2020 LIFE & ANNUITY VIRTUAL SYMPOSIUM

Pricing for Sparse Data

May 5, 2020

SOCIETY OF ACTUARIES®

SOCIETY OF ACTUARIES
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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.

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- 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.

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OLIVER WYMAN

PRICING FOR SPARSE DATA

2020 Life & Annuity Virtual Symposium

May 5, 2020

Andy King, FSA, CERA

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AGENDA

1 FIA primer

2 Pricing & assumption setting

FIXED INDEXED ANNUITIES

FIAs are a savings vehicle that provides guaranteed returns with opportunity for growth

Fixed > **Guaranteed protection**

Indexed > **Growth based on index performance**

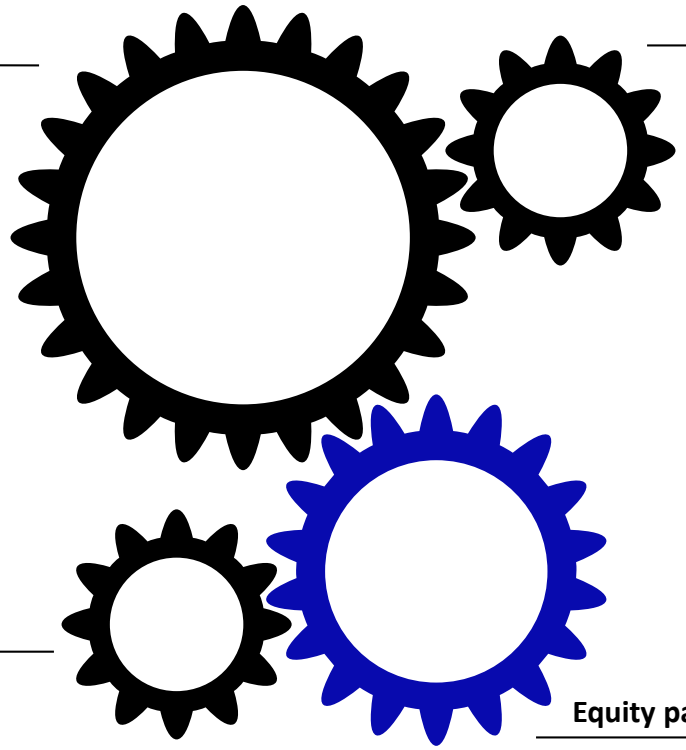
Annuity > **Guaranteed income payments over time**

FIA VALUE PROPOSITION

Fixed indexed annuities offer tax-deferred growth through equity participation

Tax deferral

- The initial premium contribution is not taxed until the policy is cashed out or annuitized into periodic payments
- Savings growth is tax-deferred until withdrawal or income is taken



Downside protection

- Guaranteed minimum crediting rate with no downside makes the product appropriate for clients with low appetites for risk
  - In traditional deferred annuities, the crediting rate can be reset on an annual basis by the insurer, subject to a floor above 0% (typically ~1%)
  - In fixed indexed annuities, the floor is typically 0%

Retirement income

- Portions of the contract value may be withdrawn periodically without penalty
- The contract value may also be annuitized into periodic payments

Equity participation

- Potential for superior upside given linkage of account value growth to equity market returns
- Growth potential considered an advantage over traditional fixed annuities to many investors

ECONOMICS OF FIXED INDEXED ANNUITIES VS. FIXED ANNUITIES

For FIAs, the insurer is simply purchasing options on behalf of its policyholders to track an equity index

From the policyholder's perspective

Traditional fixed annuity

- Account value is credited a fixed interest rate each year
- The interest rate credited may be guaranteed by the insurer for a number of years or adjusted periodically

Fixed indexed annuity

- Account value tracks a certain index – e.g., S&P 500, DJIA
- Different tracking mechanisms exist – e.g., annual PTP, monthly sum
- The account value growth is typically restricted by certain thresholds, which are periodically adjusted
  - **Cap**: account value is credited for index returns up to a maximum growth amount per year (the "cap")
  - **Spread**: account value is credited for index returns exceeding a certain threshold (the "spread")
  - **Participation rate**: account value is credited by a percentage of the index returns (the "par")

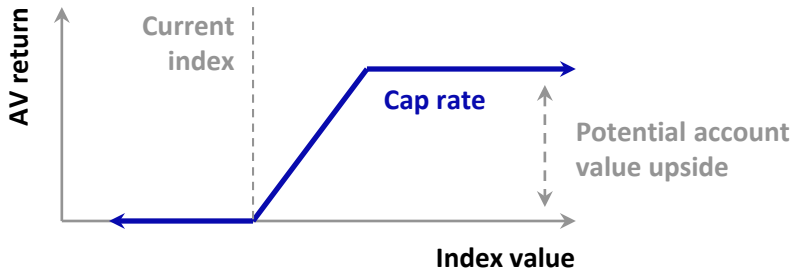
From the insurer's perspective

Traditional fixed annuity

- Credits each policy's account value by a fixed interest rate, funded by general account investment returns

Fixed indexed annuity

- Uses the interest that would otherwise be credited in a traditional fixed annuity to purchase options on the index
  - E.g., the insurer can purchase a one-year call spread
  - The strike of the short call is effectively the "cap", set such that the net cost equals the crediting rate



FIXED INDEXED ANNUITIES WITH GLWB

Fixed indexed annuities can be complemented with a Guaranteed Lifetime Withdrawal Benefit (“GLWB”) rider to provide guaranteed lifetime income

Tax deferral

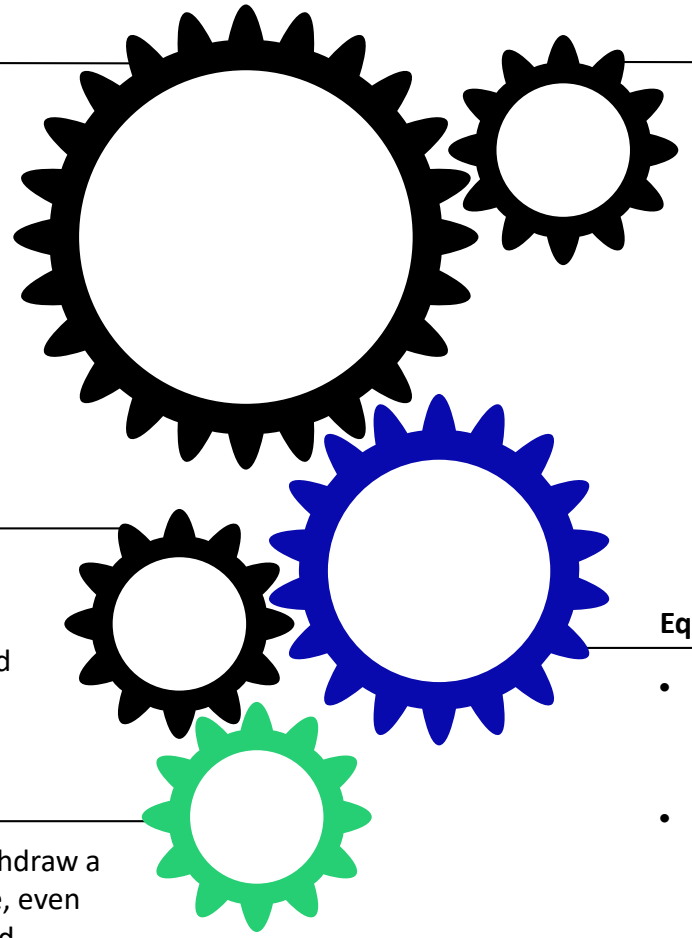
- The initial premium contribution is not taxed until the policy is cashed out or annuitized into periodic payments
- Savings growth is tax-deferred until withdrawal or income is taken

Retirement income

- Portions of the contract value may be withdrawn periodically without penalty
- The contract value may also be annuitized into periodic payments

Longevity protection with liquidity

- Guarantees that the policyholder can withdraw a certain amount of money per year for life, even after the account value has been depleted
- Does not require the policyholder to annuitize the contract, thereby preserving the contract’s liquidity



Downside protection

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Equity participation

- Potential for superior upside given linkage of account value growth to equity market returns
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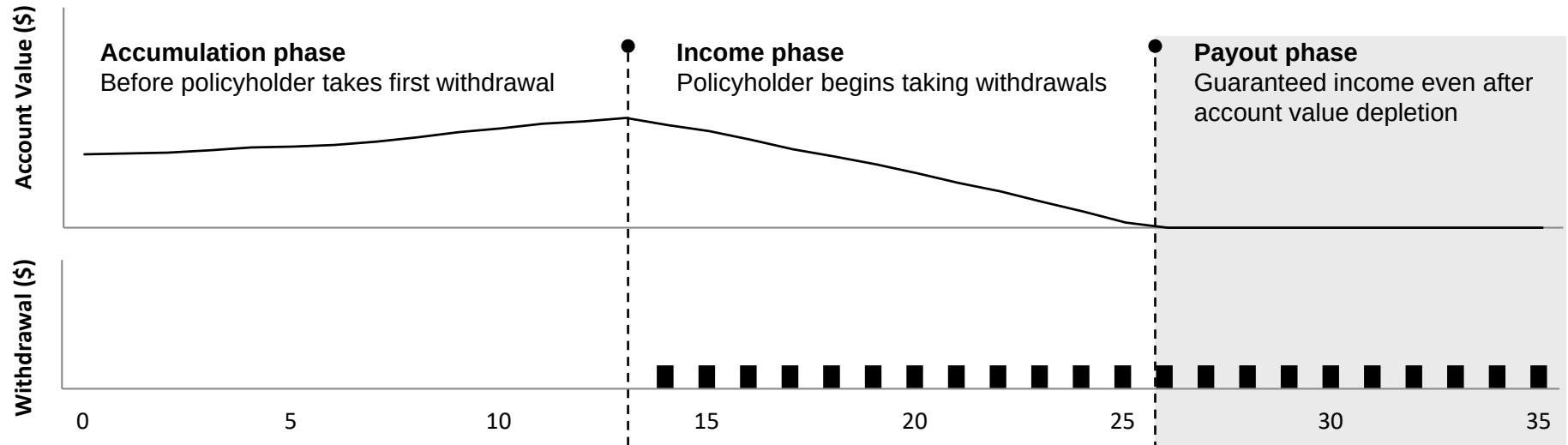
GLWB MECHANICS

GLWBs can provide policyholders with a steady income stream for life – even after the account value has been depleted

Lifespan of a fixed indexed annuity with a GLWB



Major policyholder behavior choices

1 **Should I take a first withdrawal?**
- What are my income needs?
- What are the consequences of withdrawing?

2 **Should I surrender my contract?**
- Do I need all my money now?
- What's the benefit that I'm giving up & what are alternative investment options?

1 **How much should I withdraw?**
- How much income do I need?
- What are the consequences of various withdrawal amounts?

No behavioral choices, as account value has depleted

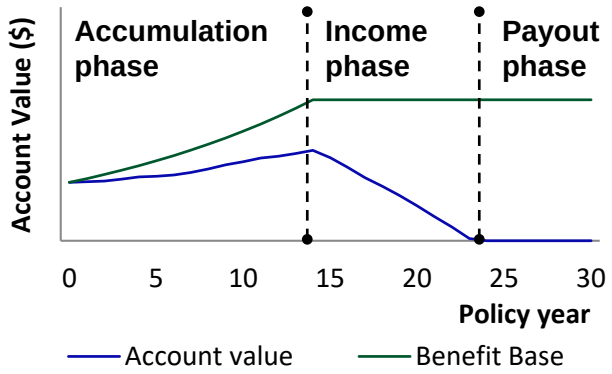
GUARANTEED WITHDRAWAL CALCULATION

Guaranteed income is calculated based on a benefit base and a guaranteed withdrawal rate determined by the policyholder's age upon first withdrawal

Guaranteed income = **Benefit base** × **Guaranteed withdrawal rate**

- Income that policyholder can withdraw each year – even if account is depleted

- A nominal amount that is detached from the account value and grows at a fixed "roll-up" rate until the first withdrawal



- A percentage determined by the age of the policyholder upon his/her first withdrawal

Guaranteed withdrawal rate

Age at first withdrawal	%
50–54	3.50%
55–59	4.00%
60–64	4.50%
65–69	5.00%
70–74	5.50%
75–79	6.00%
80–84	6.50%

- **Withdrawing in excess of the guaranteed amount penalizes the future guaranteed amount**
- While withdrawals within the guaranteed amount do not change the benefit base, withdrawals in excess reduce the benefit base on a proportional basis
- Partial withdrawals during the accumulation phase also reduce the benefit base

TOP RISKS FOR FIA GLWB

Policyholder behavior risk is the primary risk for FIA GLWBs

	Risk	Comments
1	**Policyholder behavior**	• Lapses and dynamic lapses – Risk of higher / lower lapses when option budget is uncompetitive / competitive – Risk of lower lapses when GLWB is deeply in-the-money • GLWB utilization – Policyholders can withdraw more or less than the guaranteed amount – Policyholders can elect to start withdrawals at “optimal” points
2	**Interest rate / spread**	• Low interest rates may result in pricing spreads not being achieved • Interest-sensitive policyholder behavior
3	**Equity**	• Companies can have equity risk exposure due to over-hedging • However, there is potential to benefit from index credits in excess of the option budget
4	**Longevity**	• Risk of lower base mortality • Mortality improvement • GLWB income after AV is depleted

ASOP 54 – PRICING OF LIFE INSURANCE AND ANNUITY PRODUCTS

ASOP 54 has direct applicability to pricing FIAs

Section 3.4 Pricing Assumptions

> ***"The actuary should use professional judgment to set assumptions that are reasonable for the intended purpose and reflect expected future experience based on the following considerations."***

3.4.1. Historical Experience Used When Setting Assumptions

- Ensure that historical experience is reflected in assumption setting
- Assumptions should be based on relevant and credible data, with modifications as necessary
- Are there reasons to expect that historical experience will not be indicative of future experience?
- If no relevant historical experience, consider other available sources of data – use professional judgment!

3.4.2 Assumption Margins

- Margins may be included due uncertainty around the assumptions
- Margins can change over time based on the level of uncertainty

3.4.6 Documentation of Assumptions, Rationale, and Data Modifications

- **DOCUMENT EVERYTHING!!**

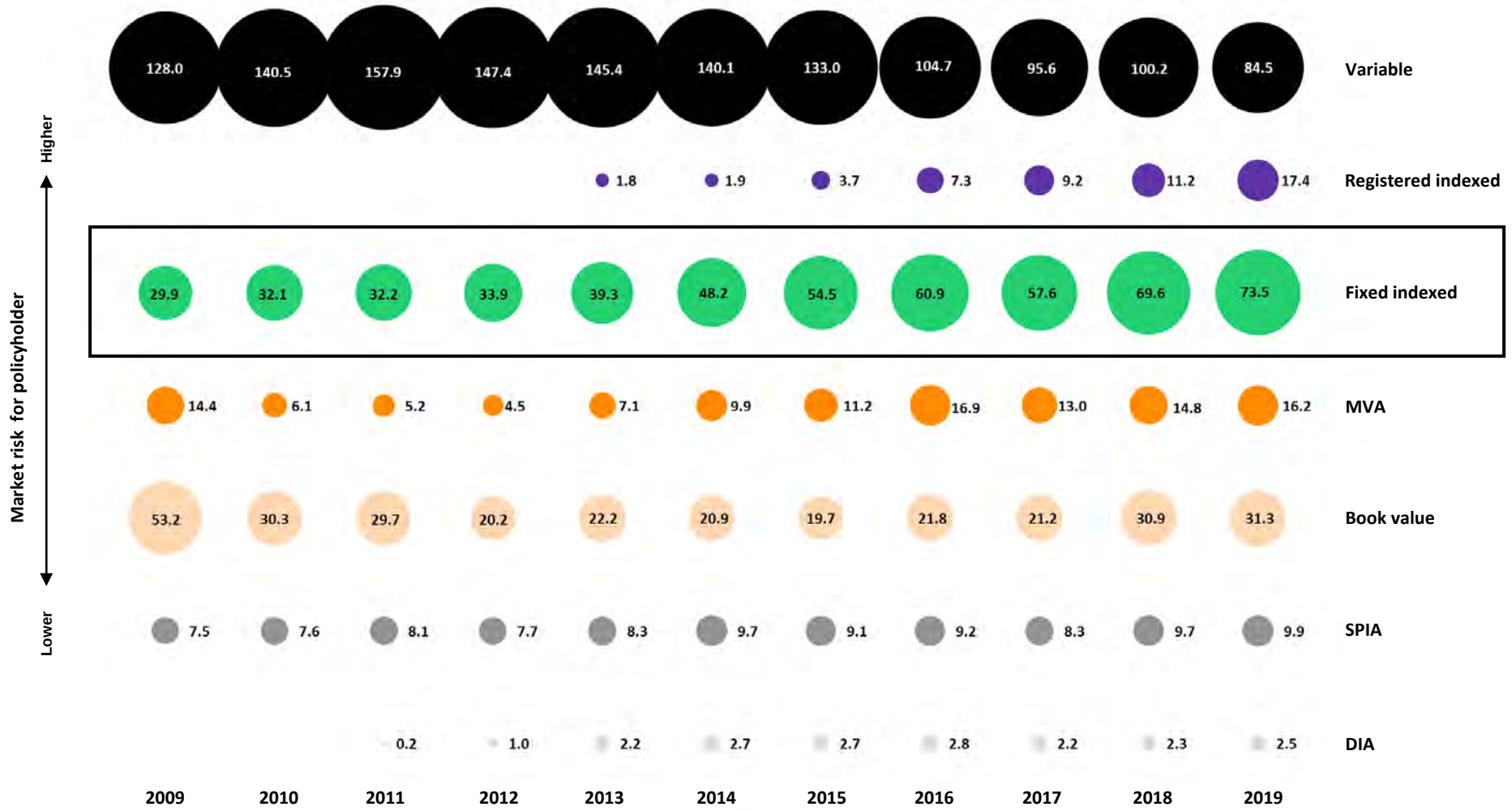
ASOP ONGOING EXPOSURE DRAFT – SETTING ASSUMPTIONS

The “Setting Assumptions” exposure draft is intended to supplement existing ASOP guidance

Topic	Considerations
Relevant ASOPs	• ASOP 23 – Data Quality • ASOP 25 – Credibility Procedures • ASOP 41 – Actuarial Communications
Assumption setting	• Use actual, relevant experience or relevant industry experience with necessary adjustments to reflect current conditions • Assumption margins • Consistency of assumptions • Reasonableness of assumptions in aggregate
Reliance on others	• Relying on data or other information provided by others • Relying on assumptions set by others
Communications and disclosures	• Documentation is still key! • Description of the actual assumptions • Analysis used to derive the assumptions • Material changes from prior assumptions

ANNUITY SALES 2009 – 2019

The FIA market has experienced significant growth over the last ten years



Source: LIMRA

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SOA Life & Annuity Virtual Symposium: Pricing for Sparse Data

TIMOTHY PARIS, FSA, MAAA

RUARK CONSULTING, LLC

May 5, 2020

3:15 – 4:30pm Central

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Case study – FIA GLIB income utilization, model development, and metrics

Fixed Indexed Annuities – large market, but still sparse data

Product design innovations
Long-term income deferral incentives

Evolution of modeling for FIA GLIB income utilization

- Your company model – traditional approaches, from simple to complex
- Your company model – using predictive analytics
- Model based on industry data – using predictive analytics
- Your improved company model – using predictive analytics and industry blending in a credibility-based framework, and quantifying the benefits

Your company model – traditional approaches

(a) Once upon a time, very basic modeling of partial withdrawals and income

e.g. 3% of account value annually, consistent with aggregate historical company experience

Your company model – traditional approaches

(b) …evolved to split between base free partial withdrawals and GLIB income utilization

(i) Base: 2.5% of account value annually

(ii) GLIB: 4.6% of premium annually

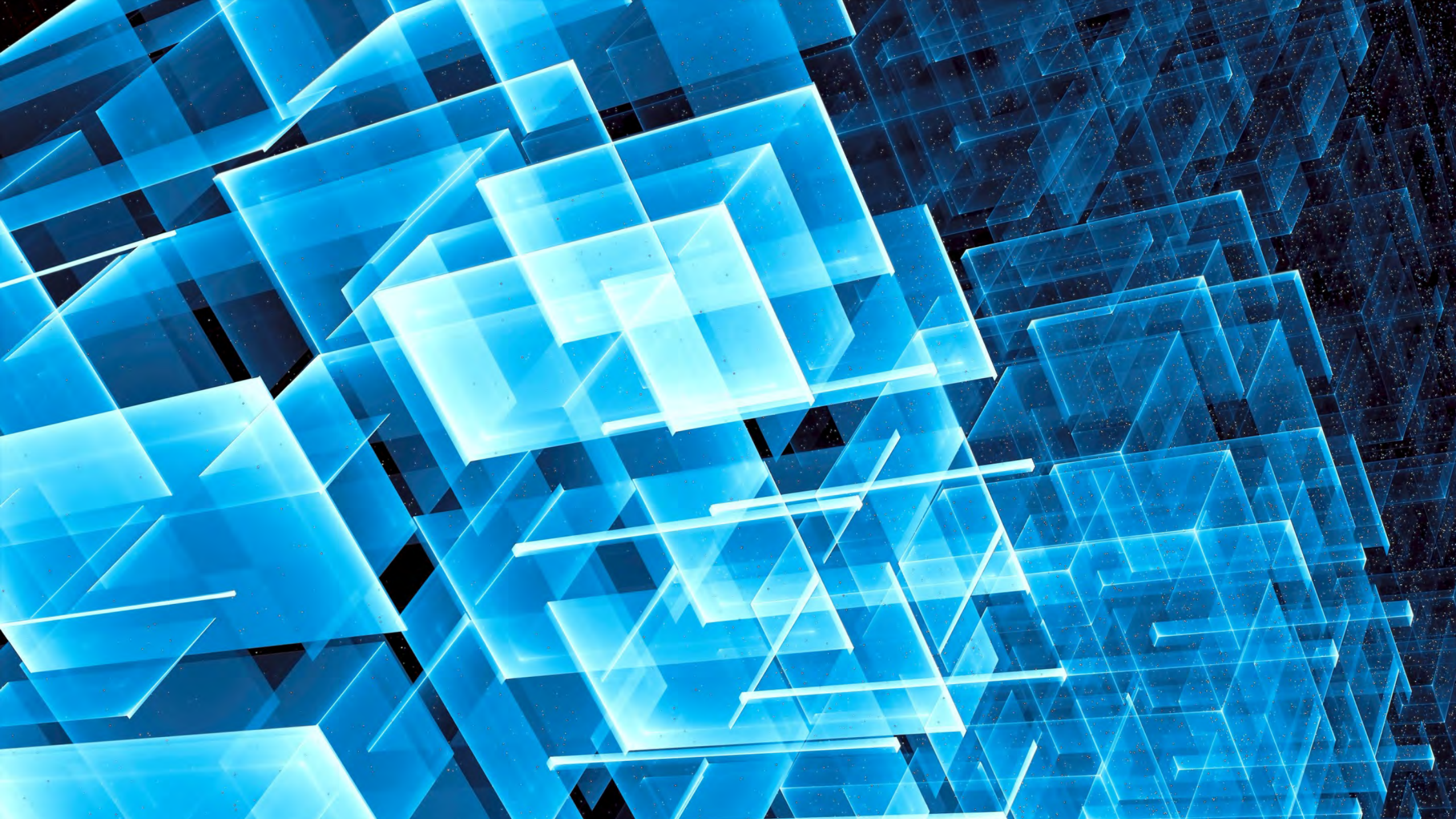
Your company model – traditional approaches

(c) …then refined for GLIB income commencement timing options

(i) Base: 2.5% of account value annually

(ii) GLIB:

Year	Income
1	10% commence with 5% of premium
2-10	5% commence with 5% of premium
11	20% commence with 10% of premium
12-15	4% commence with 10% of premium
16+	9% never commence income



Your company model – traditional approaches

Chopping into tiny cohorts with dubious credibility

Unwieldy, complex, and error-prone

Lacks a sense of range of outcomes, leading to unpredictability and endless “unlocking”

Is there a better way?

Your company model – using predictive analytics

Example: logistic regression model, which is a simple type of Generalized Linear Model

$$\ln\left(\frac{\mu}{1-\mu}\right) = \beta_0 + \sum \beta_i x_i$$

“Log of odds” of the behavior is a linear function of key factors

In this case study, the behavior is FIA GLIB income commencement

Your company model – using predictive analytics

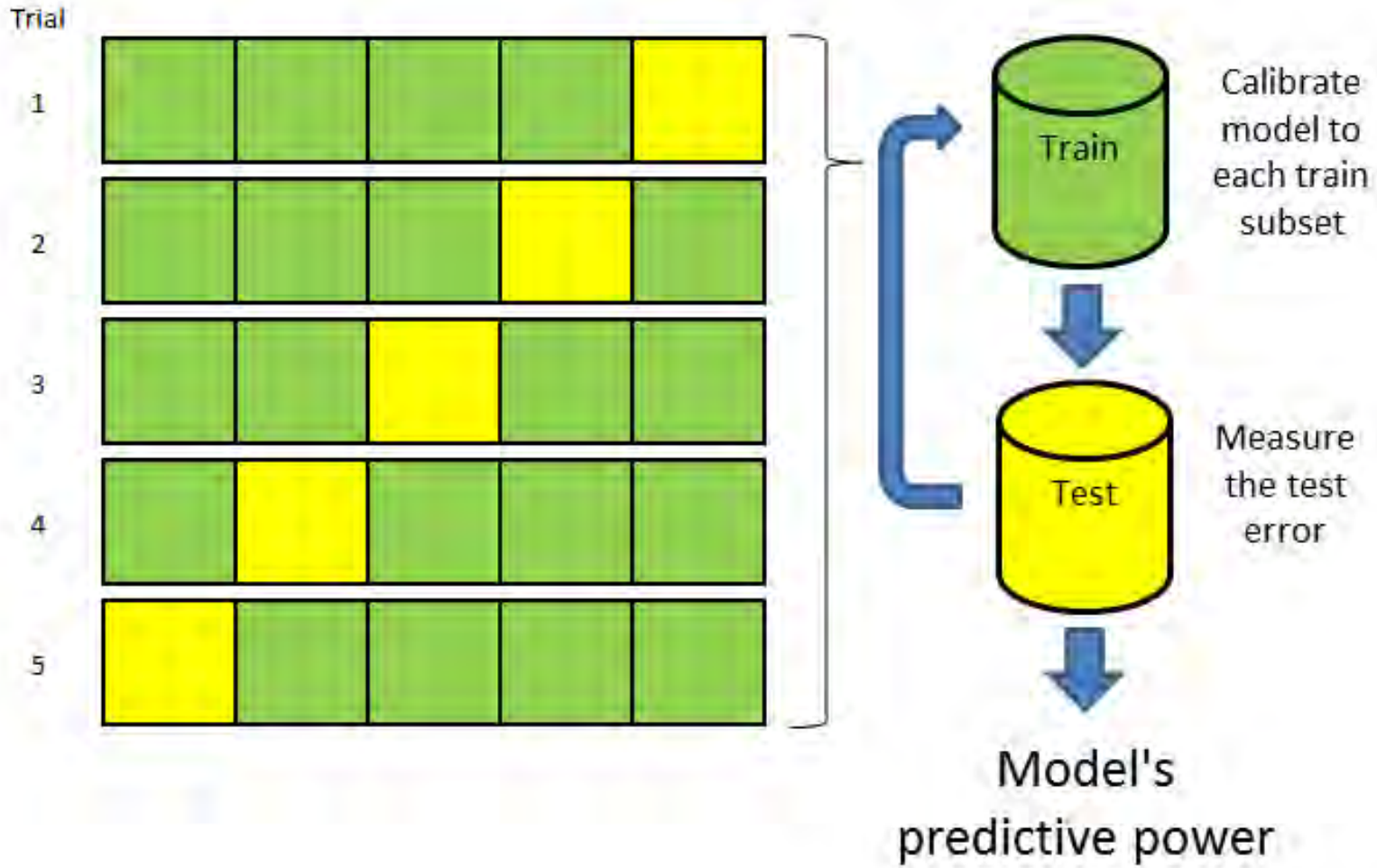
Use algorithms (R, Python, etc) to solve for the “best” model balancing goodness-of-fit, predictive power, and explainability

- Train candidate models on some of your data
- Test candidate models on the data that you held out
- Choose your model!

Refer to my presentation at the 2019 SOA Equity-Based Insurance Guarantees Conference for details on experience data analysis, sampling techniques, goodness-of-fit metrics, bias-variance trade-off, predictive power metrics, and model selection

5-Fold Cross Validation

Measures the bias-variance trade-off



Your company model – using predictive analytics

i	X_i	B_i
0	Constant base	-5.0
1	Attained age 0-69	-2.0
2	Attained age 70-75	1.0
3	Attained age 76-79	0.5
4	Attained age 80+	0.1
5	Contract duration 1	0.8
6	Contract duration 2-10	0.3
7	Contract duration 11	1.4
8	Contract duration 12-15	0.2
9	Contract size $0-50k	-3.0
10	Contract size $50-150k	0.1
11	Contract size $150k+	0.5

Representative large company with $35 billion account value and 20k GLIB income commencements, but still only a fairly simple model is statistically justified

Average absolute value 5-fold cross-validation error is 0.80% (pretty good)

Using five years of data to predict the next year resulted in A/E of 47% (yikes!)

How would this result be viewed internally? What could have been done differently to get a better result?

Model based on industry data – using predictive analytics

What if we had more (relevant) data from across the industry?

What if we fed this data into the same algorithms?

We should be able to produce a more sophisticated model that is statistically justified, with better goodness-of-fit and predictive power

Model based on industry data – using predictive analytics

i	X_i	B_i
0-11	… as above for your company model	…numerical refinements
12	Qualified and attained age 70+	0.7
13	OTM 25%+	-0.2
14	OTM 0-25%	-0.1
15	ATM	0.0
16	ITM 0-25%	0.2
17	ITM 25%+	0.6
18	Frequency of withdrawals over last five years	1.4

Industry data with $100 billion account value and 110k GLIB income commencements

Average absolute value 5-fold cross-validation error is 0.60%

Using five years of data to predict the next year resulted in A/E of 101%

Looks like a great model of industry behavior. How can we use this to improve your company model?

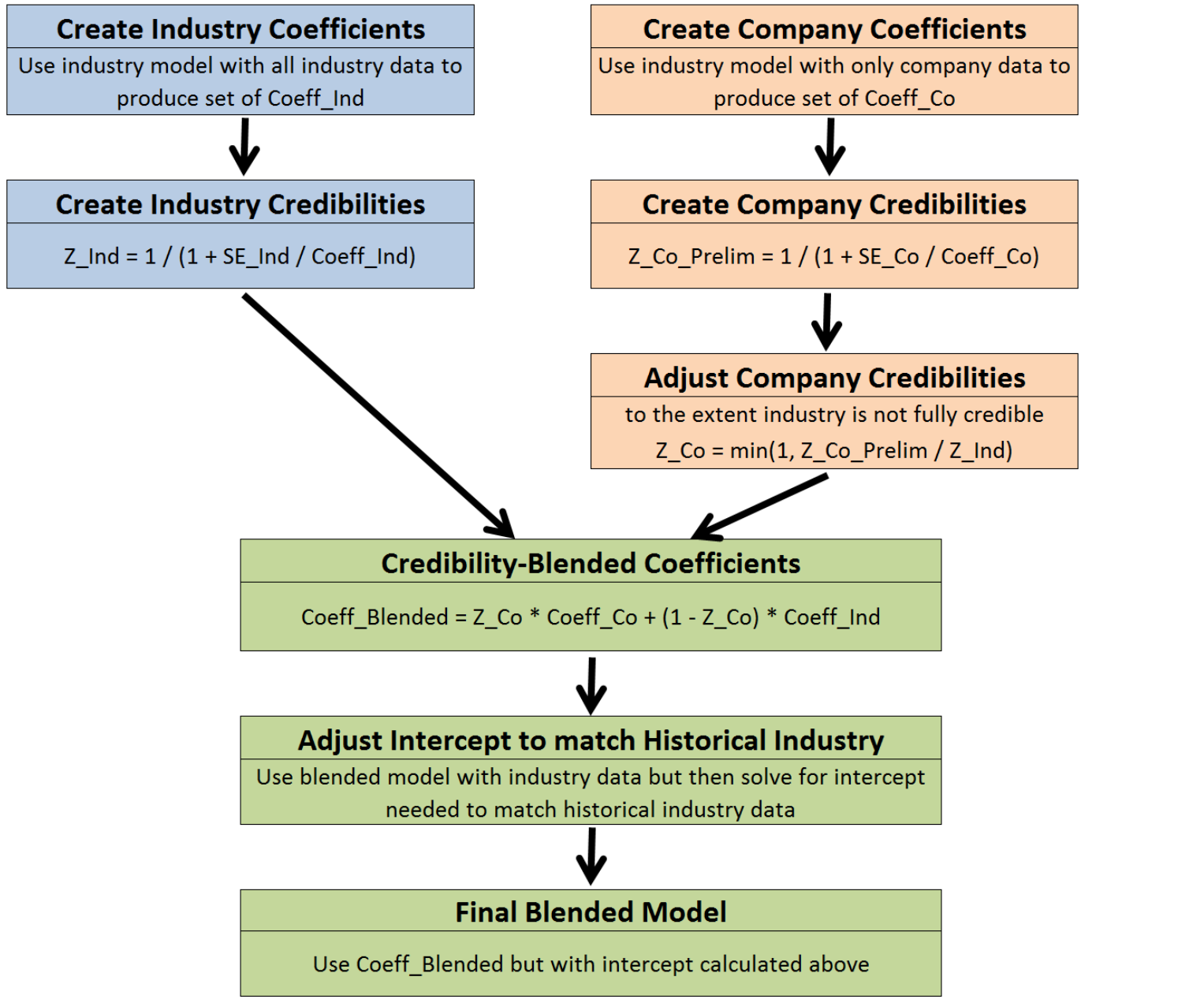
Your improved company model – using predictive analytics and industry blending in a credibility-based framework

Apply credibility concepts at the factor level

Let the data speak

Following is an approach that we have developed that produces very good results

Process to Create Credibility-Blended Model



Your improved company model – using predictive analytics and industry blending in a credibility-based framework

i	X_i	B_i
0-11	… as above for your original company model	…further numerical refinements
12	Qualified and attained age 70+	
13	OTM 25%+	
14	OTM 0-25%	
15	ATM	
16	ITM 0-25%	
17	ITM 25%+	
18	Frequency of withdrawals over last	

Average absolute value 5-fold cross-validation error is 0.62%
(improved from 0.80%)

Using five years of data to predict the next year resulted in A/E of 90%
(much improved from 47%)

Quantify the financial benefits (i.e. in your KPIs) of this improved model relative to the cost of acquiring the industry data

Discussion