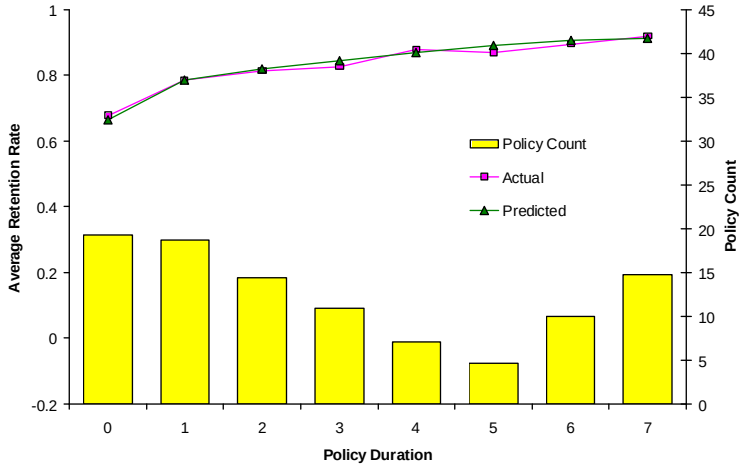
Phone

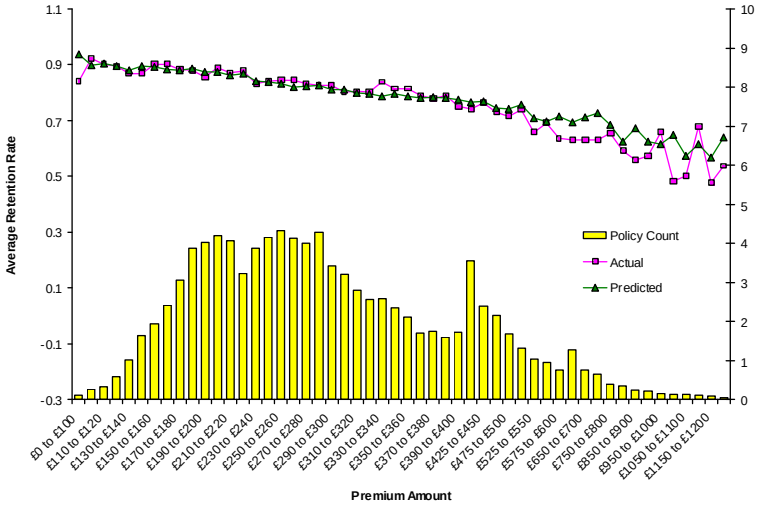


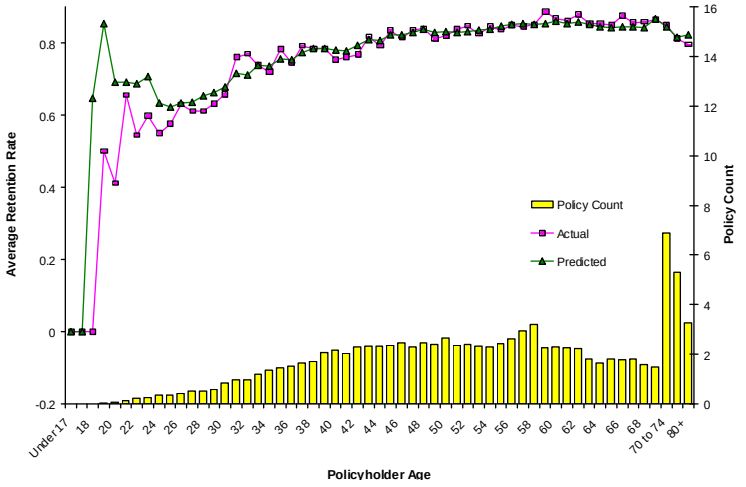
Web

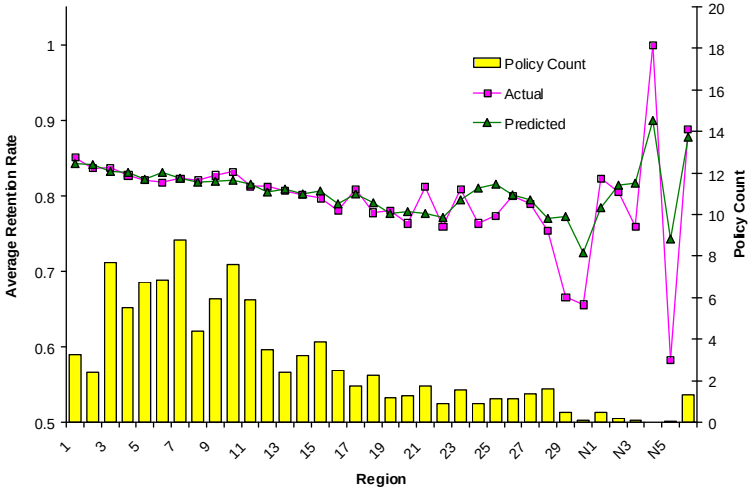


Renewals - out of time validation

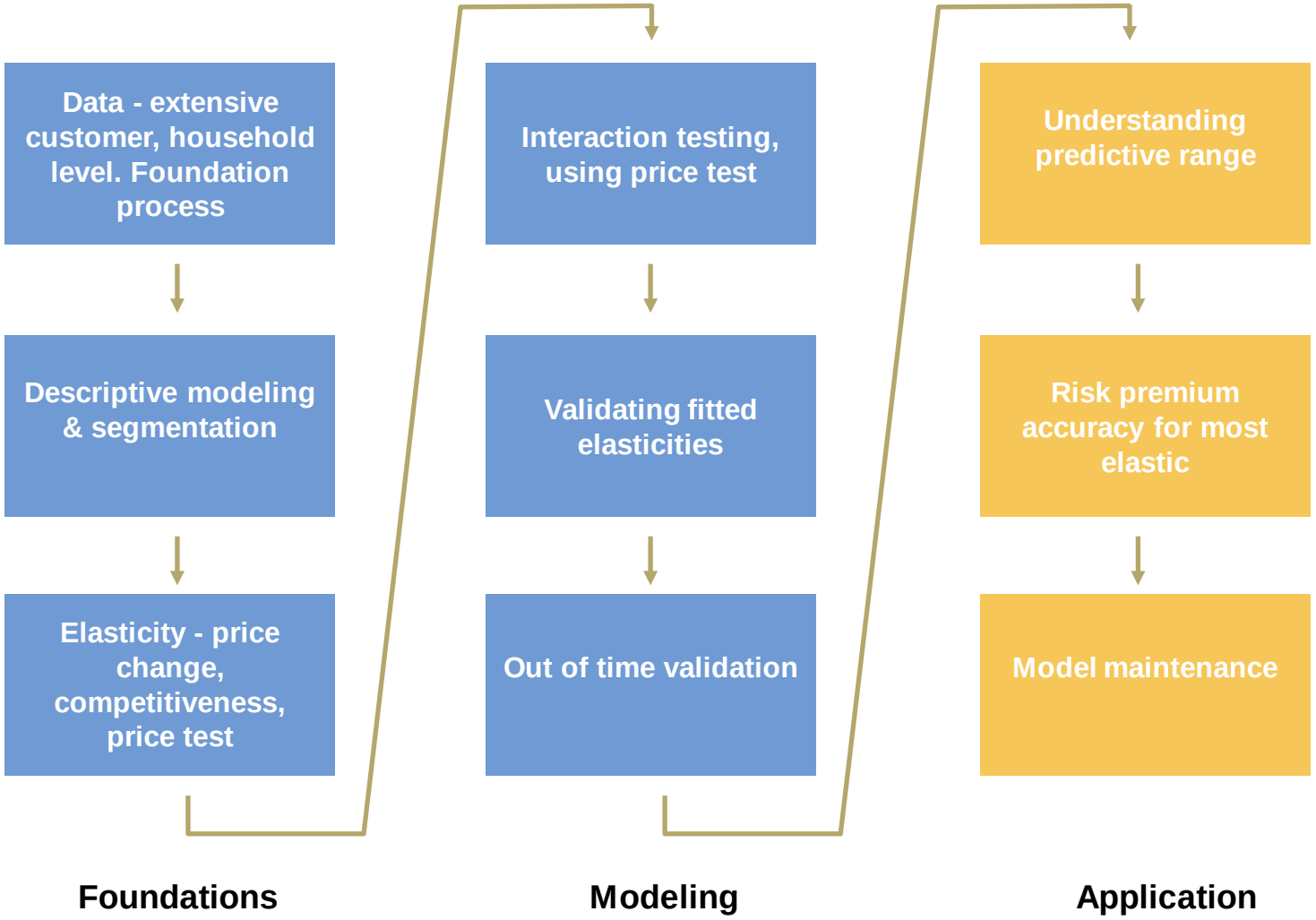




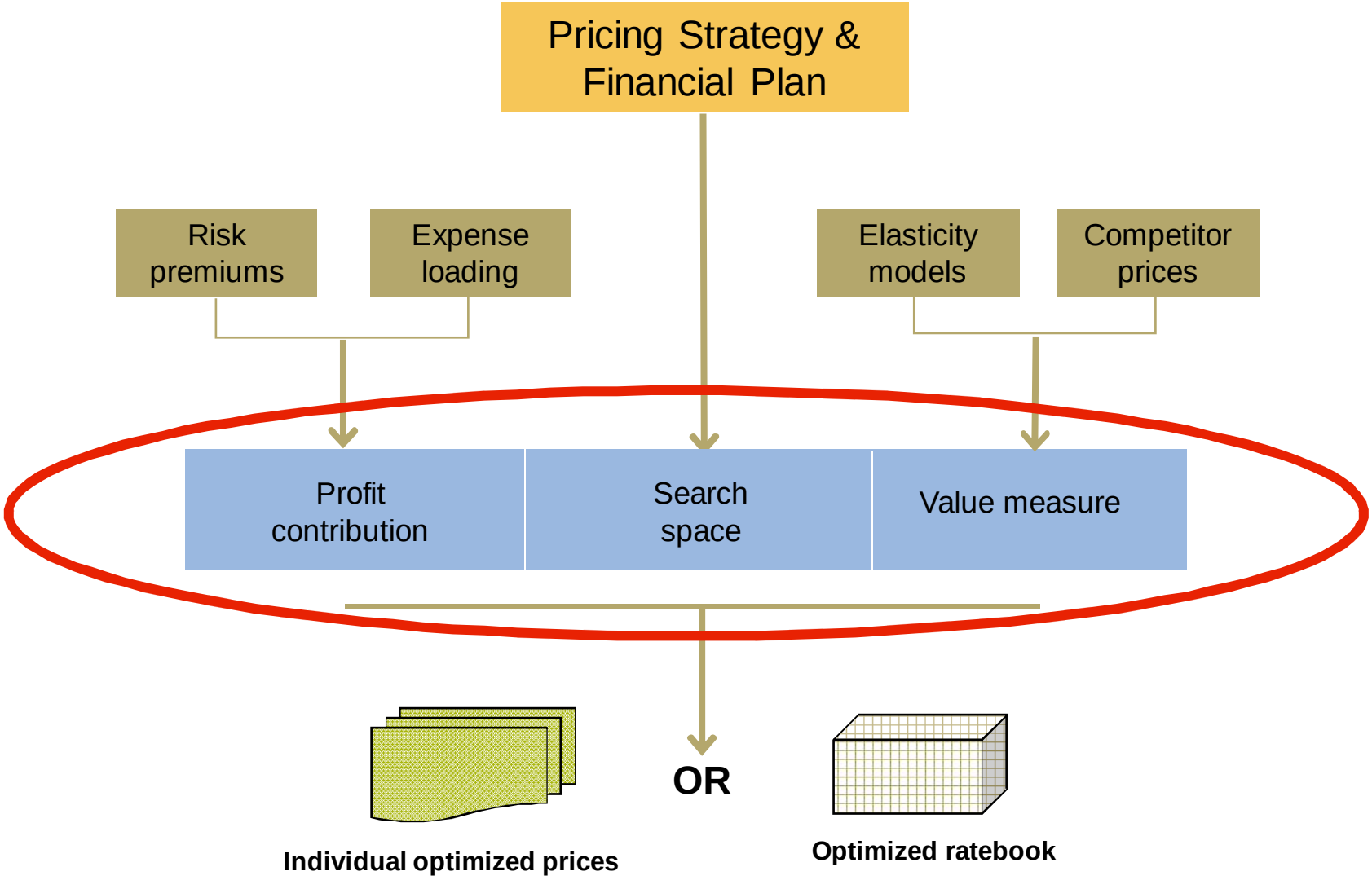




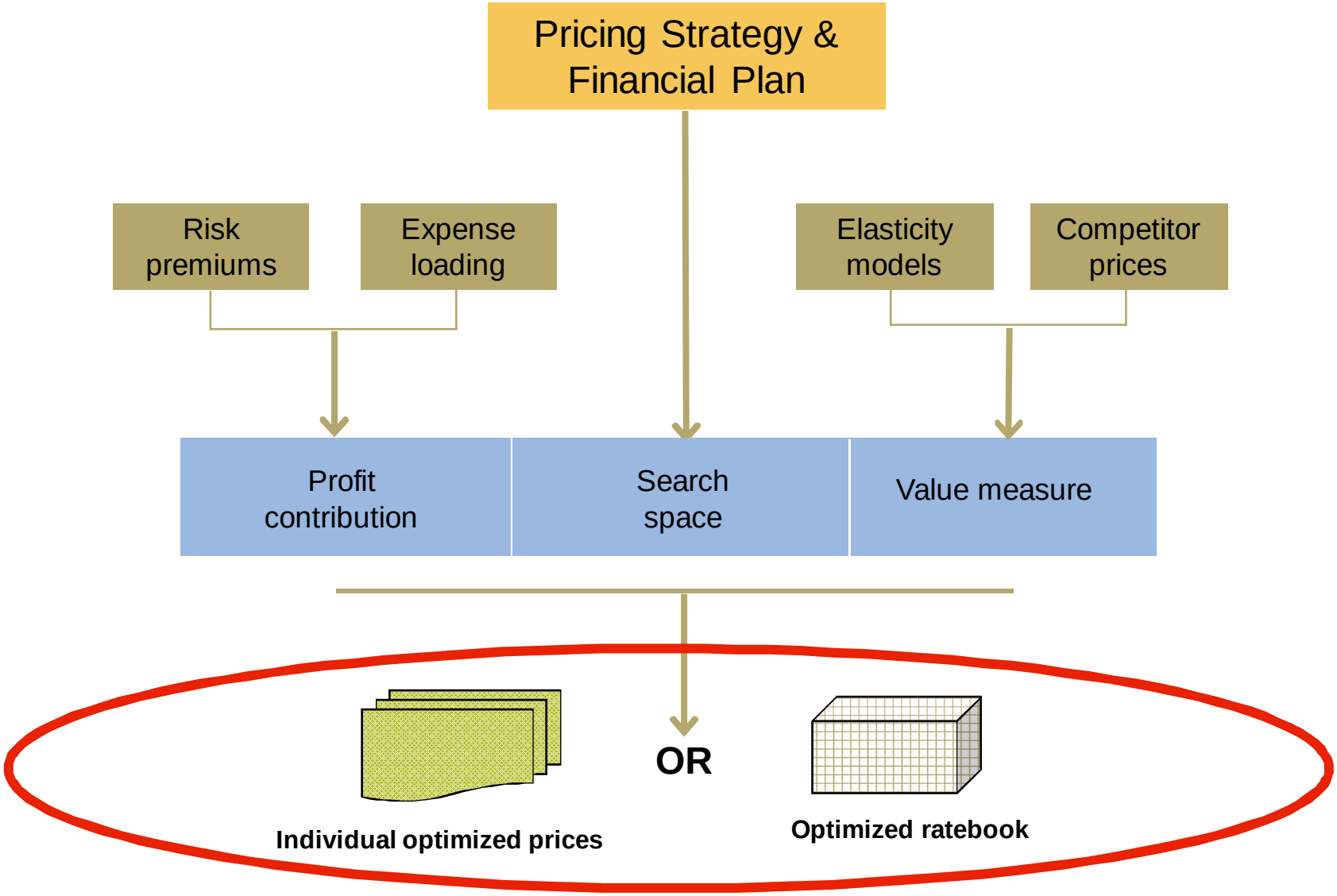
Elasticity modeling - a rigorous approach



Price optimization



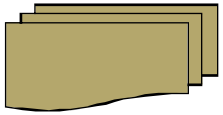
Price optimization



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 ✗

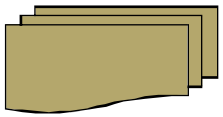
1 - Individual policy optimization



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

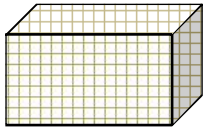


Individual optimized prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
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

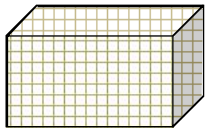
Fit model to results to yield traditional rating structure

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
…	

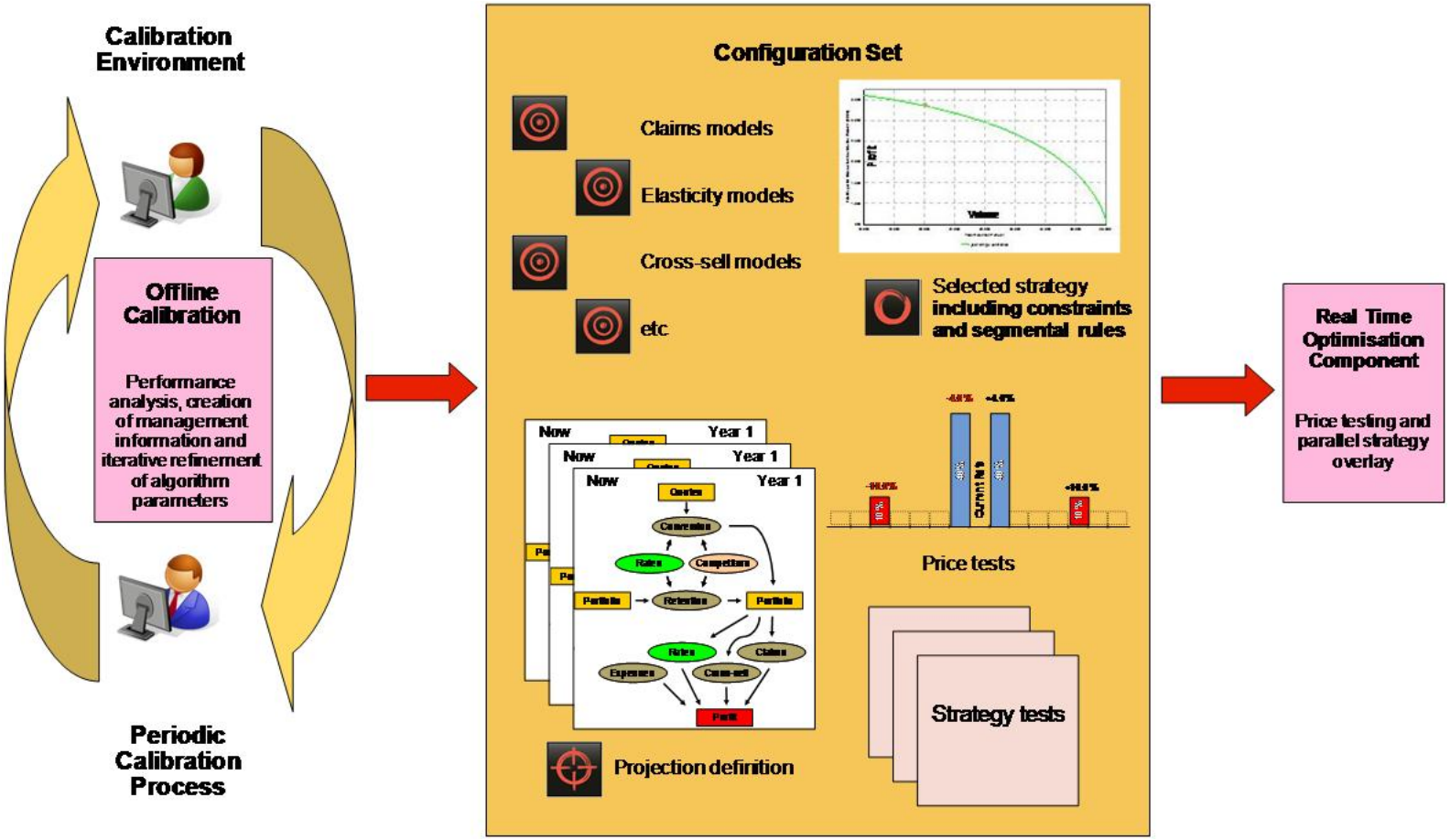
Vehicle	
1	0.56
2	0.68
3	0.82
4	0.91
5	0.98
6	1.00
7	1.11
8	1.16
9	1.19
10	1.25
11	1.34
12	1.43
…	

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
…	

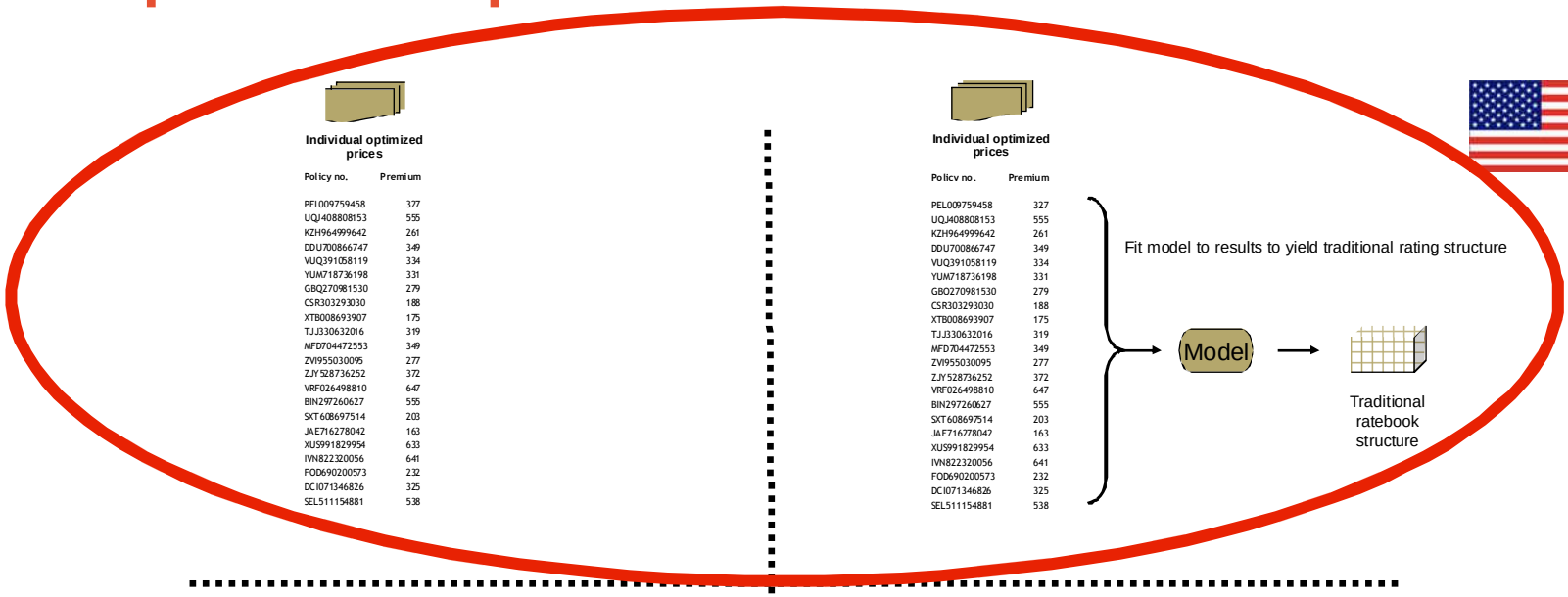
Etc
…

Etc
…

4 - Real Time Optimization

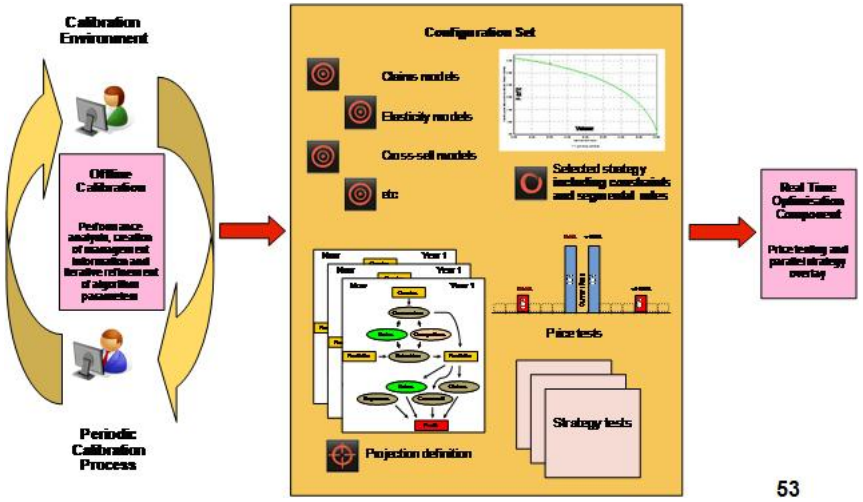


Four options for optimization

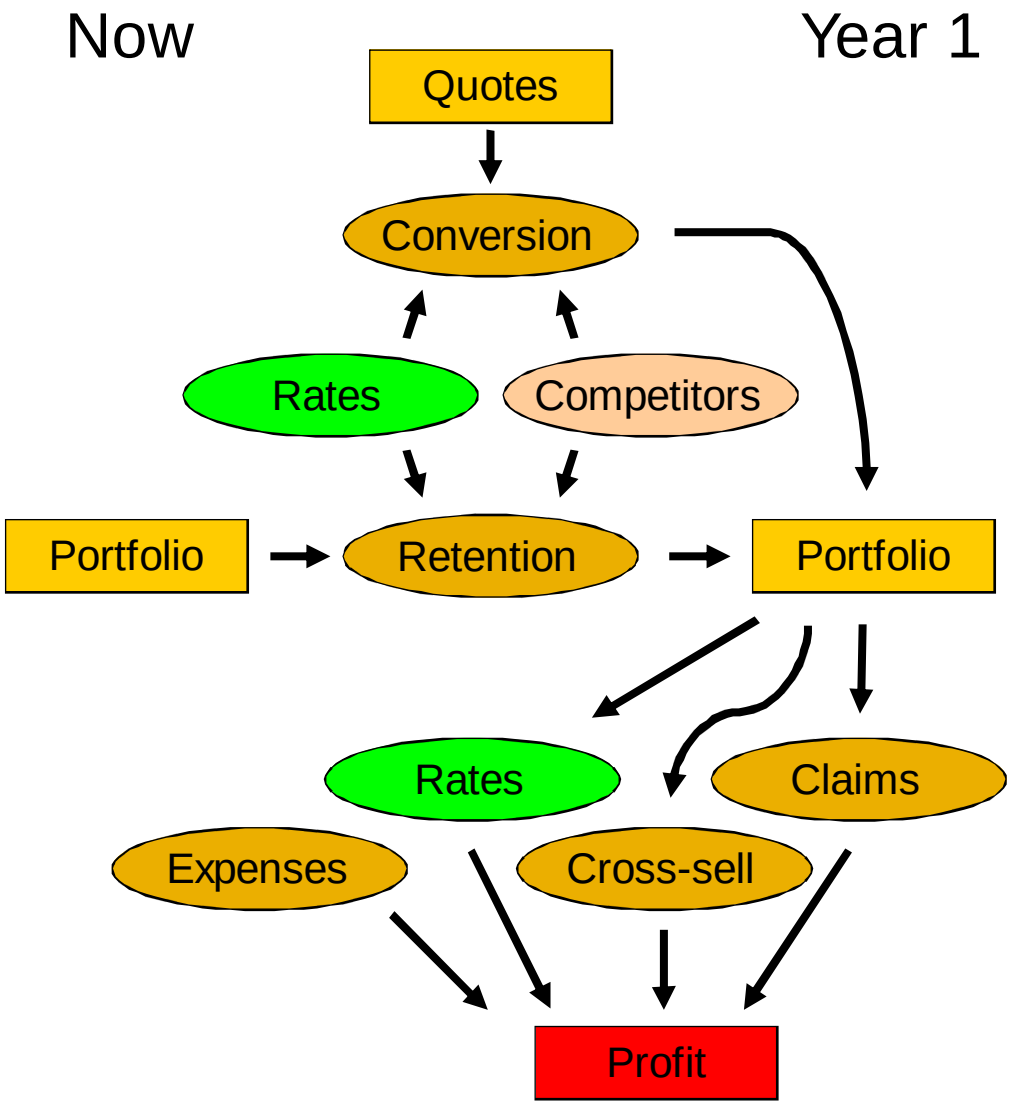


Traditional ratebook structure

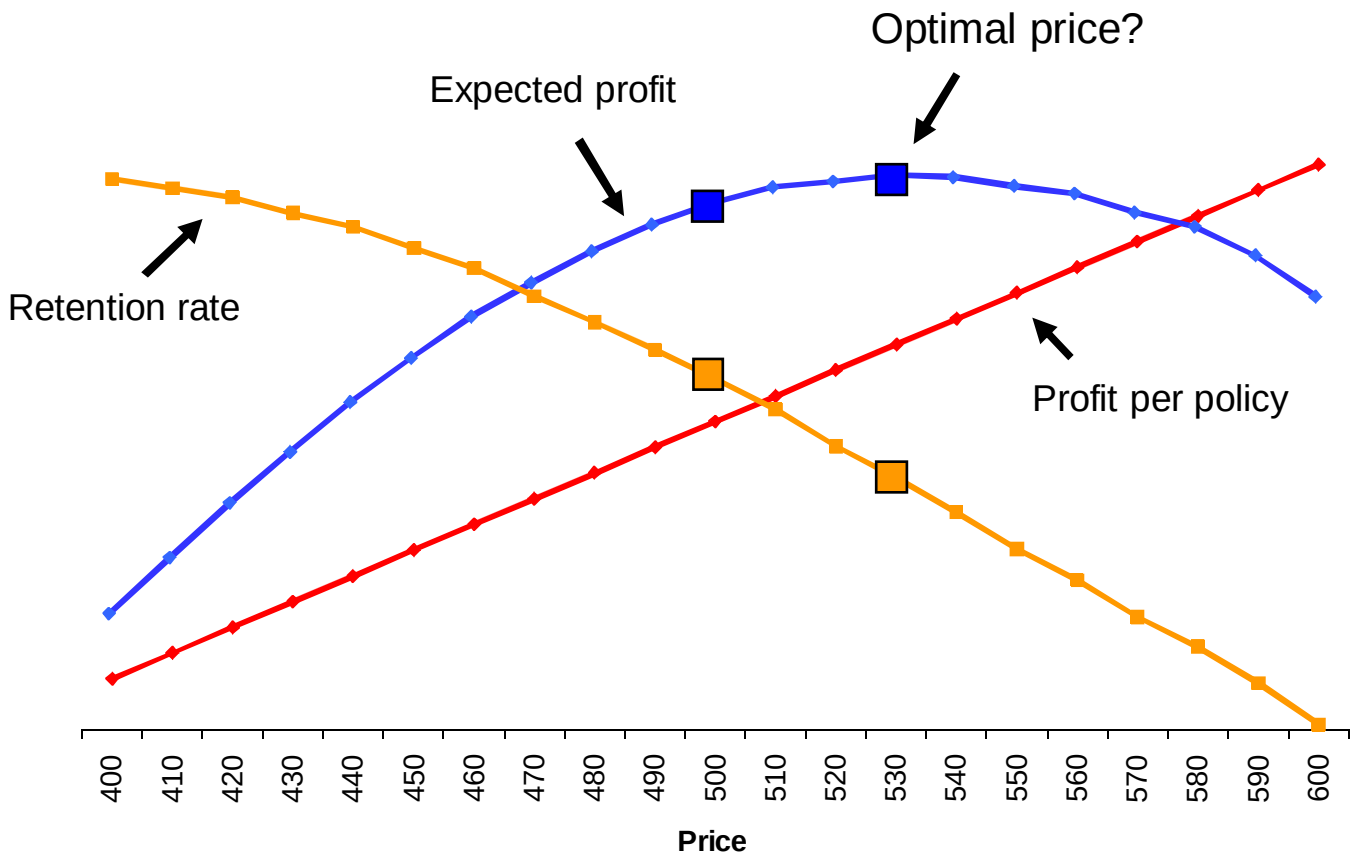
Base $445									
Age		Vehicle		Area		Etc	Etc
16	1.89	1	0.56	1	0.46	…	…
17	1.78	2	0.68	2	0.58		
18	1.65	3	0.82	3	0.72		
19	1.54	4	0.91	4	0.81		
20	1.43	5	0.98	5	0.90		
21	1.30	6	1.00	6	0.95		
22	1.28	7	1.11	7	1.01		
23	1.16	8	1.16	8	1.11		
24	1.10	9	1.19	9	1.18		
25	1.05	10	1.25	10	1.21		
26	1.04	11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



Projection

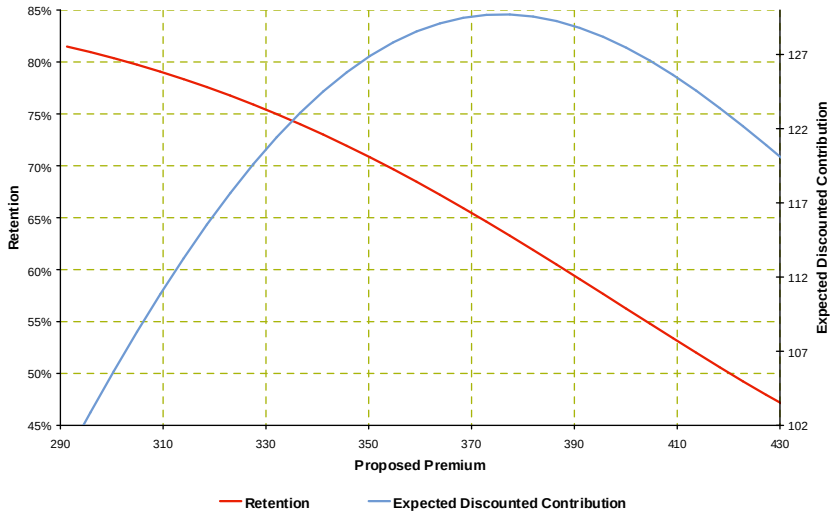

Now
Year 1
Quotes
Conversion
Rates
Competitors
Portfolio
Retention
Portfolio
Rates
Claims
Expenses
Cross-sell
Profit

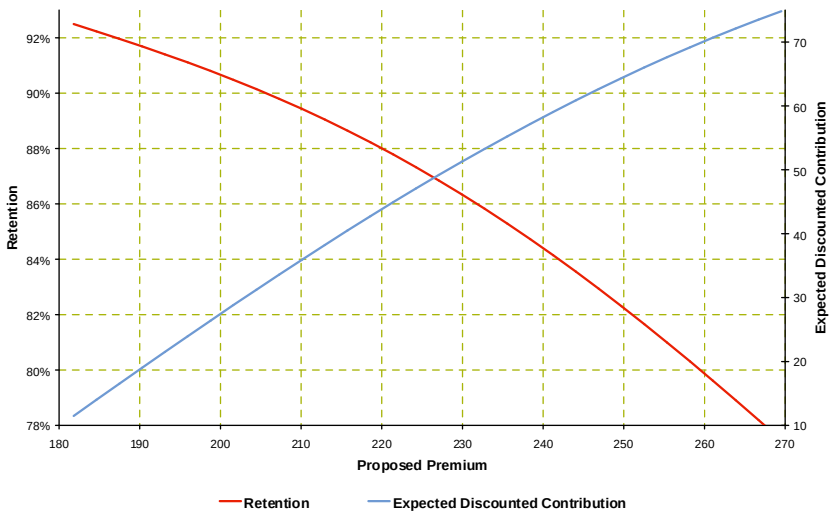
Results for one policy

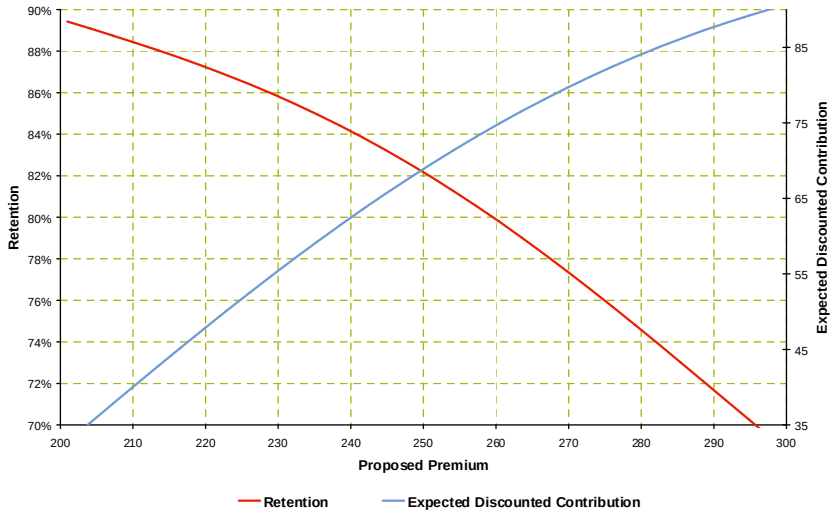


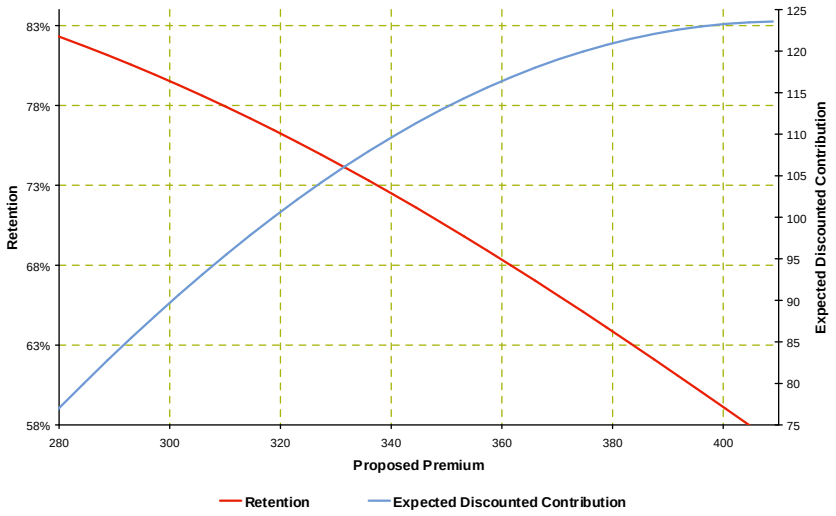
Premium for policy in question

Results for four policies







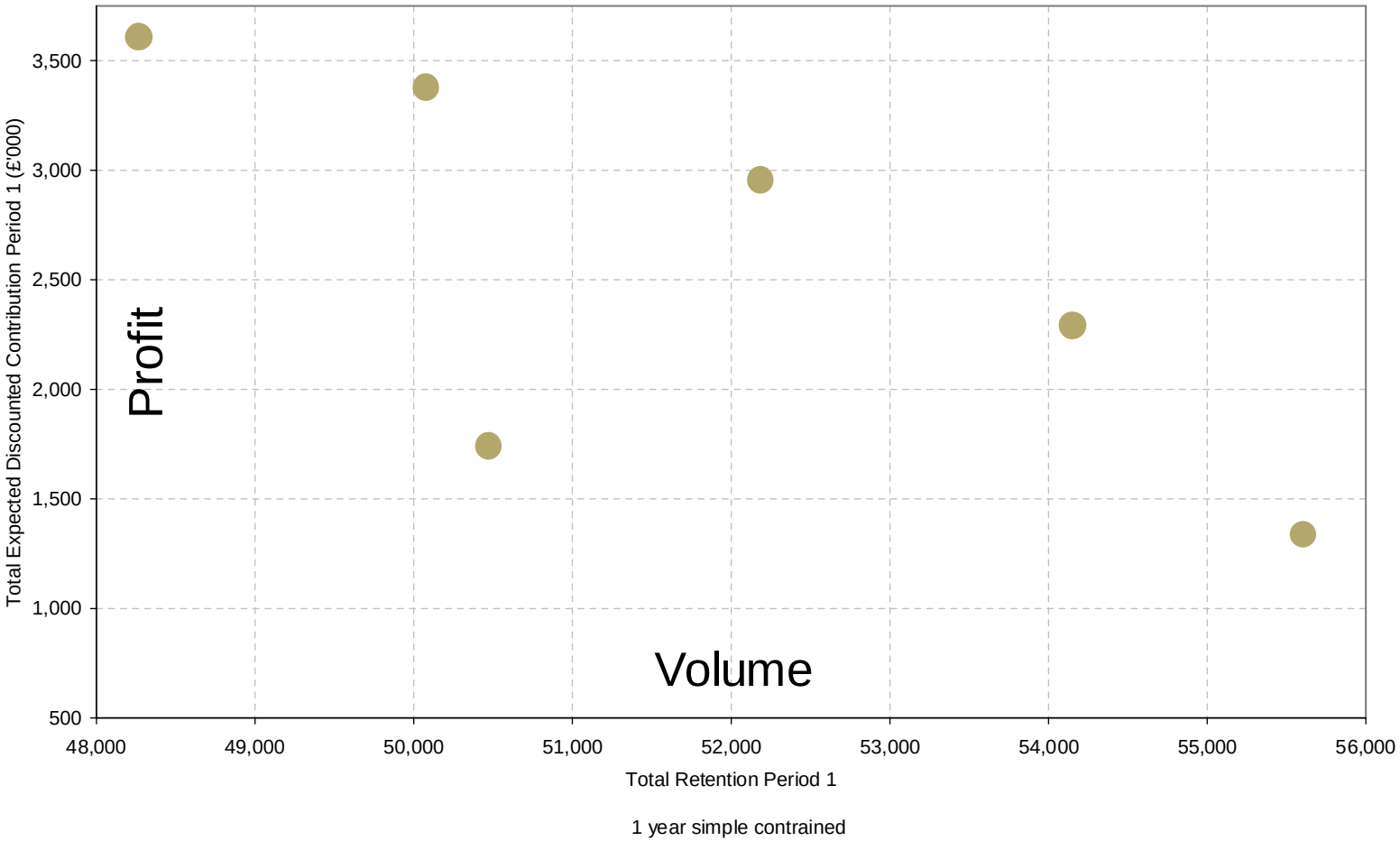


Balancing profit and volume

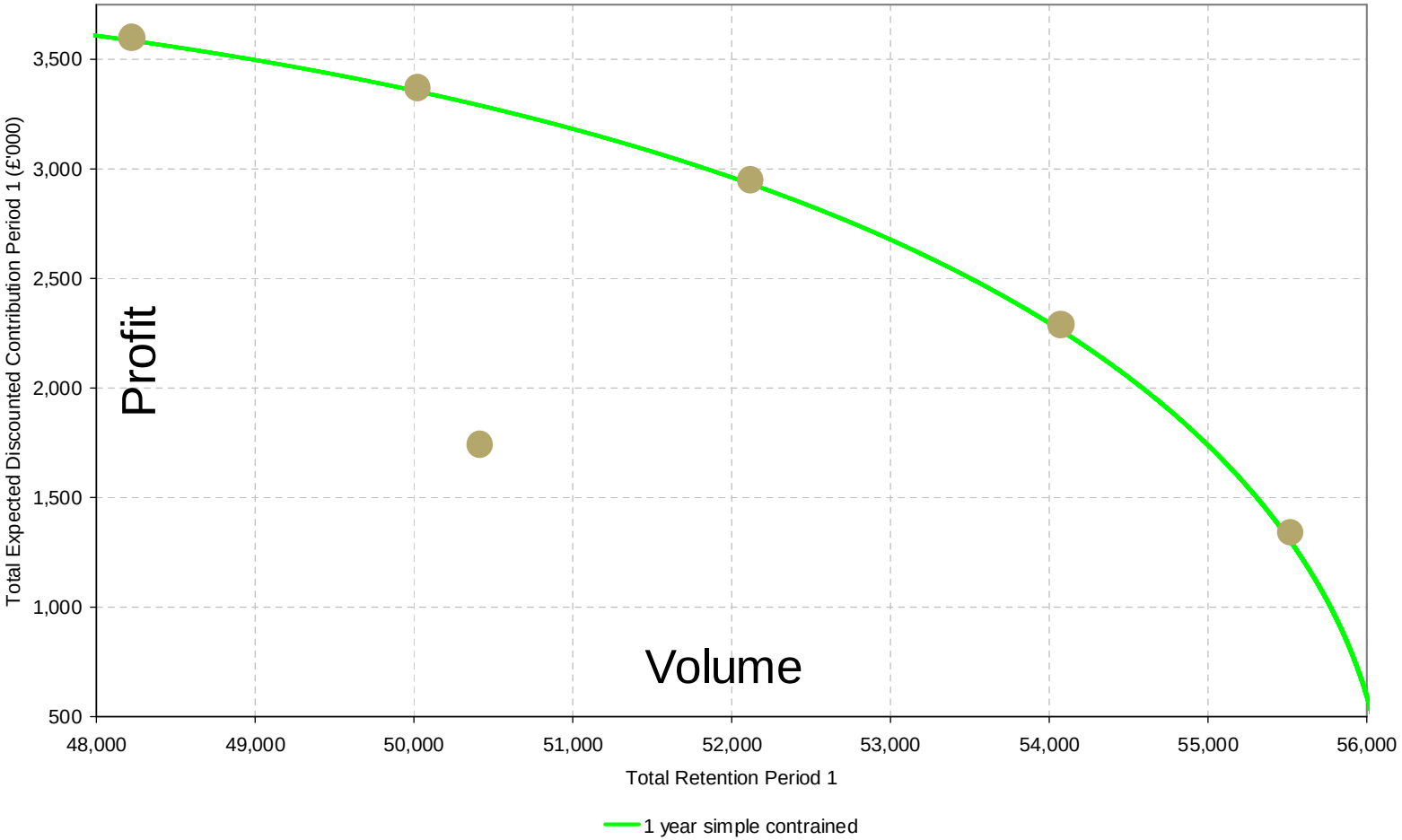
- Can optimize
  - profit for a particular volume, or
  - volume for a particular profit

  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

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

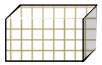
Individual optimized prices

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

Fit model to results to yield traditional rating structure

Model

Traditional ratebook structure



Traditional ratebook structure

Base $445

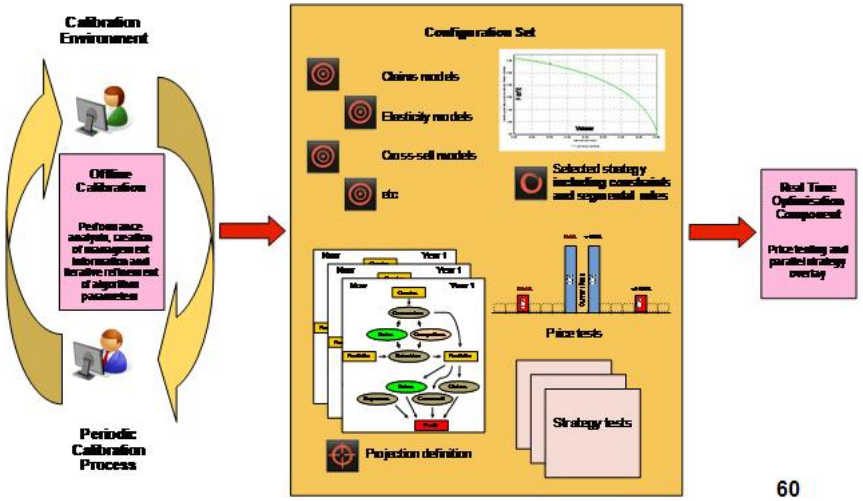
Age	
16	1.89
17	1.78
18	1.65
19	1.54
20	1.43
21	1.30
22	1.28
23	1.16
24	1.10
25	1.05
26	1.04
27	1.03
…	

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
…	

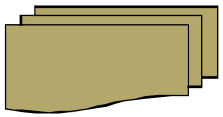
Area	
1	0.46
2	0.58
3	0.72
4	0.81
5	0.90
6	0.95
7	1.01
8	1.11
9	1.18
10	1.21
11	1.33
12	1.49
…	

Etc
…

Etc
…



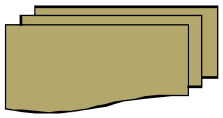
Re-expressing in ratebook form



Individual optimized prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
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

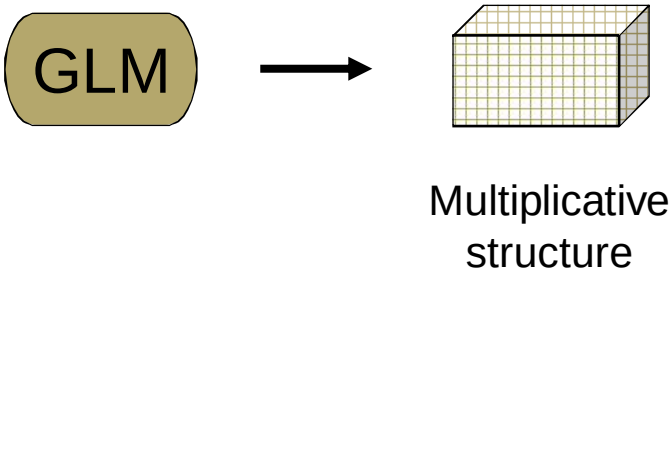
Re-expressing in ratebook form



Individual optimized prices

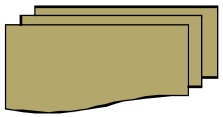
Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
XTB008693907	175
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
ZJY528736252	372
VRF026498810	647
BIN297260627	555
SXT608697514	203
JAE716278042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

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



Multiplicative structure

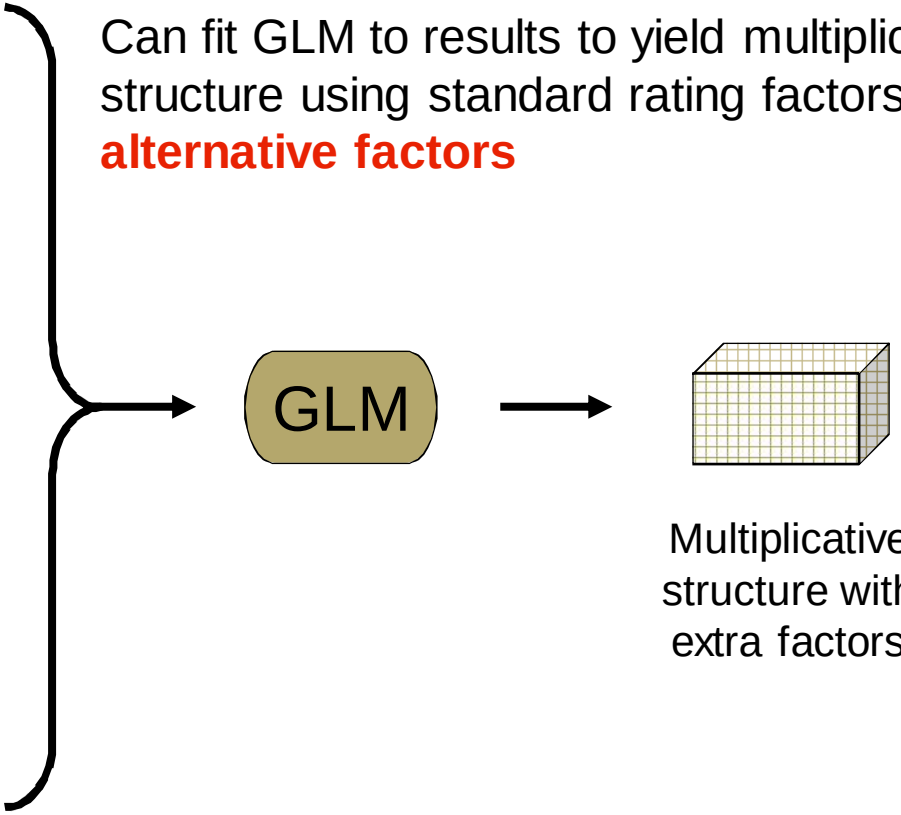
Re-expressing in ratebook form



Individual optimized Prices

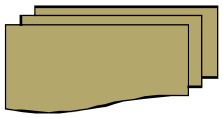
Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
XTB008693907	175
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
ZJY528736252	372
VRF026498810	647
BIN297260627	555
SXT608697514	203
JAE716278042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

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



Multiplicative structure with extra factors

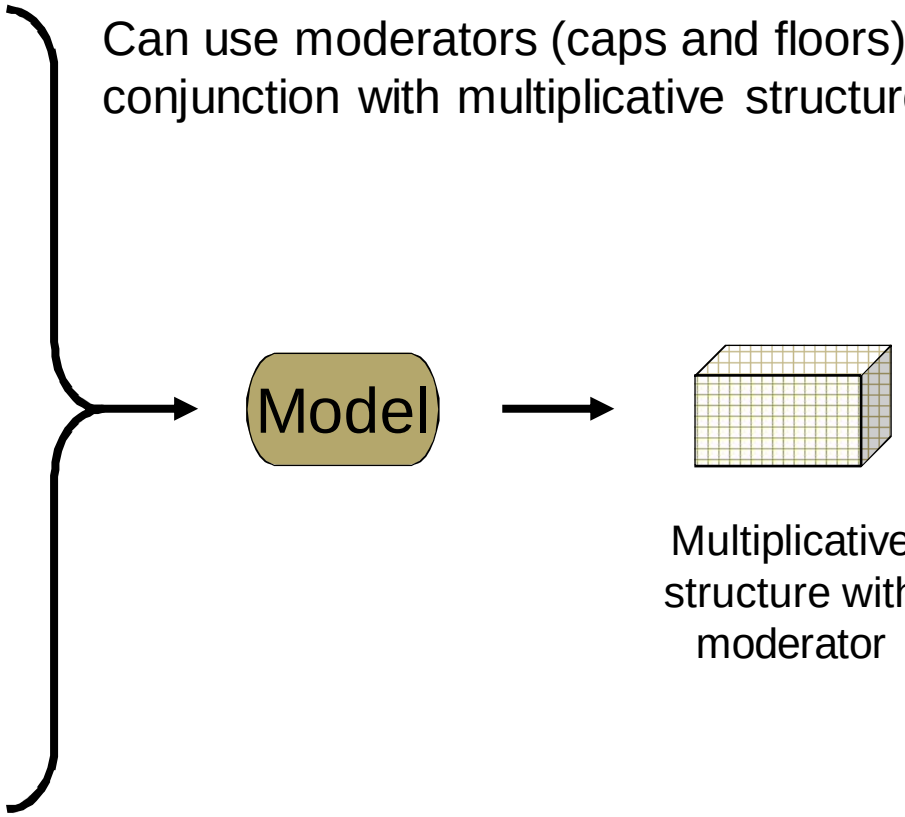
Re-expressing in ratebook form



Individual optimized Prices

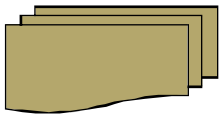
Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
XTB008693907	175
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
ZJY528736252	372
VRF026498810	647
BIN297260627	555
SXT608697514	203
JAE716278042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

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



Multiplicative structure with moderator

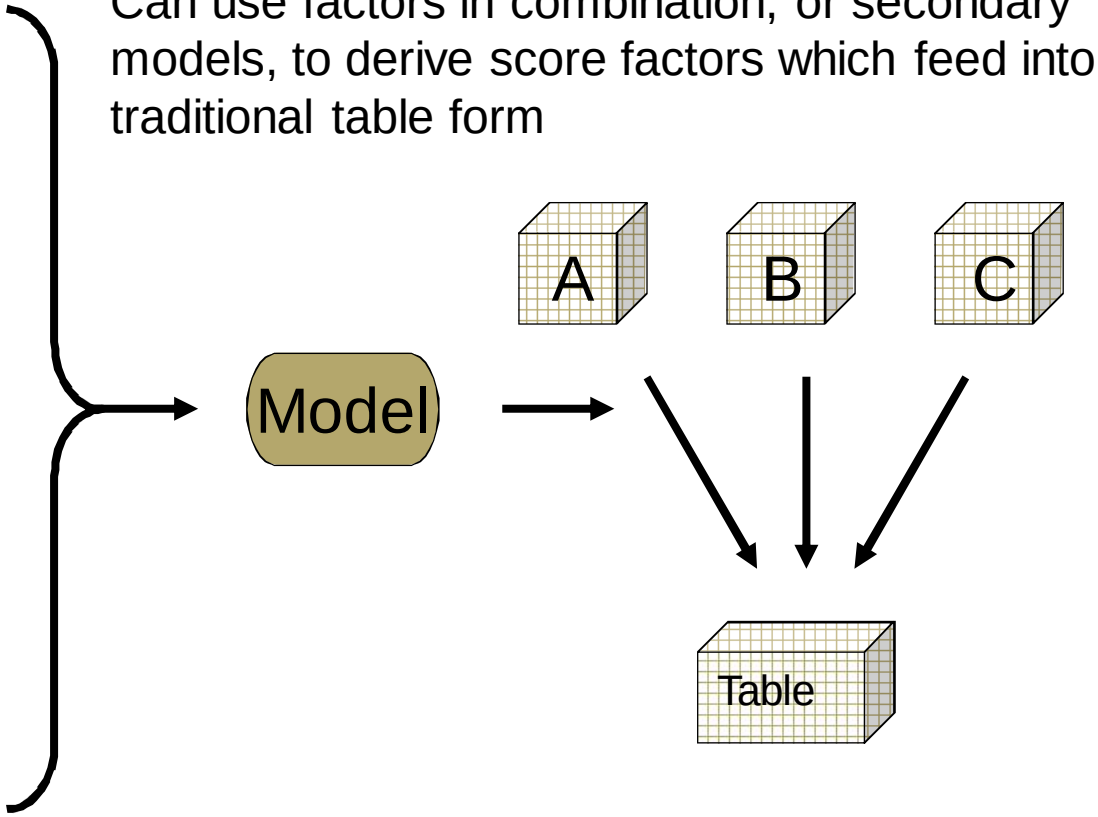
Re-expressing in ratebook form



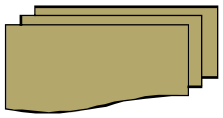
Individual optimized Prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
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

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



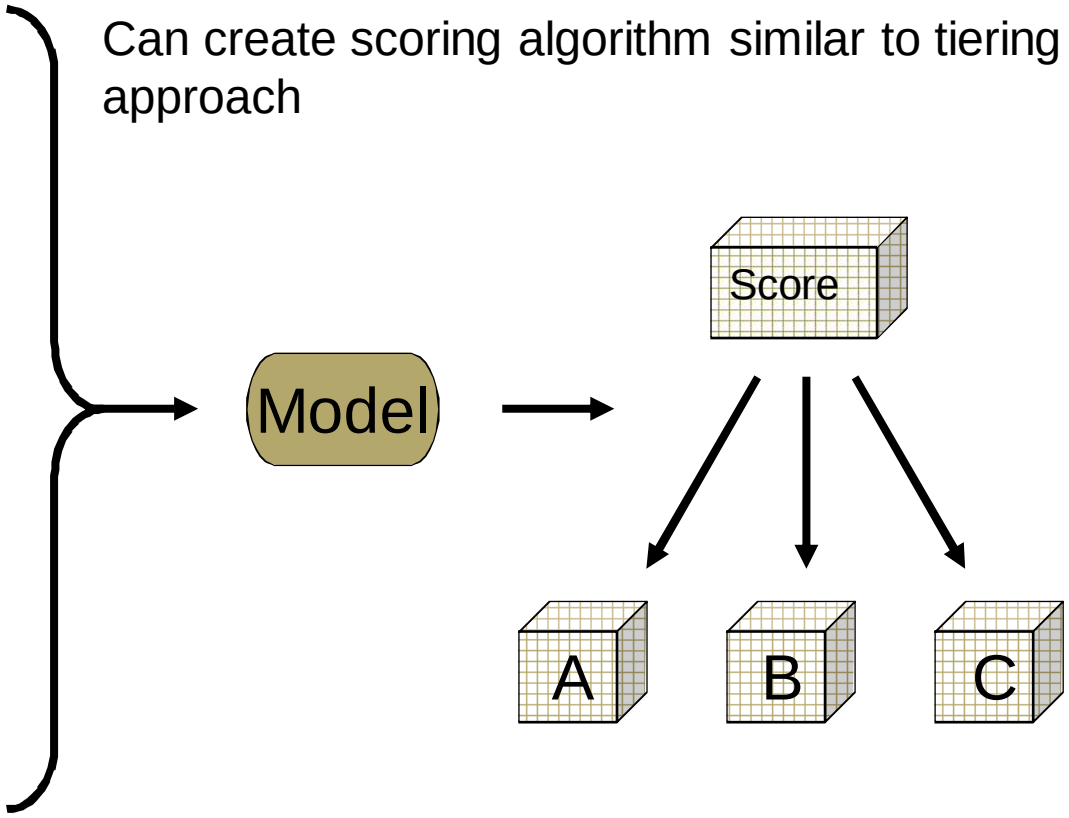
Re-expressing in ratebook form



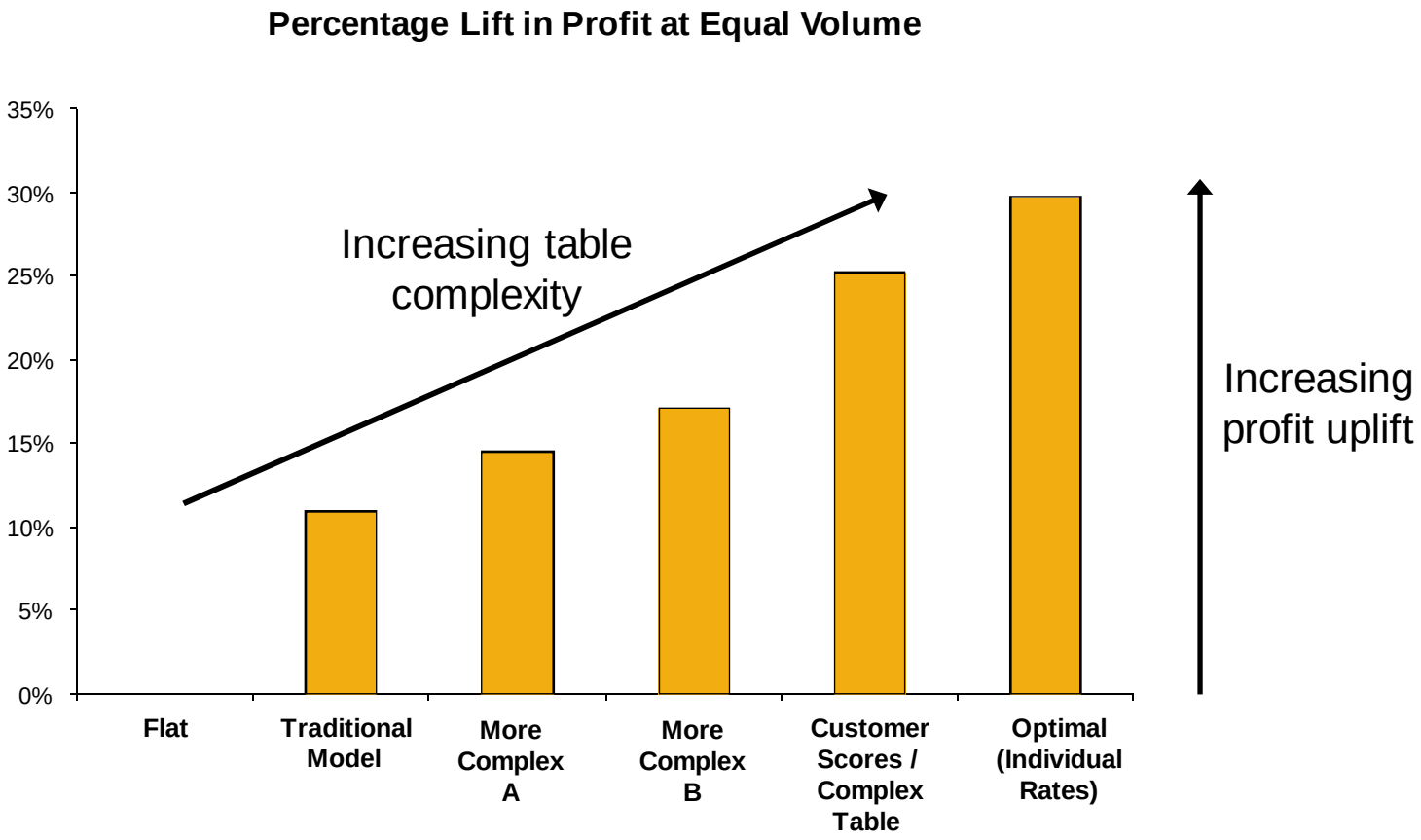
Individual optimized Prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQ270981530	279
CSR303293030	188
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

Can create scoring algorithm similar to tiering approach



Profit uplift comparison
Real example (UK motor renewals optimization)



Four options for optimization

Individual optimized prices

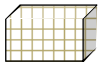
Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQZ70981530	279
CSR303293030	188
XTB008693907	175
TJJ330632016	319
MFD704472553	349
ZVI955030095	277
ZJY528736252	372
VRF026498810	647
BIN297260627	555
SXT608697514	203
JAE716278042	163
XUS991829954	633
IVN822320056	641
FOD690200573	232
DCI071346826	325
SEL511154881	538

Individual optimized prices

Policy no.	Premium
PEL009759458	327
UQJ408808153	555
KZH964999642	261
DDU700866747	349
VUQ391058119	334
YUM718736198	331
GBQZ70981530	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

Fit model to results to yield traditional rating structure

Traditional ratebook structure



Traditional ratebook structure

Base $445

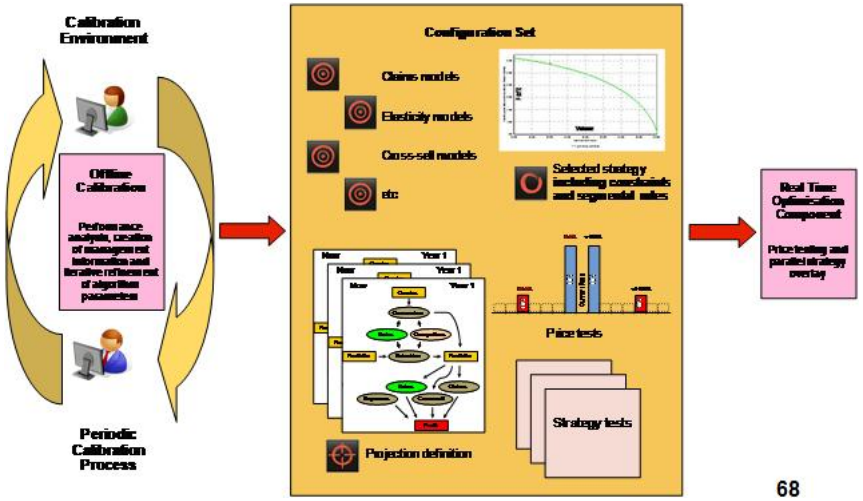
Age	
16	1.89
17	1.78
18	1.65
19	1.54
20	1.43
21	1.30
22	1.28
23	1.16
24	1.10
25	1.05
26	1.04
27	1.03
…	

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
…	

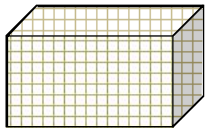
Area	
1	0.46
2	0.58
3	0.72
4	0.81
5	0.90
6	0.95
7	1.01
8	1.11
9	1.18
10	1.21
11	1.33
12	1.49
…	

Etc
…

Etc
…



3 - Direct ratebook optimization



Traditional ratebook structure

Base $445

Age	
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
…	

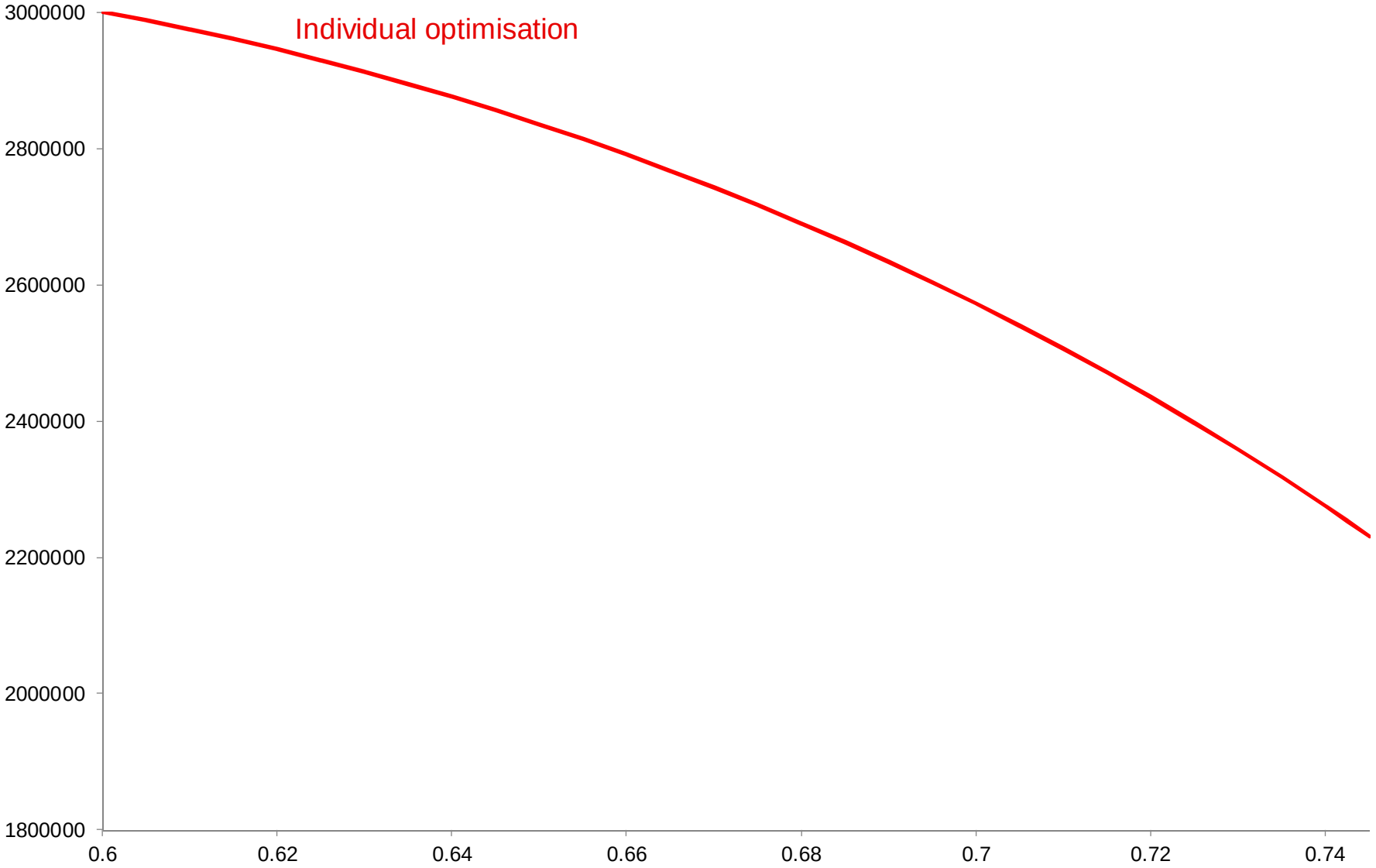
Vehicle	
1	0.56
2	0.68
3	0.82
4	0.91
5	0.98
6	1.00
7	1.11
8	1.16
9	1.19
10	1.25
11	1.34
12	1.43
…	

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
…	

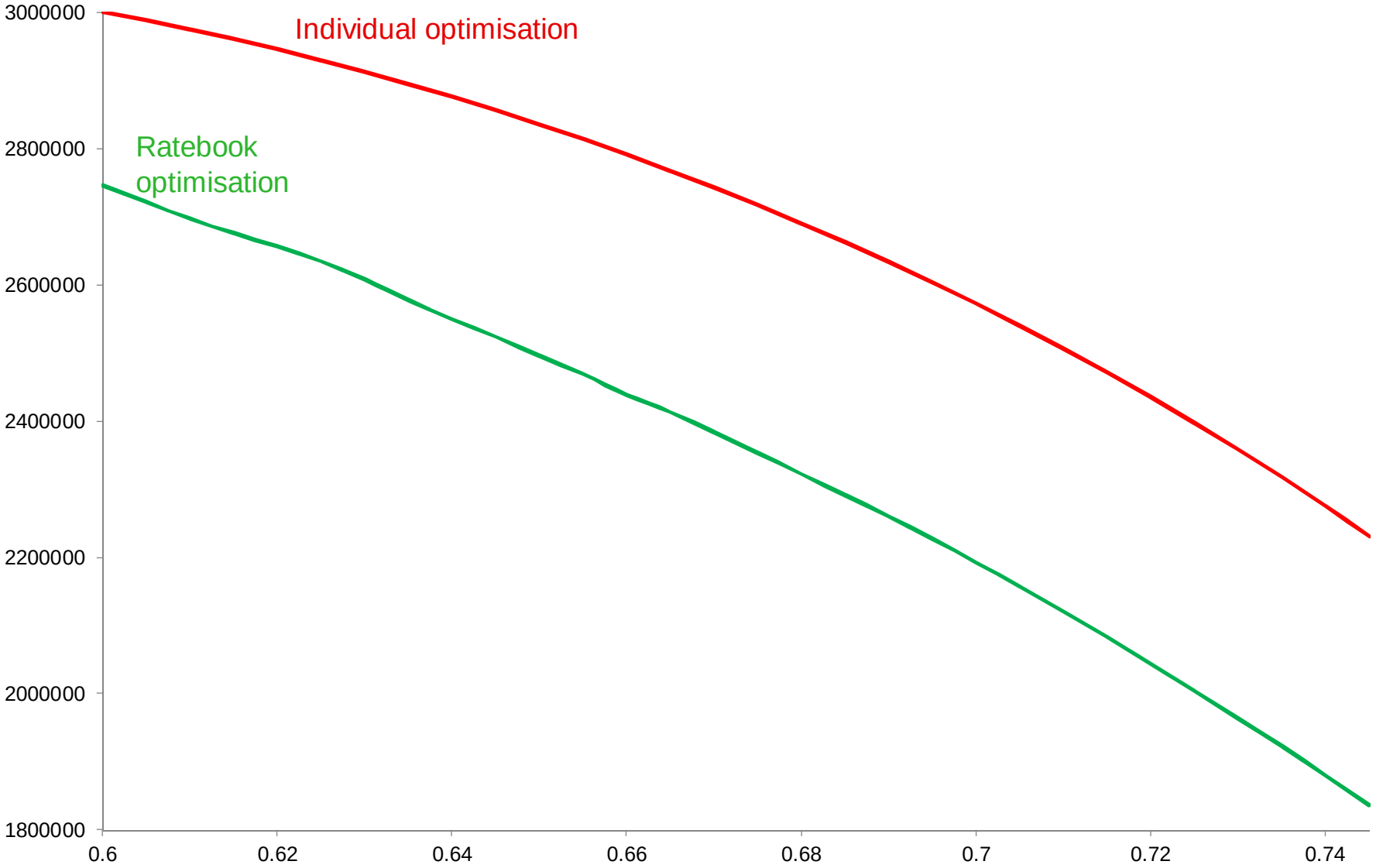
Etc
…

Etc
…

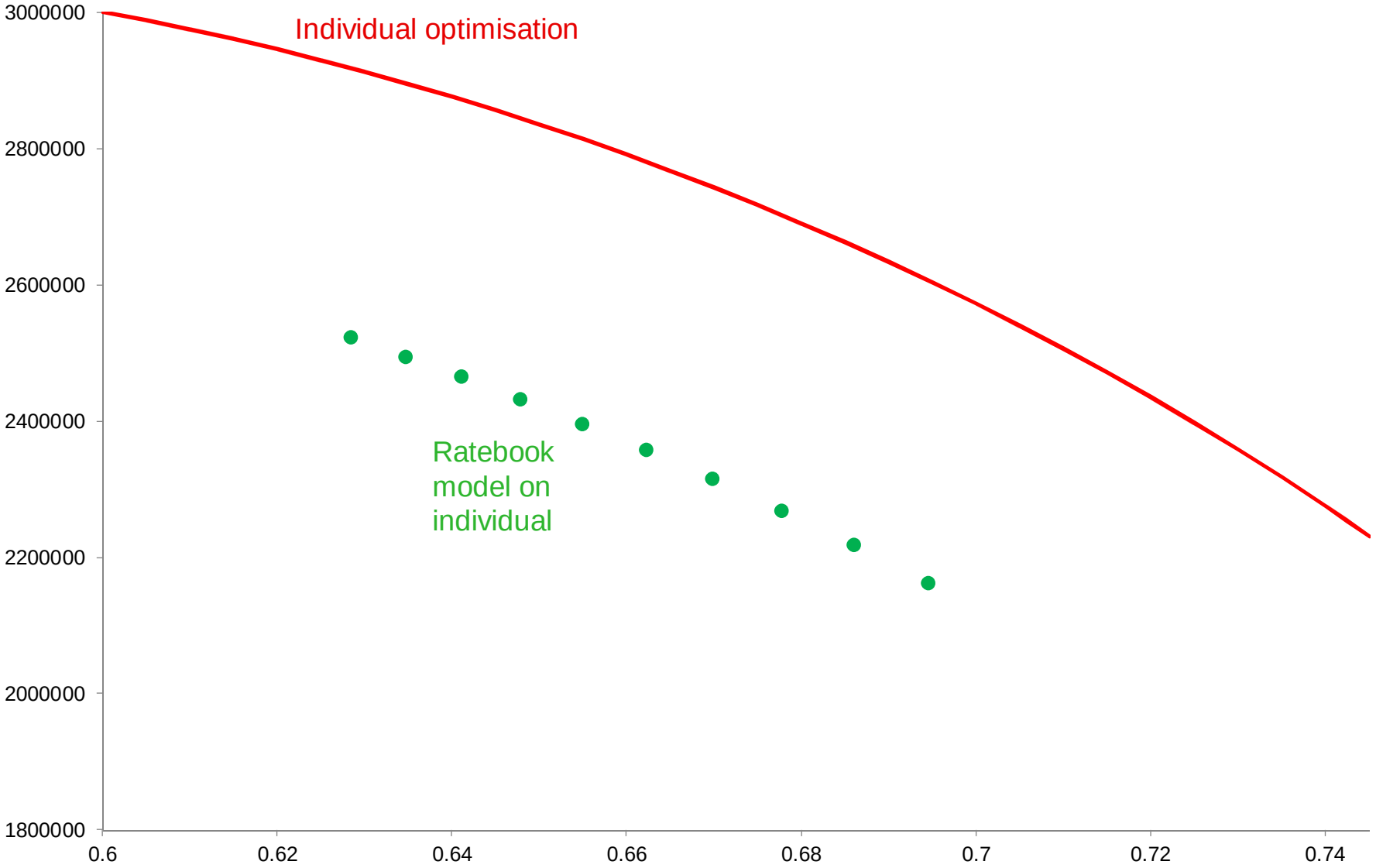
Ratebook vs individual optimisation



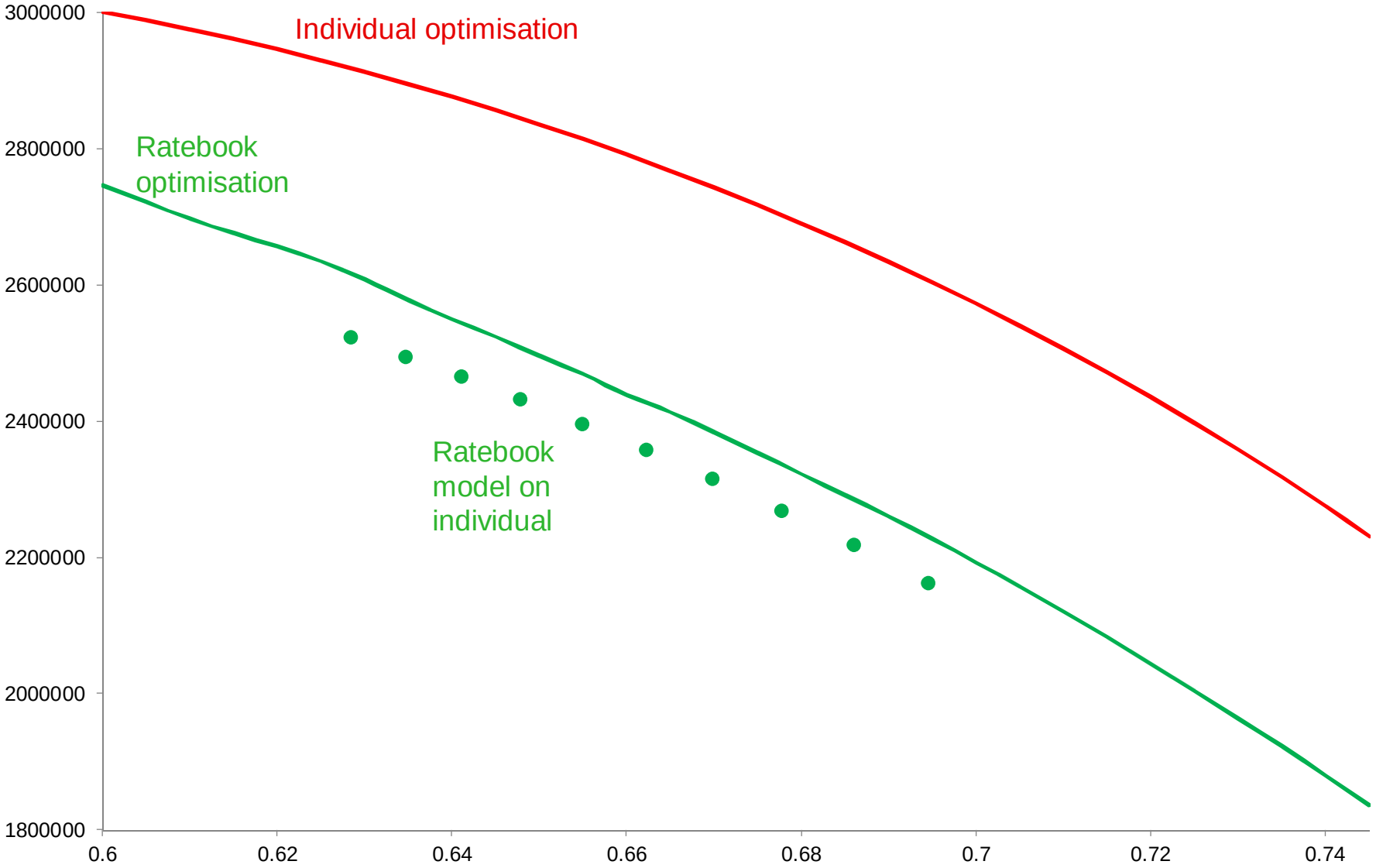
Ratebook vs individual optimisation



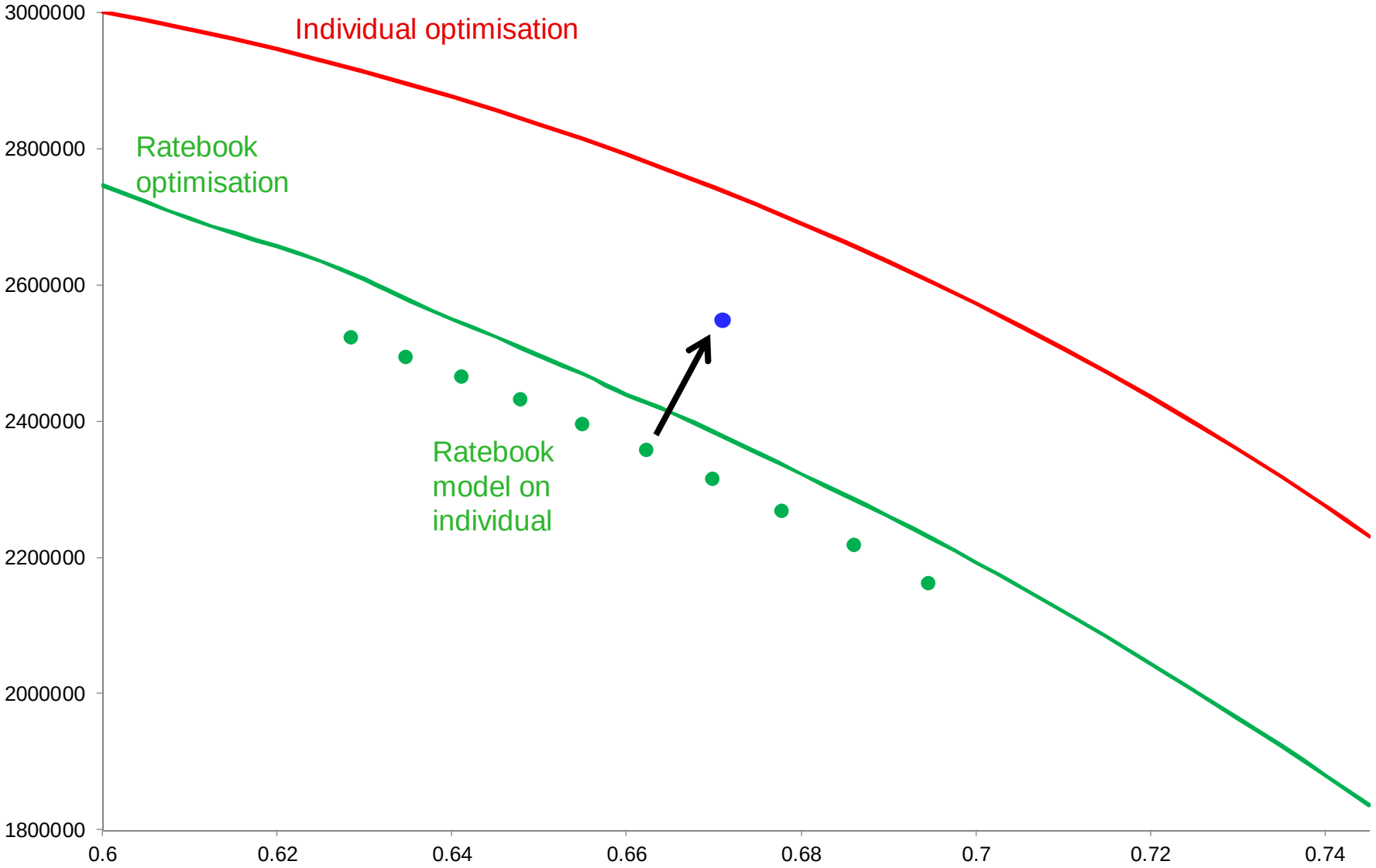
Ratebook vs individual optimisation



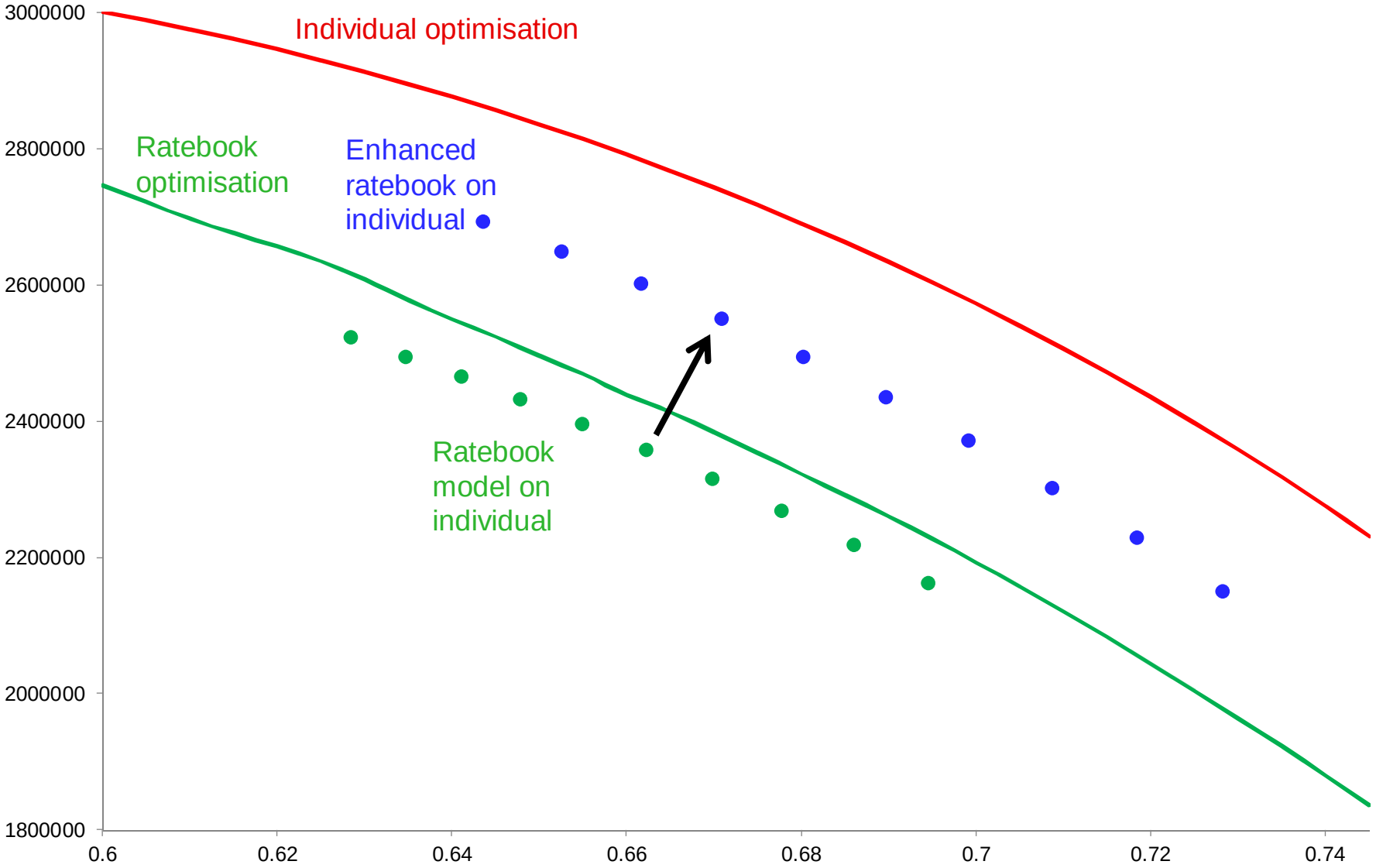
Ratebook vs individual optimisation



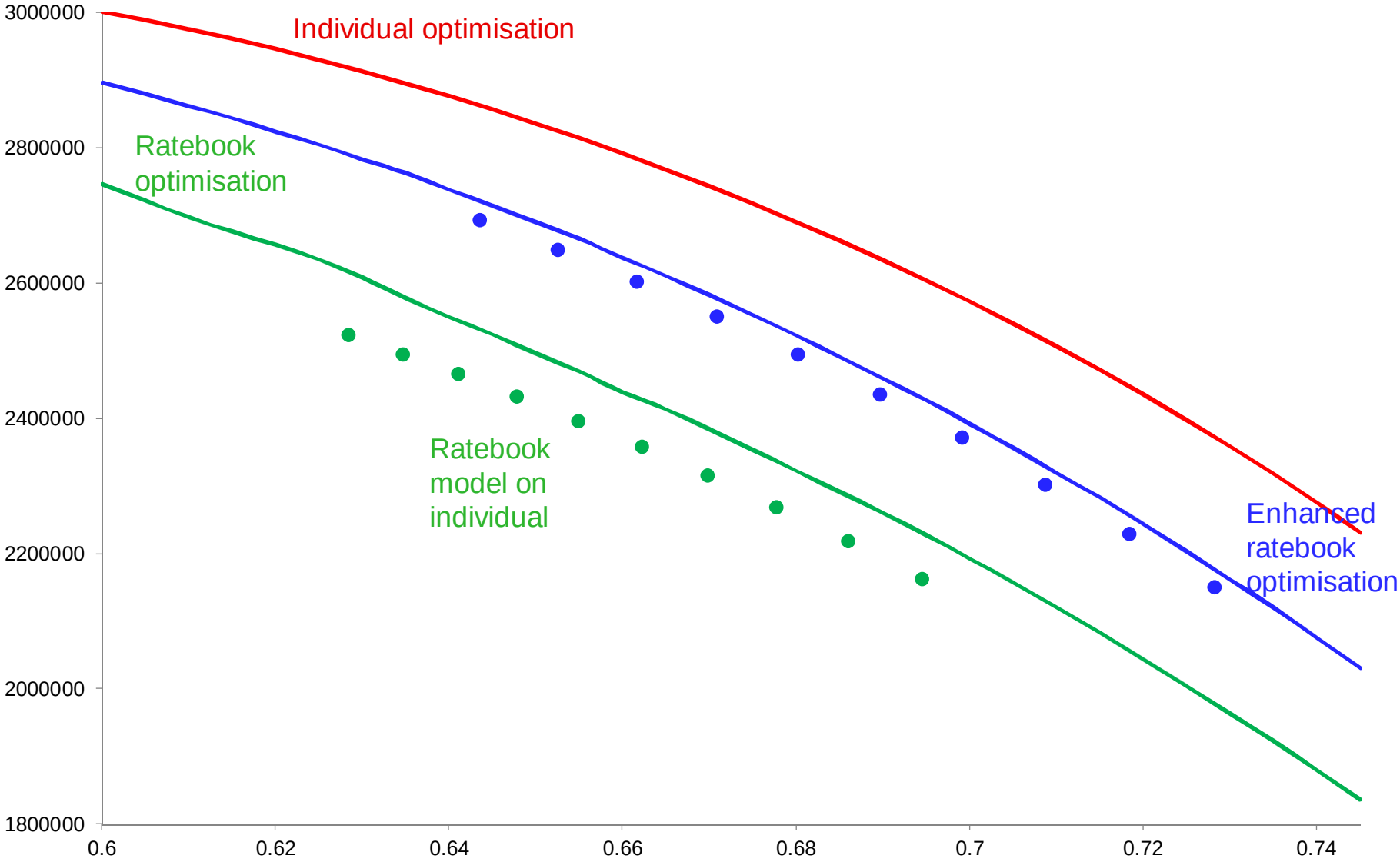
Ratebook vs individual optimisation



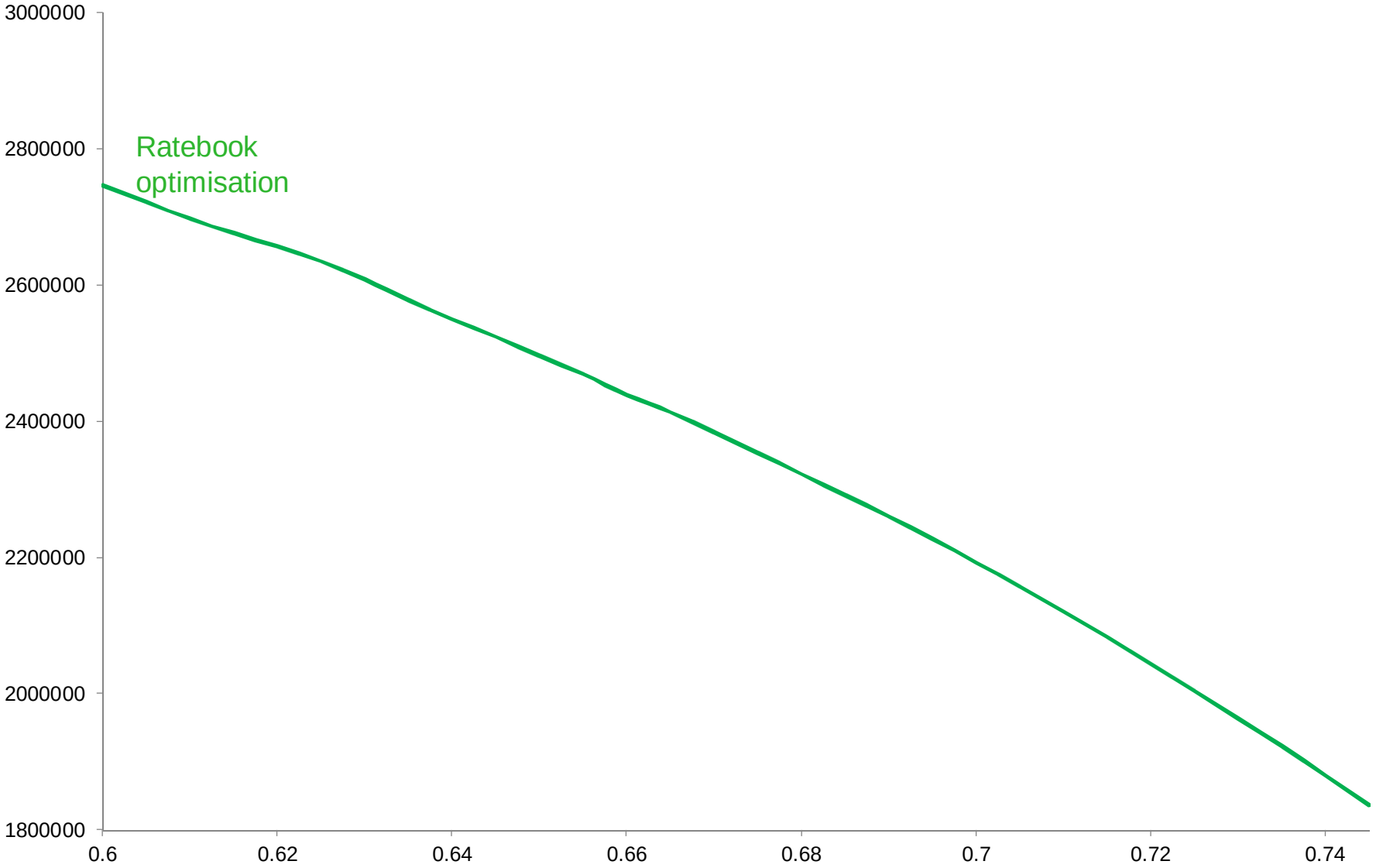
Ratebook vs individual optimisation



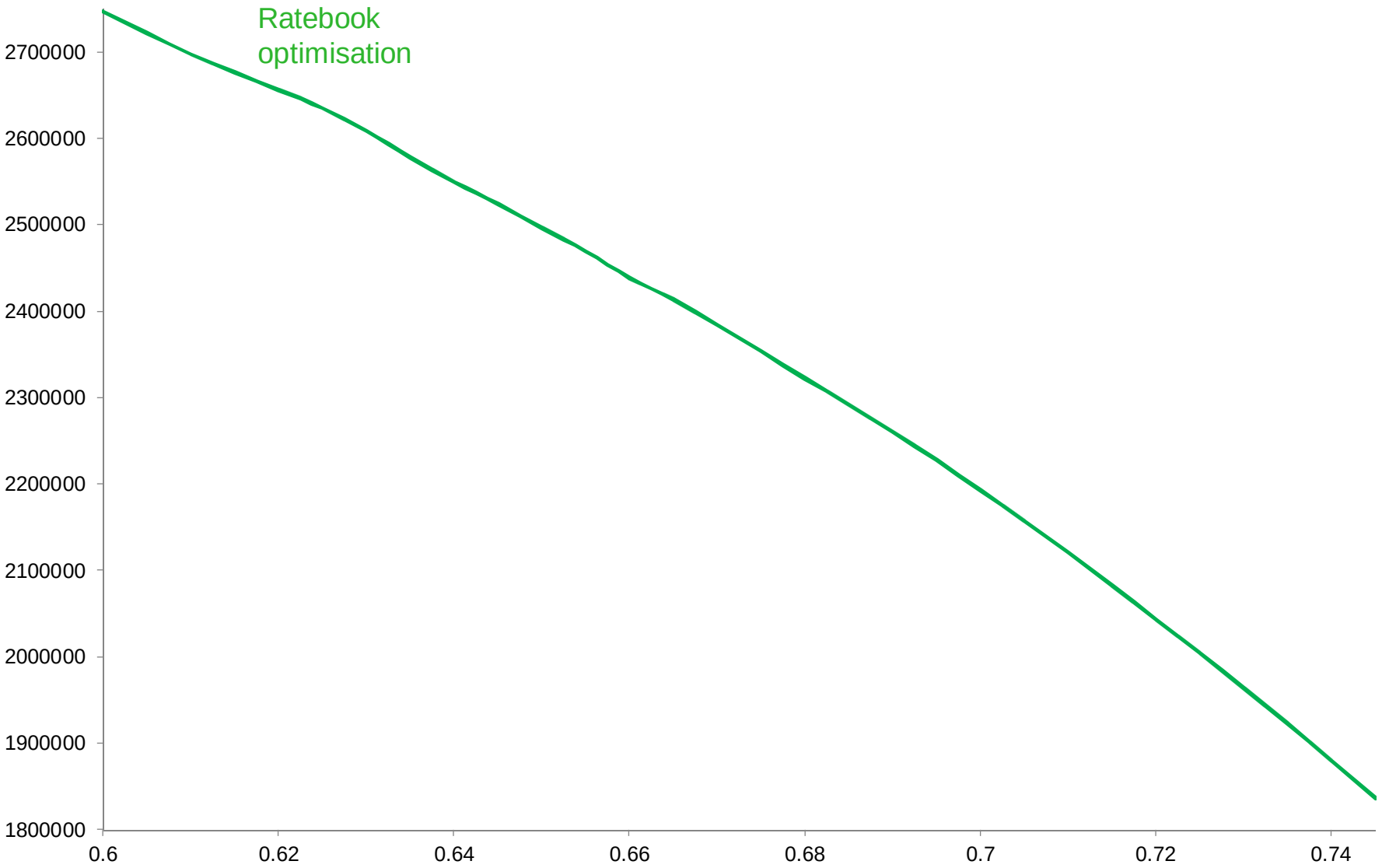
Ratebook vs individual optimisation



Ratebook vs individual optimisation



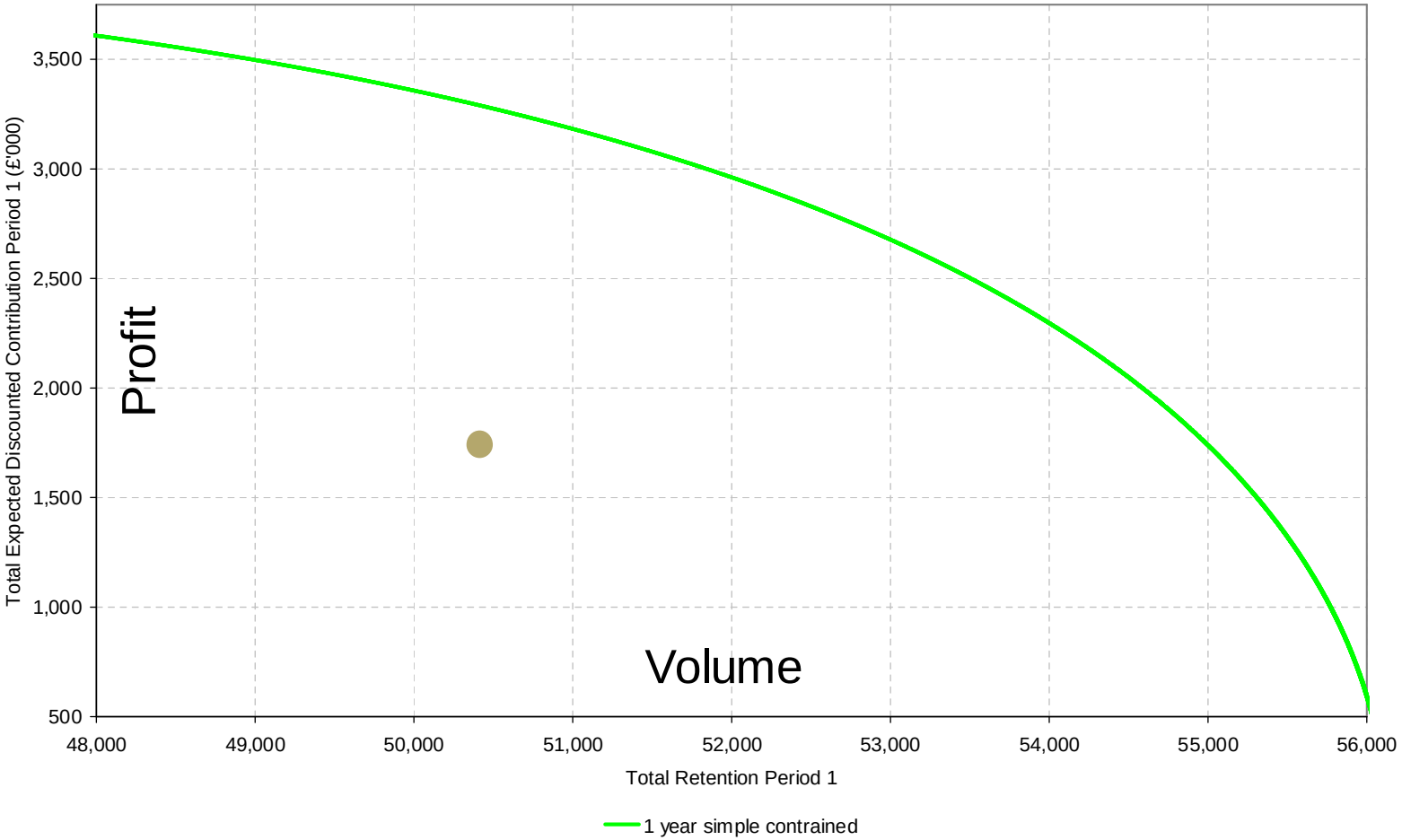
Ratebook vs individual optimisation



Individual vs ratebook

- Individual optimization gives best mathematical solution
- Direct ratebook optimization is quick and convenient when a ratebook form is required but
  - Individual optimisation shows target frontier and shows "what you're aiming for"
  - Modelling individual optimisation gets enhanced rating structure form more quickly
- Thus individual optimisation is always important

Time horizons



Time horizons

Advantages

More certain short-term profitability

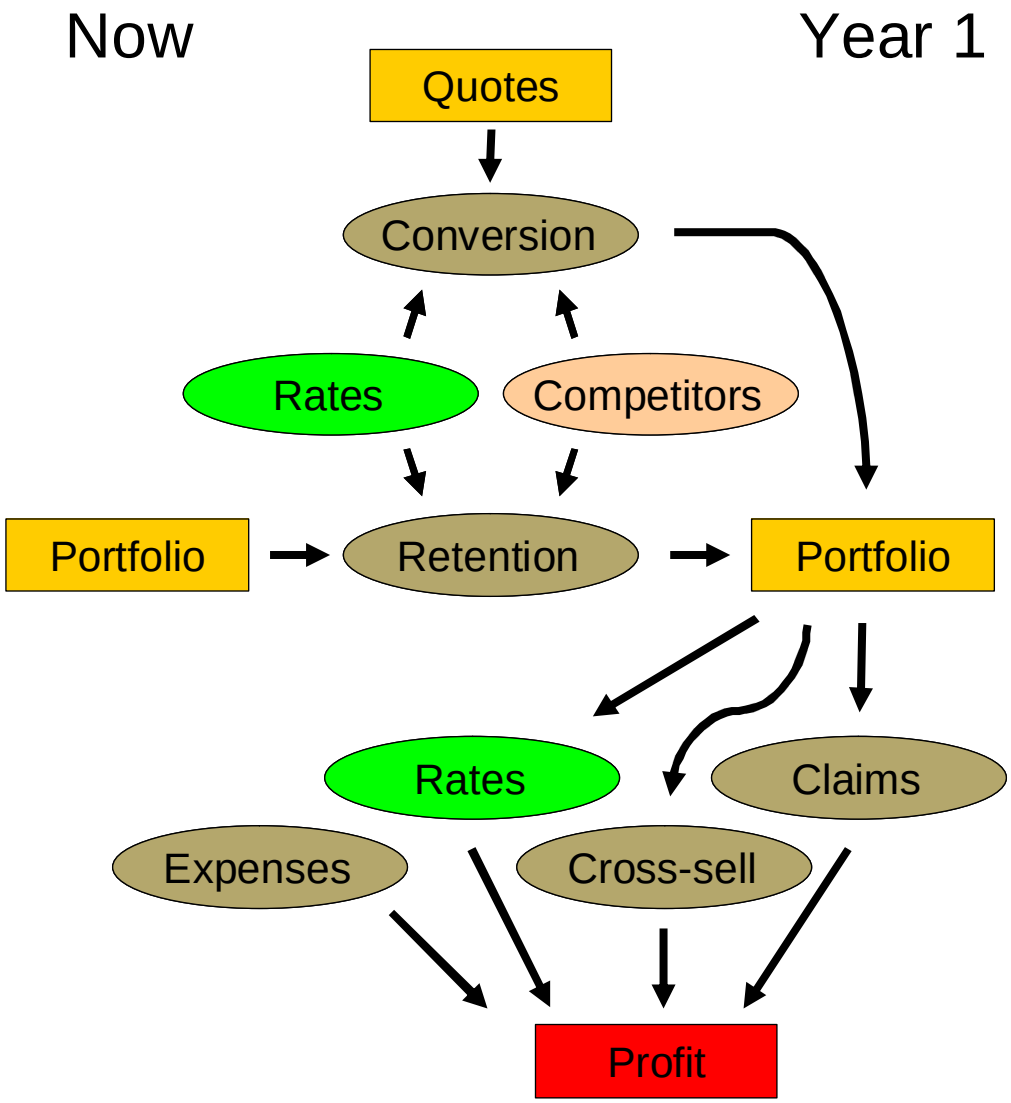
Protects long-standing customers

Disadvantages

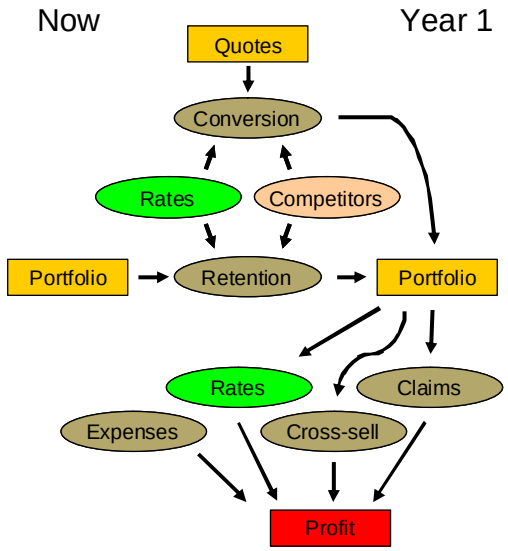
"Milks" the most inelastic customers leads to a reducing quality portfolio

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

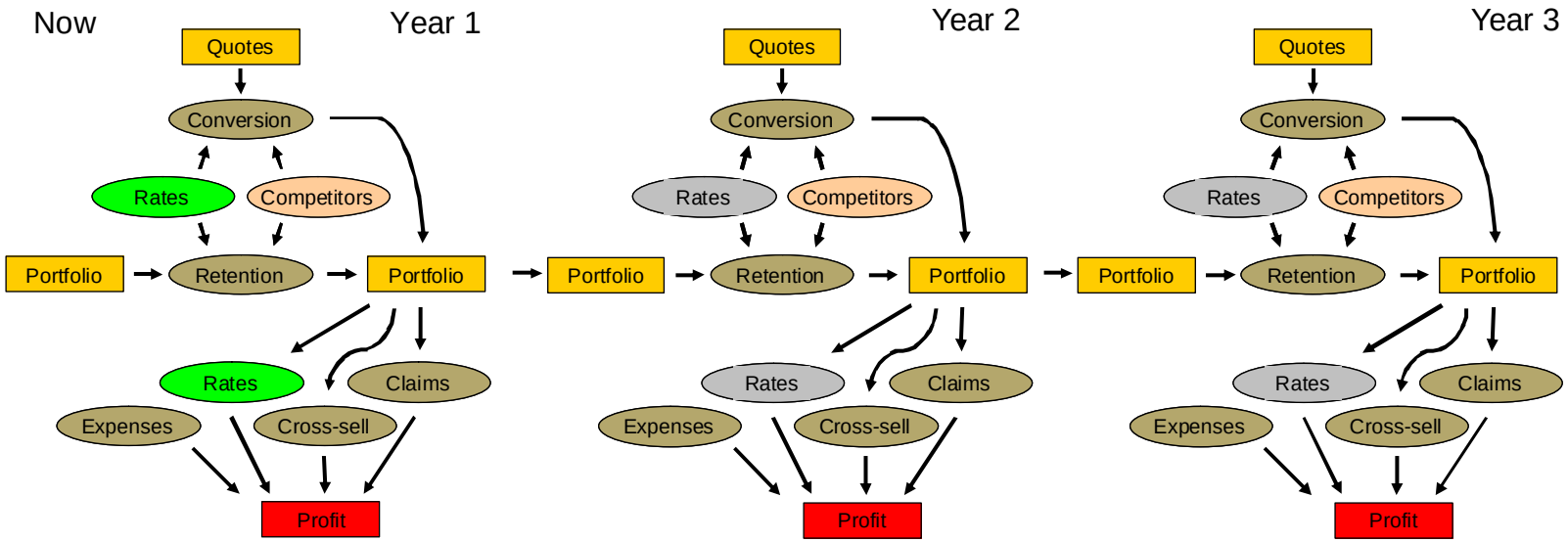
Projection


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

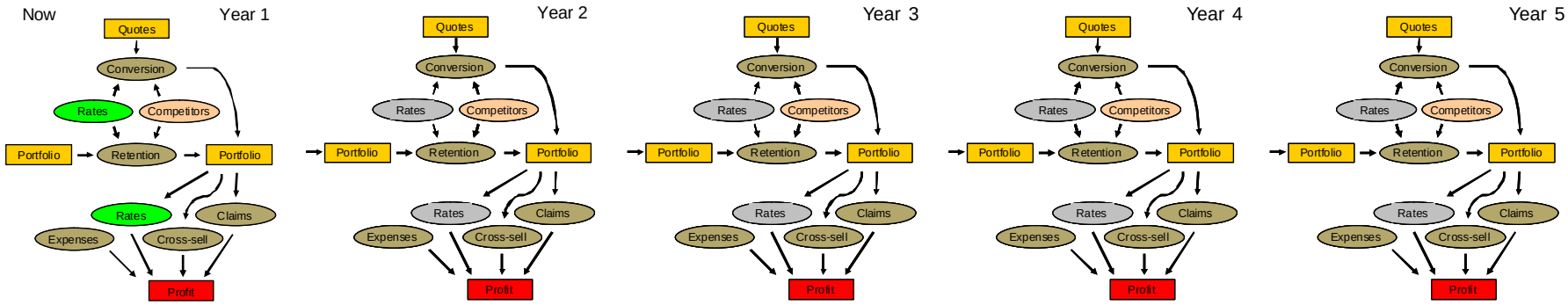
Projection


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

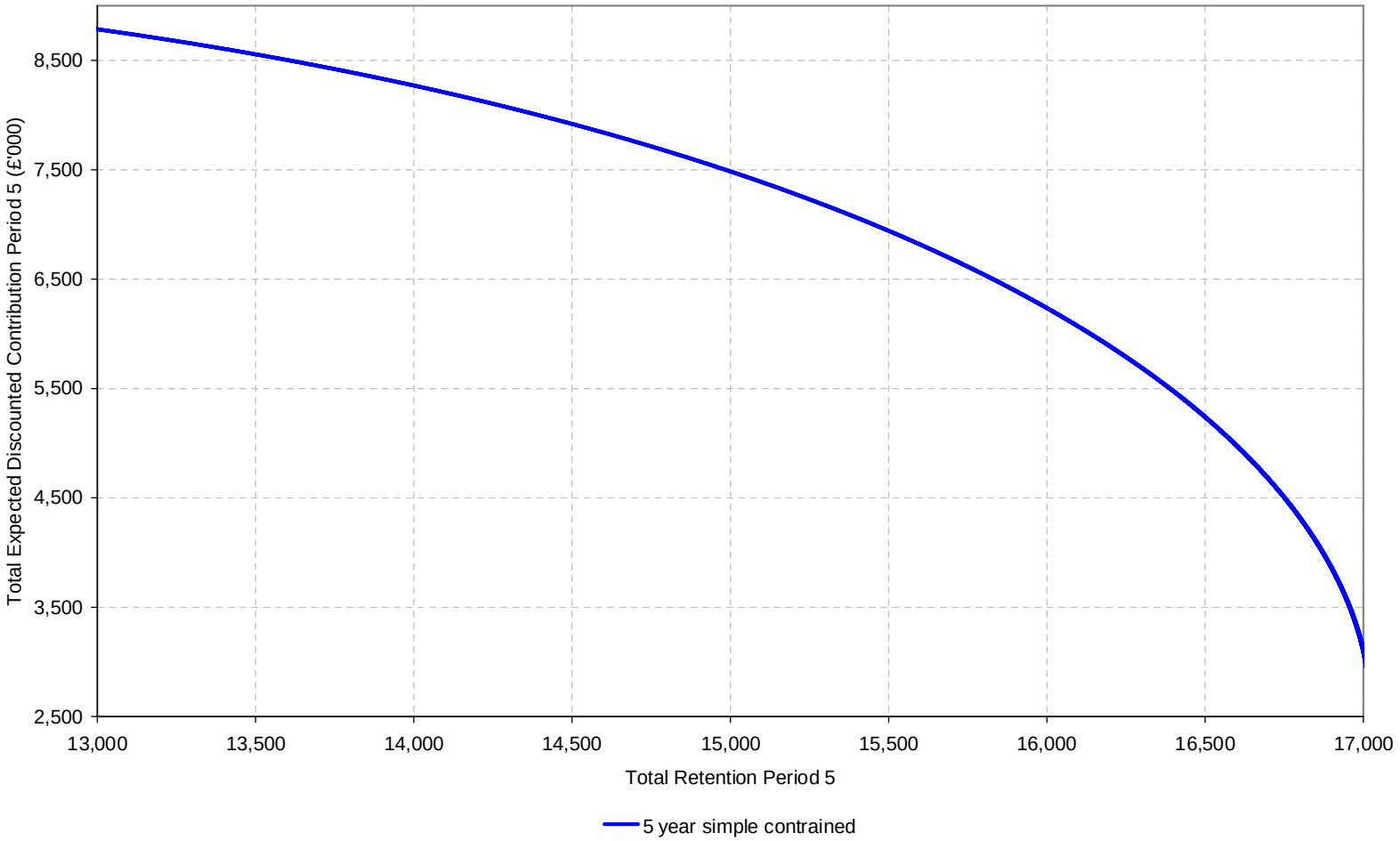
Projection


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

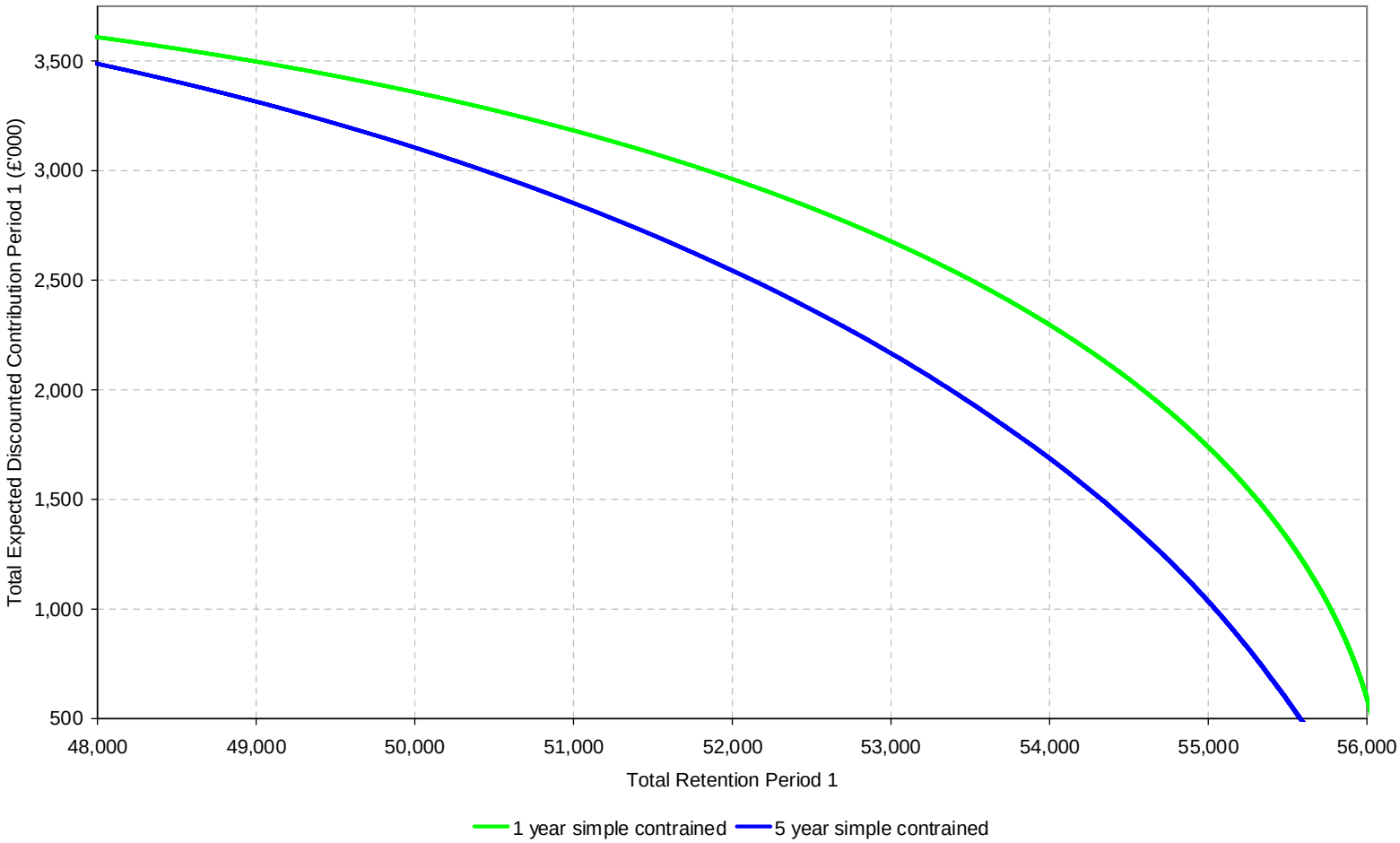
Projection


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

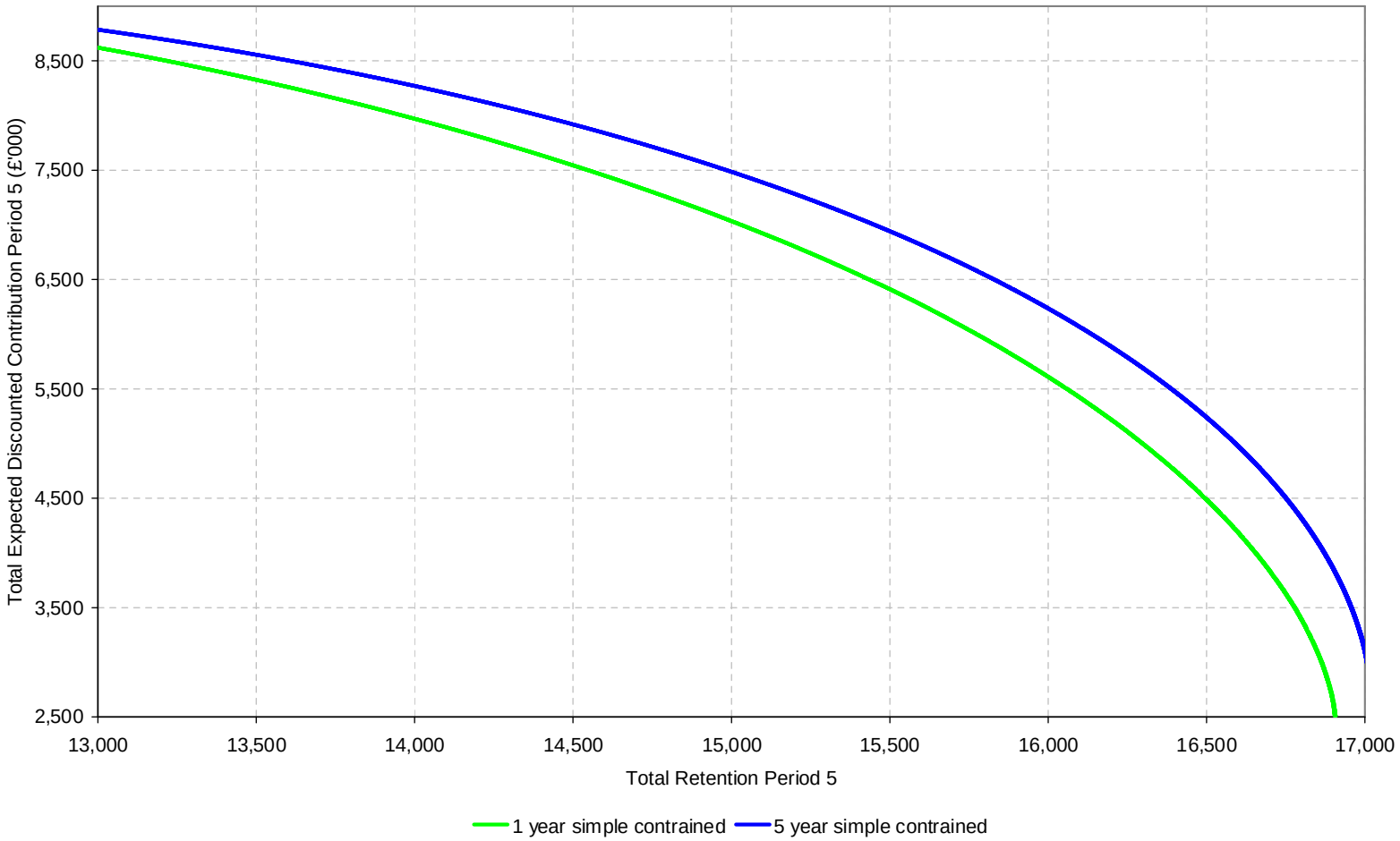
Five year efficient frontier



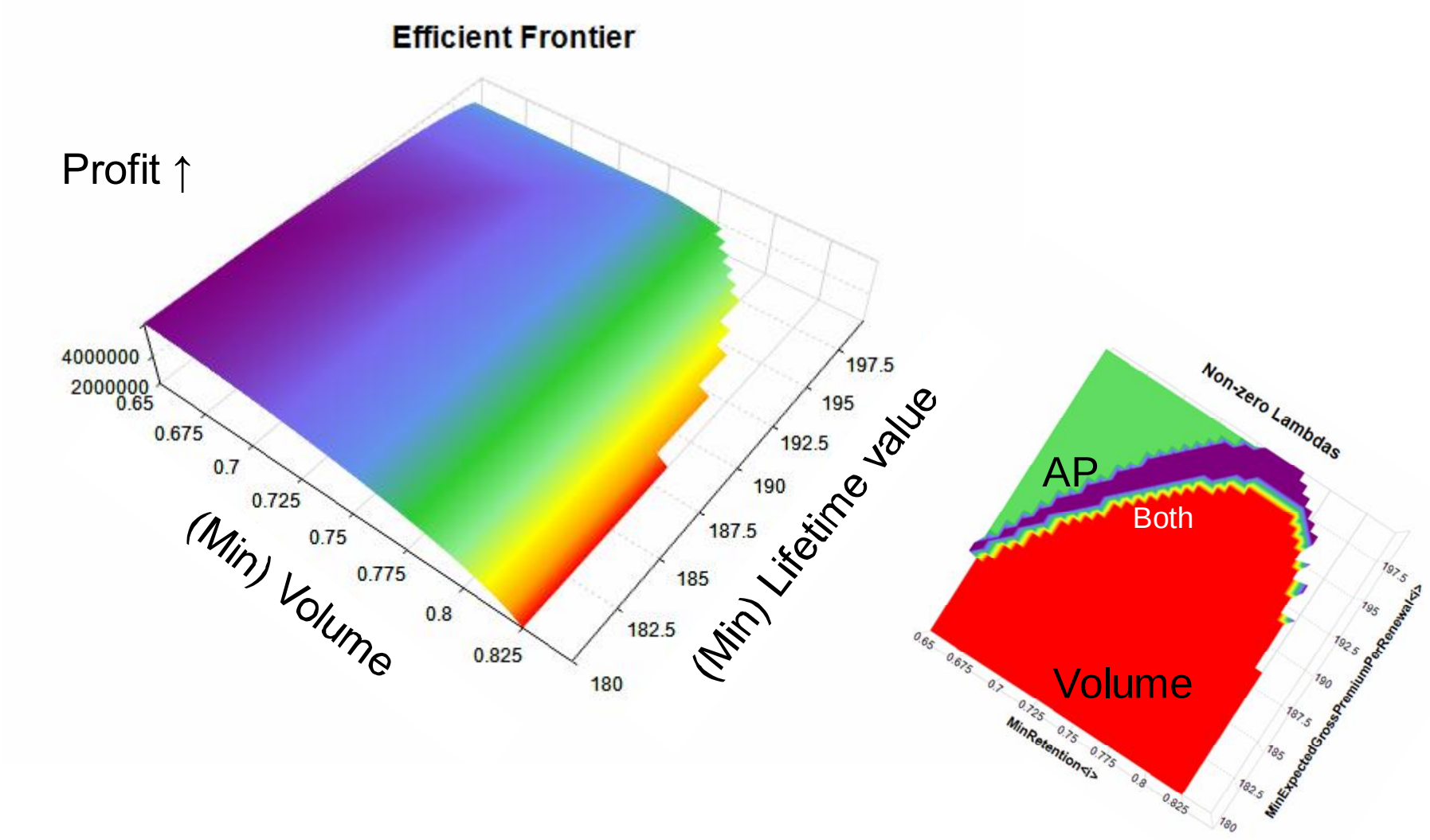
One year efficient frontier



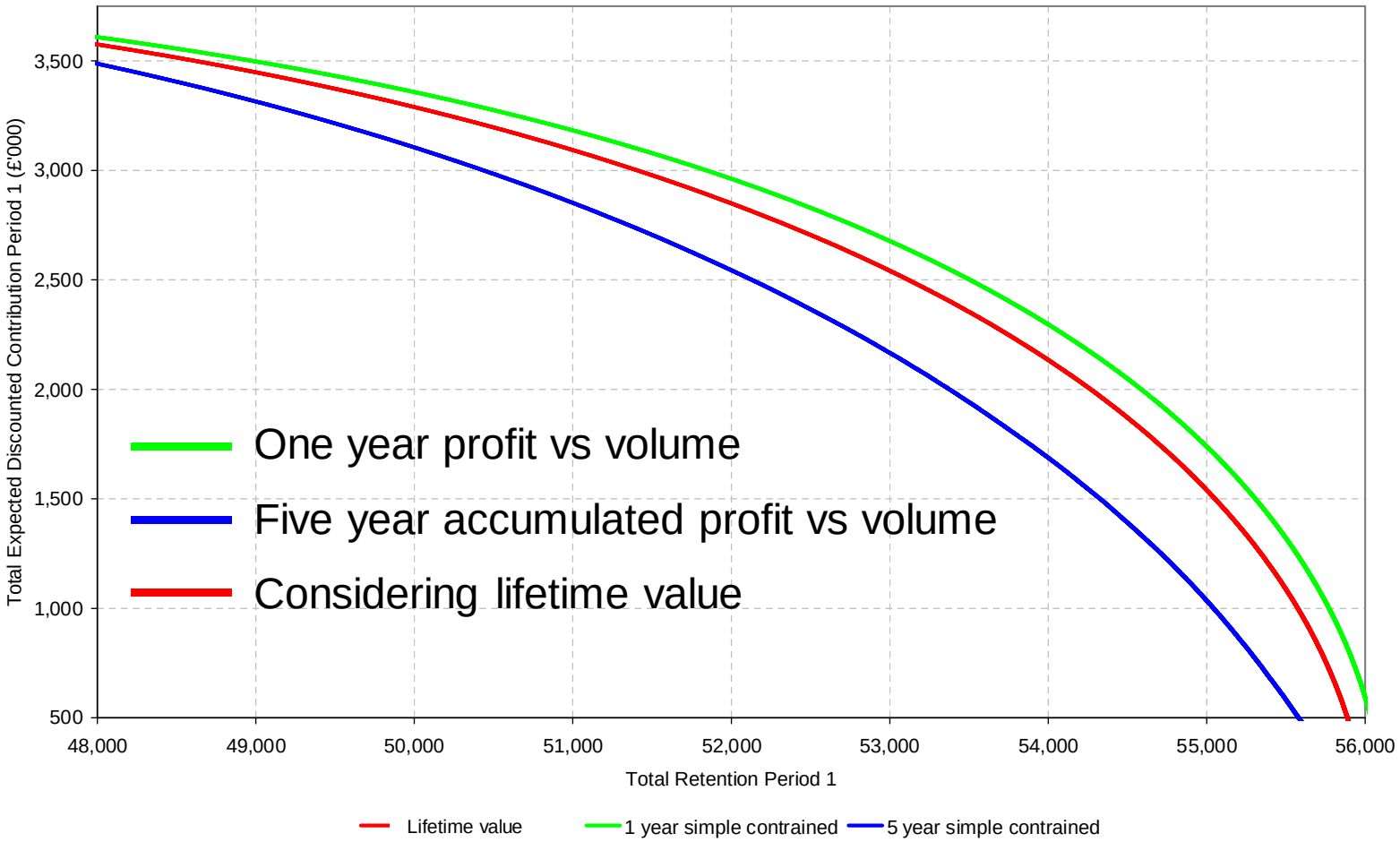
Five year efficient frontier



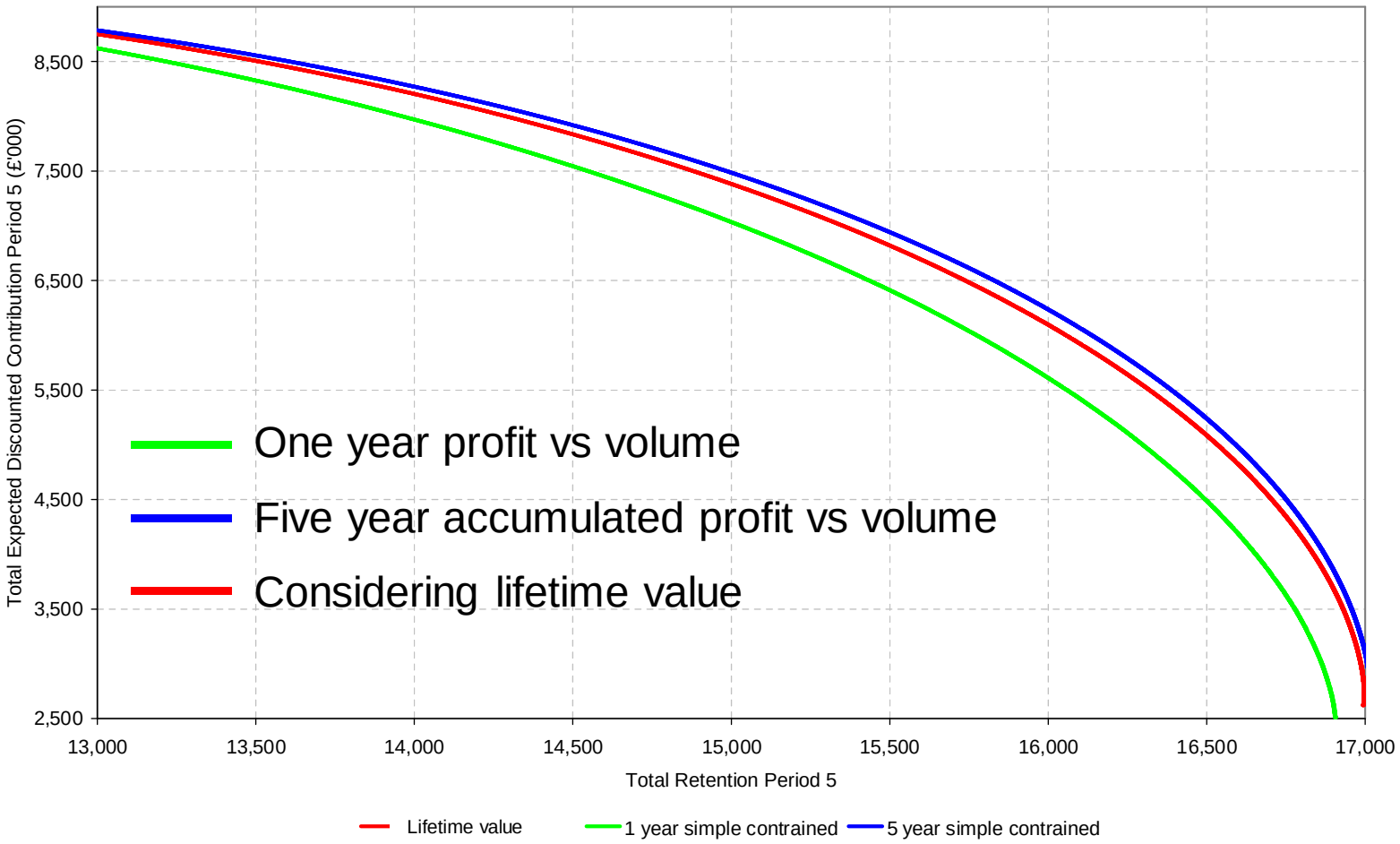
Multidimensional Optimisation



One year efficient frontier



Five year efficient frontier

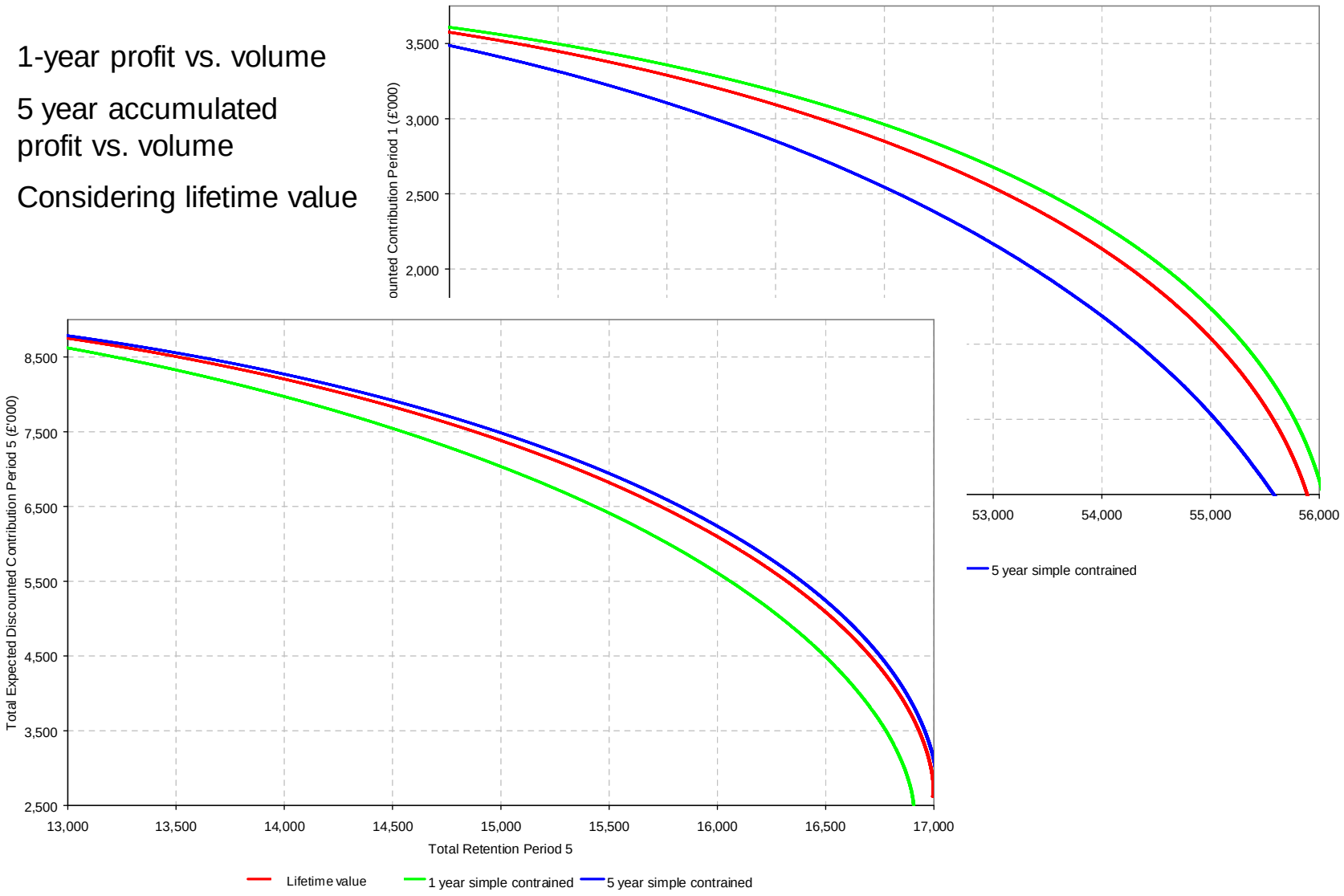


Almost the best of both worlds

1-year profit vs. volume

5 year accumulated profit vs. volume

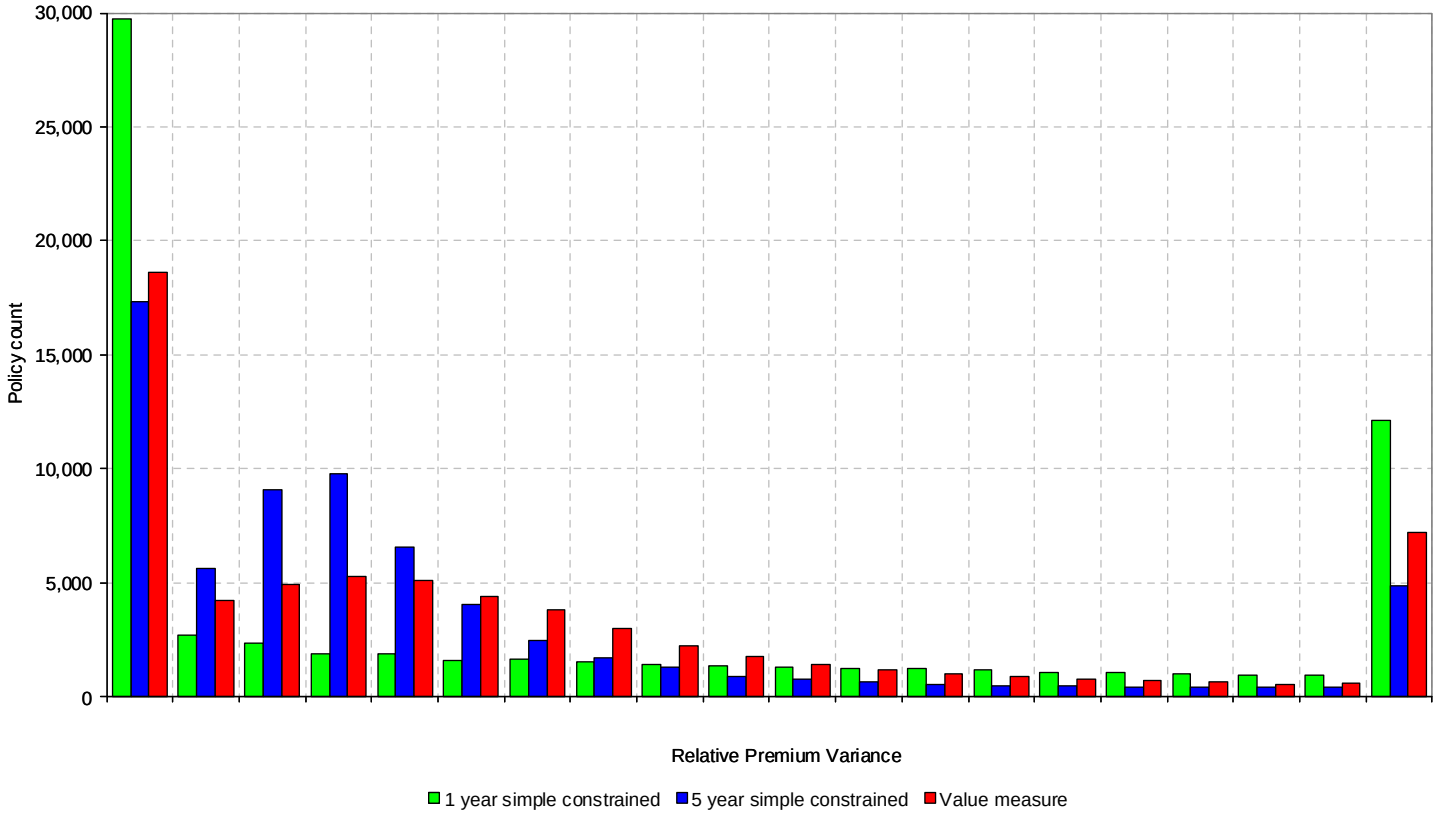
Considering lifetime value



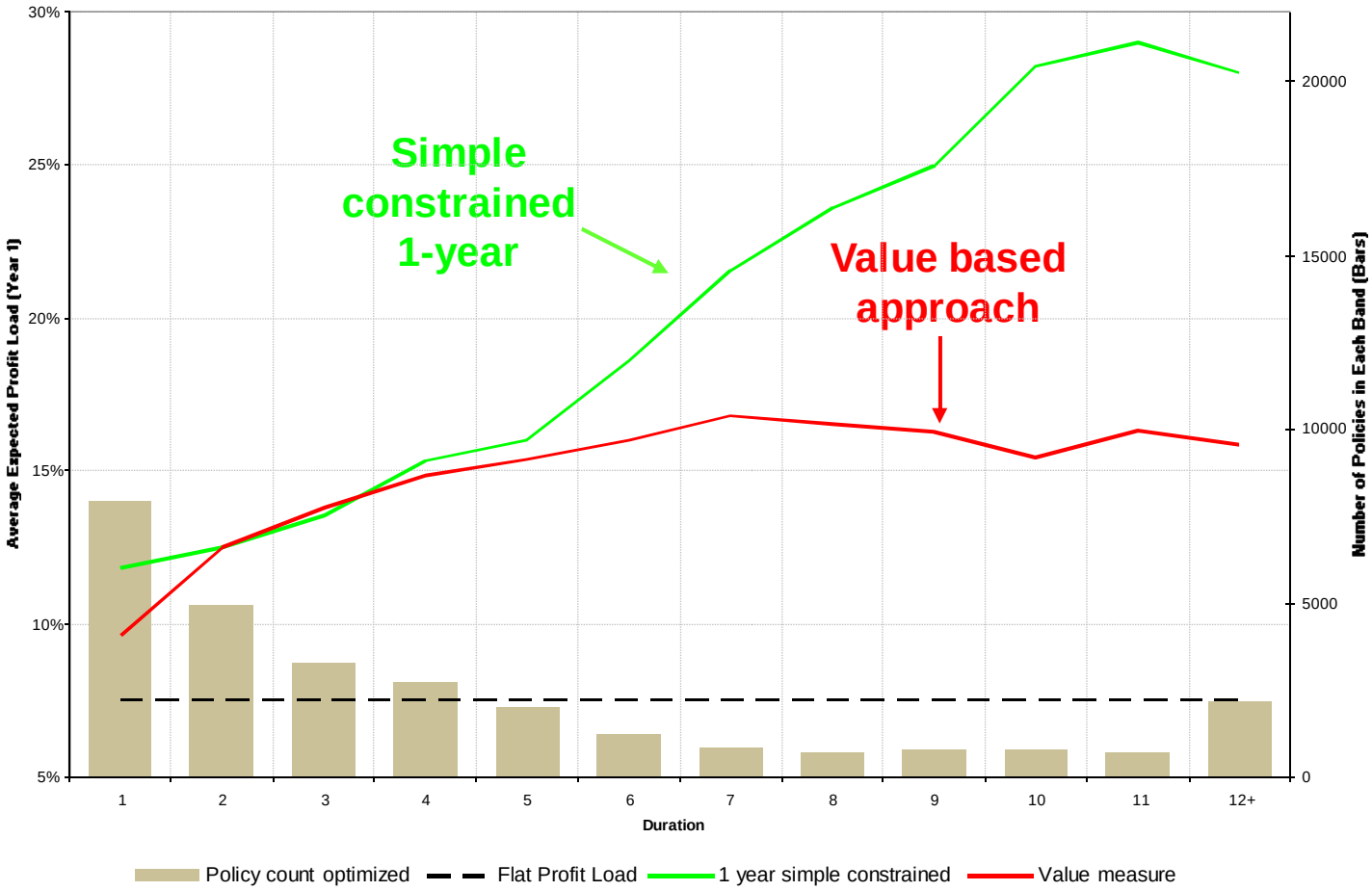
Value based approach - premium variances

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

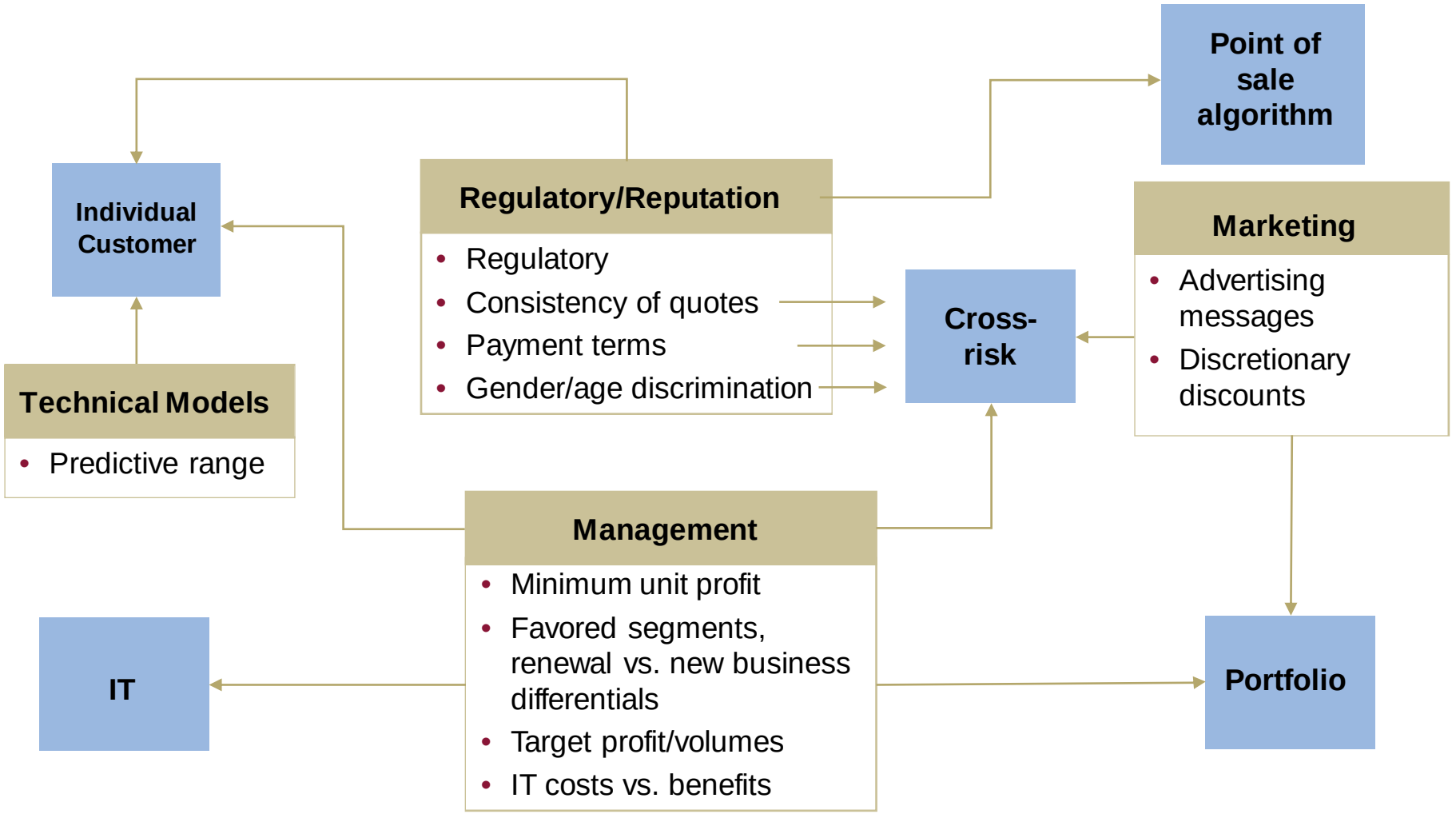
- Extracts large profits from a small customer group
- Maximizes degree of price differentiation
- Relies on predictive accuracy of models at their extremes



Value based approach - premium variances by tenure



Constraints



Example marketing messages constraints

Discount for Combined Cover

(Actual result cannot be disclosed in handout)

Example marketing messages constraints

‘Buy Buildings, Get Contents Half Price’

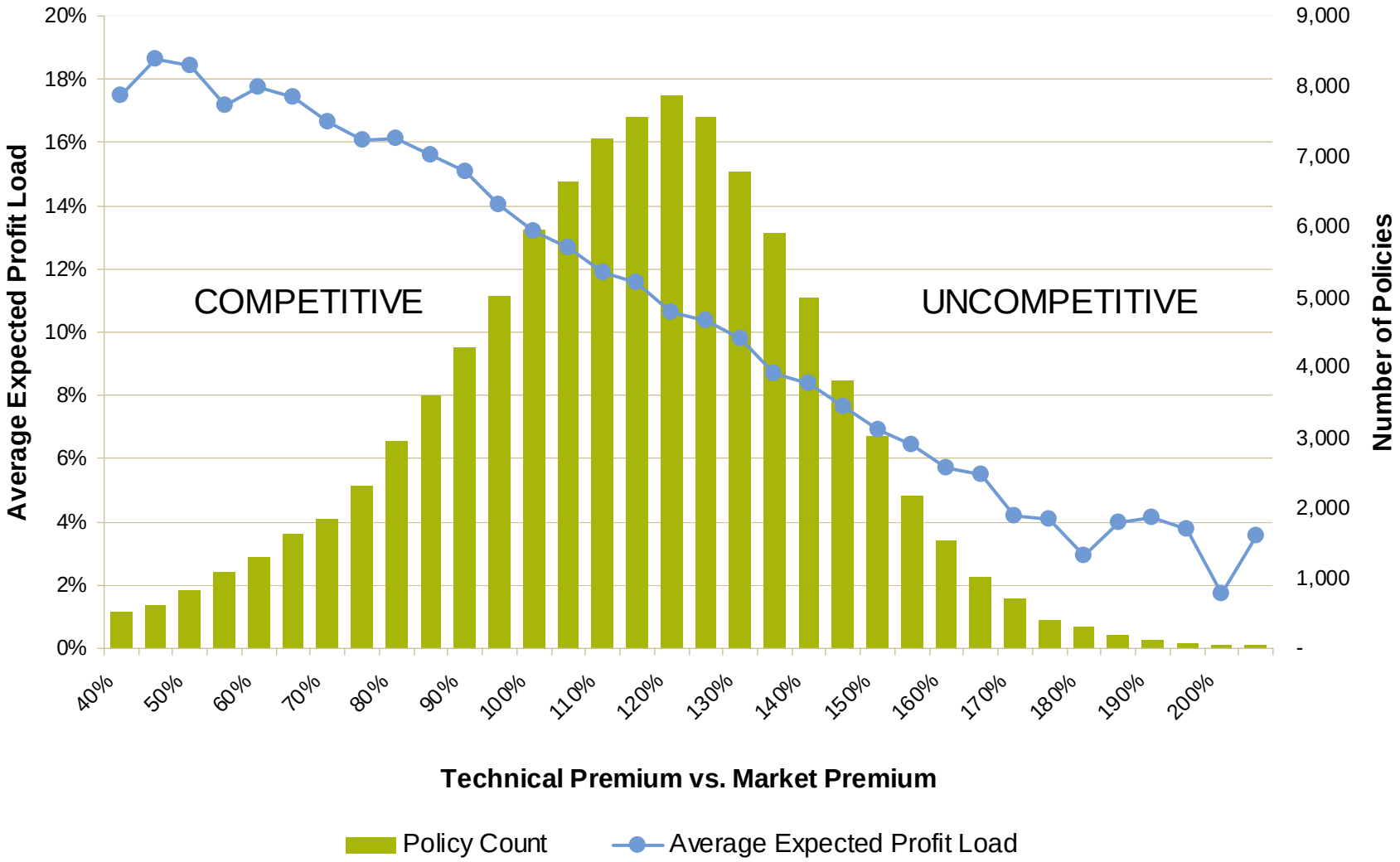
(Actual result cannot be disclosed in handout)

Example profitability constraint

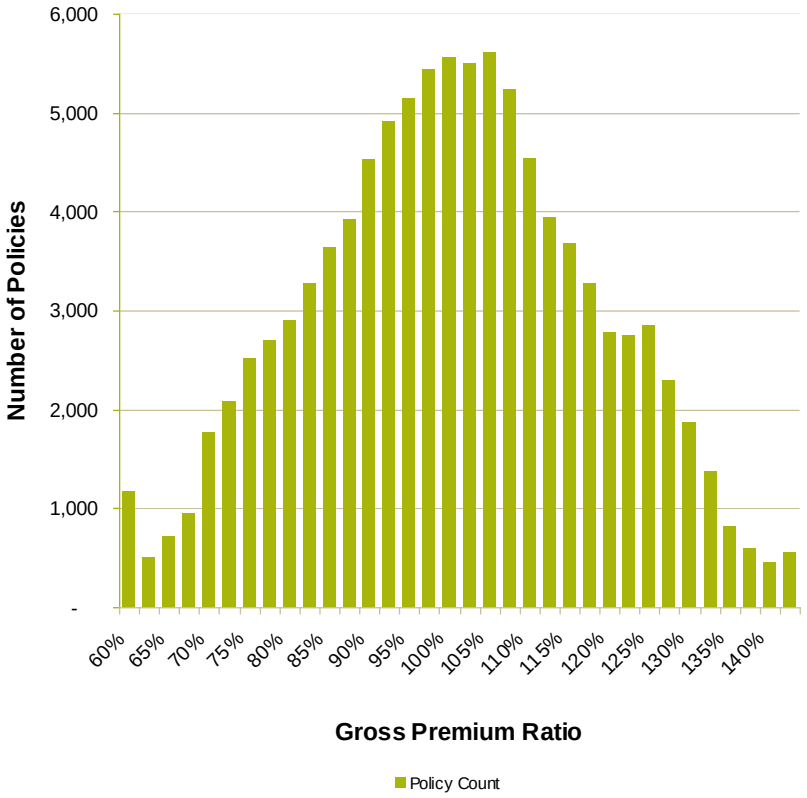
(Actual result cannot be disclosed in handout)

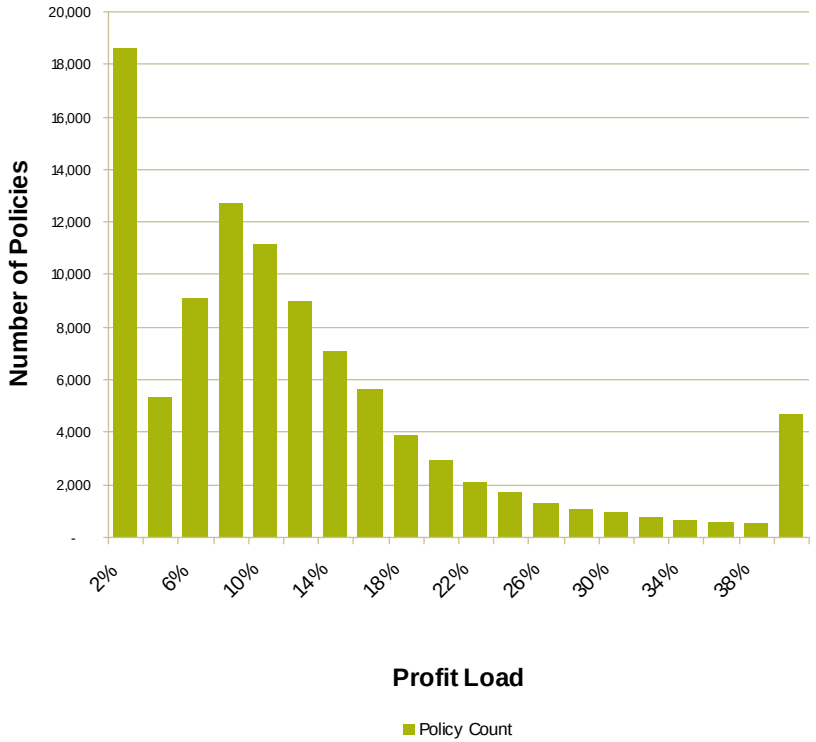
- Constraining profit loads inhibits ability to drive profit uplift(!)
- This is the “natural” dimension of uplift for an inelastic portfolio
- Constraint cedes a large percentage (65%) of potential profit uplift measured at constant retention
- Cedes around 58% of potential retention rate uplift, at constant profit load uplift

Example diagnostics

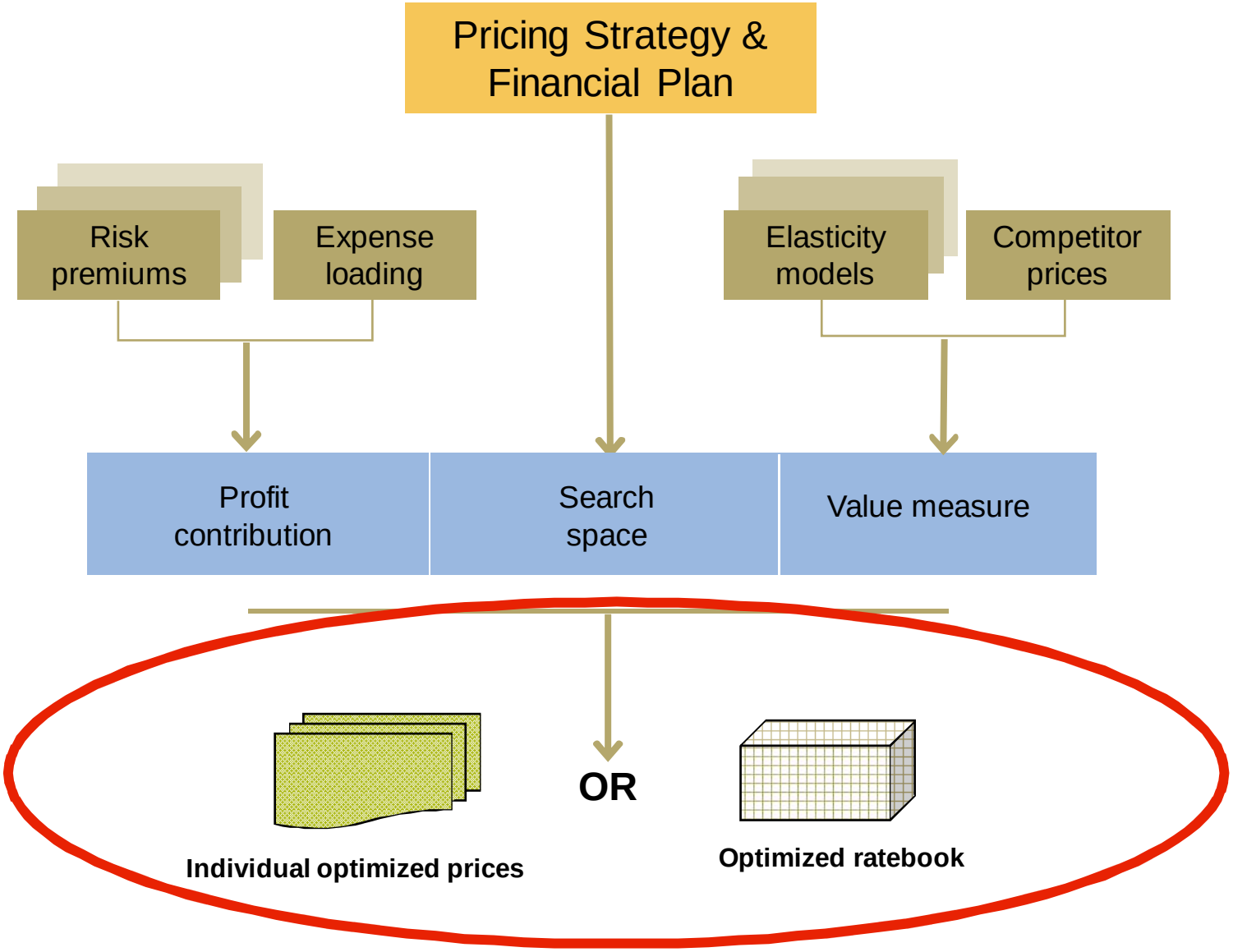


Example diagnostics





Price optimization



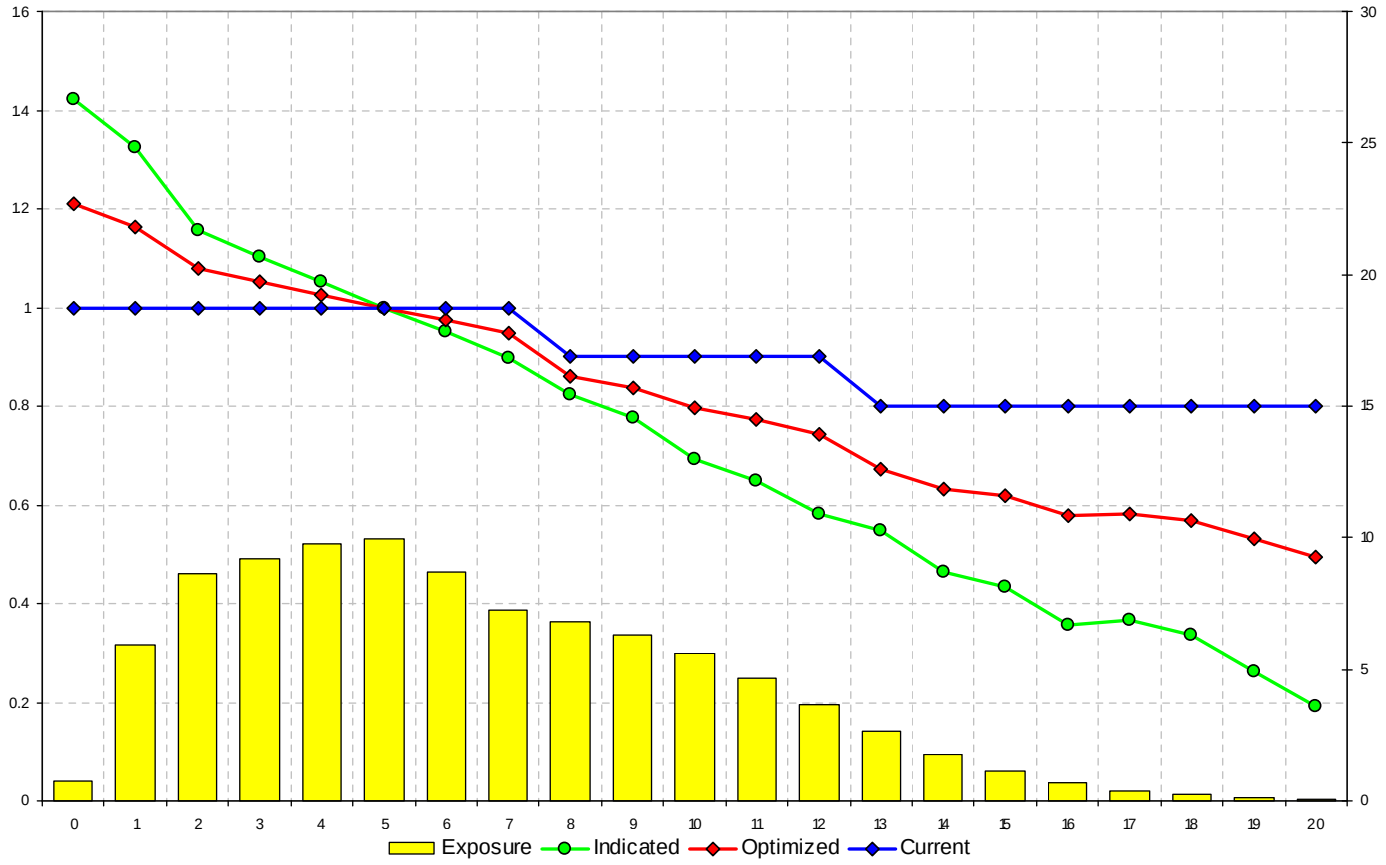
Implementing an Optimized Structure - Internal

- Company Goals
  - Growth
  - Profit
  - Segment
- Removing Biases
- Appealing to Management
- Quick Wins

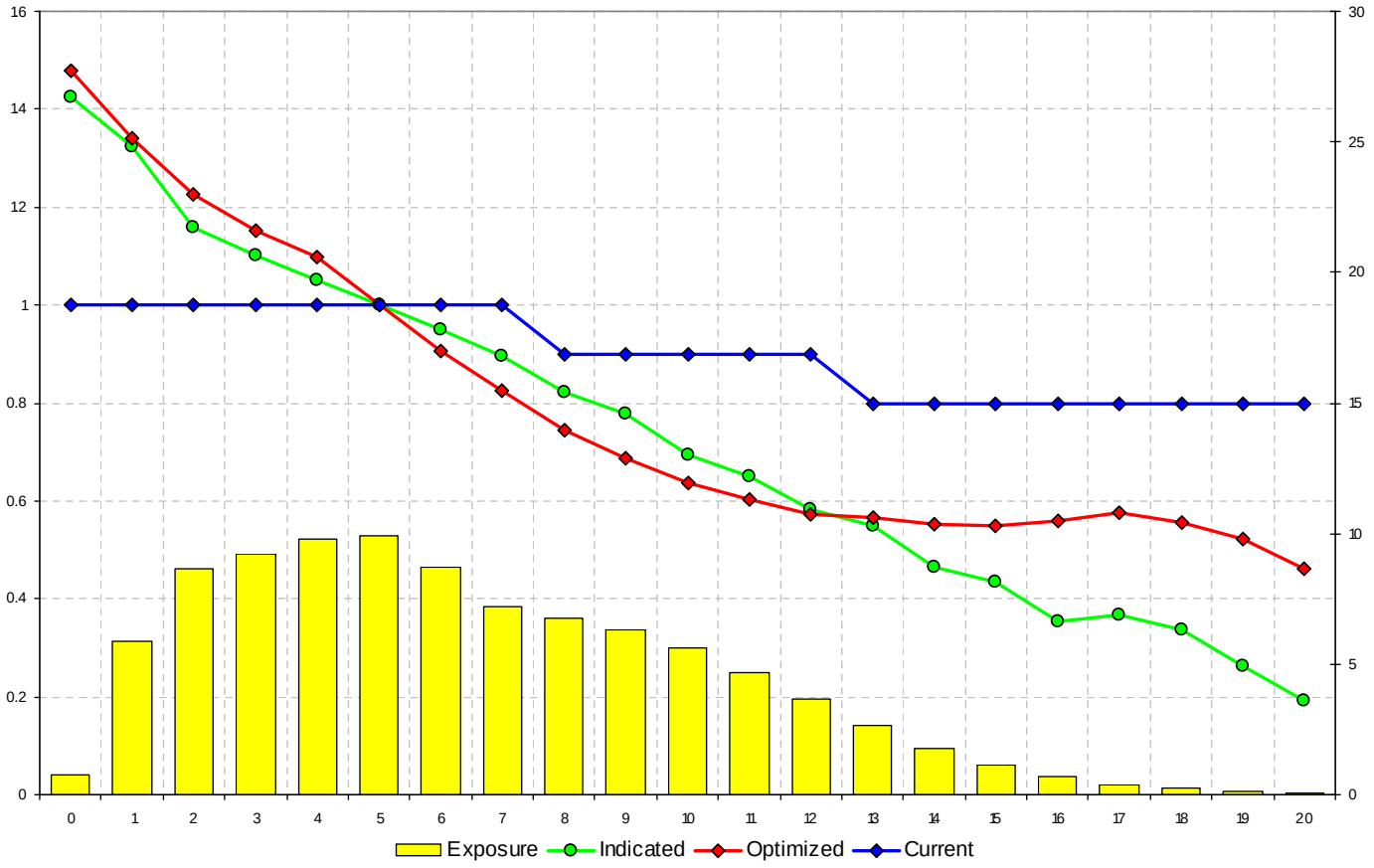
Implementing an Optimized Structure - External

- Rates shall not be excessive, inadequate, or unfairly discriminatory
- A rate is an estimate of the expected value of future costs
- **Reasonable range**

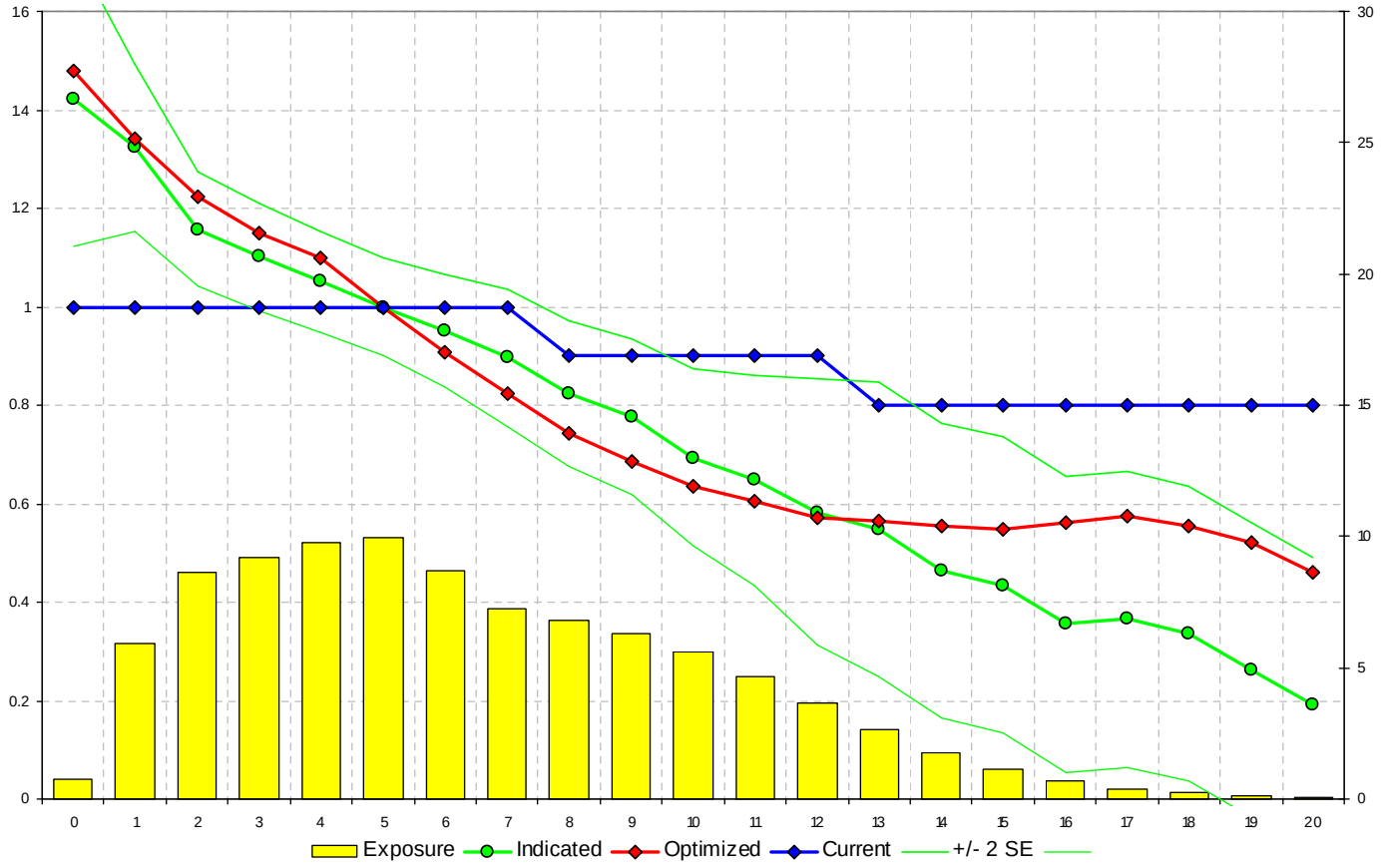
Effect of Regulatory Constraints on “Optimized” Factors



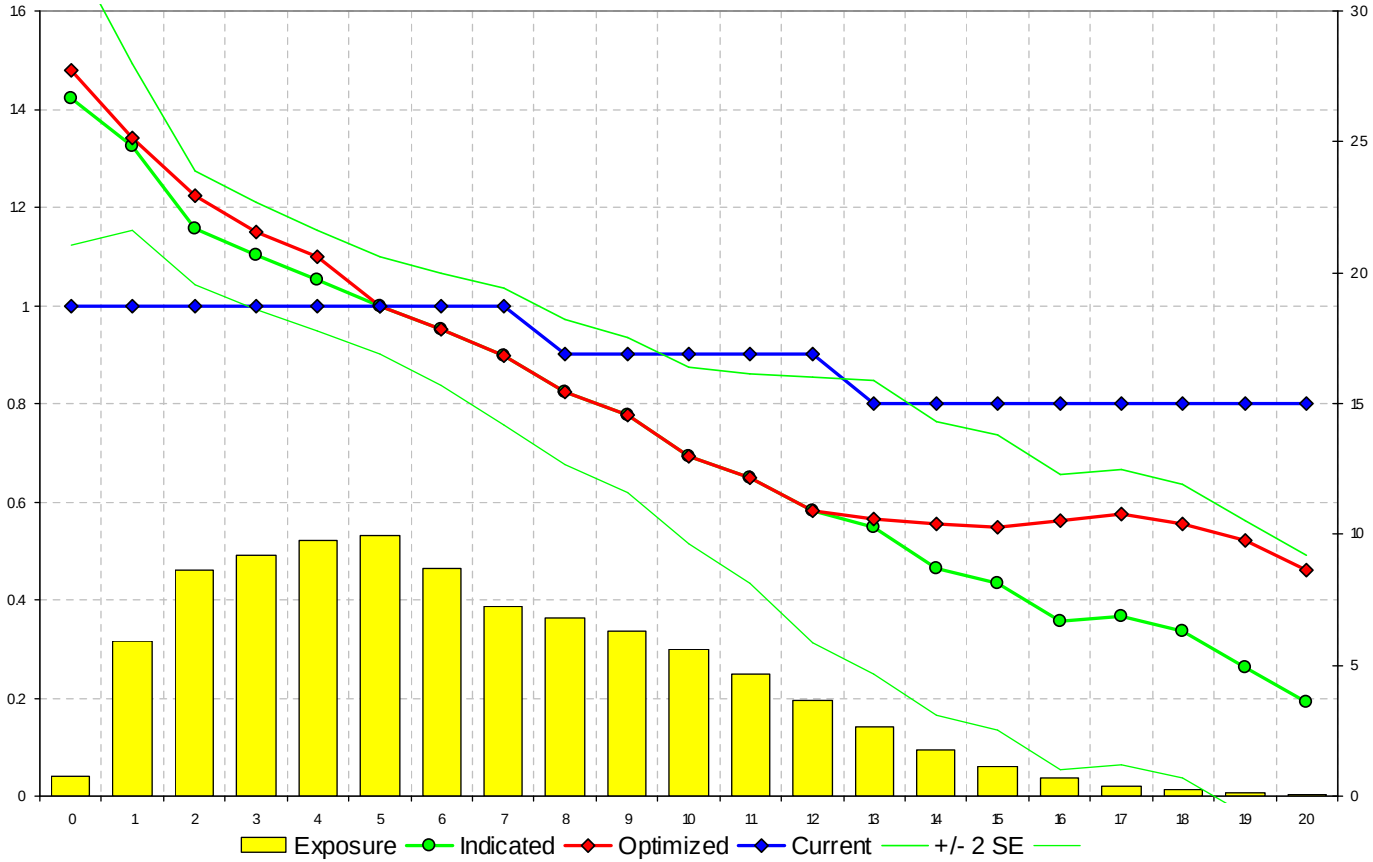
Effect of Regulatory Constraints on “Optimized” Factors



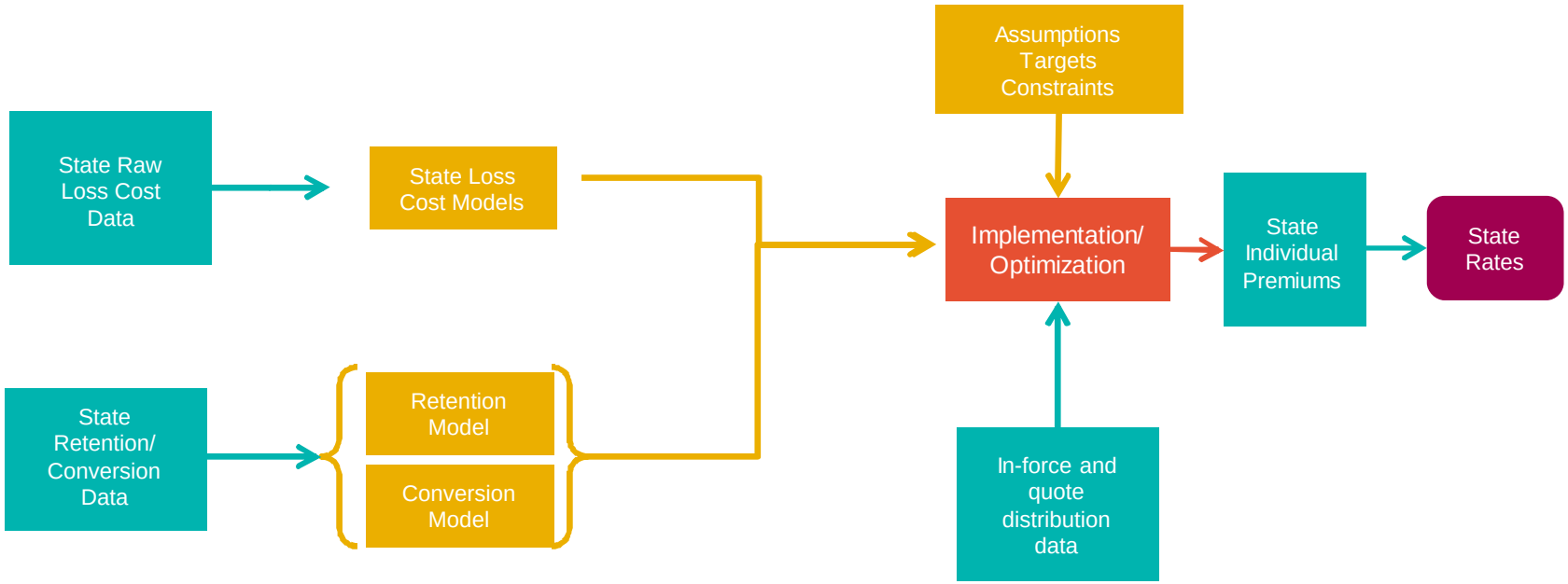
Effect of Regulatory Constraints on “Optimized” Factors



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

Duncan Anderson
Michael McPhail

March 12, 2013