Equity-Based Insurance Guarantees Conference

Nov. 6-7, 2017

Baltimore, MD

Behavioral Analytics for Annuities

Timothy Paris

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2017 Equity-Based Insurance Guarantees Conference

Session 2B – Behavioral Analytics for Annuities

November 6, 2017

1:30-3:00pm

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Ruark Consulting LLC

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Source: LIMRA	Variable Annuities	Fixed Indexed Annuities
Gross Sales (p.a.)	~$150 billion	~$100 billion
Net Sales (p.a.)	~$0 billion	?
% Qualified	65%	55%
% Guaranteed Living Benefit	77%	68%

Overview of VA Industry Experience

VA Industry Data

22 participating companies

2008 to present

68 million contract years of exposure

+22% from last year

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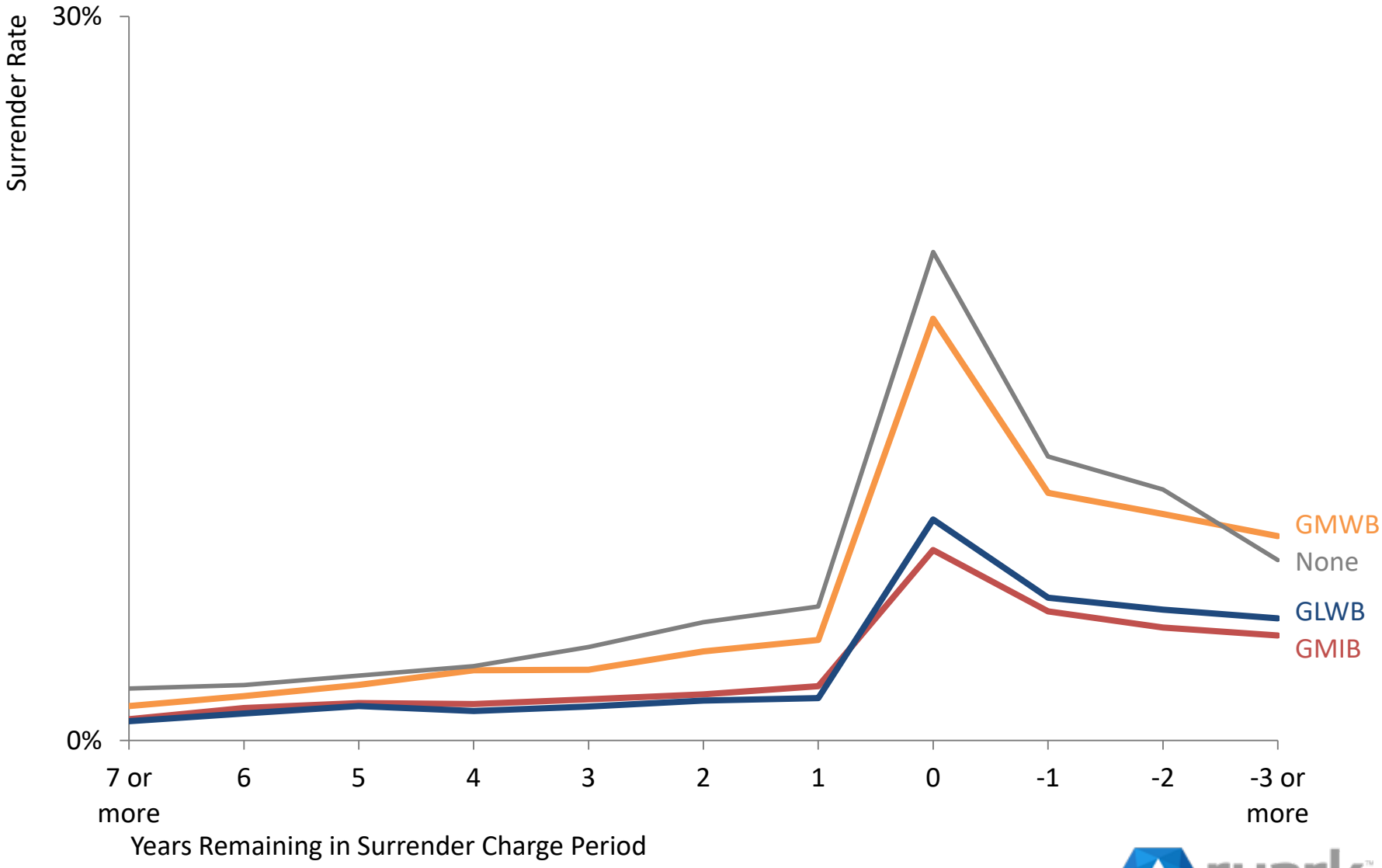
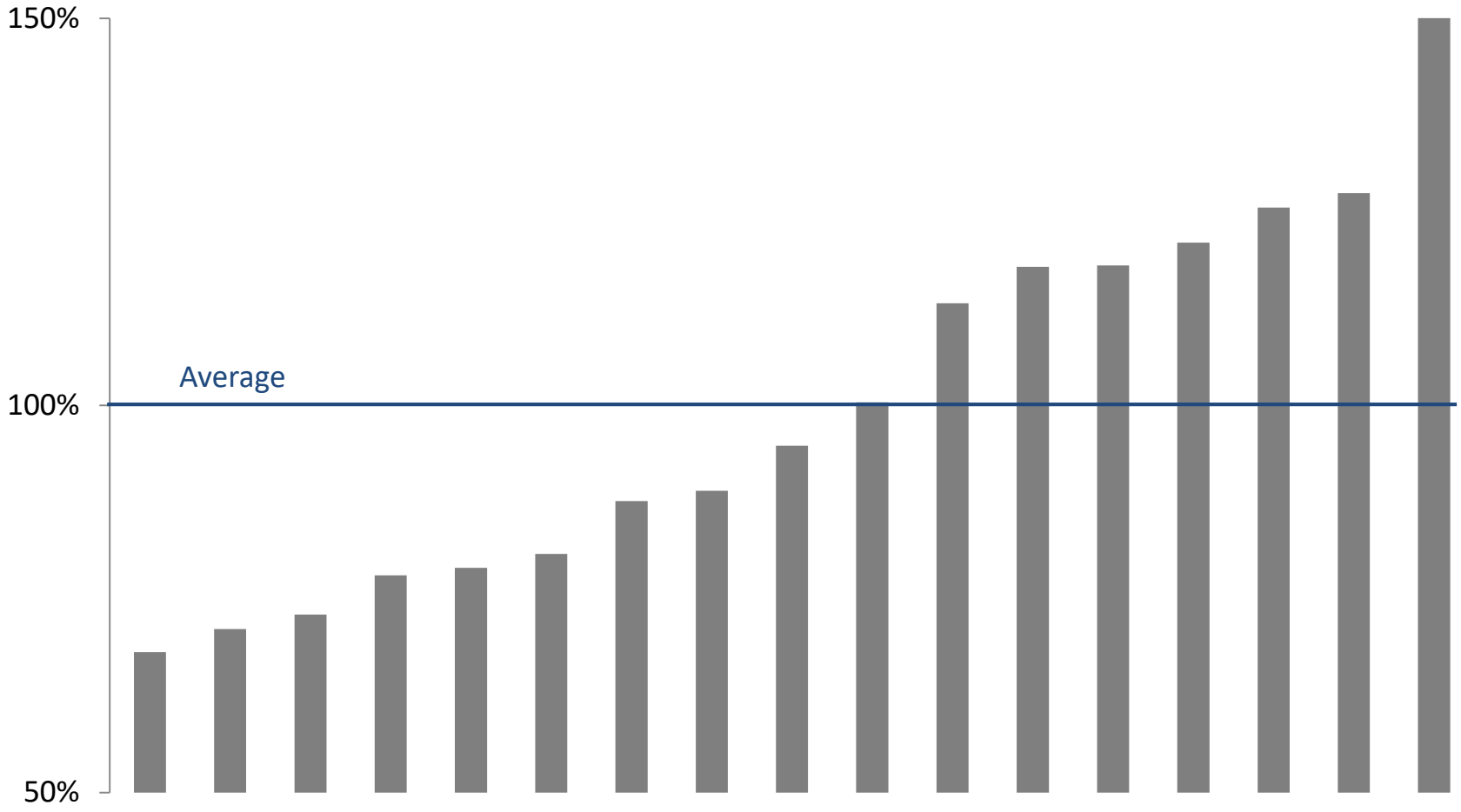
Surrenders vary by living benefit type



Experience varies by company, but why?

GLWB, Normalized by Years Remaining in Surrender Charge Period



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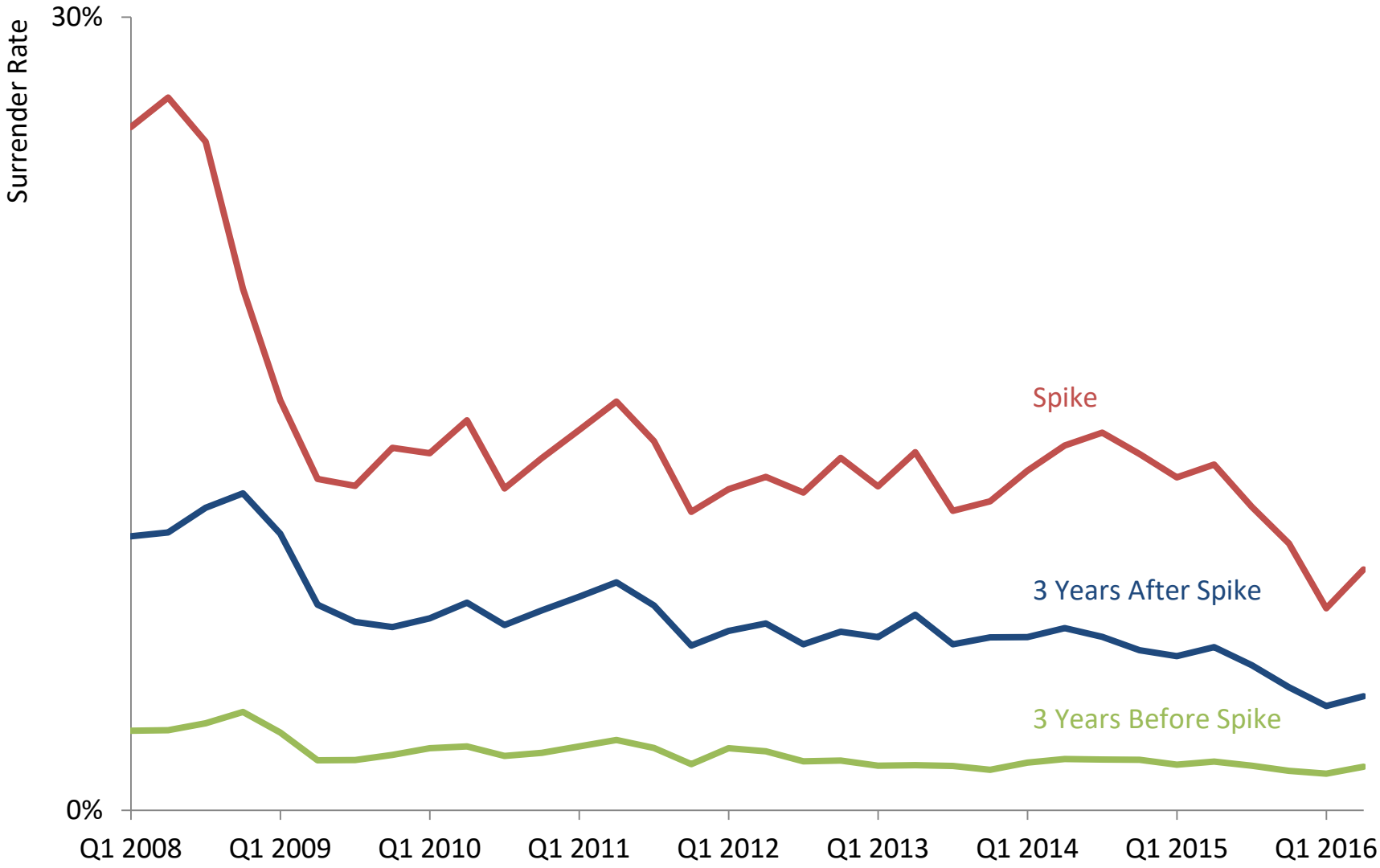
Surrenders have decreased since the crisis



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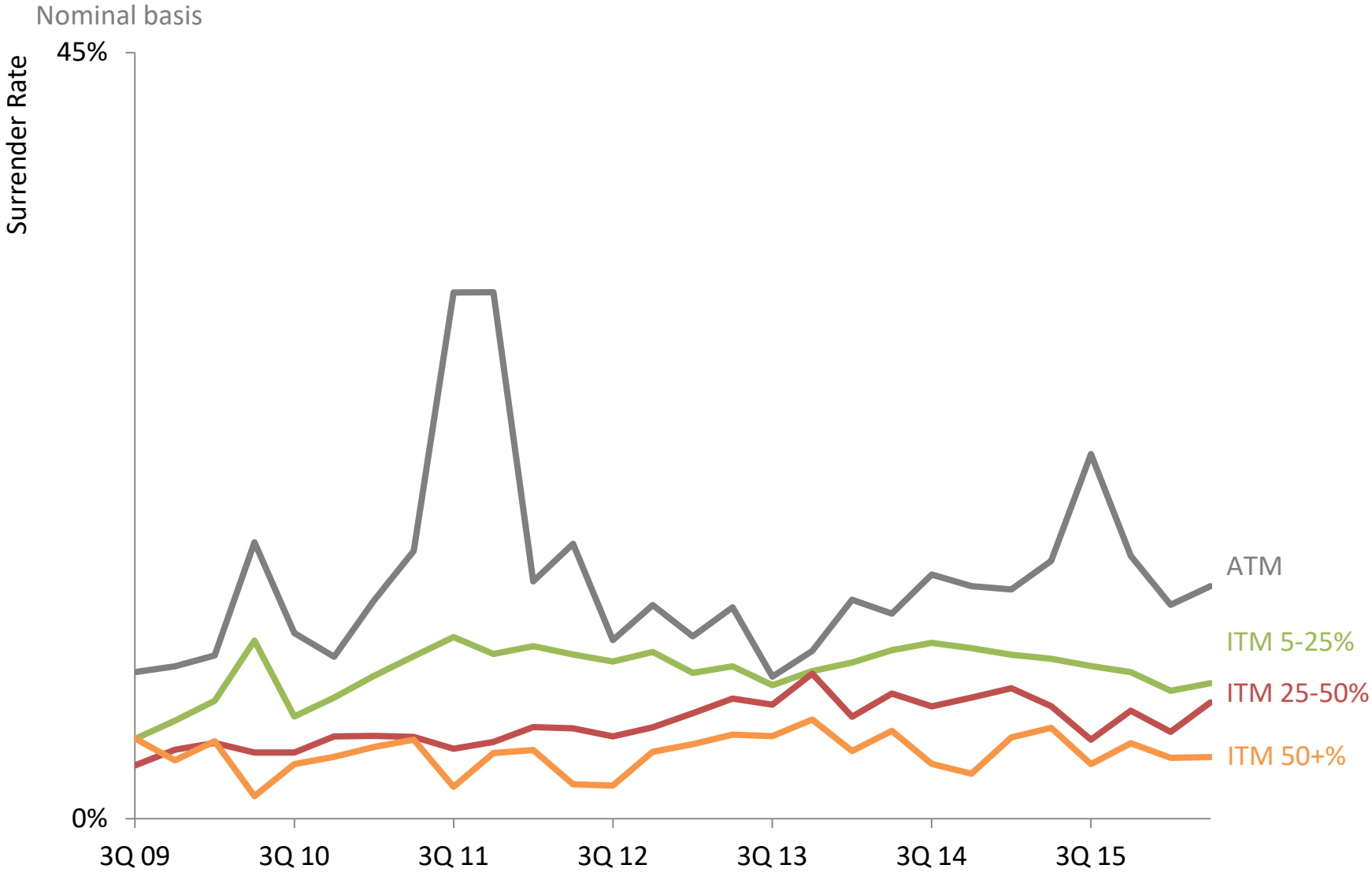
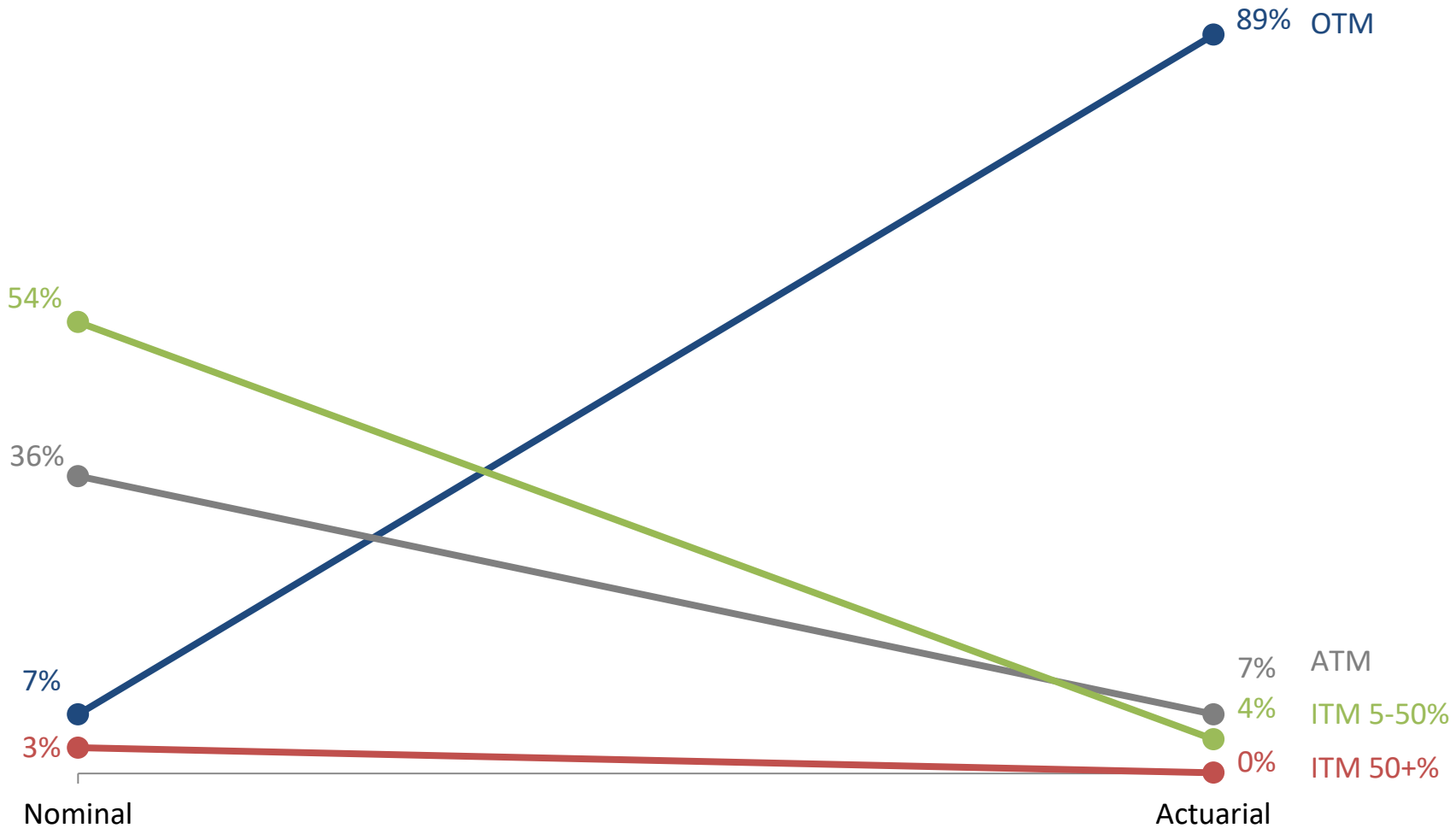
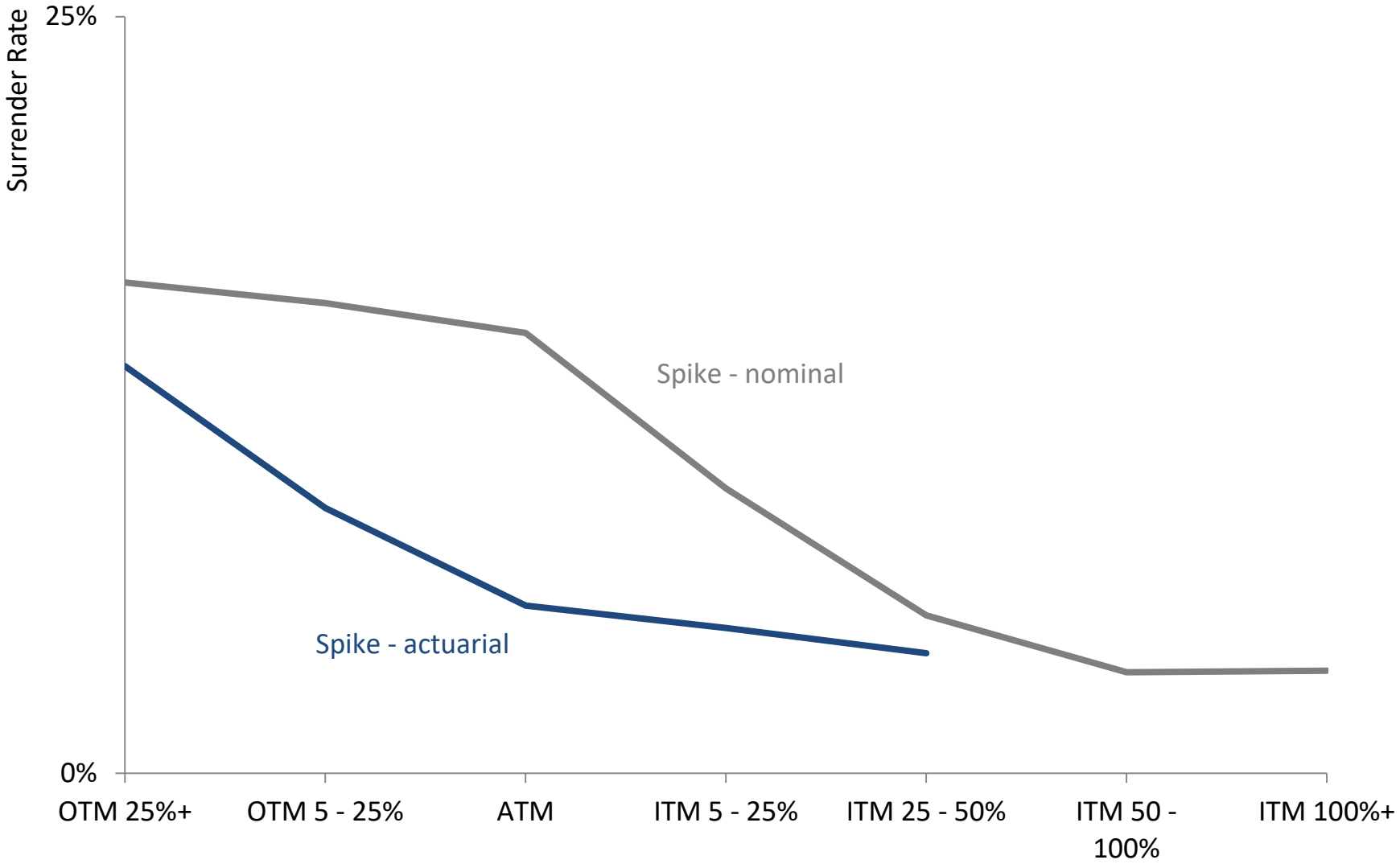
However, a different trend for GLWB “spike”



Most GLWBs are actuarially out-of-the-money



GLWB moneyness basis matters



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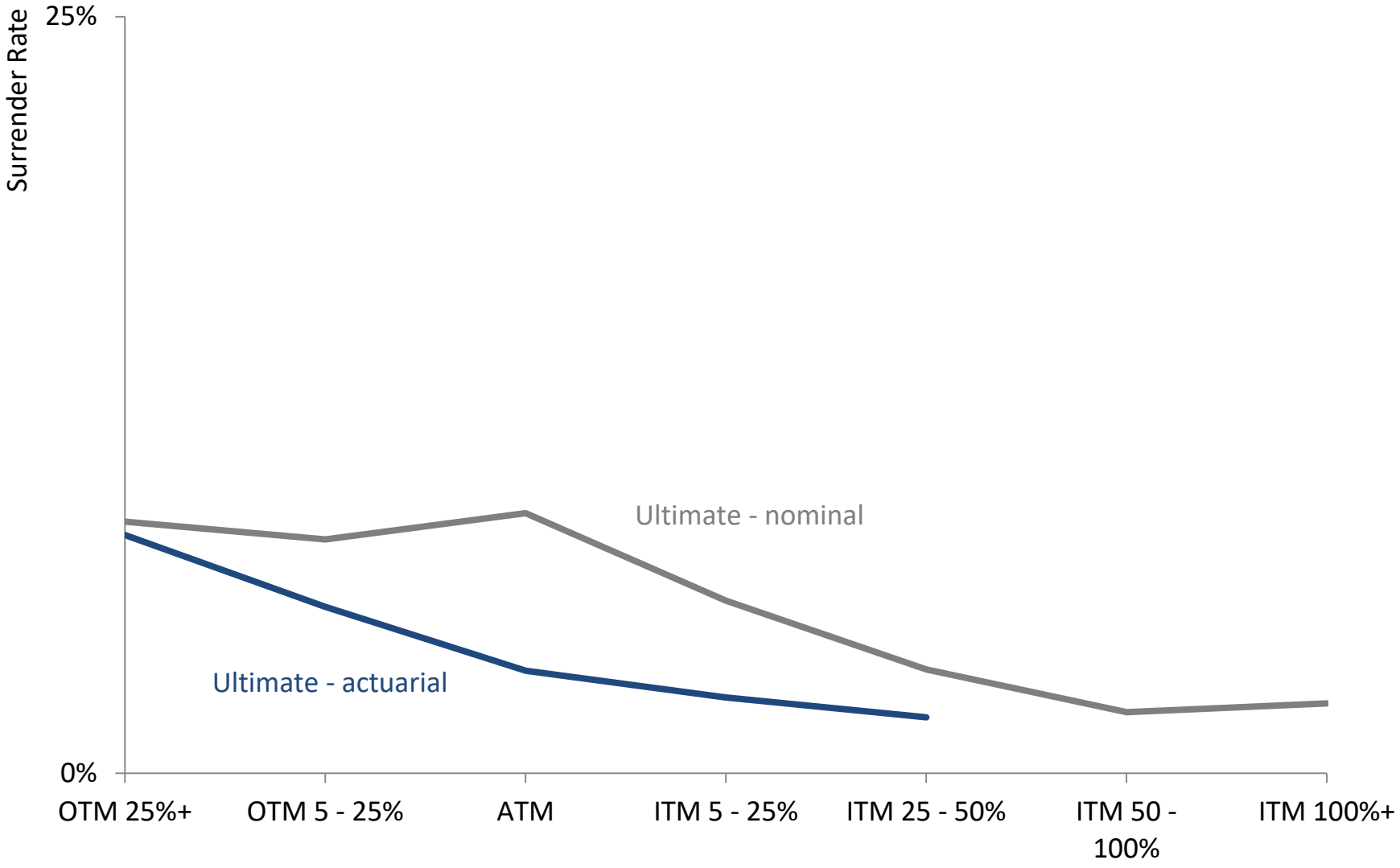
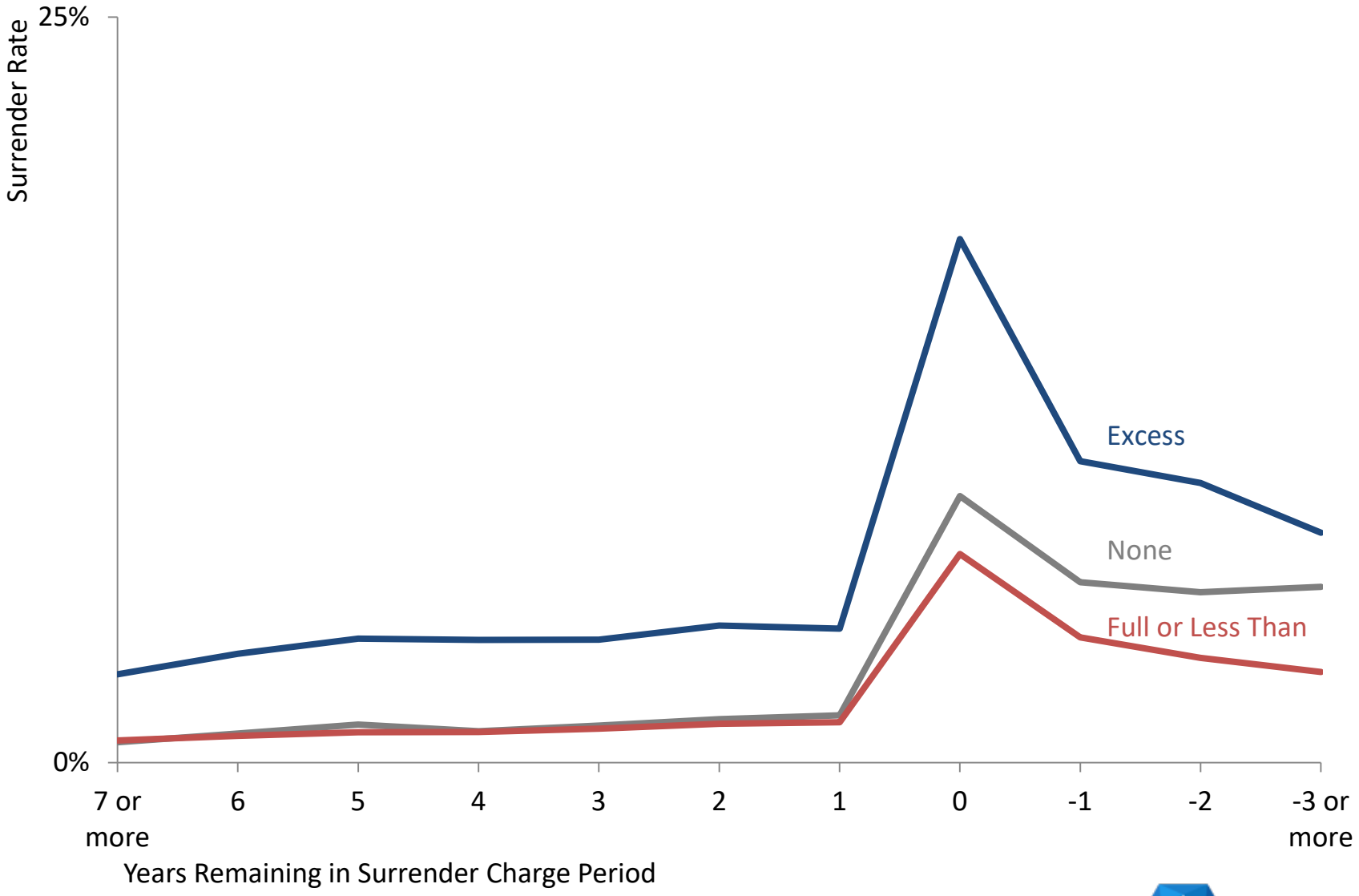
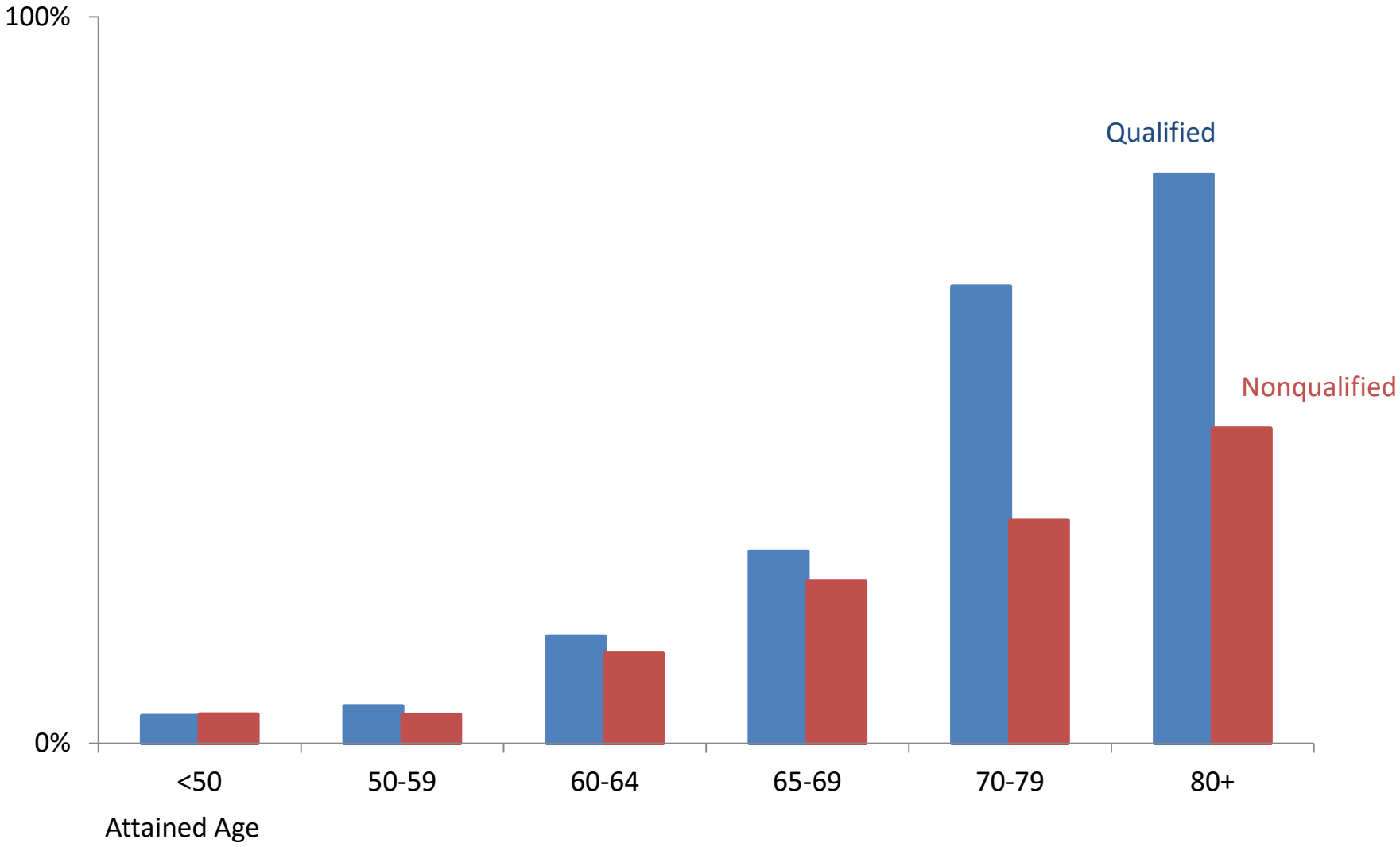


GLWB income utilization affects surrenders



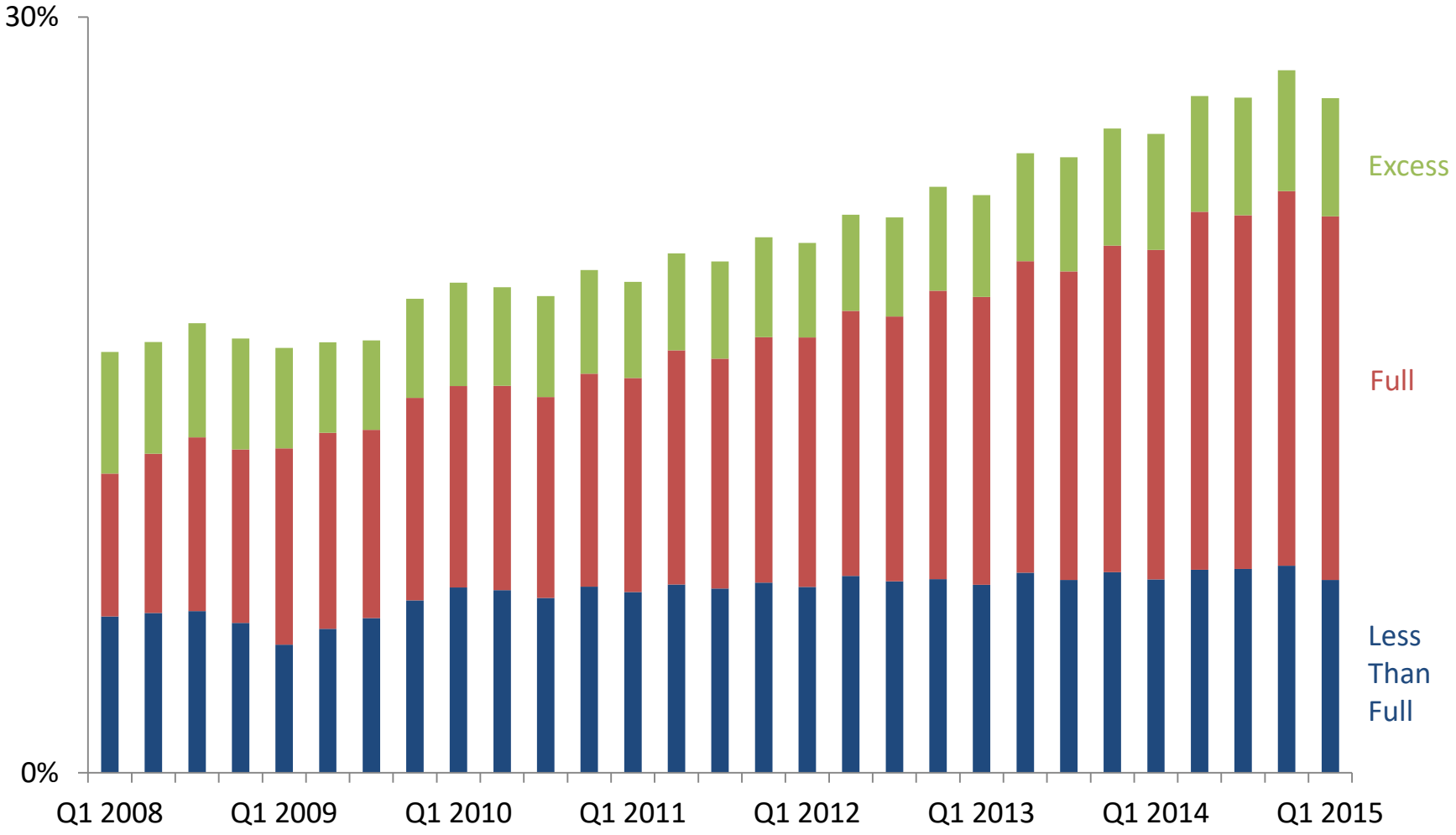
Income utilization varies by age and tax status

GLWB Partial Withdrawal Frequency



Income utilization efficiency has increased

GLWB Partial Withdrawal Frequency and Amounts



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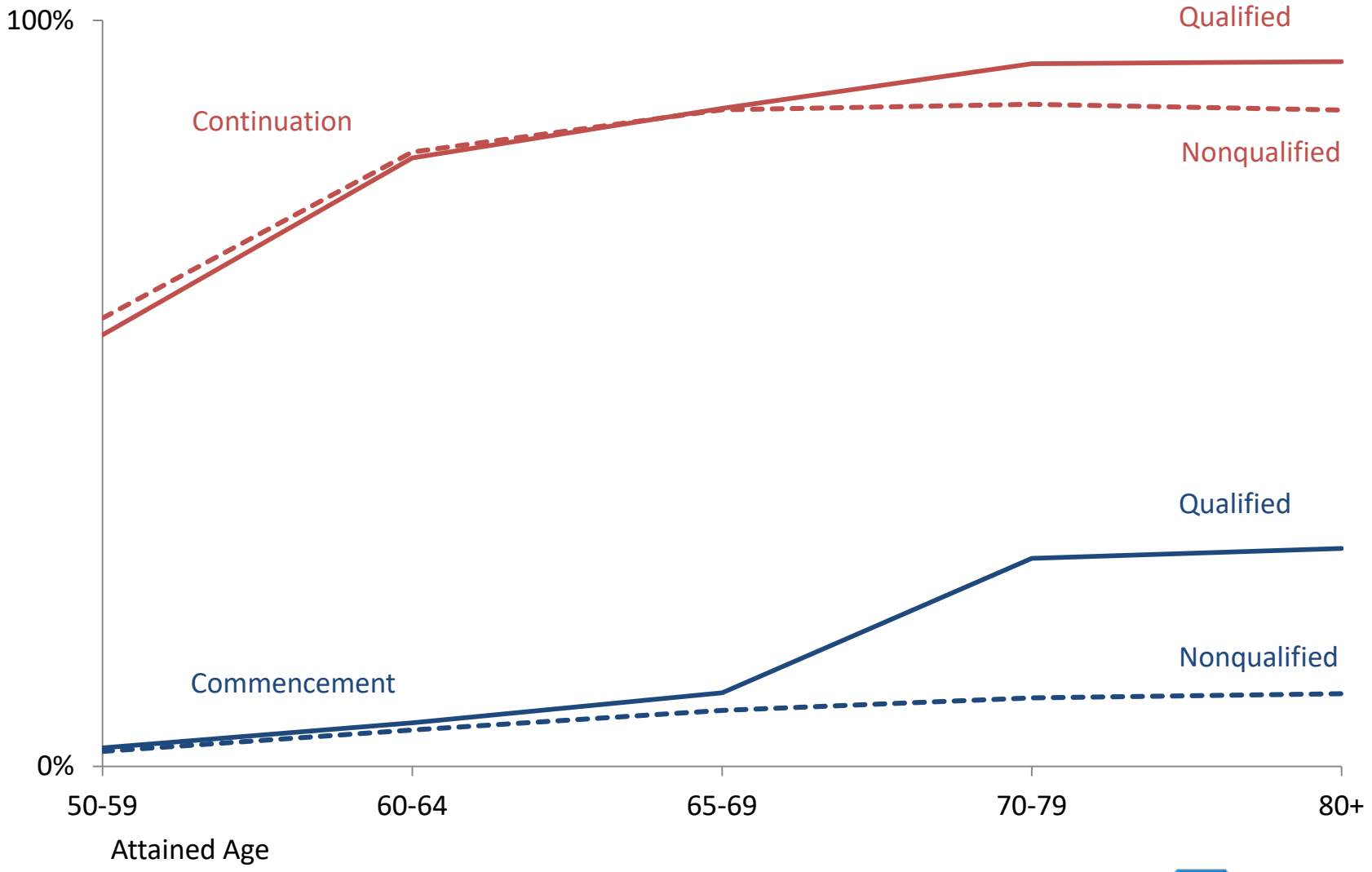
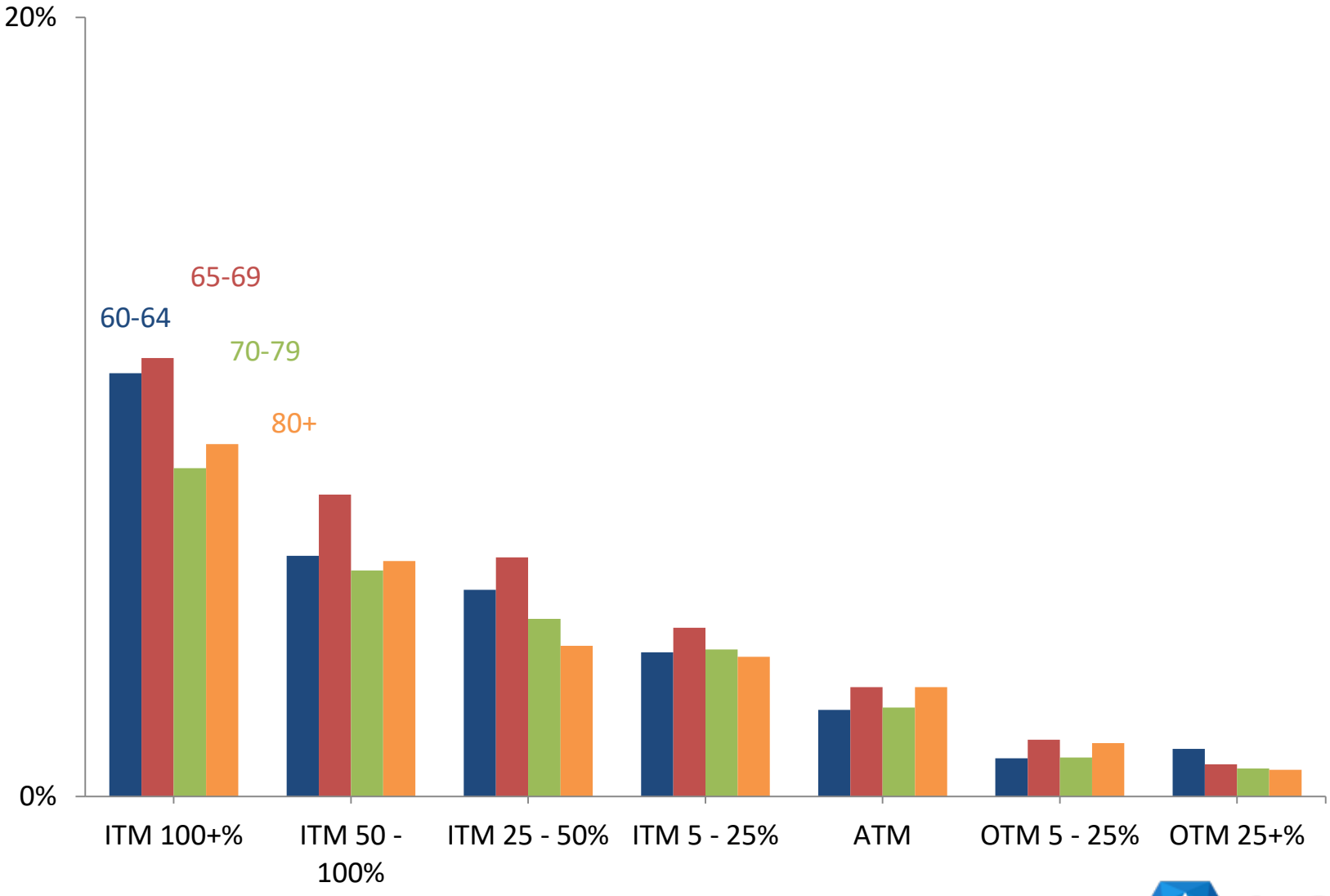
Income commencement is the key question

GLWB Partial Withdrawal Frequency

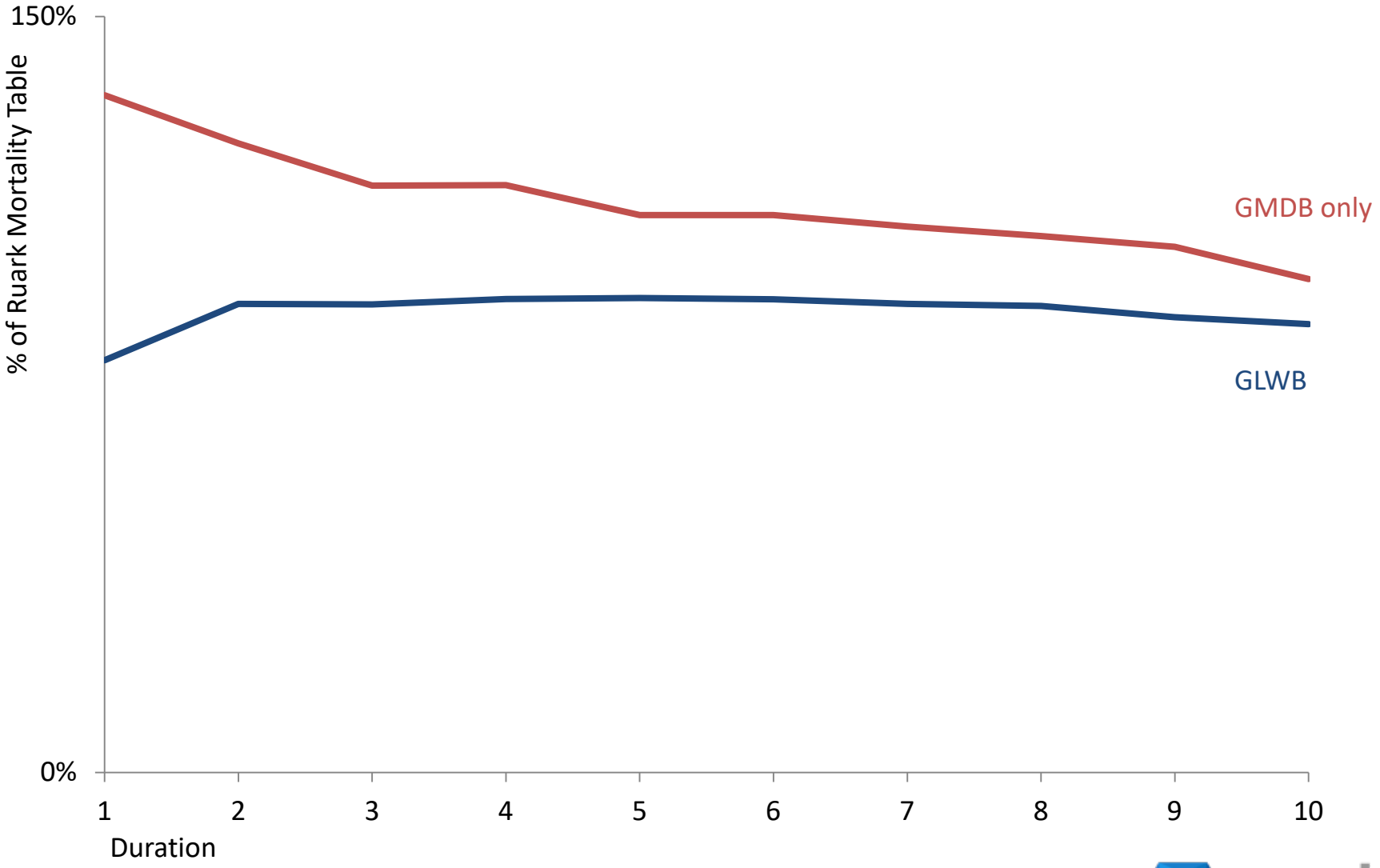


GMIB annuitizations are low

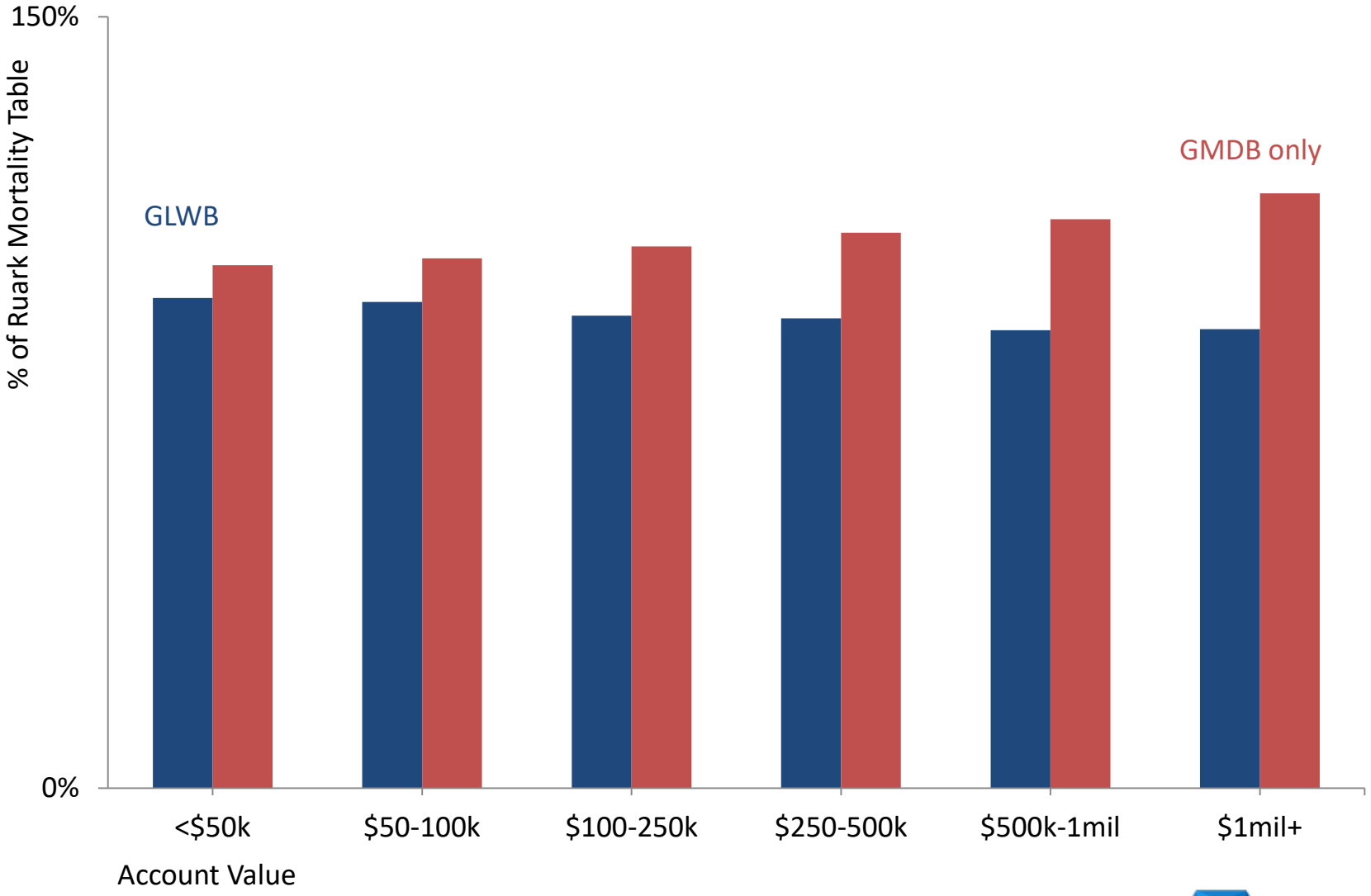
Actuarial basis



Guarantees can affect mortality too



Mortality effects are amplified by policy size



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Overview of FIA Industry Experience

FIA Industry Data

12 participating companies

2007 to present

13 million contract years of exposure

+30% from last year

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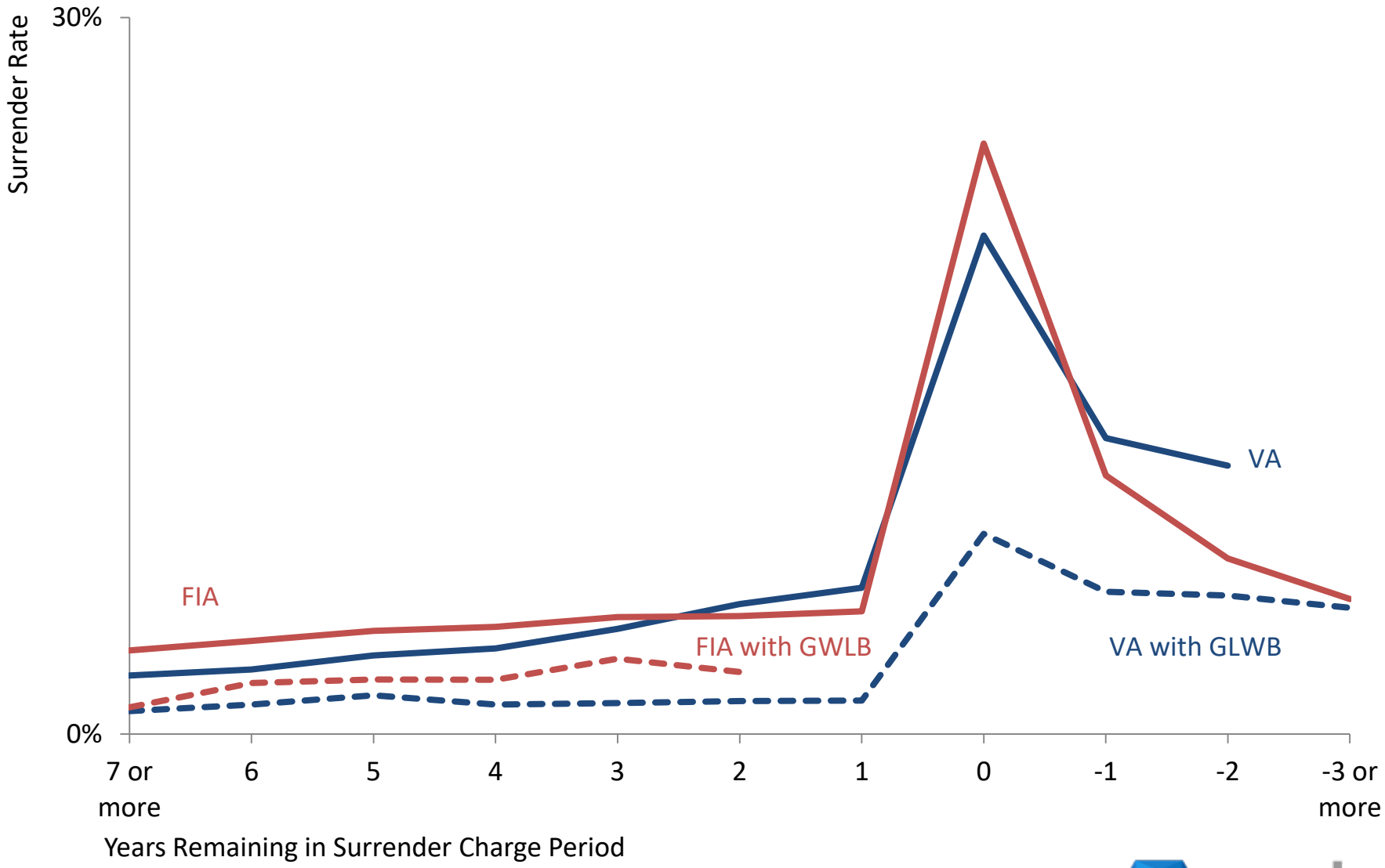
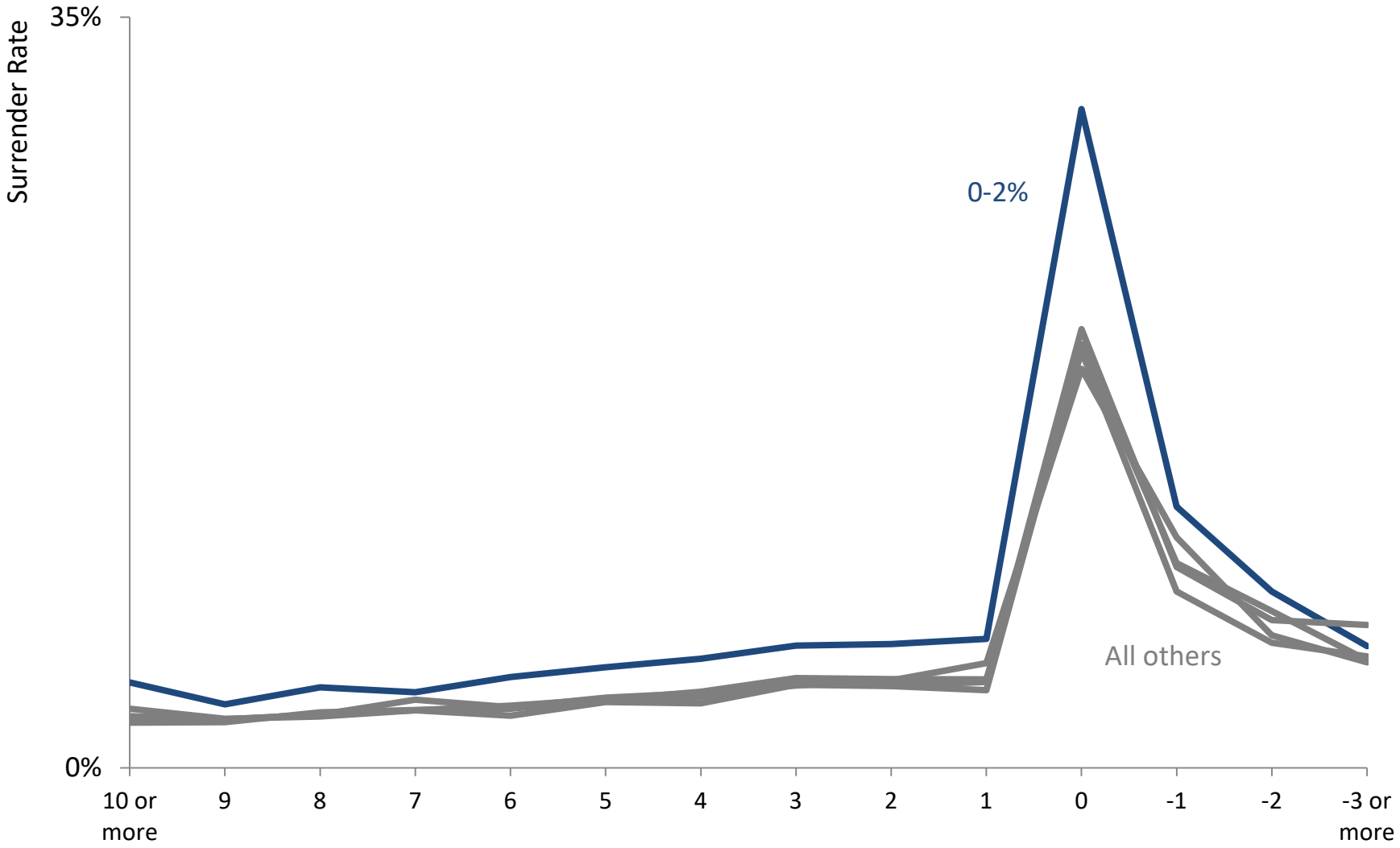
VA and FIA surrenders are lower with GLWB



FIA surrenders vary based on interest credited



Behavioral Analytics Framework

Industry
Data
Traditional Analysis
Statistical
Techniques
Expert
Judgment

Model Development

Start with maximum data set (industry)

Extract relevant subset for a company

Develop a model on this basis

Do likewise using only company's data

Customize model to reflect both, so that most important factors are included, with stable coefficients, balancing goodness-of-fit and predictive power

You can go far with Generalized Linear Models (GLM)

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Logistic Regression Model

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

"Log of odds" is a linear function of key factors

Binary values, such as surrenders or deaths

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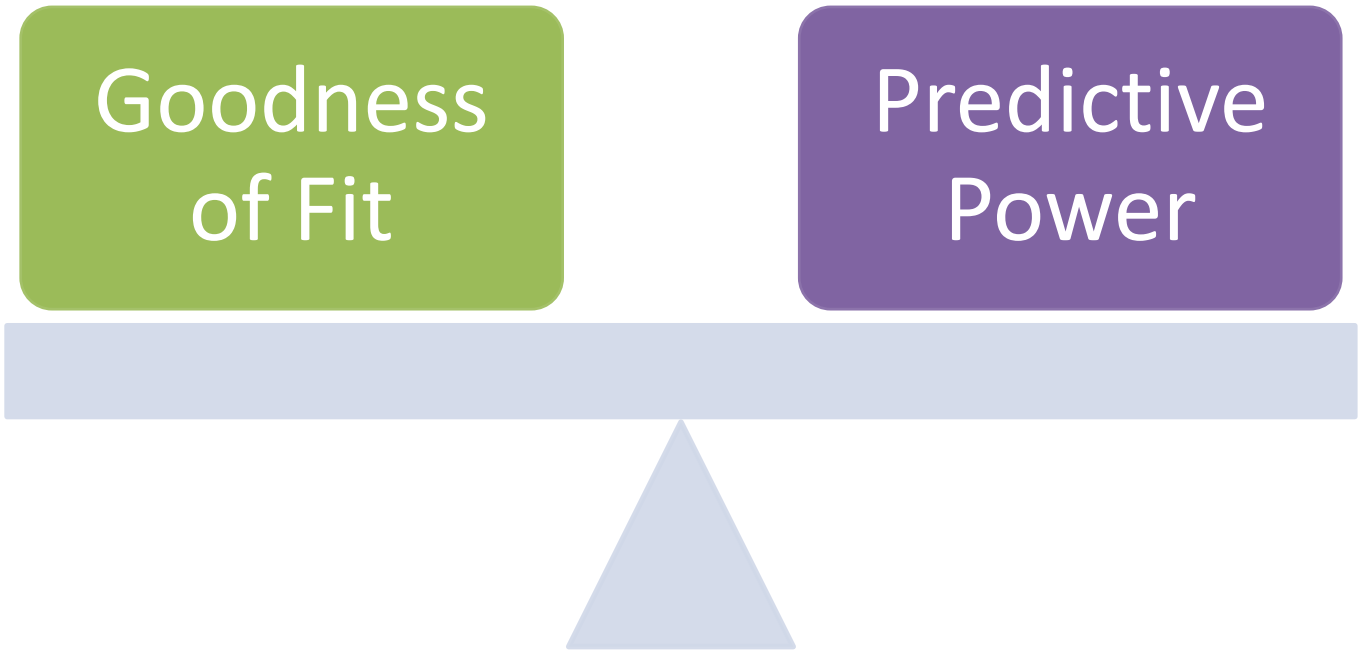

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Bayesian Information Criterion

Rewards goodness-of-fit to historical data, but penalizes for additional factors used in your model

One of many metrics to help guide your model selection process

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Actual-to-Expected Ratios

"Predictive Power" in the new vernacular

Develop E using train data, compare to A from test data

Out-of-sample, out-of-time, and k-fold cross-validations

Examine in aggregate, by cohorts, and over time

Look at range of outcomes and tails

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Expert Judgment is Vital

Business context, sensibility, materiality, parsimony

Let the data speak

More data usually beats more complex models

Build simple models for complex data, and complex models for simple data

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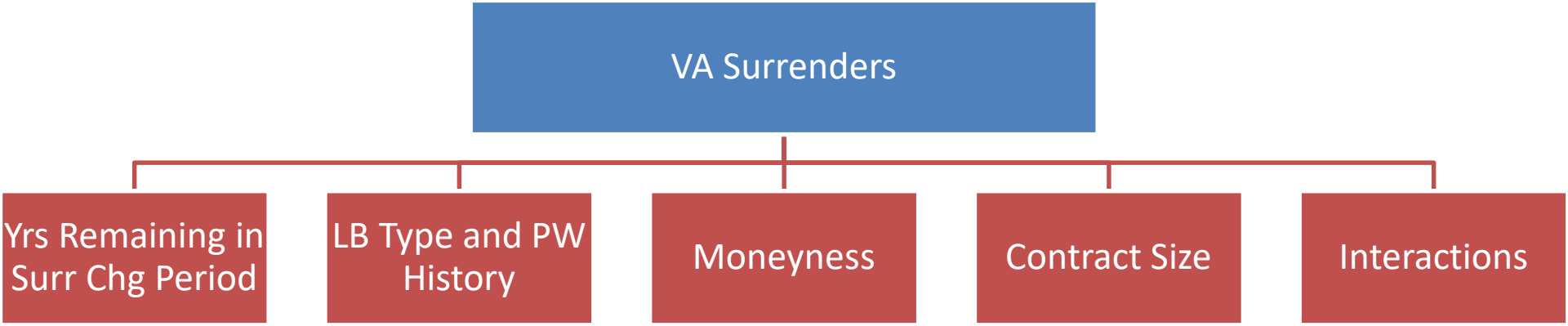
Sample Models


VA Surrenders
Yrs Remaining in Surr Chg Period
LB Type and PW History
Moneyness
Contract Size
Interactions

Using industry data

For each factor coefficient, standard error terms $\left(\frac{\sigma}{\mu}\right)$ are typically very small ~ 1/300 to 1/100.

Then testing predictive power using 5-fold cross-validation, average A/E errors are also very small ~ 1/700.

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Using company-only data

In some cases, company-only data is insufficient to even identify the key factors observed in the industry data, or it demonstrates factor coefficient estimates that are not sensible.

Even if they do, the coefficient standard error terms $\left(\frac{\sigma}{\mu}\right)$ can be 20x larger.

Similarly, the average cross-validation A/E errors can be 10x larger.

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Combining industry and company-only data

A customized combination of industry and company-only data can produce a vastly superior model with much better fit and predictive power.

Such a model should identify and quantify the effects of each additional factor in the presence of the others, and the interactions between them.

Confidence increases with additional data.

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Integration Across Behaviors

Factor		Coefficient
Intercept		-2.0
Years	7	-4.0
	6	...
	...	...
Remaining in SurrChg Period	1	-1.0
	0	Intercept
	-1	-0.5
	-2	...
	-3	-0.8
LB Type and PW History	GMDB only	Intercept
	Less than Full	...
	Full	-1.2
	Excess	...
	...	...
Moneyness	OTM	...
	ATM	Intercept
	ITM Band1	...
	ITM Band2	...
	ITM Band3	...
	ITM Band4	-1.0
Size	log (AV)	-0.2

Very important to model behavior on integrated basis

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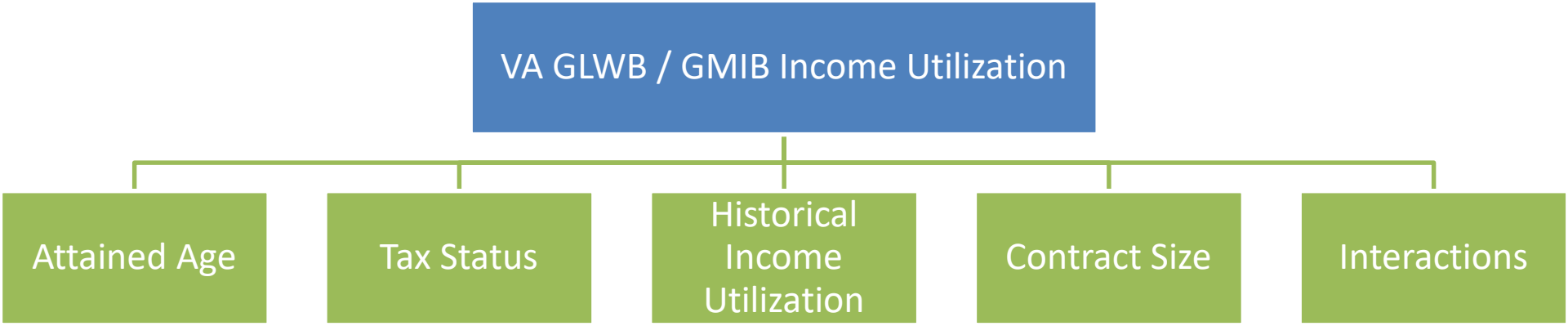
VA GLWB / GMIB Income Utilization
Attained Age
Tax Status
Historical Income Utilization
Contract Size
Interactions

The power of more data

As above, but for GWLB / GMIB income utilization, need to address complexities of frequency and severity relative to guarantee amounts.

	Average A/E Error		
	Less Than	Full	Greater Than
Industry	0.20%	0.30%	0.50%
Company-only	2.80%	1.50%	3.60%
Customized	2.00%	0.70%	3.20%

Customized model using industry data can reduce error by half where it matters most, for Full income utilization.

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Discussion