

2019 **LIFE &
ANNUITY**

SYMPOSIUM

May 20–21 • Tampa, FL



Session 8: Policyholder Behavior Modeling and the Risks of Overfitting Data

[SOA Antitrust Disclaimer](#)

[SOA Presentation Disclaimer](#)



2019 Life and Annuity Symposium

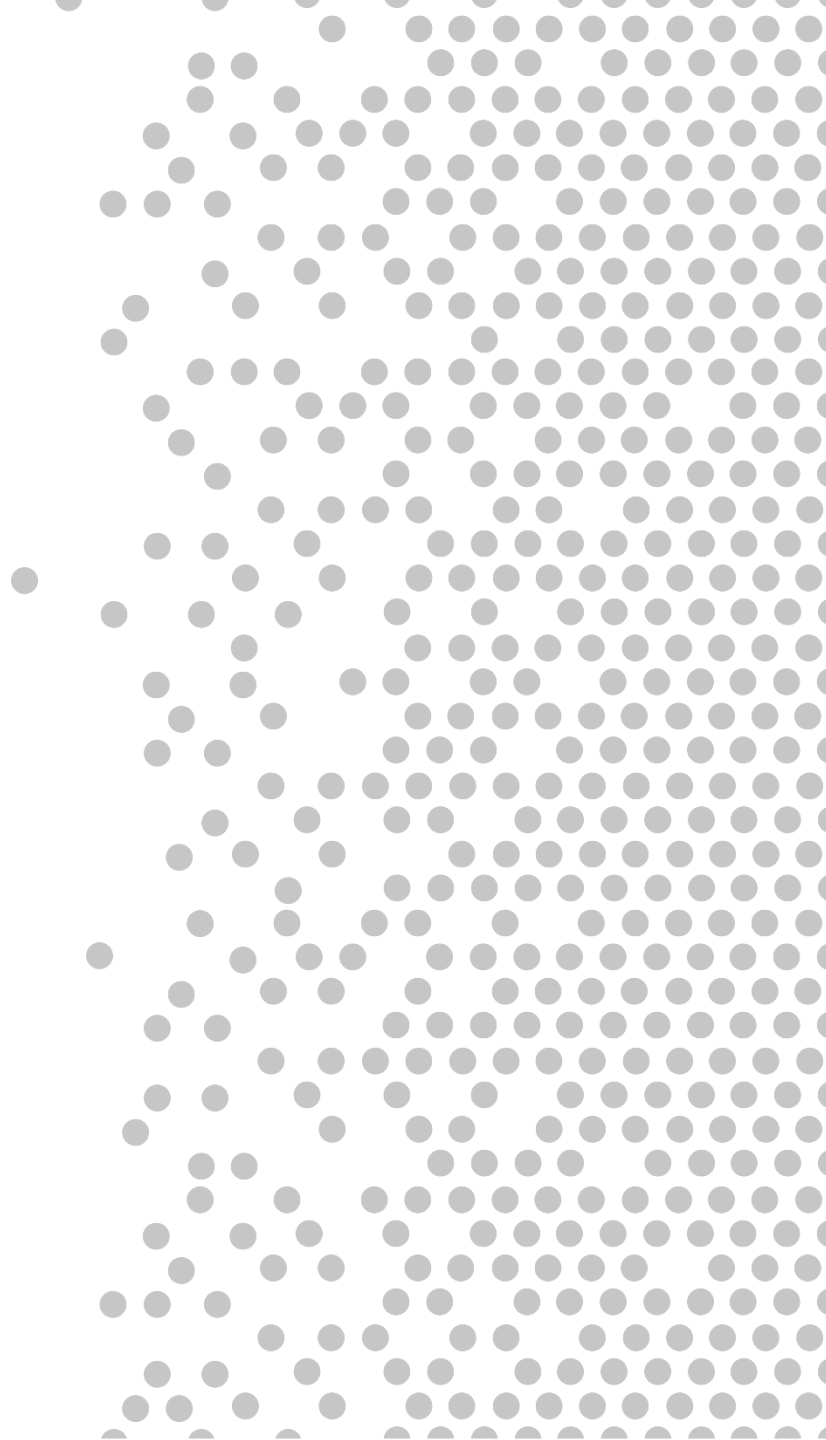
Session 08:

Policyholder Behavior Modeling and the Risks of Overfitting Data

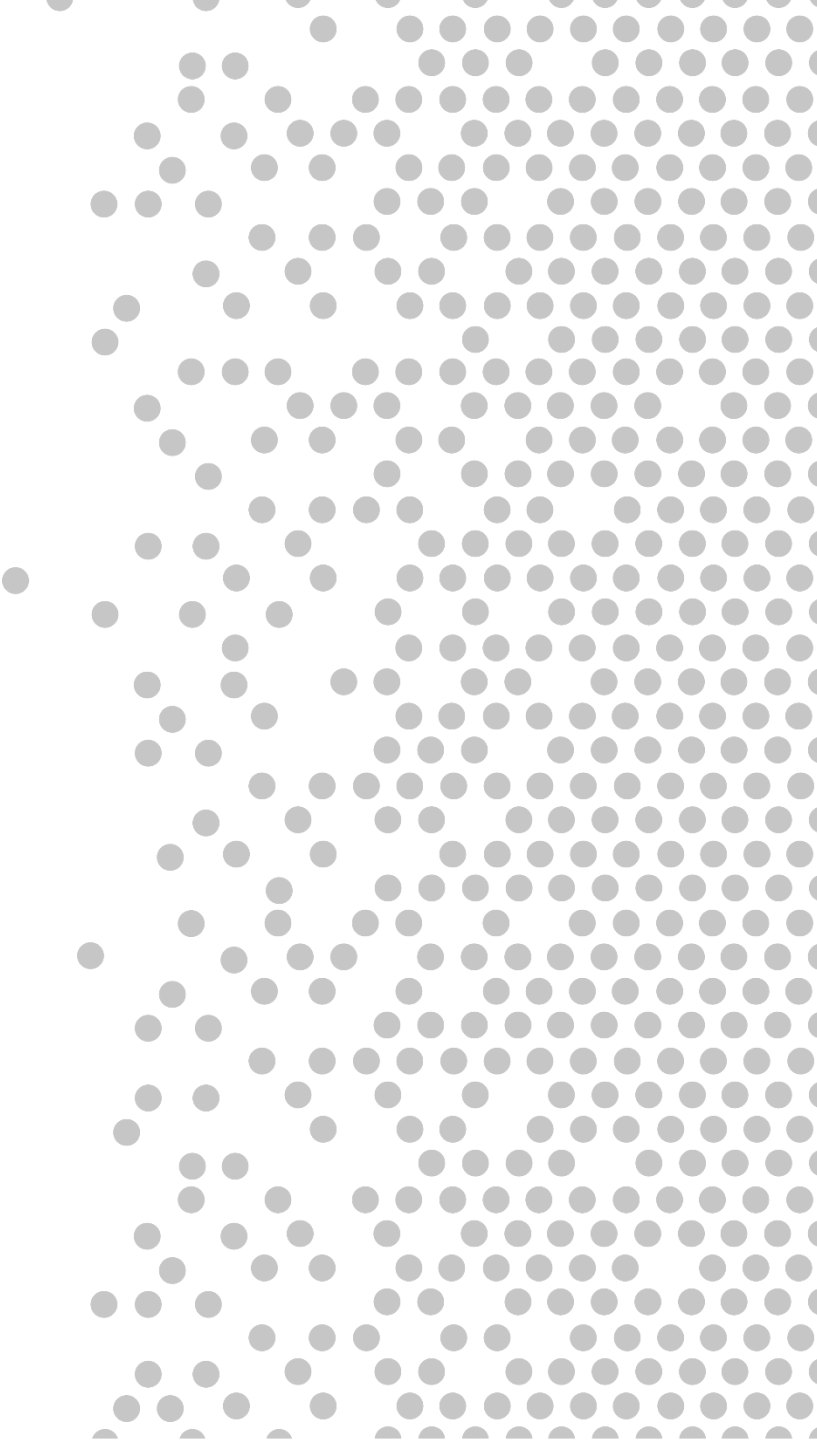
Chanseo Lee, FSA, MAAA MassMutual Financial Group

Contents

- **Policyholder Behavior Driving Factors of Fixed Annuity**
- **Considerations**
- **Modeling**
- **Concerns**



Policyholder Behavior Driving Factors of Fixed Annuity



Fixed Annuity

- Invested in general (fixed) account
- Guarantee credited interest rate like a bank's "CD"
- Tax deferral until withdrawal, death benefit, annuity benefit, & surrender
- Guaranteed living and/or death benefit



Annuity Industry Sales

Variable	Q4 2017	Q4 2018	YTD 2018	Q4 2018 / Q3 2018	Q4 2018 / Q4 2017	YTD 2018 / YTD 2017
Variable separate accounts	19.8	19.0	79.5	-9%	-4%	5%
Variable fixed option	5.7	5.8	20.7	38%	2%	-8%
Total Variable	25.5	24.8	100.2	-1%	-3%	2%

Registered Indexed Linked	2.3	3.5	11.2	19%	51%	22%
---------------------------	-----	-----	------	-----	-----	-----

Fixed	Q4 2017	Q4 2018	YTD 2018	Q4 2018 / Q3 2018	Q4 2018 / Q4 2017	YTD 2018 / YTD 2017
Book value	4.9	9.9	30.9	30%	102%	46%
MVA	2.5	3.4	14.8	-13%	36%	14%
Fixed-rate deferred	7.4	13.3	45.7	16%	80%	34%
Indexed	13.9	19.5	69.6	8%	40%	27%
Total Fixed deferred	21.3	32.8	115.3	11%	54%	29%

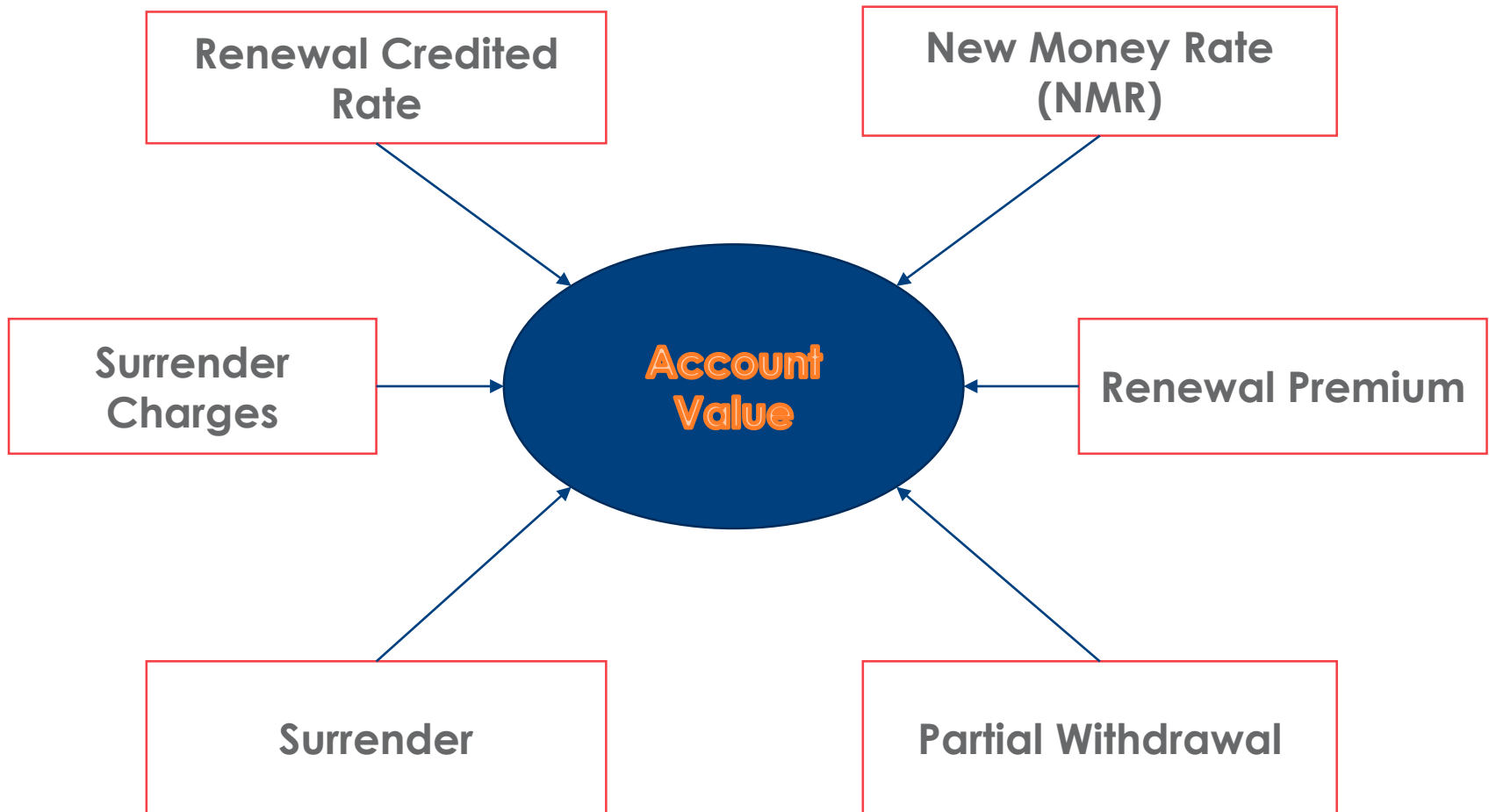
Deferred income	0.55	0.66	2.3	19%	20%	4%
Fixed immediate	2.1	2.7	9.7	13%	29%	17%
Structured settlements	1.4	1.6	6.2	0%	14%	11%

Total Fixed	25.3	37.8	133.5	11%	49%	27%
--------------------	-------------	-------------	--------------	------------	------------	------------

Total U.S. Annuities	50.8	62.6	233.7	6%	23%	15%
-----------------------------	-------------	-------------	--------------	-----------	------------	------------

Source: LIMRA US Individual Annuity Sales Survey Q4 2018 (Sales in \$Billion)

Factors to impact Policyholder Behavior



Surrender Charges

Deter surrenders

- Heaped schedules
- Deter lapses for small interest rate move
- Instead, utilize partial withdrawal. Usually, 10% of AV can be withdrawn free of surrender charges each year

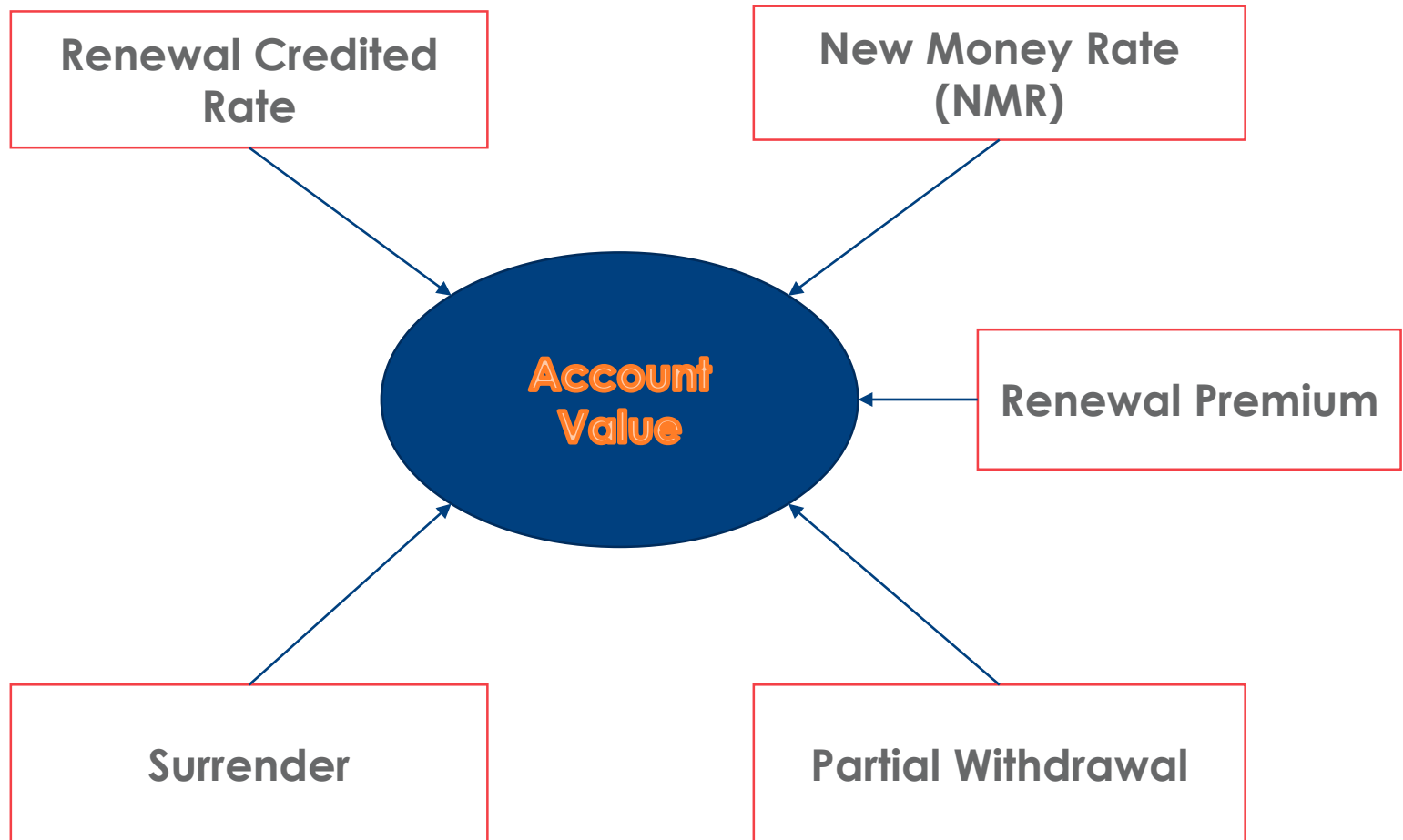
When credited rate is guaranteed for the whole surrender charge period

- Just utilize partial withdrawal if a higher new market rate (NMR) is offered
- Add renewal (additional) premium if a guaranteed credited rate is higher than NMR

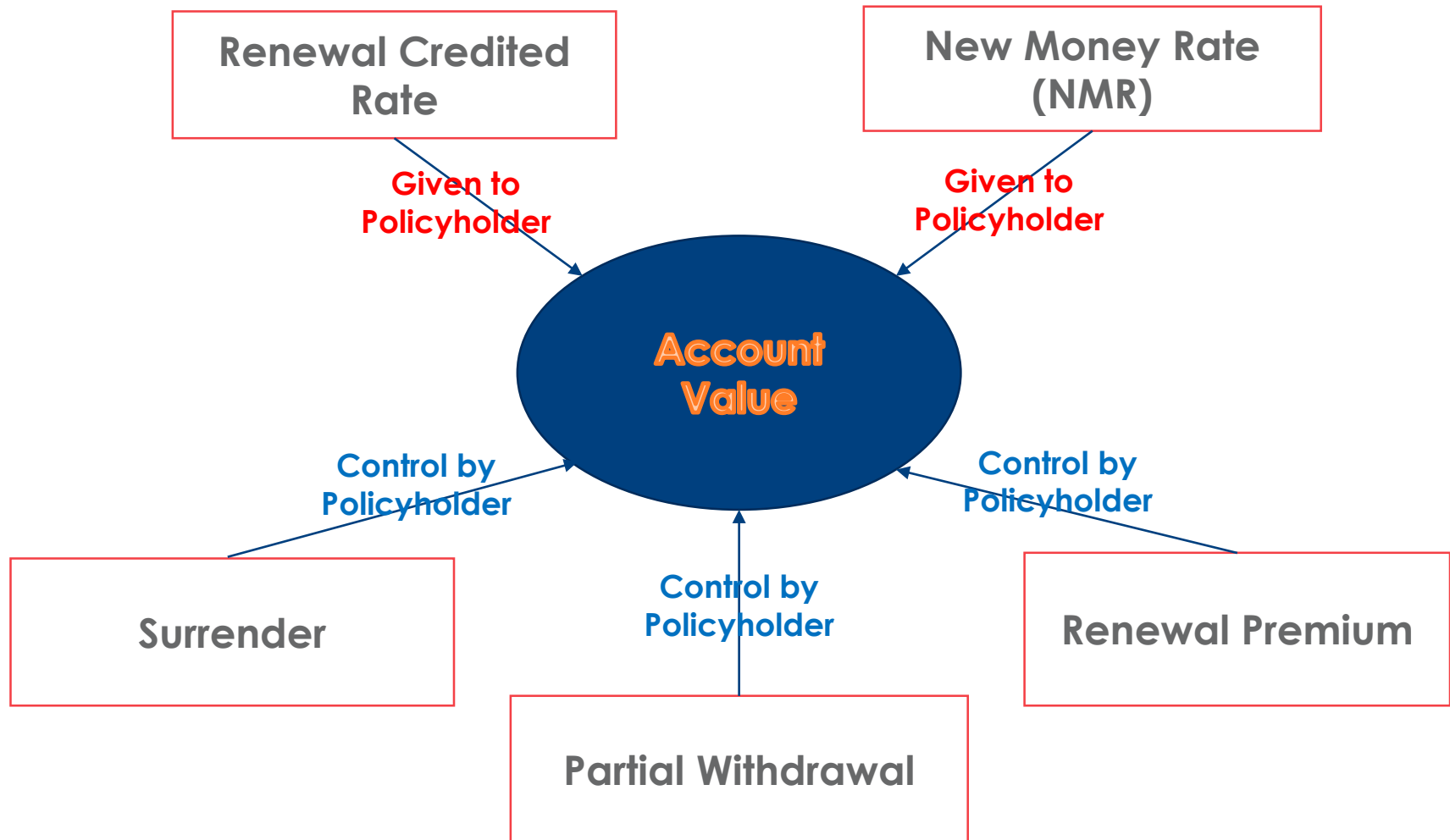
When credited rate is guaranteed for a part of the surrender charge period

- Policyholder responds dynamically to renewal credited rate
- If a higher NMR is available, no renewal premium and more partial withdrawal
- If a renewal rate is higher than NMR, more renewal premium and no/little partial withdrawal

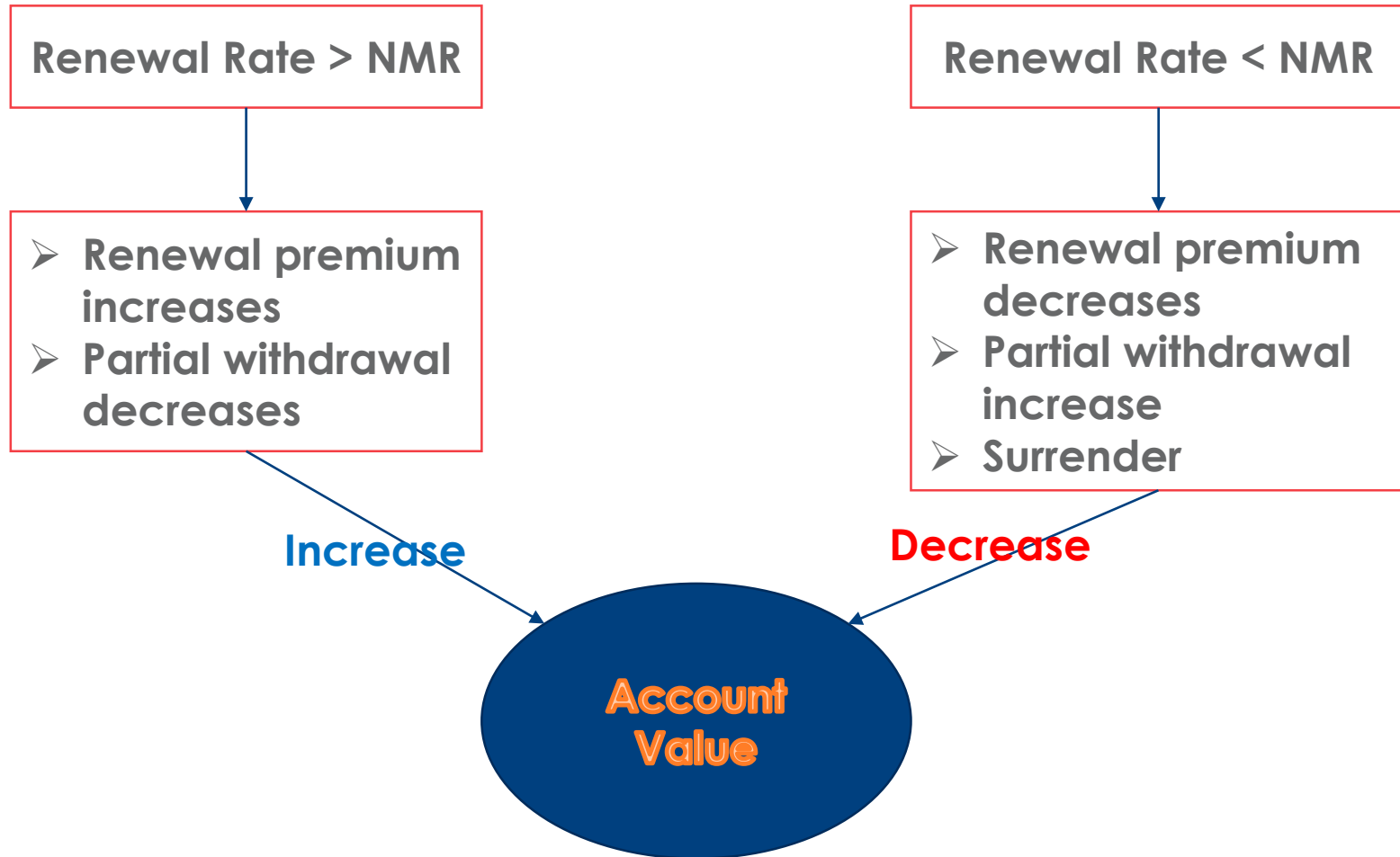
When out of Surrender Charge Period



What determines Policyholder Behavior?



Renewal Rate vs NMR



Policyholder Behavior Driving Factors

Factors given to policyholder

- Renewal credited rate
- New money rate (NMR) – available at the market

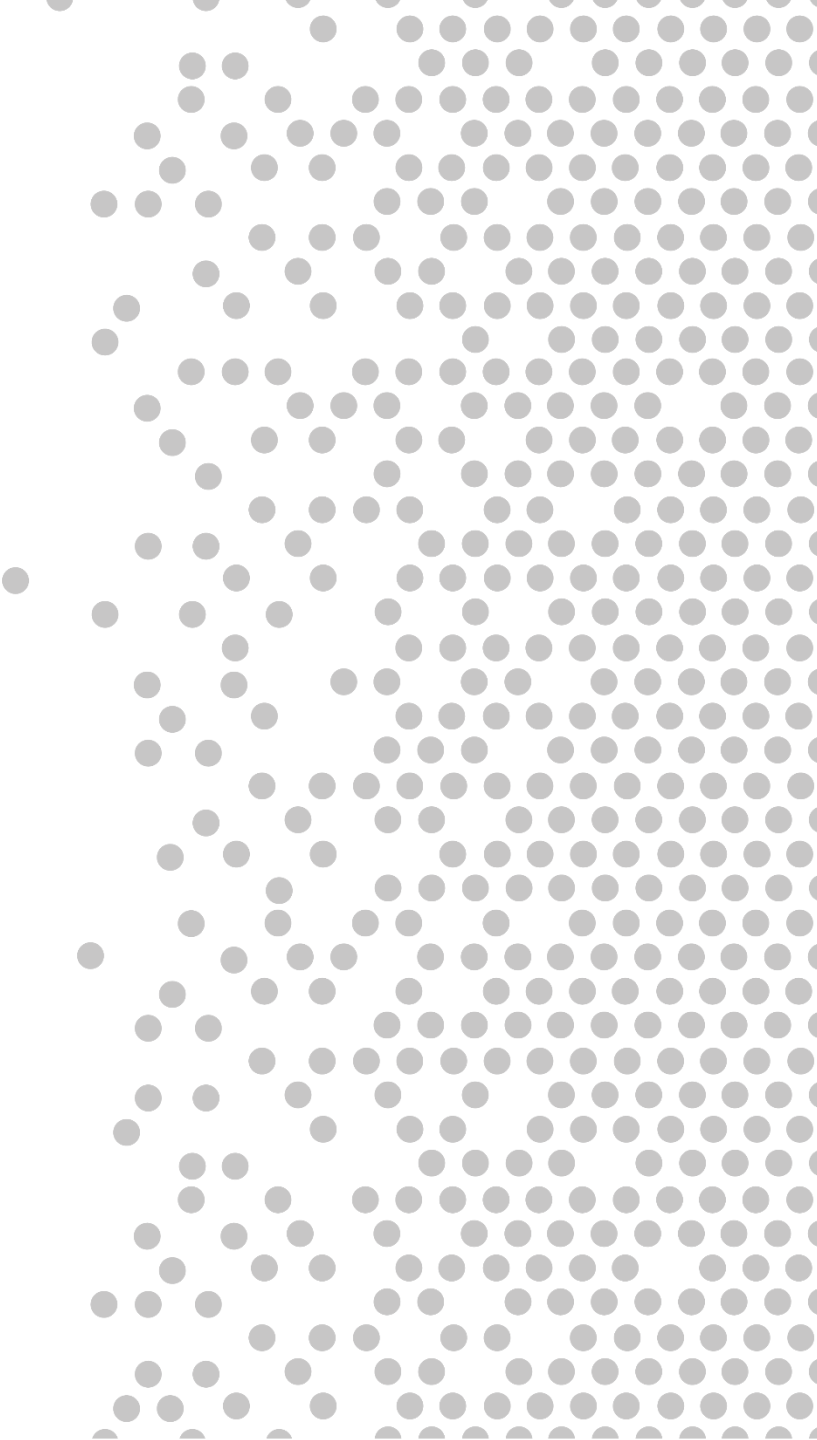
Factors controlled by policyholder

- Surrender
- Partial withdrawal
- Renewal (additional) premium

Impacts

- Base and spike lapses
- Partial withdrawal
- Premium persistency
- Anti-select the company

Considerations



1. Determine Modeling Method

Traditional analysis

- Split experience data into groups
- Analyze each group's experience and develop assumptions
- Concerns
 - Difficult to separate “base behavior” from “dynamic behavior”
 - More granularization of data results in loss of credibility
 - Ignores interactions between variables

Predictive analysis

- Use advanced statistical method to predict target variable using independent variables
- Can mitigate concerns of traditional analysis

2. Gather Experience Data

Experience study period

- Long-term trend vs recent experience
- Current low interest rate environment

Product generations

- Multiple product generations based on different interest rate environments

Types of behavior

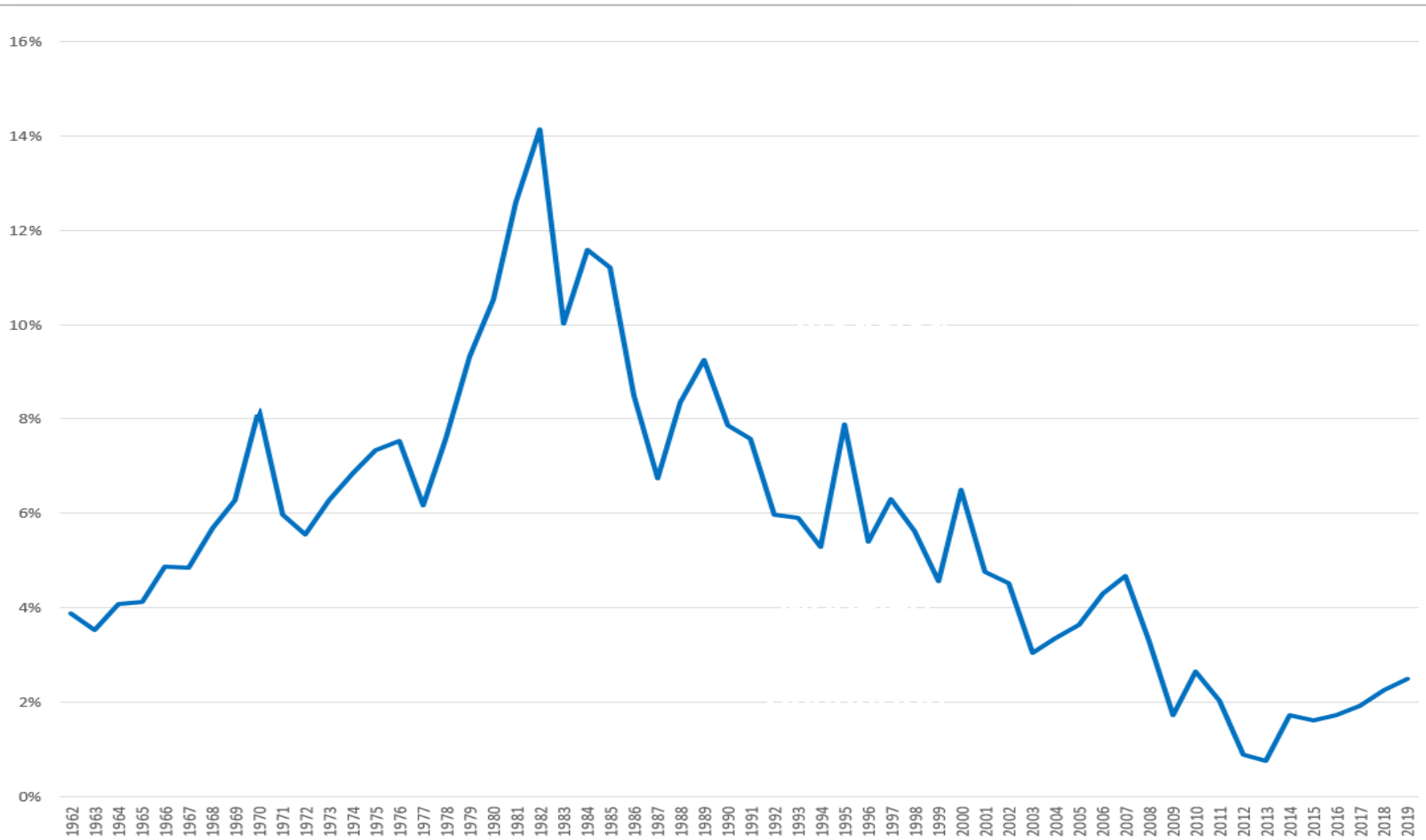
- Base lapse vs dynamic lapse
- Partial withdrawal
- Premium persistency

Types of data

- Inforce data at one point of time (e.g., year end inforce data)
- Transaction data of surrender, partial withdrawal, & renewal premium for a set time period (e.g., for a year)

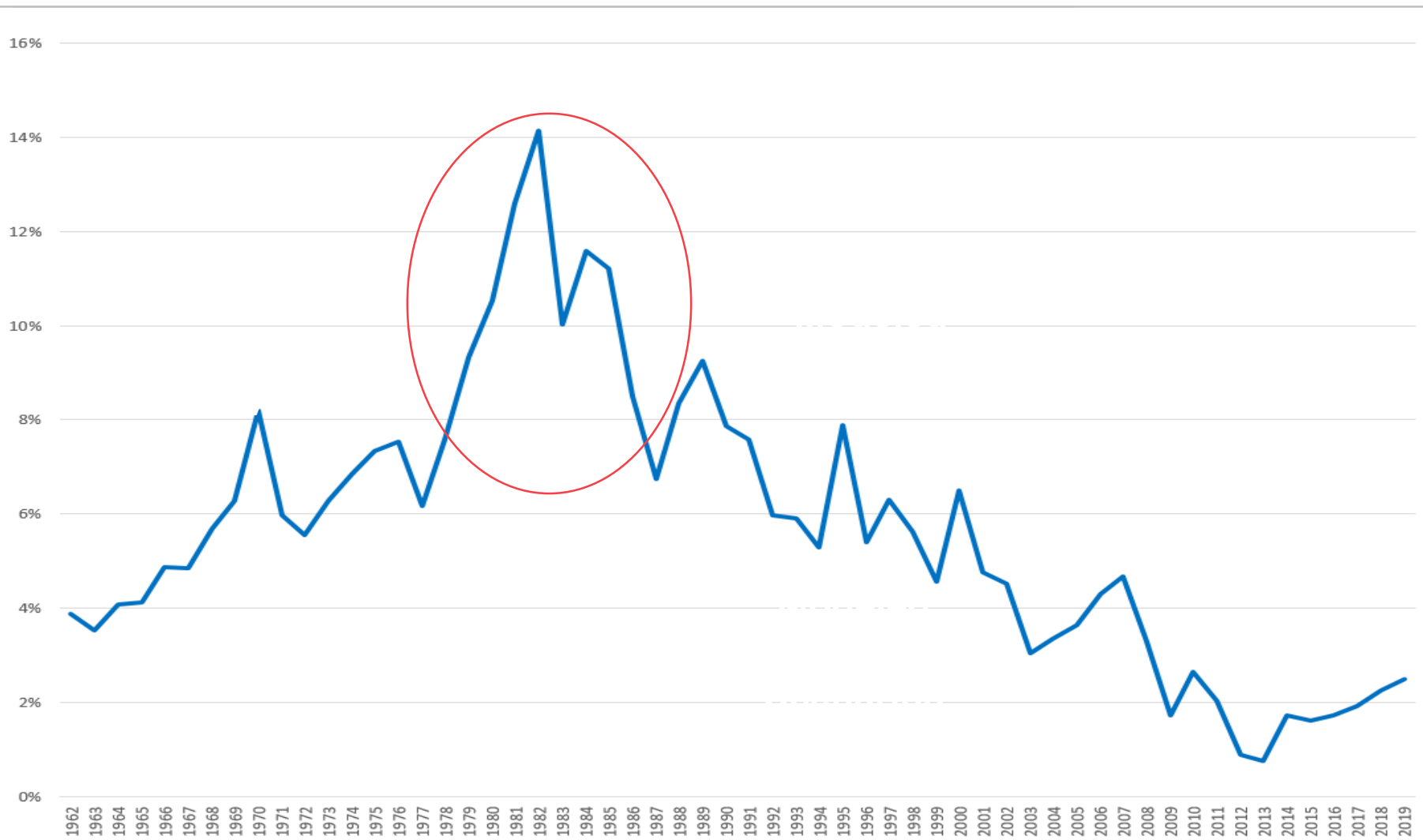
Long-Term Trend

5 Year Treasury Rates at Beginning of Year over 1962-2019



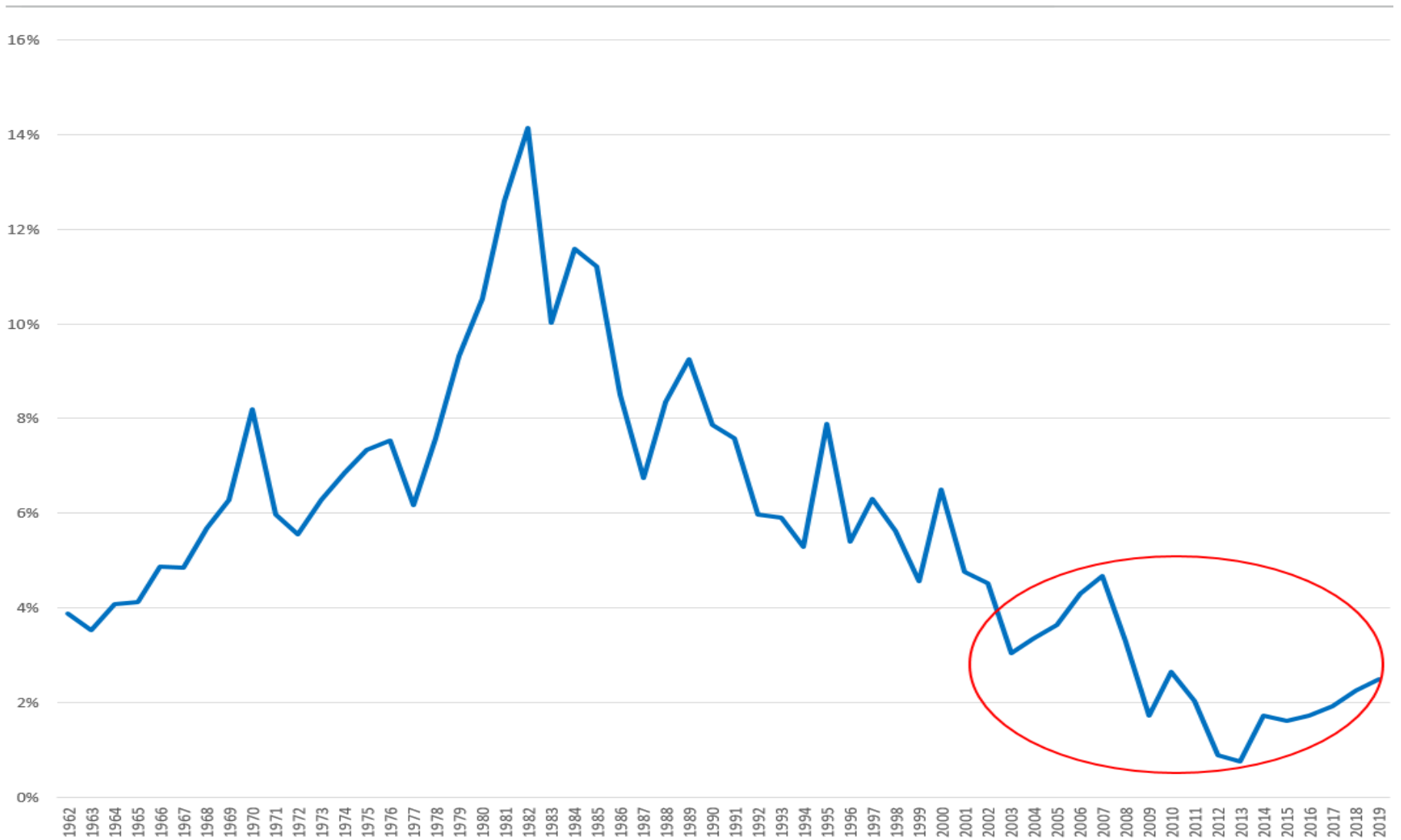
Long-Term Trend

5 Year Treasury Rates at Beginning of Year over 1962-2019

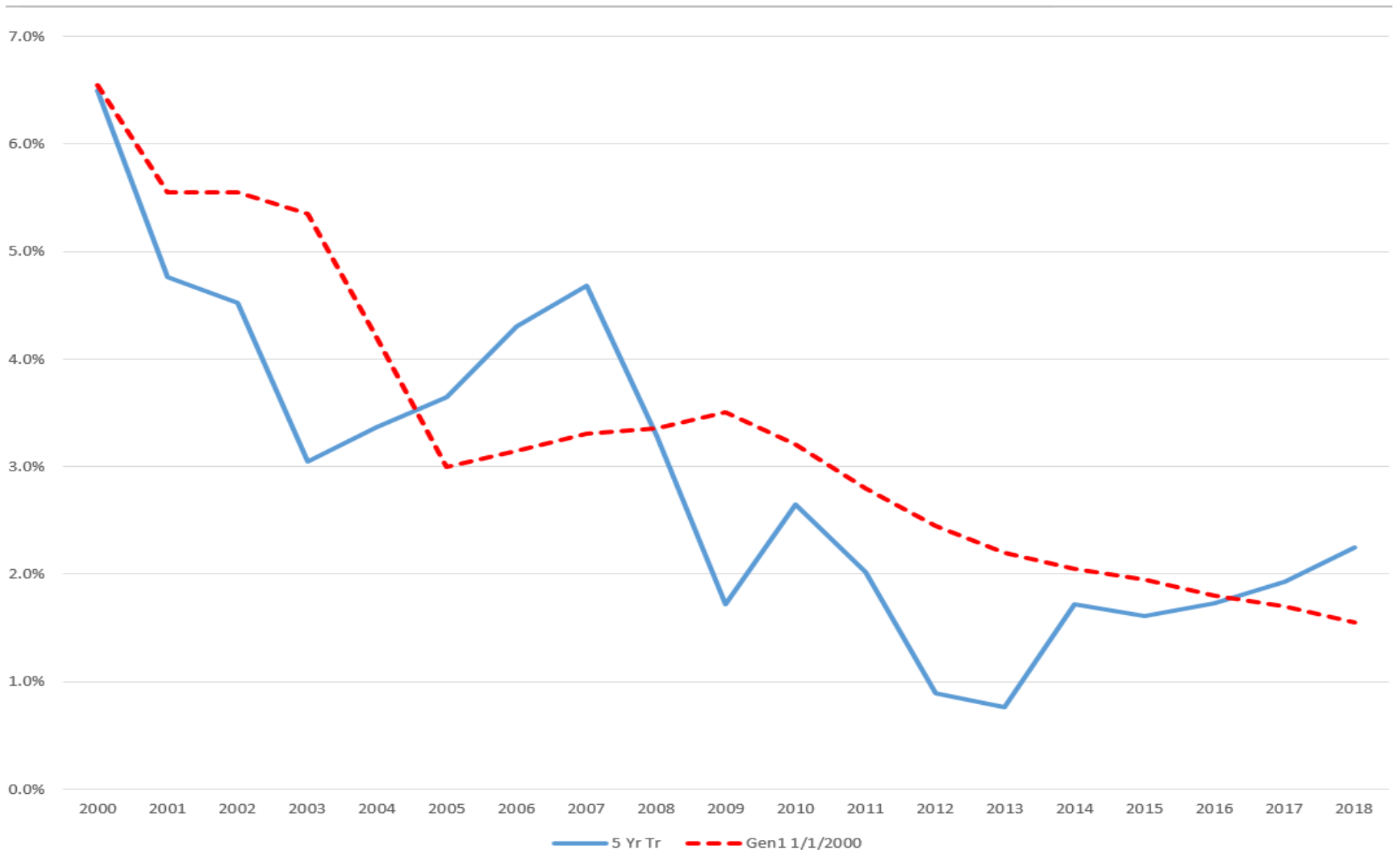


Long-Term Trend vs Recent Experience

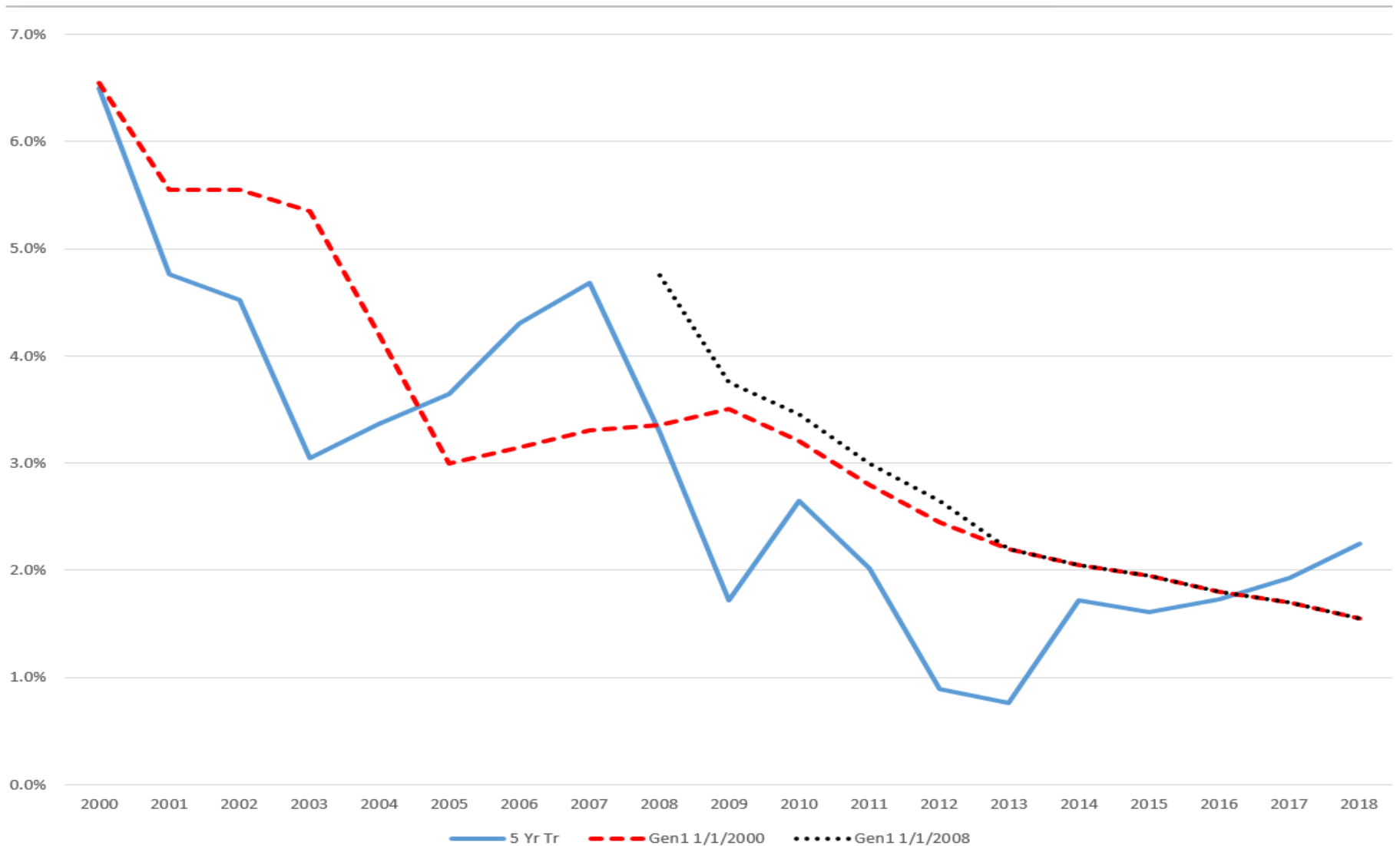
5 Year Treasury Rates at Beginning of Year over 1962-2019



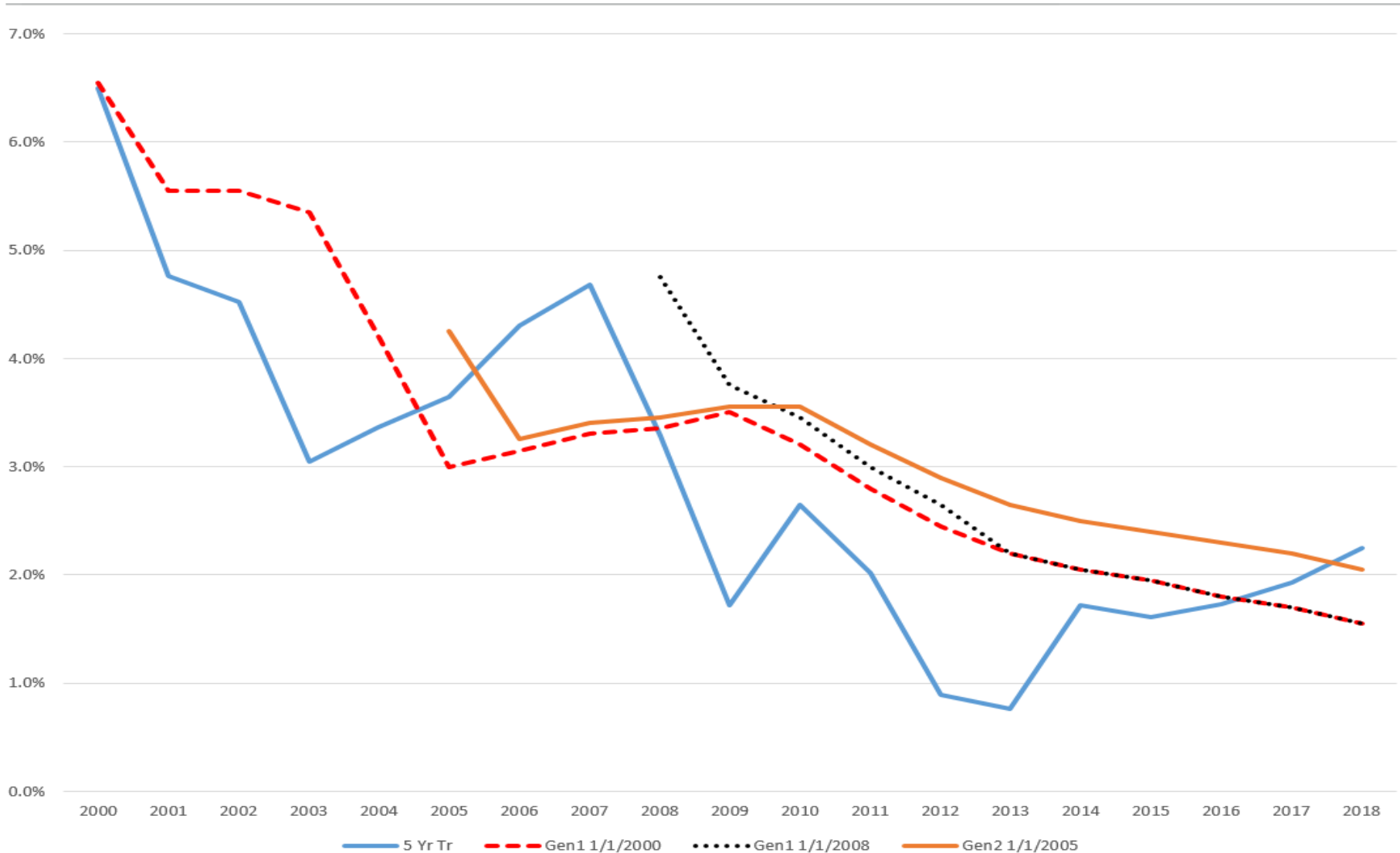
5 Year Treasury Rates vs 1st Generation Product



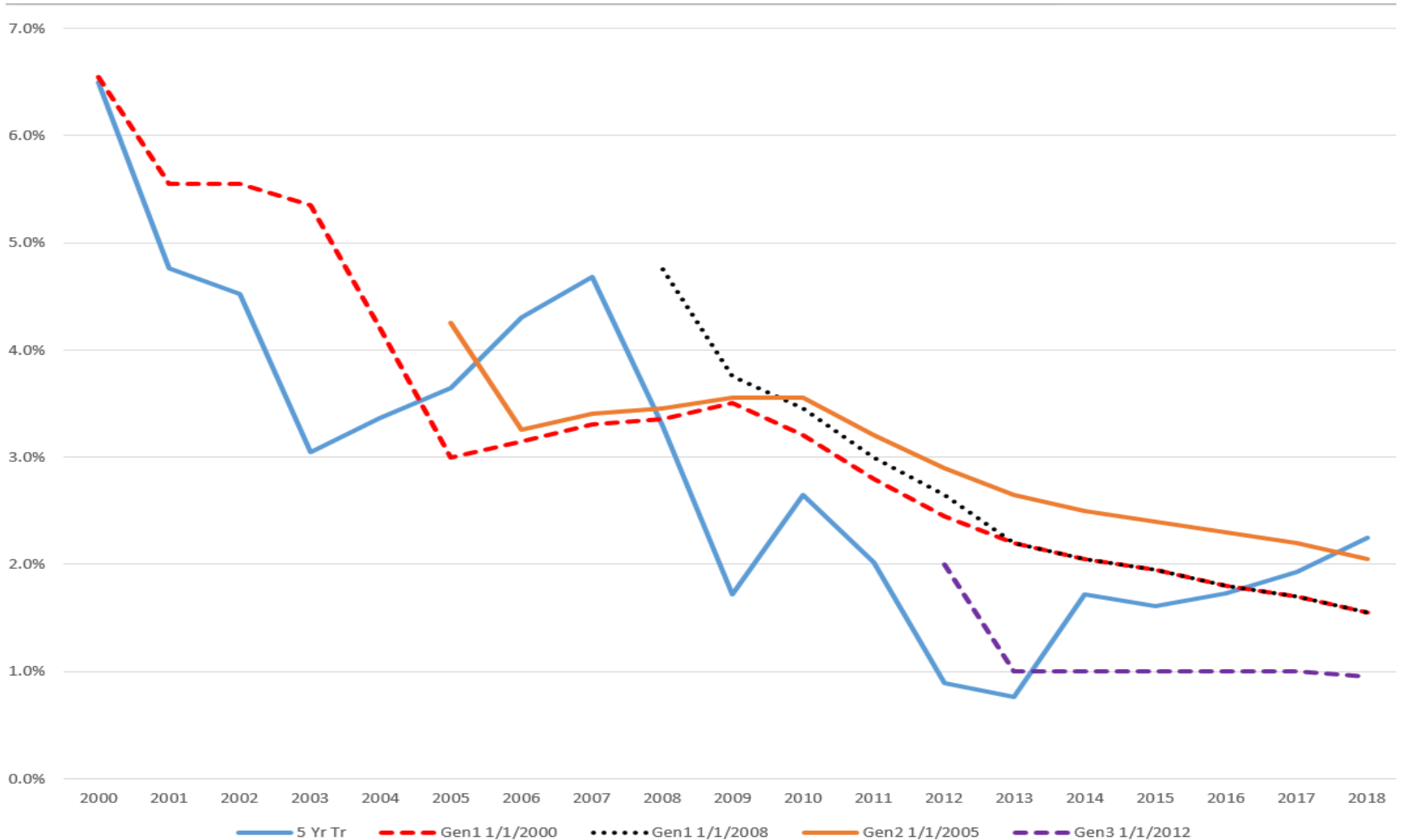
5 Year Treasury Rates vs 1st Generation Product



5 Year Treasury Rates vs Different Generation Products



5 Year Treasury Rates vs Different Generation Products



3. Analyze Trends

Stability and trend of experience

- Long-term trend vs current trend

Credibility of experience

- Minimum number of contracts
- Granularization vs credibility

Relevance of experience

- Relevant experience period and product

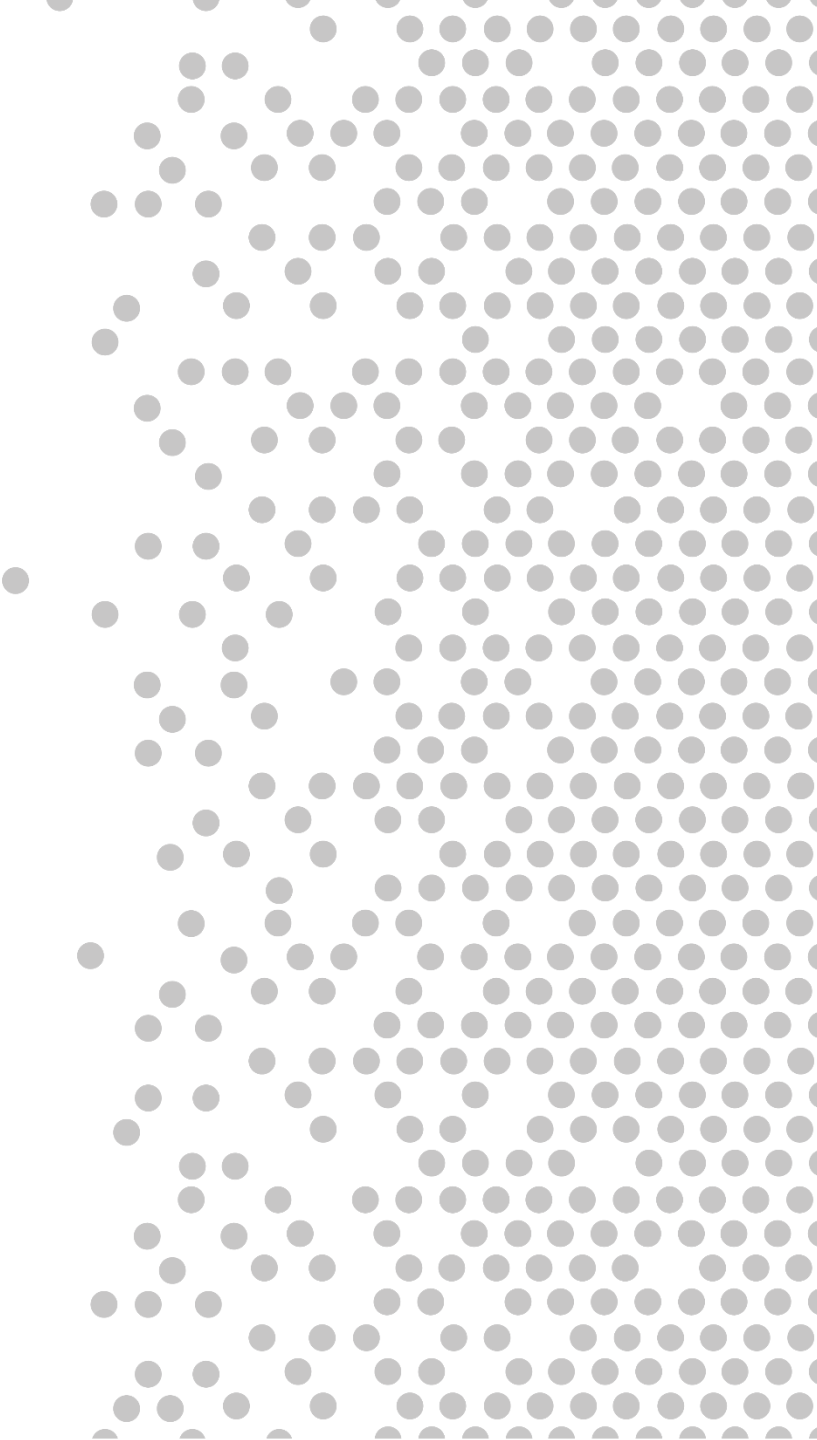
Future expectations

- Forecast based on experience

Industry comparisons

- Validation
- Understand where the company's experience stands

Modeling



Modeling Process

1. Develop data bases for exposure and target variables

- Exposure = inforce + decrements
- Transactions on target variables (relevant types of behavior)

2. Calculate exposure and target variables

- Reflect partial exposure
- Target variables have full exposure

3. Analyze experience in multiple perspectives

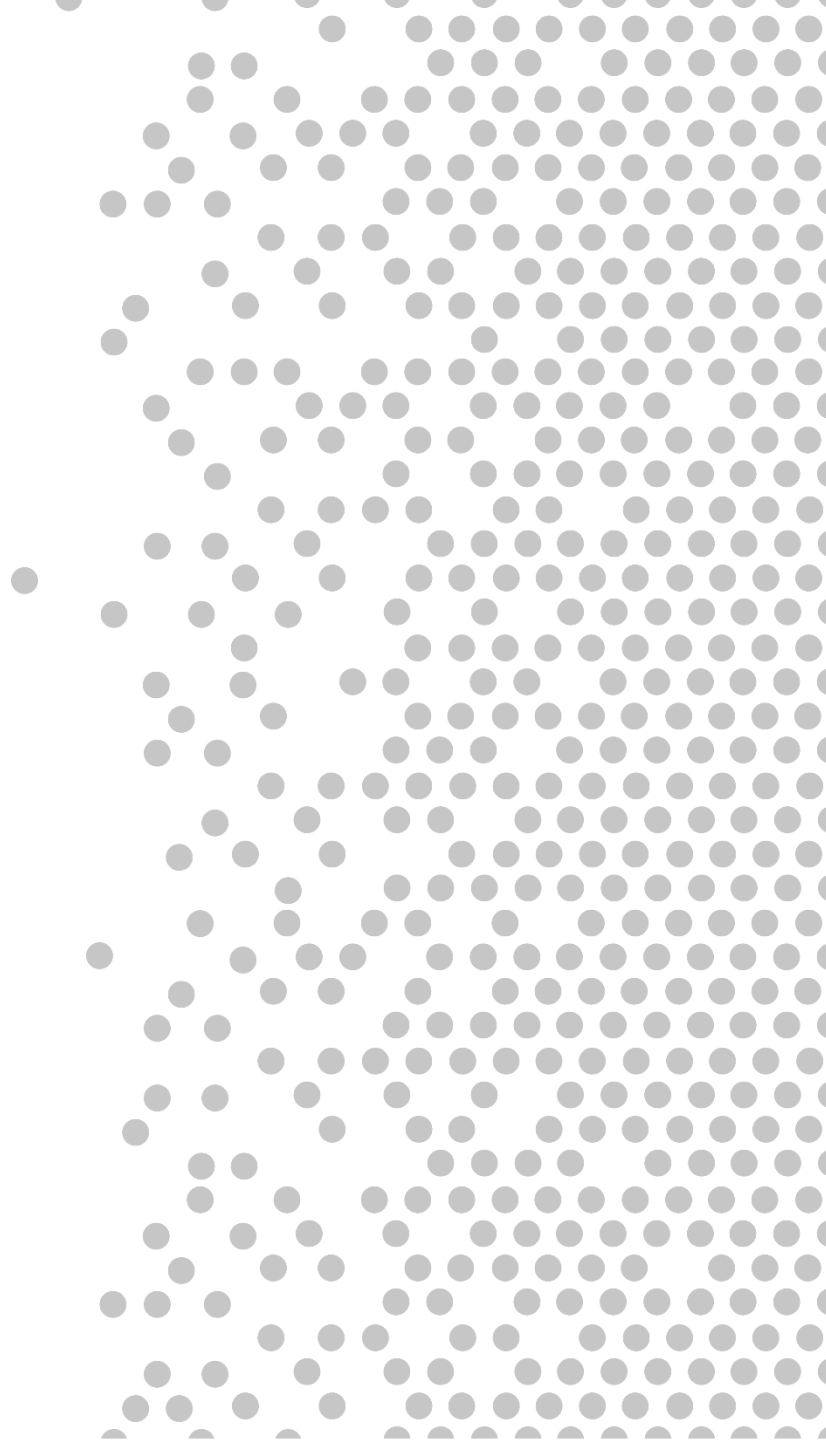
- Process data bases using pivot tables
- Combine different perspectives

Analyze Experience in Multiple Perspectives

		AA 0-59			AA 60-69			AA 70+			
Product		Gen 1	Gen 2	Gen 3	Gen 1	Gen 2	Gen 3	Gen 1	Gen 2	Gen 3	Total
PY Prior to/After End of CDSC	-5 & Earlier	3	2	3	2	1	3	2	1	2	2
	-4	6	2	3	5	2	3	3	2	3	3
	-3	6	2	3	5	2	4	3	2	4	3
	-2	5	2	3	6	2	4	4	2	4	3
	-1	4	3	4	5	2	3	4	3	4	3
	0	12	6	7	16	11	12	11	8	12	9
	1	7	5	7	10	7	6	7	6	15	6
	2	7	7	51	8	5	5	7	6	12	5
	3 & Later	5	4	0	6	6	15	7	5	11	5
	Total	5	3	3	6	3	3	5	3	4	4

*: Experience values are in terms of %. They are not actual experience.

Concerns



Base Lapse

Past experience

- Granularization vs credibility
- Trend vs random noise

		AA 0-59			AA 60-69			AA 70+			
Product		Gen 1	Gen 2	Gen 3	Gen 1	Gen 2	Gen 3	Gen 1	Gen 2	Gen 3	Total
PY Prior to/After End of CDSC	-5 & Earlier	3	2	3	2	1	3	2	1	2	2
	-4	6	2	3	5	2	3	3	2	3	3
	-3	6	2	3	5	2	4	3	2	4	3
	-2	5	2	3	6	2	4	4	2	4	3
	-1	4	3	4	5	2	3	4	3	4	3
	0	12	6	7	16	11	12	11	8	12	9
	1	7	5	7	10	7	6	7	6	15	6
	2	7	7	51	8	5	5	7	6	12	5
	3 & Later	5	4	0	6	6	15	7	5	11	5
Total	5	3	3	6	3	3	5	3	4	4	

*: Experience values are in terms of %. They are not actual experience.

Dynamic Lapse

Past experience

- Very limited experience internally
- No meaningful experience in rising interest rate environments – internal & industry level
- No experience outside of +/- 1% gap between current rate & new money rate

Without enough experience, need to make judgement based on:

- Surrender charge schedules deter lapse for small interest rate move
- Comparison to new money rates available in the market
- Minimum guaranteed interest rate
- Distribution channel – exclusive agents vs broker

Dynamic Lapse

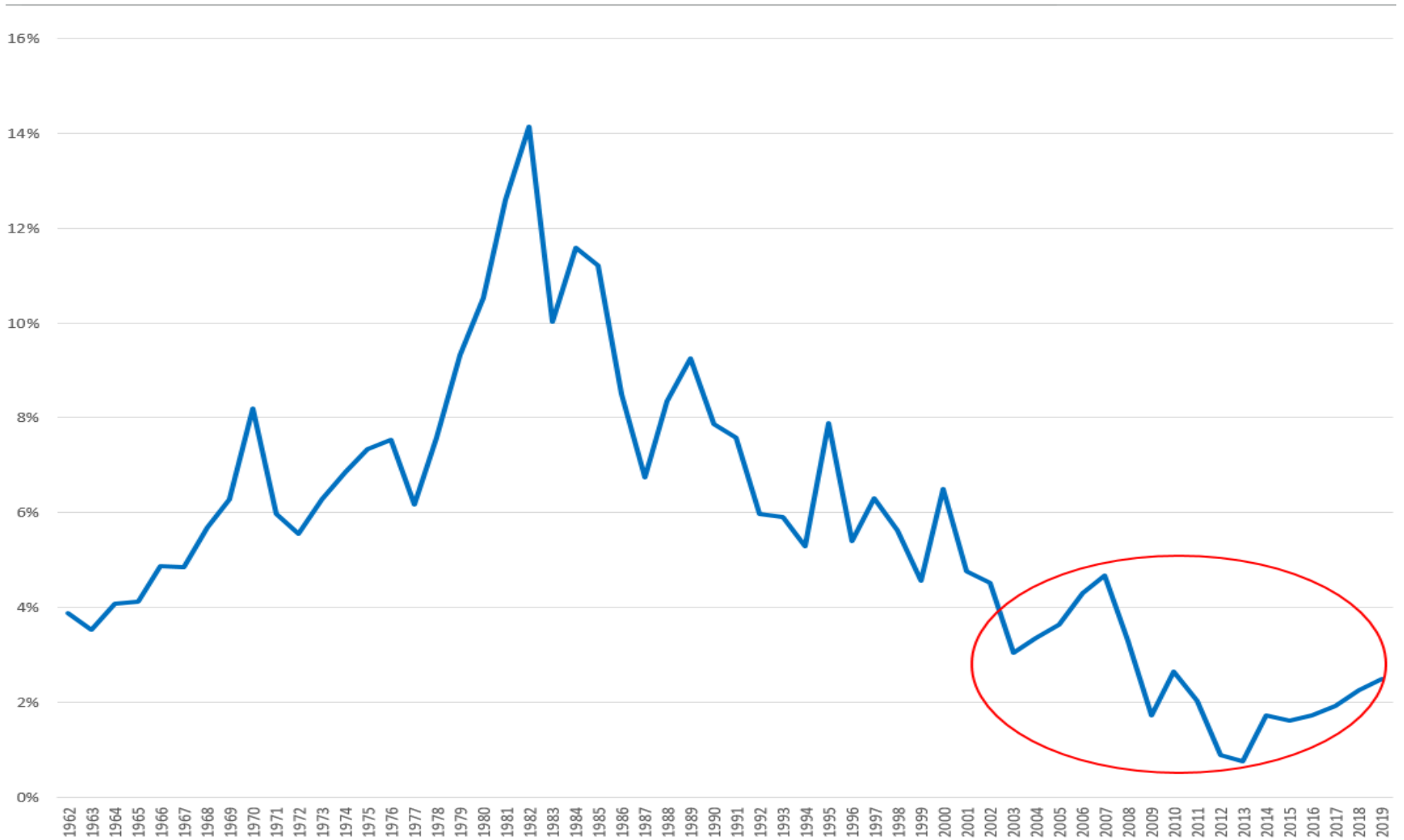
New Money Rate - Credited Rate Gap									
Year	-2%	-1%	0%	1%	2%	3%	4%	5%	6%
1		x%	y%	z%					
2		x%	y%	z%					
3		x%	y%	z%					
4		x%	y%	z%					
5		x%	y%	z%					
6		x%	y%	z%					
7		x%	y%	z%					
8		x%	y%	z%					
9		x%	y%	z%					
10+		x%	y%	z%					

Baseline lapse

Critical ranges for expected rising interest rate environment

Long-Term Trend vs Recent Experience

5 Year Treasury Rates at Beginning of Year over 1962-2019



Partial Withdrawal

Past experience

- Big data size issue due to very large number of transactions with small partial withdrawal amount each
- Solution: sort cash flow by product family, transaction year, transaction month, transaction category (RMD, NQ), issue year, issue month, CDSC period, NQ/Q, & attained age group without identifying individual contract's partial withdrawal amount
- High partial withdrawal rates are largely driven by out of surrender charge contracts
- For out of surrender charge contracts, contract holders utilize fixed annuity in a way similar to a bank savings account, while crediting higher rate than a bank savings account, that is, withdraw & add additional premium at the best timing for them

Premium Persistency

Past experience

- For out of surrender charge contracts, fixed annuity works similar to a saving account with credited rates higher than bank's, that is, anti-selection issue



Policyholder Behavior Modeling and the Risks of Overfitting Data

Session 08

Timothy Paris, FSA, MAAA

Ruark Consulting LLC

May 20, 2019



SOCIETY OF ACTUARIES

Antitrust Compliance Guidelines

Active participation in the Society of Actuaries is an important aspect of membership. While the positive contributions of professional societies and associations are well-recognized and encouraged, association activities are vulnerable to close antitrust scrutiny. By their very nature, associations bring together industry competitors and other market participants.

The United States antitrust laws aim to protect consumers by preserving the free economy and prohibiting anti-competitive business practices; they promote competition. There are both state and federal antitrust laws, although state antitrust laws closely follow federal law. The Sherman Act, is the primary U.S. antitrust law pertaining to association activities. The Sherman Act prohibits every contract, combination or conspiracy that places an unreasonable restraint on trade. There are, however, some activities that are illegal under all circumstances, such as price fixing, market allocation and collusive bidding.

There is no safe harbor under the antitrust law for professional association activities. Therefore, association meeting participants should refrain from discussing any activity that could potentially be construed as having an anti-competitive effect. Discussions relating to product or service pricing, market allocations, membership restrictions, product standardization or other conditions on trade could arguably be perceived as a restraint on trade and may expose the SOA and its members to antitrust enforcement procedures.

While participating in all SOA in person meetings, webinars, teleconferences or side discussions, you should avoid discussing competitively sensitive information with competitors and follow these guidelines:

- **Do not** discuss prices for services or products or anything else that might affect prices
- **Do not** discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- **Do not** speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- **Do** leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
- **Do** alert SOA staff and/or legal counsel to any concerning discussions
- **Do** consult with legal counsel before raising any matter or making a statement that may involve competitively sensitive information.

Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone's responsibility; however, please seek legal counsel if you have any questions or concerns.

Presentation Disclaimer

Presentations are intended for educational purposes only and do not replace independent professional judgment. Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.

Examples: deferred annuity policyholder behavior and mortality

FIA

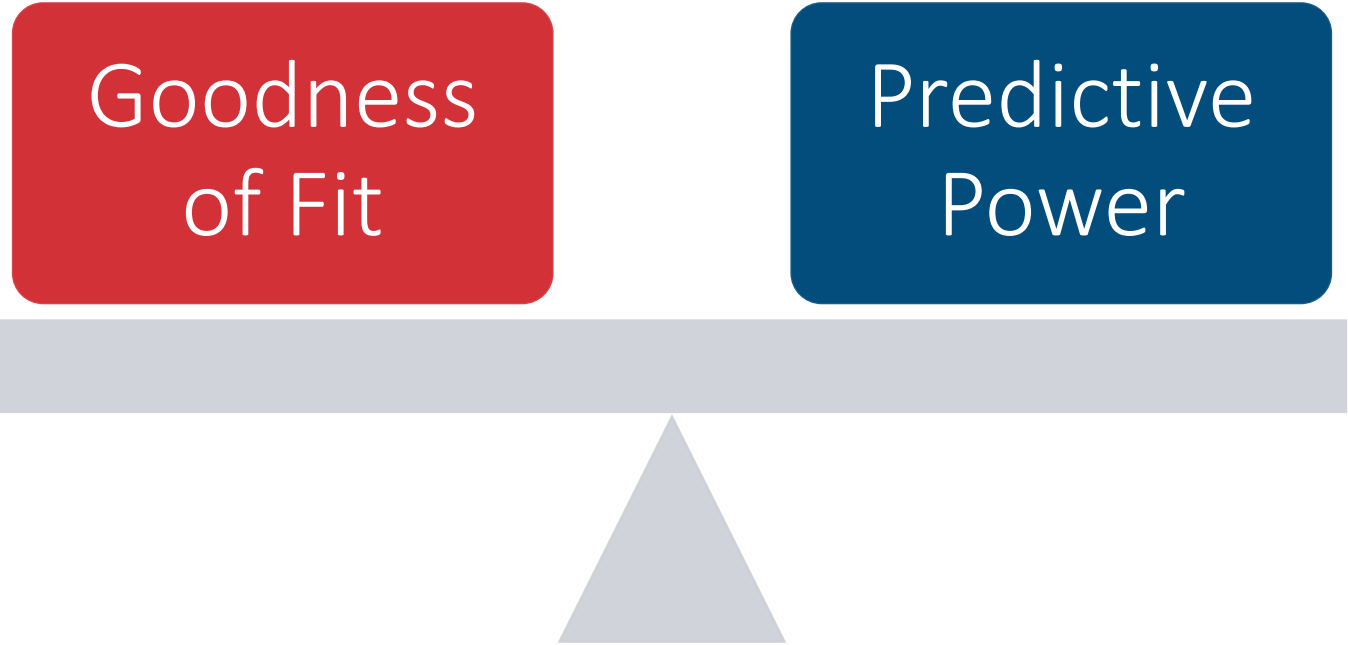
<https://ruark.co/ruark-releases-2019-fixed-indexed-annuity-study/>

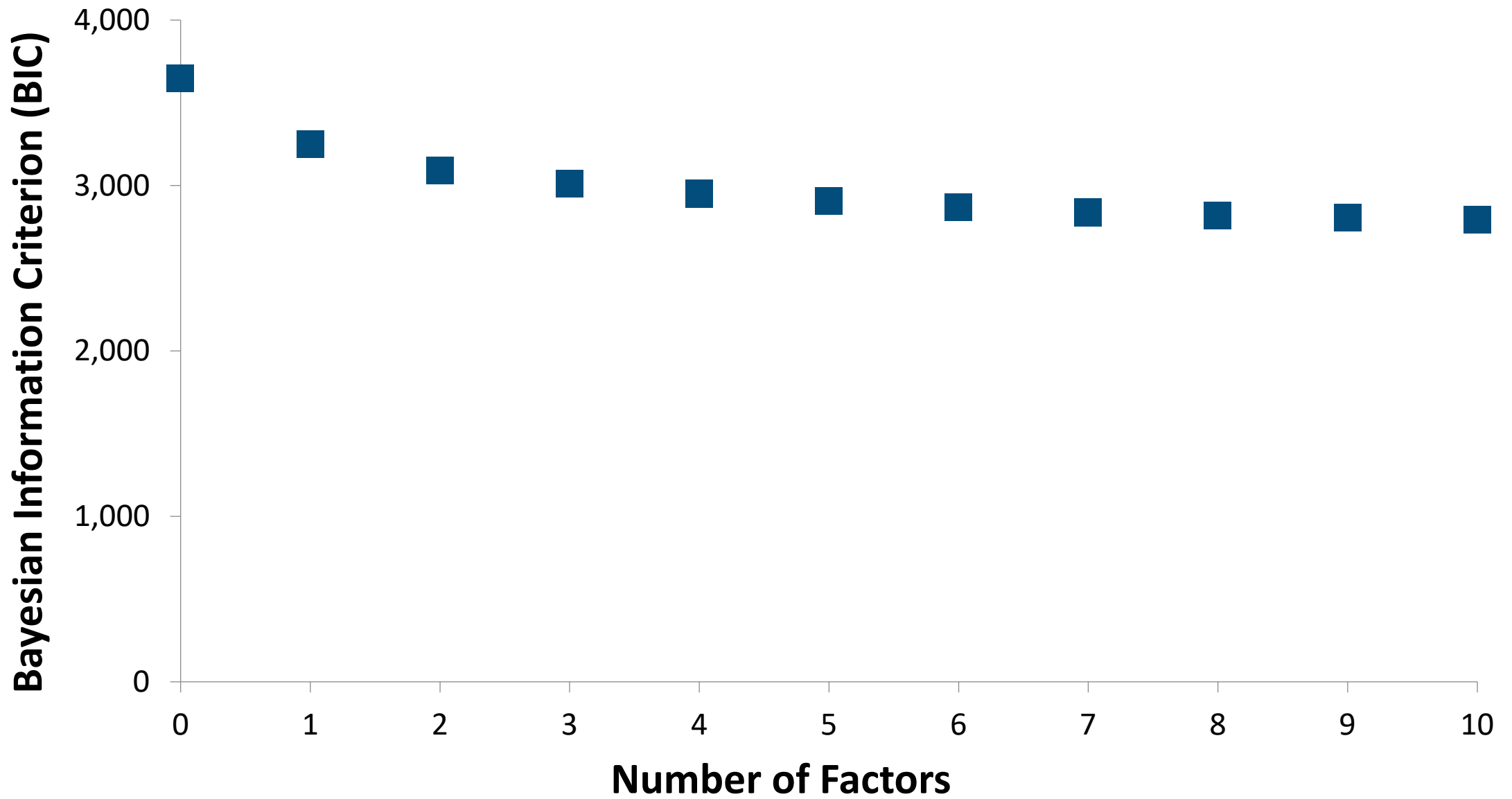
<https://ruark.co/ruark-consulting-releases-2018-fixed-indexed-annuity-mortality-study/>

VA

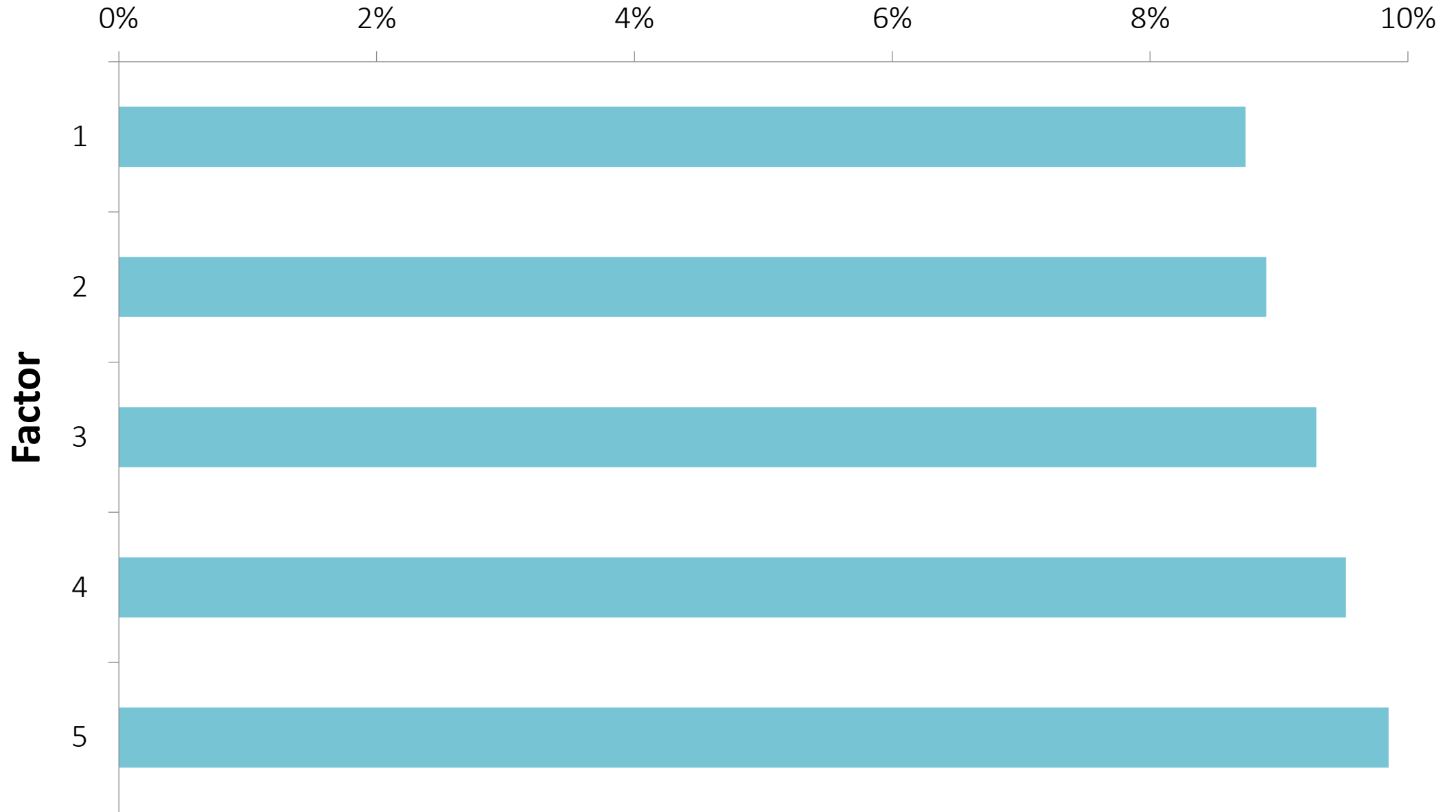
<https://ruark.co/ruark-releases-fall-2018-variable-annuity-study-results/>

<https://ruark.co/ruark-consulting-releases-variable-annuity-mortality-study-results/>



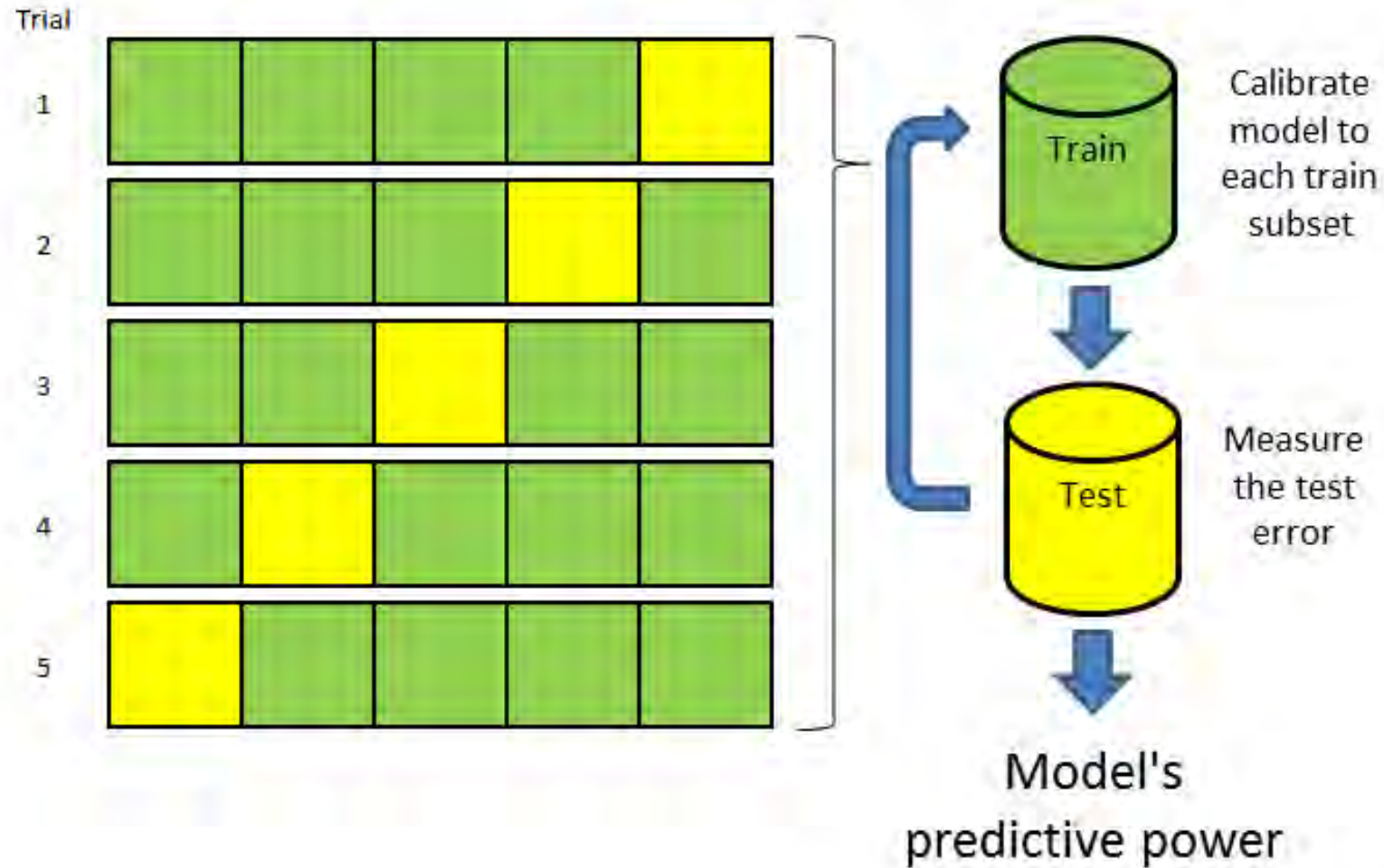


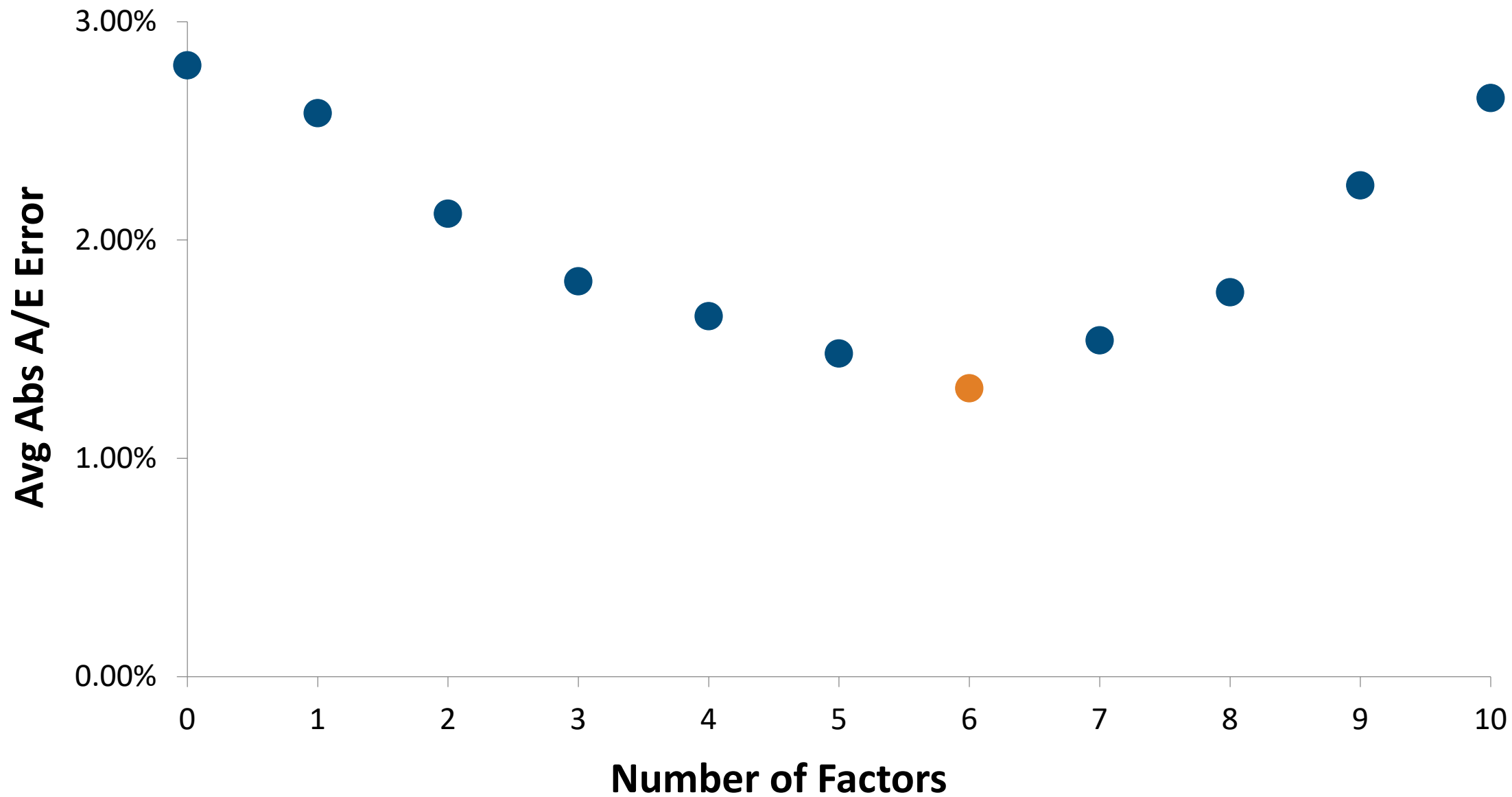
Coefficient Standard Error



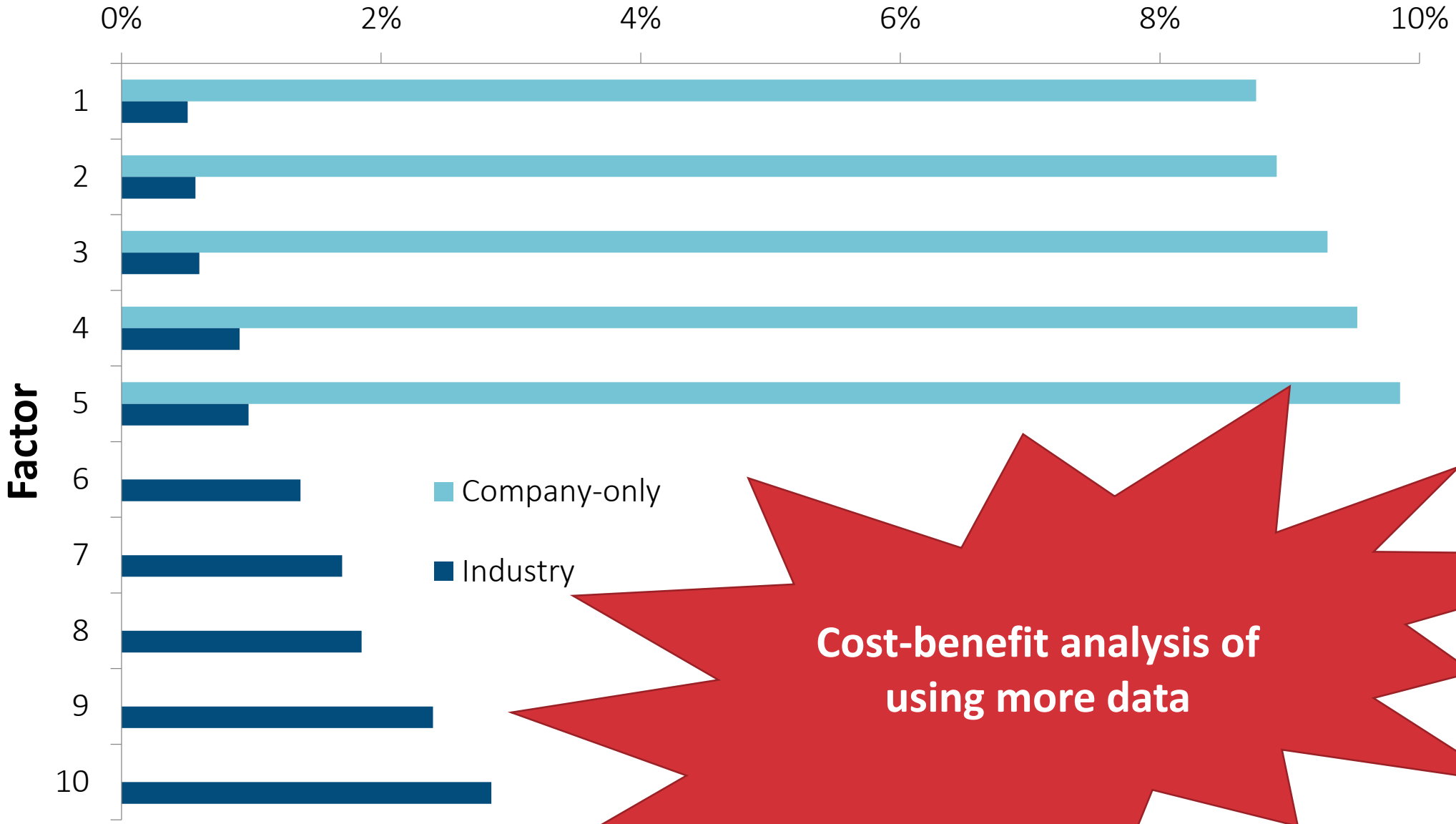
5-Fold Cross Validation

Measures the bias-variance trade-off

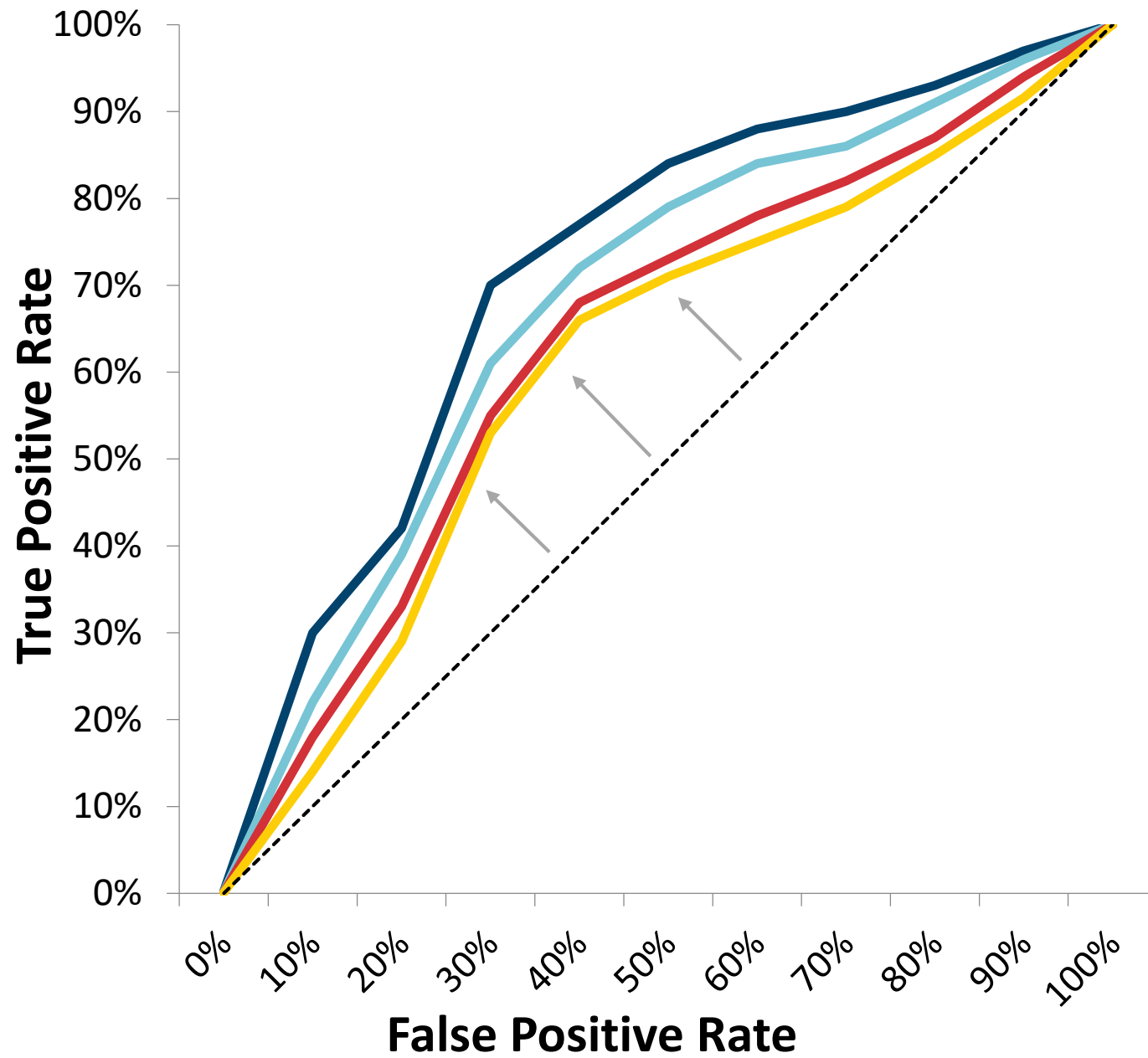




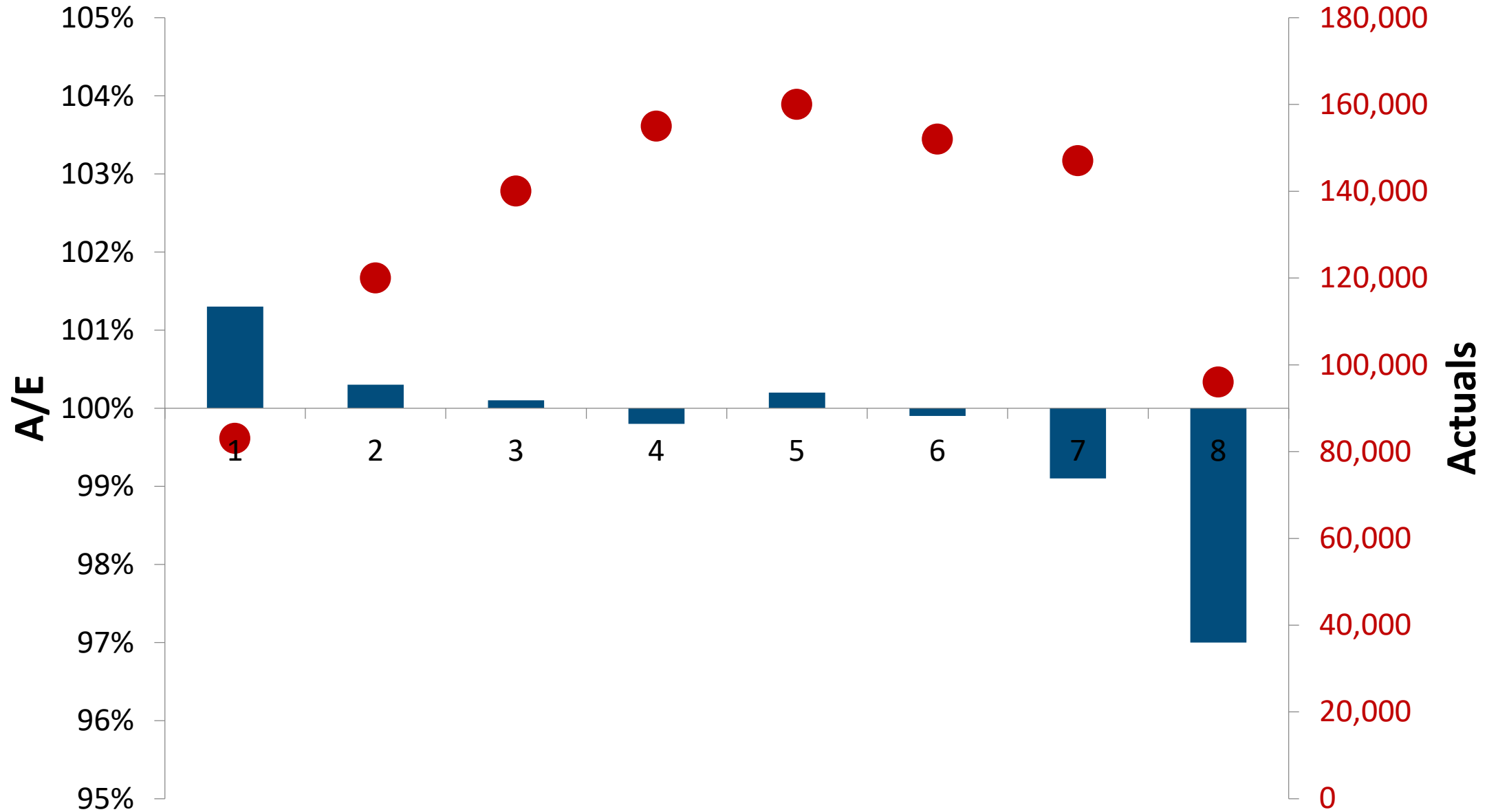
Coefficient Standard Error

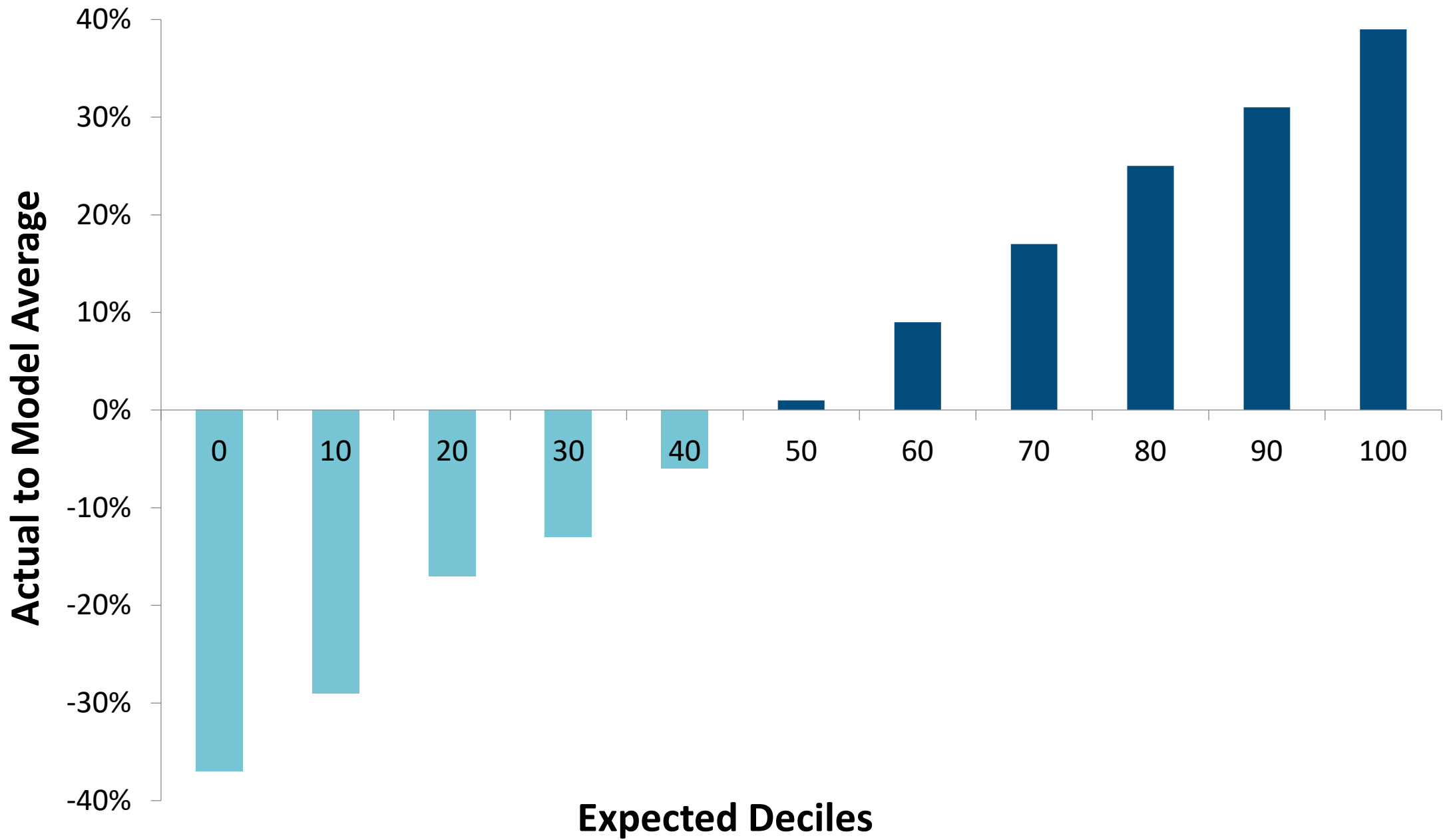


Cost-benefit analysis of using more data



Factor Xi





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



2019 **LIFE &
ANNUITY**
SYMPOSIUM