39 - The Use of Predictive Analytics to Set Valuation Assumptions

2019 Valuation Actuary Symposium

TIMOTHY PARIS, FSA, MAAA

Session 039, The Use of Predictive Analytics to Set Valuation Assumptions

August 26, 2019

SOCIETY OF ACTUARIES®

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Antitrust Compliance Guidelines

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Example: VM-21 PBR for Variable Annuities

Public redline exposure draft as of April 30, 2019
https://naic-cms.org/exposure-drafts

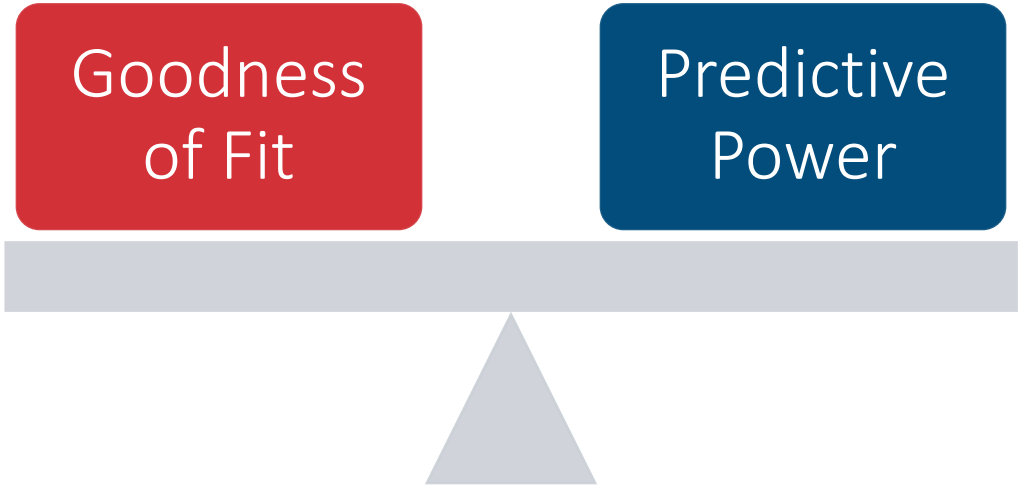
Section 10: Contract Holder Behavior Assumptions

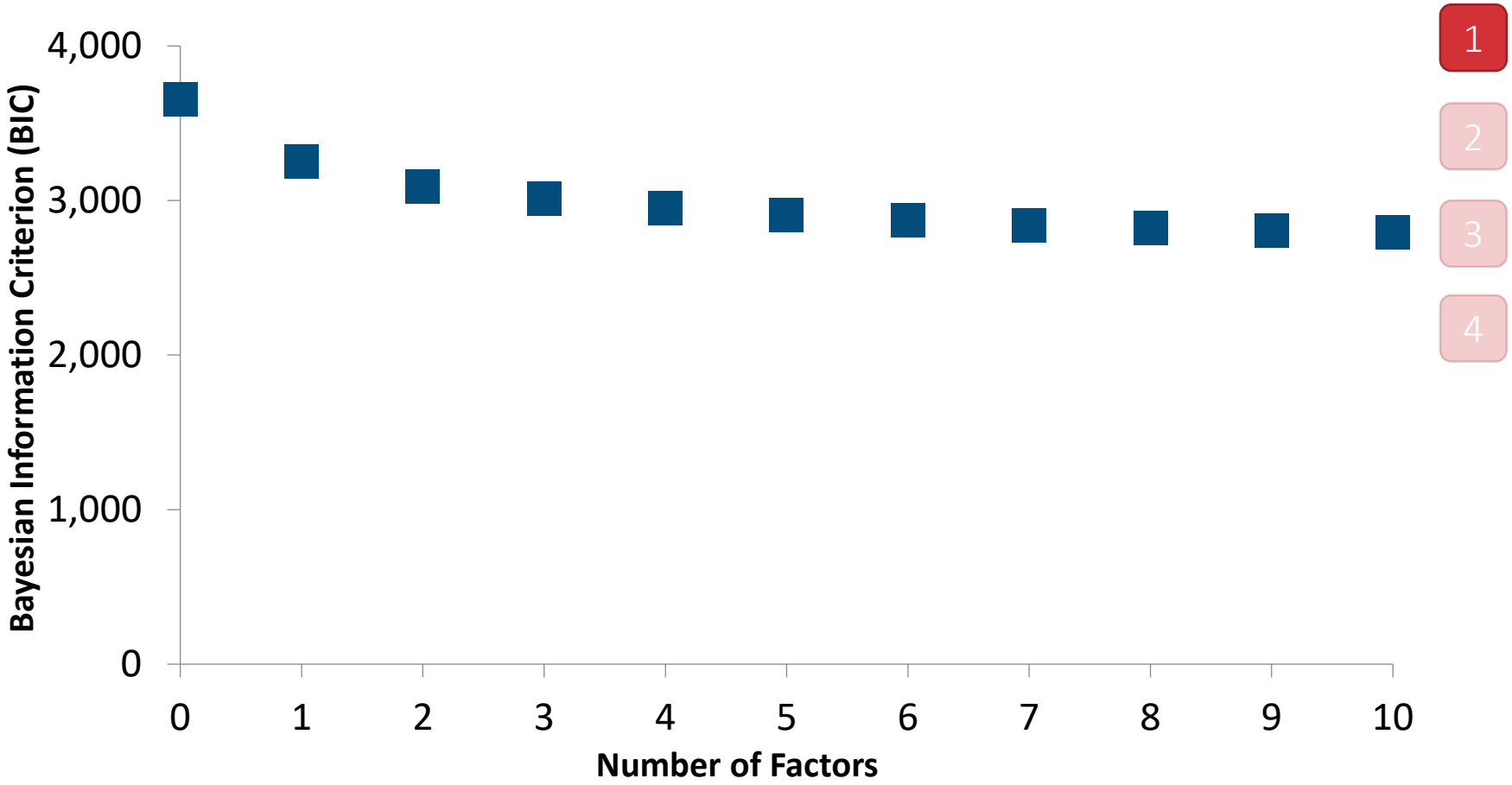
1. Should examine many factors including cohorts, product features, distribution channels, option values, rationality, static vs dynamic
2. Required sensitivity testing, with margins inversely related to data credibility
3. Unless there is clear evidence to the contrary, should be no less conservative than past experience and efficiency should increase over time
4. Where direct data is lacking, should look to similar data from other sources/companies

Examples: deferred annuity industry data

FIA
https://ruark.co/ruark-releases-2019-fixed-indexed-annuity-study/
https://ruark.co/ruark-consulting-releases-2018-fixed-indexed-annuity-mortality-study/

VA
https://ruark.co/ruark-releases-fall-2018-variable-annuity-study-results/
https://ruark.co/ruark-consulting-releases-variable-annuity-mortality-study-results/


Goodness of Fit
Predictive Power


Bayesian Information Criterion (BIC)
4,000
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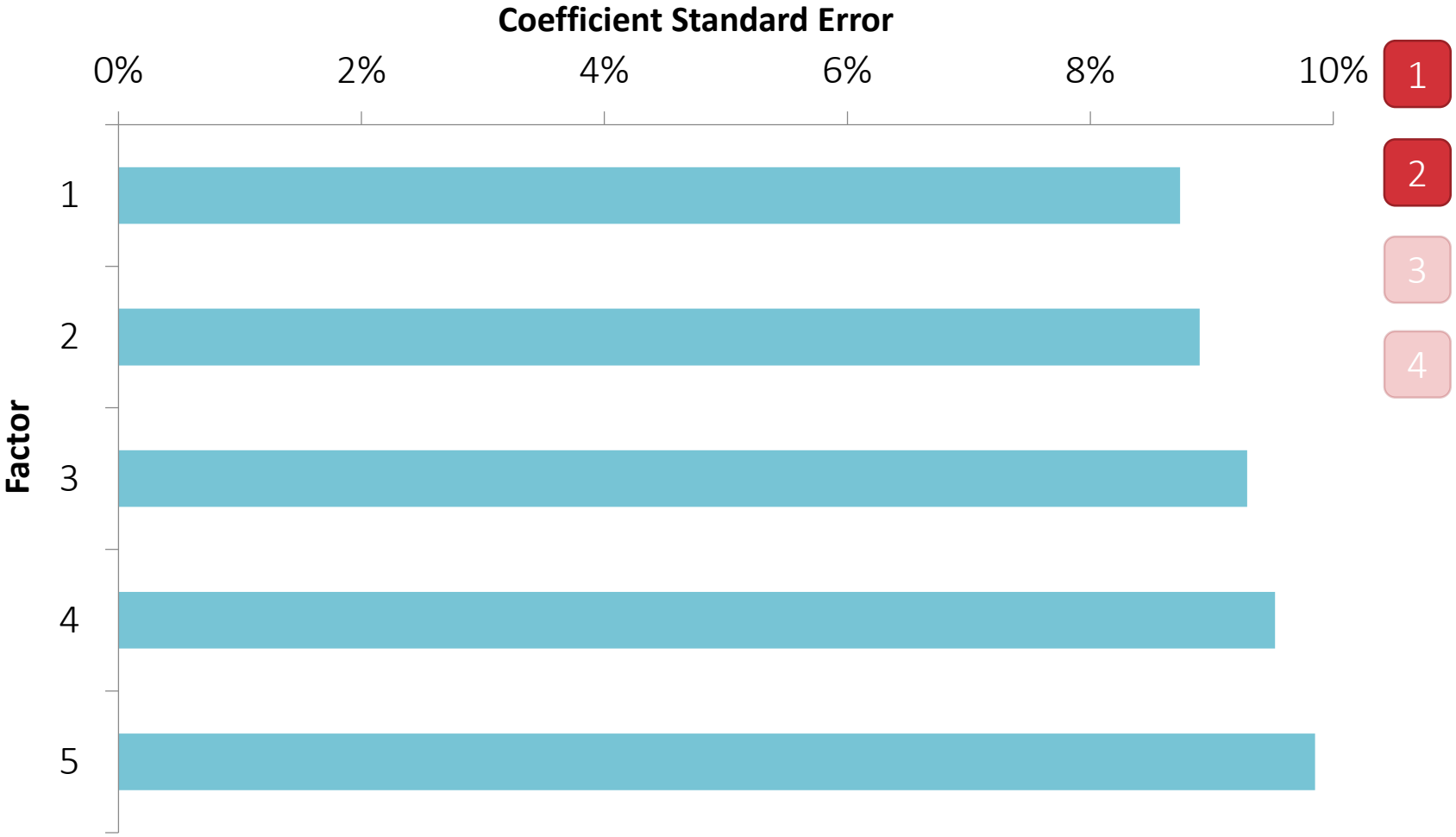
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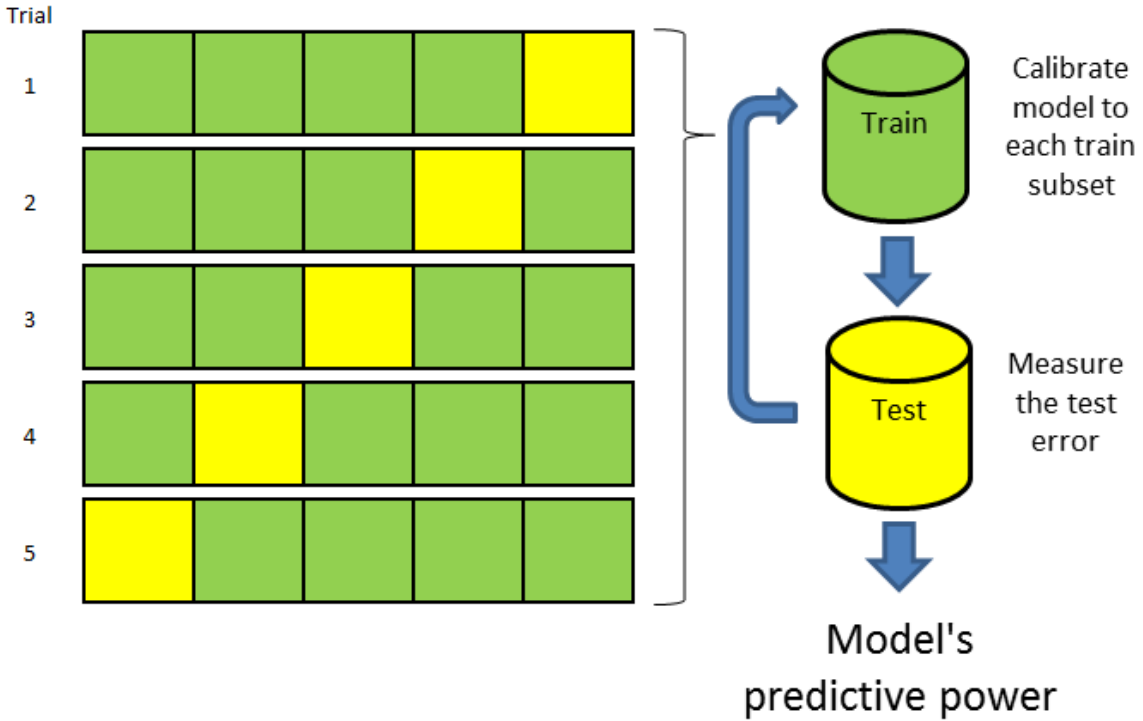
5-Fold Cross Validation

Measures the bias-variance trade-off



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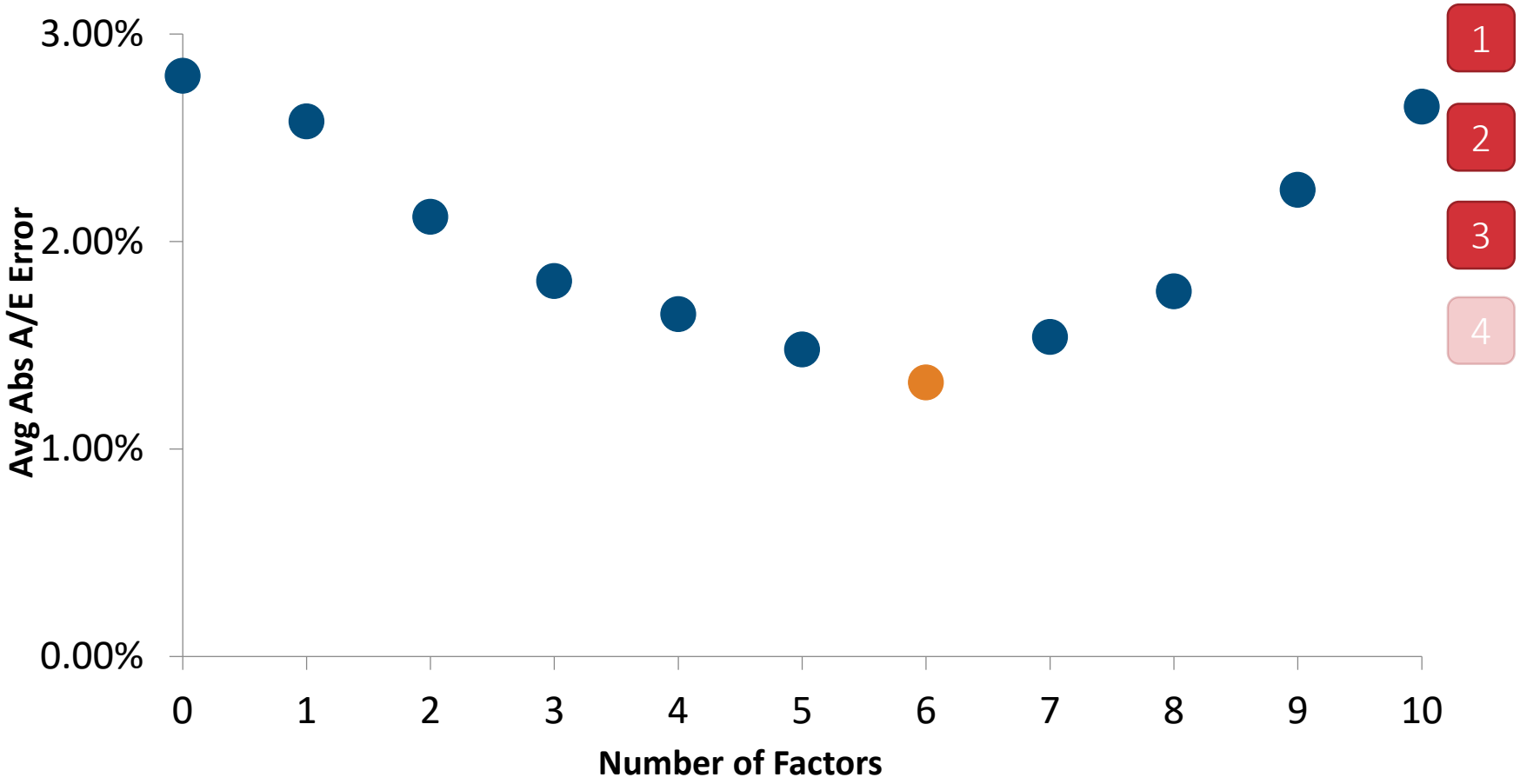
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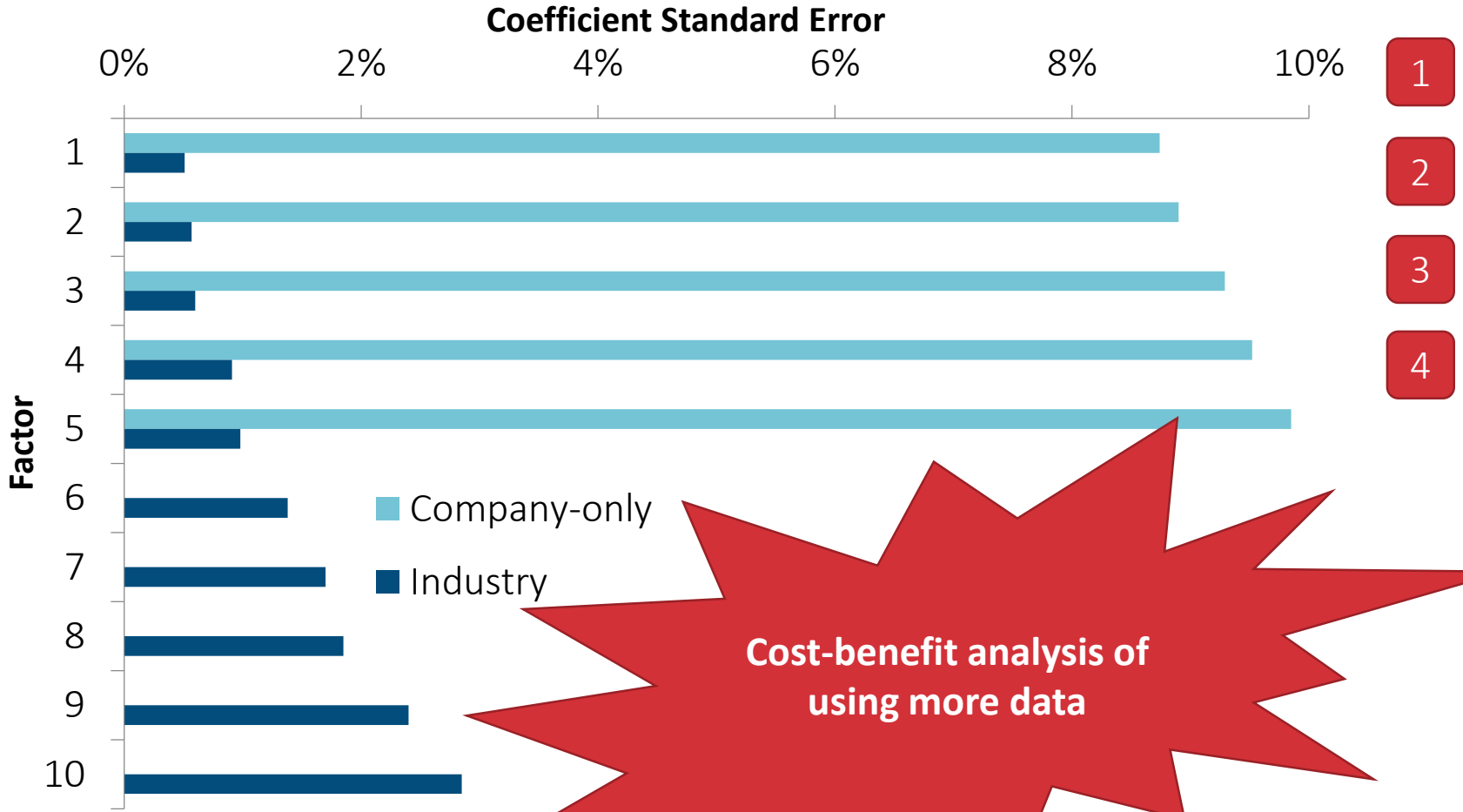
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Company-only
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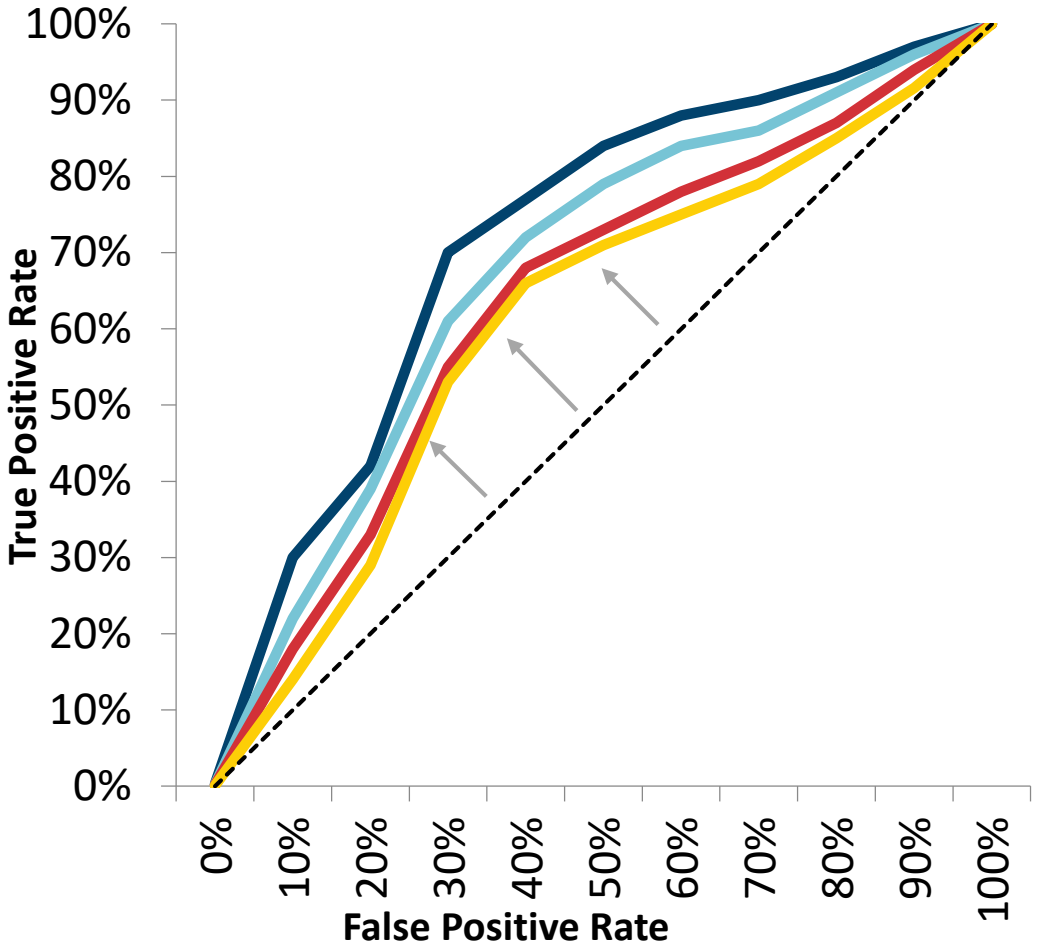
Cost-benefit analysis of using more data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False Positive Rate

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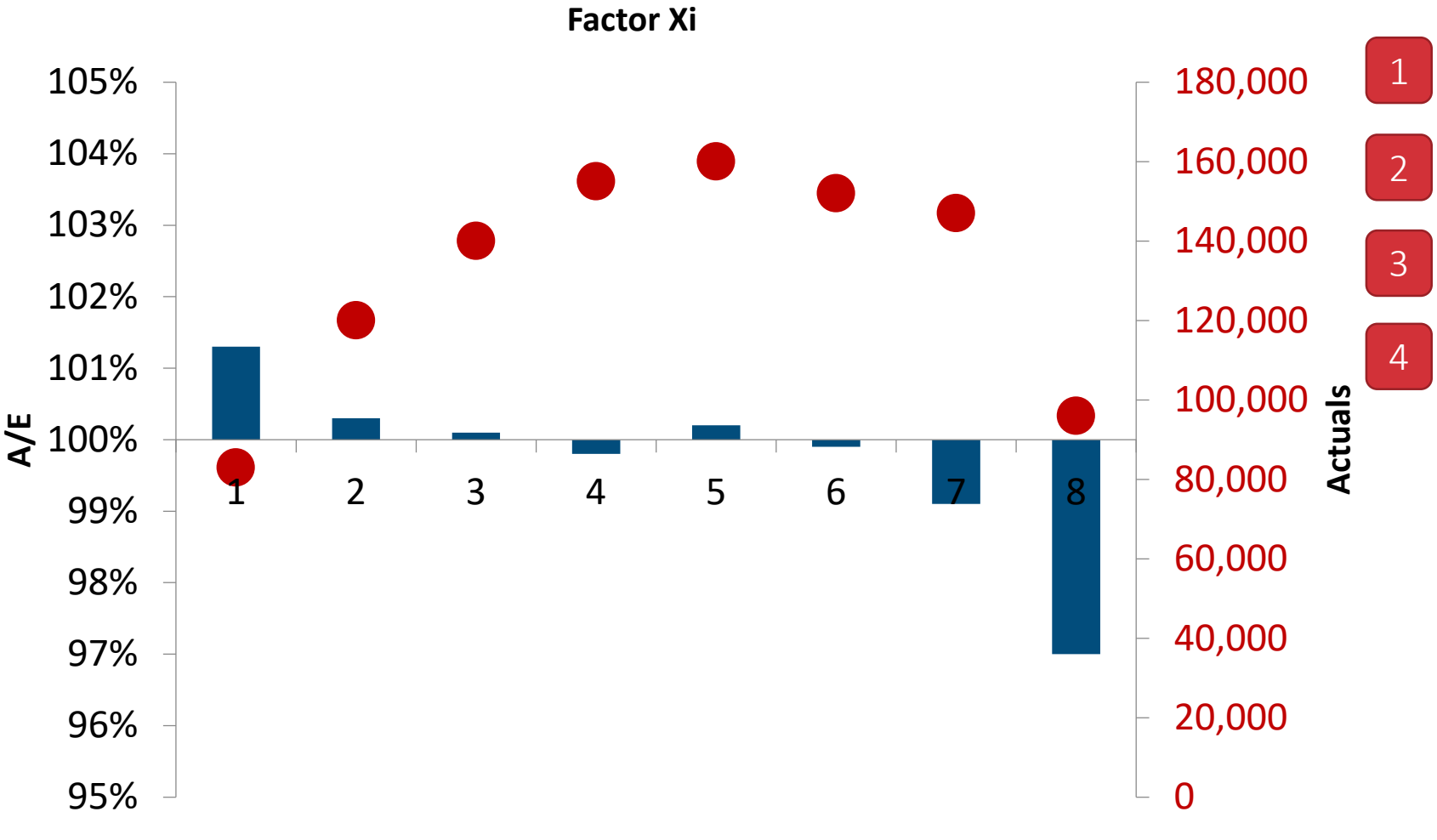
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Actuals
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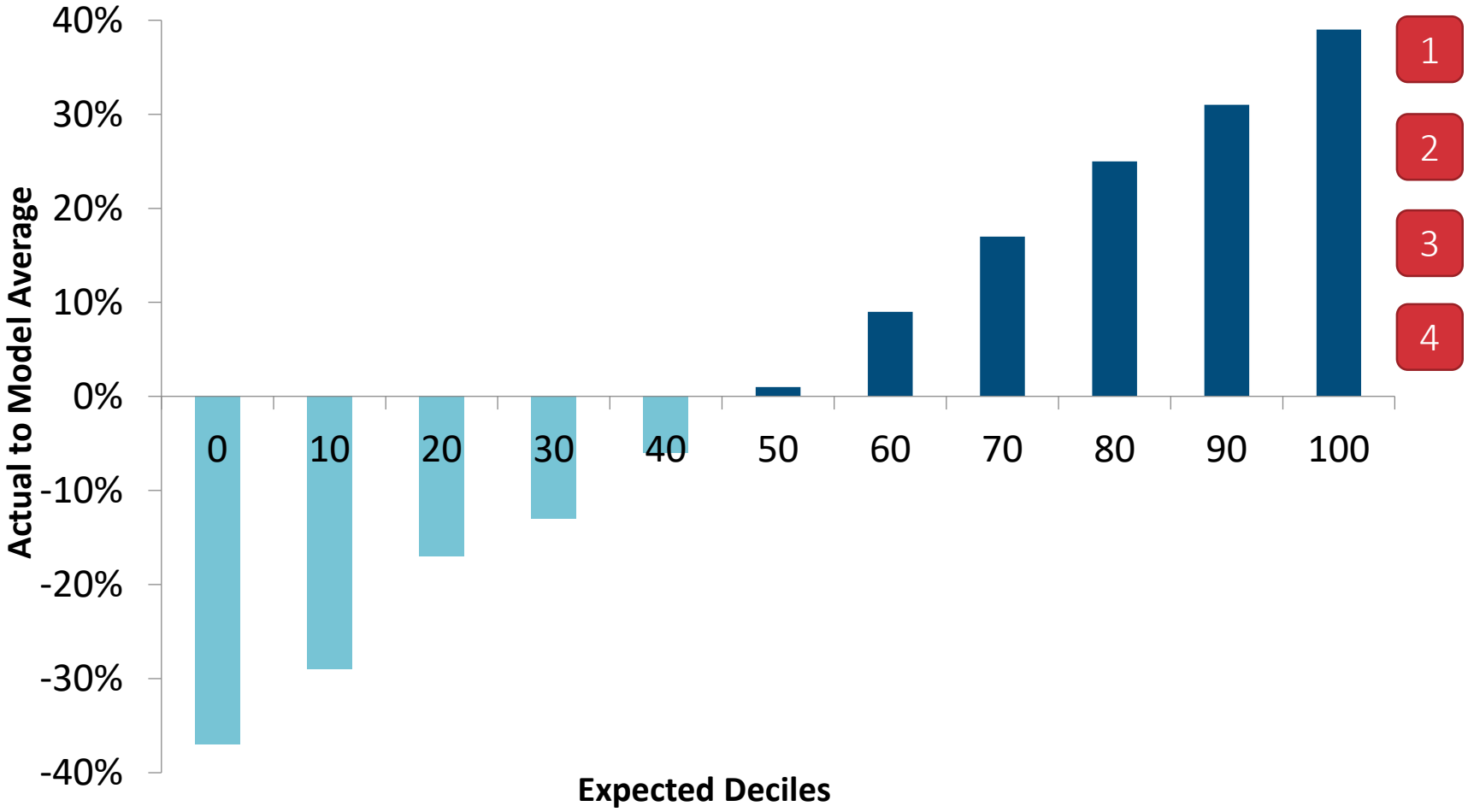
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Actual to Model Average
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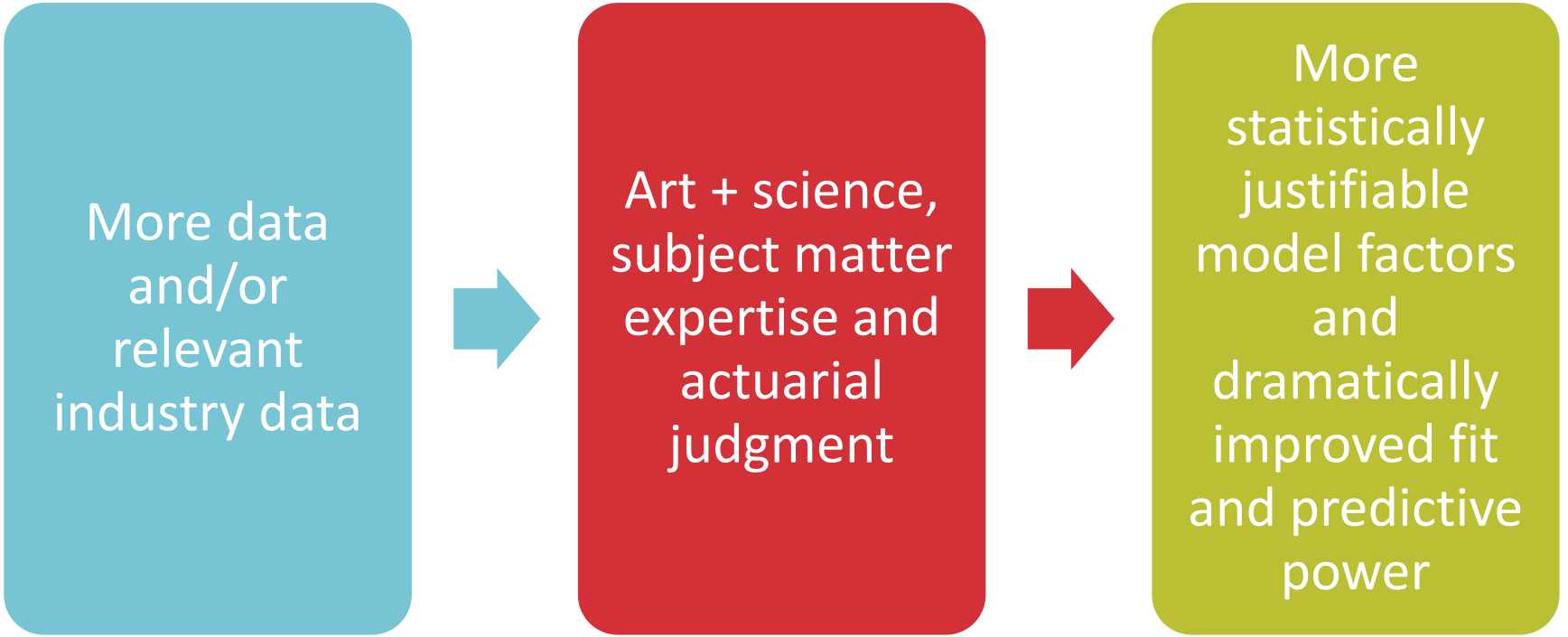
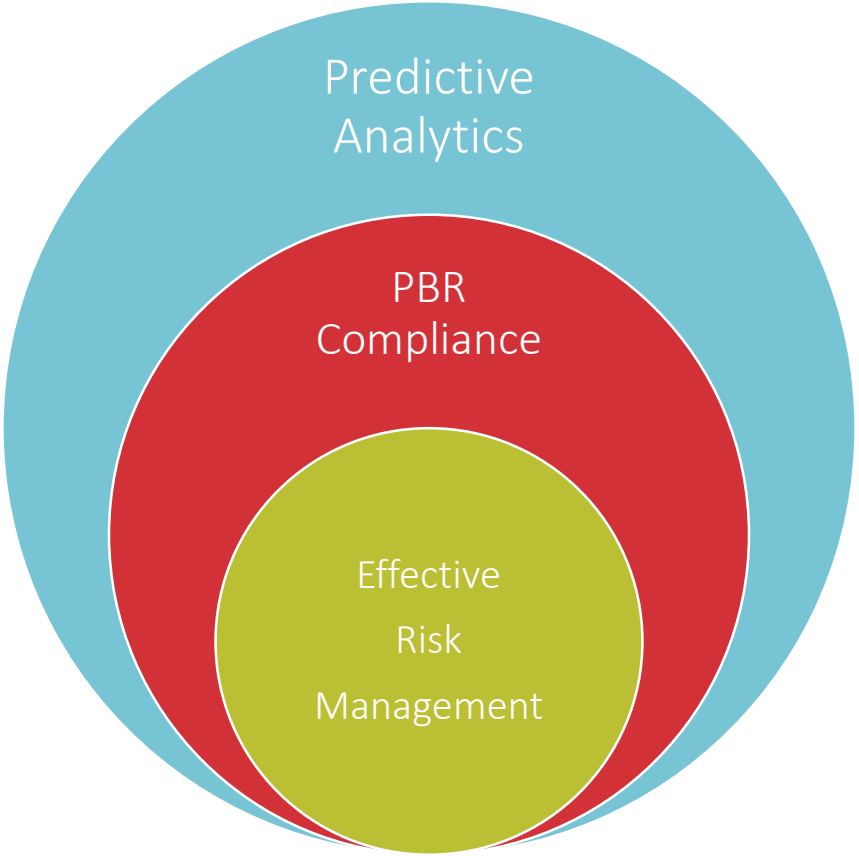

More data and/or relevant industry data
Art + science, subject matter expertise and actuarial judgment
More statistically justifiable model factors and dramatically improved fit and predictive power


Predictive Analytics
PBR Compliance
Effective Risk Management

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Martin Snow, FSA, MAAA

Atidot
Makes Insurance Smarter

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Predictive Analytics and AI in Valuation

- Emergence of Change
- How data transformed the Entertainment and Mass Media industries
- Why is this relevant to the Insurance industry?
- What should an Actuary do?
- Use cases for valuation assumptions

Netflix vs. Blockbuster

Why Did Blockbuster Fail?

- Strengths
  - Well-disciplined operation
  - Tight organization with efficient execution
- Weaknesses
  - Did not easily incorporate new information
  - Failed at change management
  - Did not use data effectively

What Netflix Did Right

- Saw how technology would change movie rental delivery
- Understood data and used it effectively
- Operated online – avoid the burden of retail outlets
- Improved service and pricing
- Set a new standard for the exploding movie / video market

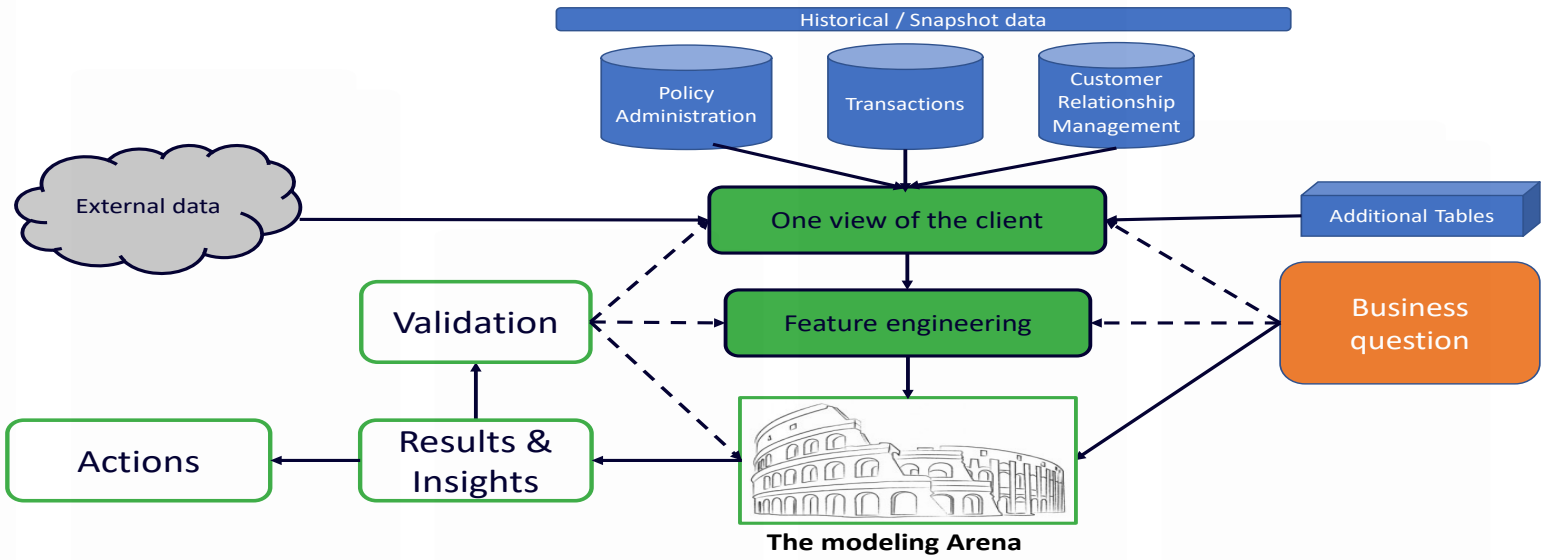
How Does This Apply to Insurance?

- How responsive is the insurance sales model?
- How engaging is the insurance customer relationship model?
- How successful are we at claims management?
- How will more precise assumptions with lower variability improve your bottom line? Valuation?
- Insurers have more data on their customers than Facebook does.

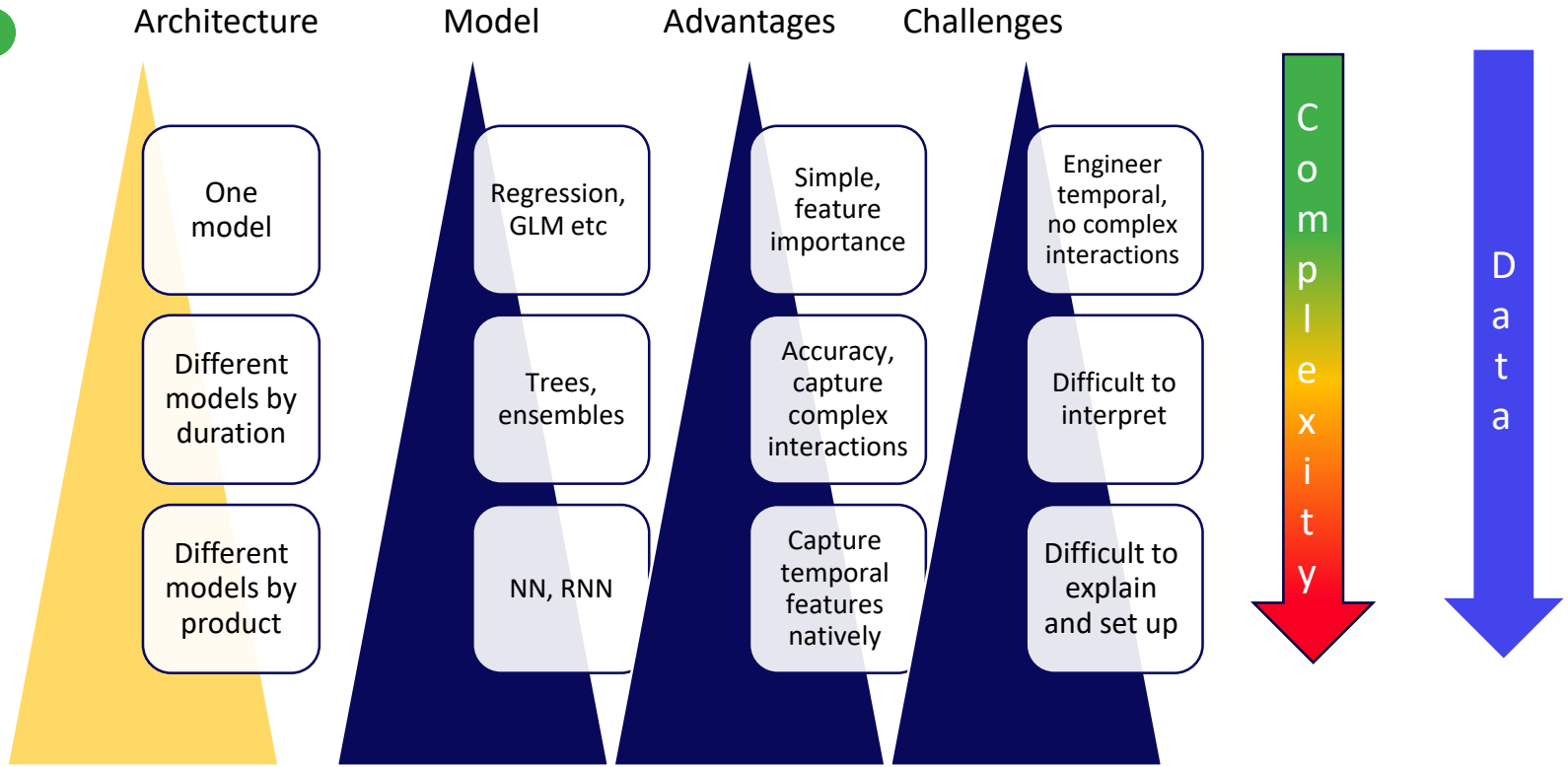
What Should an Actuary Do?

- Be educated (and can also be data scientist)
- Be a change agent
- How is your business represented in the model?
- Is the model producing reasonable and usable results?
- Are the algorithms correct?
- Have the results been validated?
- Is the data being used legal and ethical?
- How can predictive analytics be used in your domain?

Predictive Analytics Data Flow



Modelling landscape



Fixed Annuities and Reinsurance

- Low interest rate environment leads to spread compression
- Companies are not prepared to invest more capital
- De-risk the balance sheet, diversify the business and improve investment margins
- How well does the cedant understand its lapse experience?
- How well does the reinsurer understand its lapse experience?

Fixed Annuity Lapse Experience

- What data do you have?
- Do you have the skills to use machine learning and predictive analytics on this data?
- Do you have data scientists with expertise in the annuity business?
- What type of data have your machines been trained on?
- What type of turn around do you want from predictive analytics?

How Lapse Studies Are Improved

- Challenge:
  - How many years can be combined in a lapse analysis?
  - What if interest rates were different two years ago and last?
- Predictive Analytics solves this challenge:
  - Define the change in rates as a key feature for the machine.
  - The machine will now identify the underlying base lapse rate that is independent of interest rate movements.

How Lapse Studies Are Improved

- This enables the following outcomes:
  - Use more data to set your lapse assumption.
  - Dynamically increase experience periods.
  - Categorize lapse rates by newly identified segments.
- Results:
  - Better predictions with reduced volatility
  - Smart and dynamic customer segmentation

Lapse Case Study

- Difficult to predict early duration lapse rates
- Poor financial projections
- Unable to target leads who are likely to persist
- How should call center be staffed

Lapse Case Study

- Identified additional segments, e.g., profession
- Lapse rates by segment were much more accurate
  - Accounts for changes in new issue populations
  - Enables targeting of those likely to persist
  - Call centers can know – in real time – whether a customer has a high likelihood of lapse

Ye-Olde Lapse Study

By Gender

Universal Life
Policy Lapse Rates

Males

Policy Year	Lapse Rate	Exposure Distribution
1	8.2	4.7
2	8.2	4.5
3	5.7	4.3
4	5.1	4.2
5	5.1	3.9
6	4.4	3.5
7	4.4	3.1
8	4.3	2.5
9	4.3	2.1
10	4.1	2.1
11	3.9	2.6
12	3.8	2.9
13	3.8	2.9
14	3.7	3.1
15	3.8	3.3
16	3.8	3.5
17	3.9	3.8
18	3.9	4.0
19	3.9	4.2
20	4.0	4.4
21	4.0	4.6
22	4.1	5.1
23	4.3	6.0

Universal Life
Policy Lapse Rates

Females

Policy Year	Lapse Rate	Exposure Distribution
1	9.3	6.0
2	8.6	5.5
3	5.8	5.2
4	5.2	5.0
5	4.8	4.6
6	4.4	4.1
7	4.4	3.6
8	4.1	2.9
9	4.1	2.5
10	4.0	2.6
11	3.7	3.0
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14	3.4	3.3
15	3.3	3.3
16	3.3	3.5
17	3.3	3.7
18	3.4	3.8
19	3.4	3.9
20	3.3	3.9
21	3.3	4.0
22	3.3	4.3
23	3.4	4.6

Universal Life
Policy Lapse Rates

40-49

Policy Year	Lapse Rate	Exposure Distribution
1	7.1	4.4
2	7.7	4.4
3	5.6	4.6
4	5.1	4.5
5	5.1	4.1
6	4.4	3.8
7	4.4	3.4
8	4.2	2.6
9	4.2	2.0
10	4.2	2.1

Universal Life
Policy Lapse Rates

50-59

Policy Year	Lapse Rate	Exposure Distribution
1	4.6	7.5
2	5.4	7.0
3	4.2	7.0
4	3.8	6.9
5	4.0	6.1
6	3.5	5.2
7	3.4	4.2
8	3.5	3.0
9	3.8	2.3
10	3.8	2.3

U.S. Individual Life Persistency

A Joint Study Sponsored by the Society of Actuaries and LIMRA

Lapse Experience Detail
For Experience Period 2007-2009

Yo dy

What features really influence lapses? Did I capture all of them?

By Gende

Univ ersal Life
Policy Lapse R / Policy Lapse Rates

Males / *Females*

Policy Year	Lapse Rate	Exposure Distribution	Policy Year	Lapse Rate	Exposure Distribution
1	8.2	4.7	1	9.3	6.0
2	8.2	4.5	2	8.6	5.5
3	5.7	4.3	3	5.8	5.2
4	5.1	4.2	4	5.2	5.0
5	5.1	3.9	5	4.8	4.6
6	4.4	3.5	6	4.4	4.1
7	4.4	3.1	7	4.4	3.6
8	4.3	2.5	8	4.1	2.9
9	4.3	2.1	9	4.1	2.5
10	4.1	2.1	10	4.0	2.6
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17	3.9	3.8	17	3.3	3.7
18	3.9	4.0	18	3.4	3.8
19	3.9	4.2	19	3.4	3.9
20	4.0	4.4	20	3.3	3.9
21	4.0	4.6	21	3.3	4.0
22	4.1	5.1	22	3.3	4.3
23	4.3	6.0	23	3.4	4.6

Universal Life
Policy Lapse Rates

40-49

Policy Year	Lapse Rate	Exposure Distribution
1	7.1	4.4
2	7.7	4.4
3	5.6	4.6
4	5.1	4.5
5	5.1	4.1
6	4.4	3.8
7	4.4	3.4
8	4.2	2.6
9	4.2	2.0
10	4.2	2.1

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Policy Lapse Rates

50-59

Policy Year	Lapse Rate	Exposure Distribution
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3	4.2	7.0
4	3.8	6.9
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7	4.4	3.1	7	4.4	3.6
8	4.3	2.5	8	4.1	2.9
9	4.3	2.1	9	4.1	2.5
10	4.1	2.1	10	4.0	2.6
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17	3.9	3.8	17	3.3	3.7
18	3.9	4.0	18	3.4	3.8
19	3.9	4.2	19	3.4	3.9
20	4.0	4.4	20	3.3	3.9
21	4.0	4.6	21	3.3	4.0
22	4.1	5.1	22	3.3	4.3
23	4.3	6.0	23	3.4	4.6

Grouping can influence the results

Univ niversal Life

Policy Lapse R *Policy Lapse Rates*

40-49 *50-59*

Policy Year	Lapse Rate	Exposure Distribution	Policy Year	Lapse Rate	Exposure Distribution
1	7.1	4.4	1	4.6	7.5
2	7.7	4.4	2	5.4	7.0
3	5.6	4.6	3	4.2	7.0
4	5.1	4.5	4	3.8	6.9
5	5.1	4.1	5	4.0	6.1
6	4.4	3.8	6	3.5	5.2
7	4.4	3.4	7	3.4	4.2
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10	4.2	2.1	10	3.8	2.3

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6	4.4	3.5	6	4.4	4.1
7	4.4	3.1	7	4.4	3.6
8	4.3	2.5	8	4.1	2.9
9	4.3	2.1	9	4.1	2.5
10	4.1	2.1	10	4.0	2.6
11	3.9	2.6	11	3.7	3.0
12	3.8	2.9	12	3.4	3.3
13	3.8	2.9	13	3.4	3.2
14	3.7	3.1	14	3.4	3.3
15	3.8	3.3	15	3.3	3.3
16	3.8	3.5	16	3.3	3.5
17	3.9	3.8	17	3.3	3.7
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22	4.1	5.1	22	3.3	4.3
23	4.3	6.0	23	3.4	4.6

Grouping can influence the results

Univ niversal Life

Policy Lapse R *Policy Lapse Rates*

40-49 *50-59*

Policy Year	Lapse Rate	Exposure Distribution	Policy Year	Lapse Rate	Exposure Distribution
1	7.1	4.4	1	4.6	7.5
2	7.7	4.4	2	5.4	7.0
3	5.6	4.6	3	4.2	7.0
4	5.1	4.5	4	3.8	6.9
5	5.1	4.1	5	4.0	6.1
6	4.4	3.8	6	3.5	5.2
7	4.4	3.4	7	3.4	4.2
8	4.2	2.6	8	3.5	3.0
9	4.2	2.0	9	3.8	2.3
10	4.2	2.1	10		

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How far back do I need to go?

Lapse Experience Detail

For Experience Period 2007-2009

Yo dy

What features really influence lapses? Did I capture all of them?

By Gende

Univ ersal Life

Policy Lapse R *Policy Lapse Rates*

Males *Females*

Policy Year	Lapse Rate	Exposure Distribution	Policy Year	Lapse Rate	Exposure Distribution
1	8.2	4.7	1	9.3	6.0
2	8.2	4.5	2	8.6	5.5
3	5.7	4.3	3	5.8	5.2
4	5.1	4.2	4	5.2	5.0
5	5.1	3.9	5	4.8	4.6
6	4.4	3.5	6	4.4	4.1
7	4.4	3.1	7	4.4	3.6
8	4.3	2.5	8	4.1	2.9
9	4.3	2.1	9	4.1	2.5
10	4.1	2.1	10	4.0	2.6
11	3.9	2.6	11	3.7	3.0
12	3.8	2.9	12	3.4	3.3
13	3.8	2.9	13	3.4	3.2
14	3.7	3.1	14	3.4	3.3
15	3.8	3.3	15	3.3	3.3
16	3.8	3.5	16	3.3	3.5
17	3.9	3.8	17	3.3	3.7
18	3.9	4.0	18	3.4	3.8
19	3.9	4.2	19	3.4	3.9
20	4.0	4.4	20	3.3	3.9
21	4.0	4.6	21	3.3	4.0
22	4.1	5.1	22	3.3	4.3
23	4.3	6.0	23	3.4	4.6

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40-49 *50-59*

Policy Year	Lapse Rate	Exposure Distribution	Policy Year	Lapse Rate	Exposure Distribution
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3	5.6	4.6	3	4.2	7.0
4	5.1	4.5	4	3.8	6.9
5	5.1	4.1	5		
6	4.4	3.8	6		
7	4.4	3.4	7		
8	4.2	2.6	8		
9	4.2	2.0	9	3.8	
10	4.2	2.1	10		

How can I capture trends?

How far back do I need to go?

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1	8.2	4.7
2		
3		
4		
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6		
7	4.4	3.1
8	4.3	2.5
9	4.3	2.1
10	4.1	2.1
11	3.9	2.6
12	3.8	2.9
13	3.8	2.9
14	3.7	3.1
15	3.8	3.3
16	3.8	3.5
17	3.9	3.8
18	3.9	4.0
19	3.9	4.2
20	4.0	4.4
21	4.0	4.6
22	4.1	5.1
23	4.3	6.0

Policy Year	Lapse Rate	Exposure Distribution
1	9.3	6.0
2	8.6	5.5
3	5.8	5.2
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15	3.3	3.3
16	3.3	3.5
17	3.3	3.7
18	3.4	3.8
19	3.4	3.9
20	3.3	3.9
21	3.3	4.0
22	3.3	4.3
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What is the right model for the job?

Grouping can influence the results

Univ niversal Life

Policy Lapse *Policy Lapse Rates*

40-49 *50-59*

Policy Year	Lapse Rate	Exposure Distribution
1	7.1	4.4
2	7.7	4.4
3	5.6	4.6
4	5.1	4.5
5	5.1	4.1
6	4.4	3.8
7	4.4	3.4
8	4.2	2.6
9	4.2	2.0

Policy Year	Lapse Rate	Exposure Distribution
1	4.6	7.5
2	5.4	7.0
3	4.2	7.0
4	3.8	6.9
5		
6		
7		
8		
9	3.8	

How can I capture trends?

How far back do I need to go?

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Lapse Experience Detail

For Experience Period 2007-2009

Yo dy

I want to easily understand the effect of multiple features on lapse rate

What features really influence lapses? Did I capture all of them?

Grouping can influence the results

What is the right model for the job?

How can I capture trends?

How far back do I need to go?

By Gende

Univ ersal Life

Policy Lapse R *Policy Lapse Rates*

Males

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1	8.2	4.7
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12	3.8	2.9
13	3.8	2.9
14	3.7	3.1
15	3.8	3.3
16	3.8	3.5
17	3.9	3.8
18	3.9	4.0
19	3.9	4.2
20	4.0	4.4
21	4.0	4.6
22	4.1	5.1
23	4.3	6.0

Females

Policy Year	Lapse Rate	Exposure Distribution
1	9.3	6.0
2	8.6	5.5
3	5.8	5.2
4	5.2	5.0
5	4.8	4.6
6	4.4	4.1
7	4.4	3.6
8	4.1	2.9
9	4.1	2.5
10	4.0	2.6
11	3.7	3.0
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15	3.3	3.3
16	3.3	3.5
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Univ niversal Life

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8	4.2	2.6
9	4.2	2.0

50-59

Policy Year	Lapse Rate	Exposure Distribution
1	4.6	7.5
2	5.4	7.0
3	4.2	7.0
4	3.8	6.9
5		
6		
7		
8		
9	3.8	

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Lapse Experience Detail

For Experience Period 2007-2009

Yo dy

I want to easily understand the effect of multiple features on lapse rate

What features really influence lapses? Did I capture all of them?

Grouping can influence the results

What is the right model for the job?

How can I capture trends?

How good are my predictions?

How far back do I need to go?

By Gende

Univ ersal Life

Policy Lapse R *Policy Lapse Rates*

Males

Policy Year	Lapse Rate	Exposure Distribution
1	8.2	4.7
7	4.4	3.1
8	4.3	2.5
9	4.3	2.1
10	4.1	2.1
11	3.9	2.6
12	3.8	
13	3.8	
14	3.7	
15	3.6	
16	3.8	
17	3.9	
18	3.9	
19	3.9	4.2
20	4.0	4.4
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10	4.0	2.6
		3.0
		3.3
		3.2
		3.7
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50-59

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4	3.8	6.9
5		
6		
7		
8		
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10		

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Lapse Experience Detail

For Experience Period 2007-2009

I want to easily understand the effect of multiple

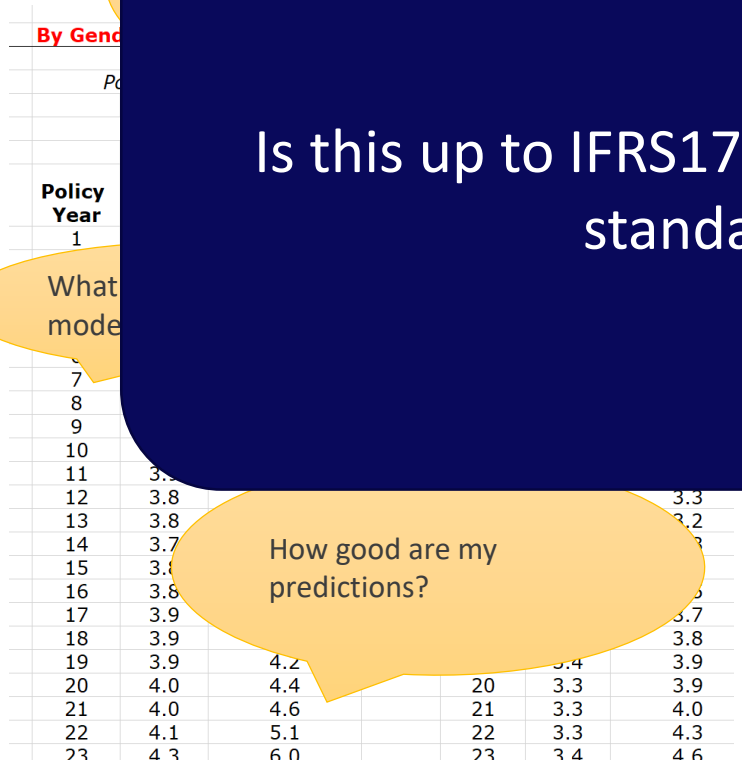
Is this up to IFRS17 / Solvency II / PBR standards??

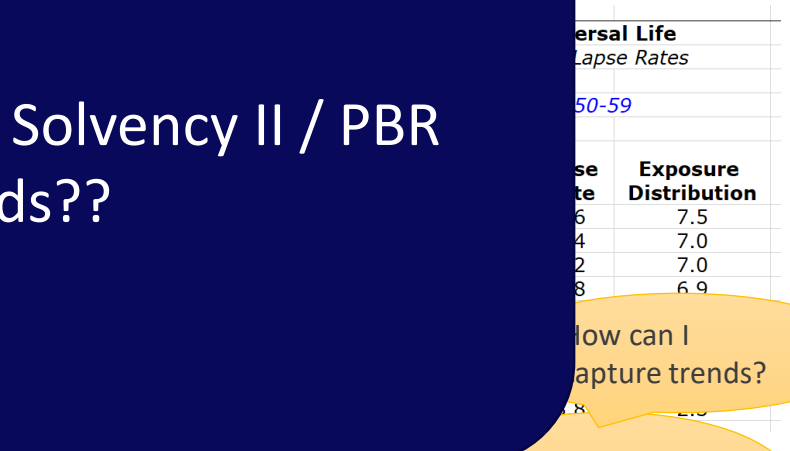
What mode

How good are my predictions?

How can I capture trends?

How far back do I need to go?





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Lapse Experience Detail
For Experience Period 2007-2009

Can a predictive model help?

I wish I could….		Solved by a predictive model
Include all possible relevant features. Objectively identify significant features	✓✓	Automatically by model
Group features automatically in the way that highlights the differences between the groups	✓✓	Automatically by model
Use all the data I have	✓	Automatic + Feature engineering
Allow for temporal (changes through time) features	✓	Depends on models
Try out various models of varying complexity (and have a concrete way of measuring their result)	✓	Define criteria for success
Easily construct multiple-feature rate effects without doing more analysis	✓✓	Output from the model
Confidence intervals	✓	Yes, depends on model

How Annuity Option Studies Are Improved

- When do policyholders exercise options?
- What impact do different features have on this?
- When in the market or economic cycle are options exercised?
- How can the exercise decision be influenced?

How Annuity Option Studies Are Improved

- Use data – optimally
- Robust validation
- Achieve credibility
- Data managed effectively
- Know your customers – personally
- Achieve data driven decision making framework

Artificial Intelligence in LTC

- Improved assumption setting, financial projections, and risk management
- Better claims management
- Advanced education techniques
- Data includes quantity, quality and type of local LTC facilities

Product Development & Pricing

- You now know how policyholders respond to each feature and each price
- You can identify how changes in price and product features influence customer behavior and impact risk.
- Use this information to design better – and lower risk – products that are more optimally priced.
- Do the same with your communication campaigns!

Conclusion

- Predictive Analytics, Artificial Intelligence, and Machine Learning will create a massive revolution in the insurance industry.
- The determinant of future success for established insurers will be how well they embrace the new technology
- Core changes are required for insurers to succeed and reap the major strategic benefits that will accrue to early adapters.
- How are you going to change the thinking at your company?

Thank You

Martin Snow, FSA, MAAA

Vice-President & Chief Delivery Officer

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Atidot

Makes Insurance Smarter