

2019 Investment Seminar

October 27, 2019

Toronto, Canada



Session 3B: Insurance Company Investment Risk Management: What Remains to be Addressed

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NEUBERGER BERMAN

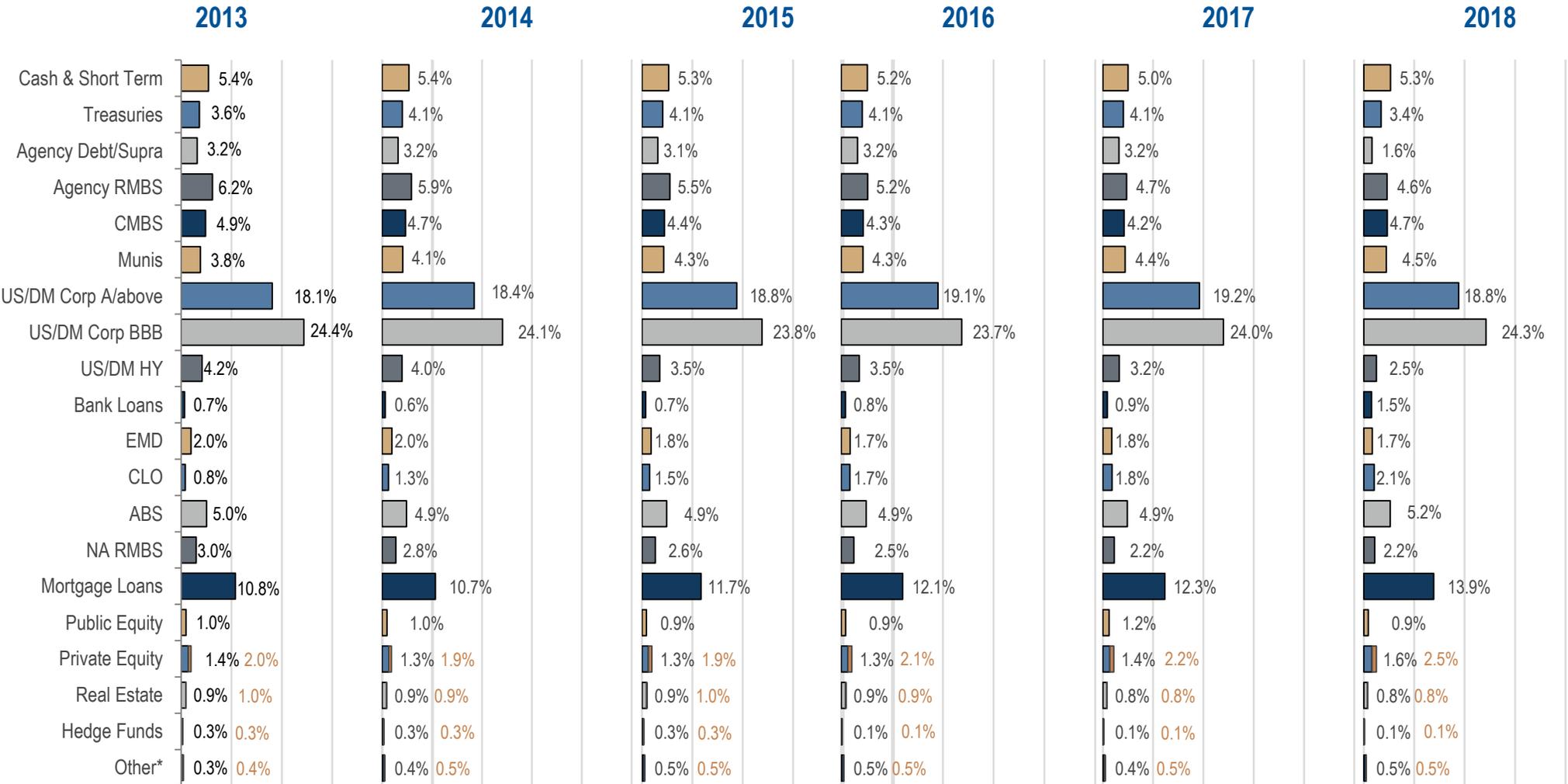
Insurance Company Investment Risk Management

October 2019

Detailed Historical Life Industry Allocation, 2013–2018

The life industry has steadily increased allocation to CLOs, mortgage loans, and illiquid assets

*Bars and numbers in orange represent NAV + Unfunded



Sources: SNL, Bloomberg–Barclays POINT, FactSet. Agency Debt/Supra: includes Developed Market Sovereign Bonds

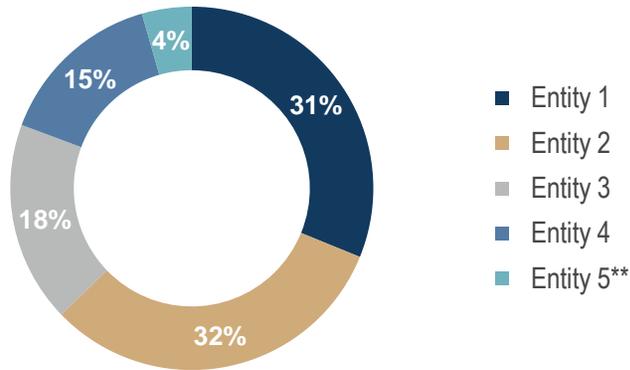
Asset holdings are as of 12/31 of each year. Prior to 2018, some bank loans may be reported in high yield asset class due to data limitations. This material is provided for informational purposes only. Views expressed herein are as of the date indicated and subject to change. Nothing herein constitutes a prediction or projection of future events or future market behavior. Due to a variety of factors, actual events or market behavior may differ significantly from any views expressed. Please see Additional Disclosures at the end of the presentation. Prior to 2018, some bank loans may be reported in high yield asset class due to data limitations.

*Other includes Collateral Loans, FHLB stock, PD, and LIHTC

Understanding an Insurer's Structure

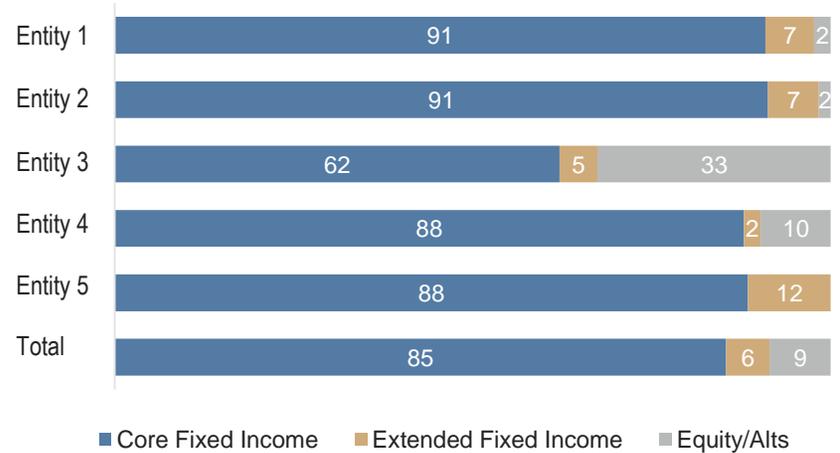
The structure of the insurer affects how risks and investments are managed

Total Portfolio Composition



**Includes all other entities/holdings

Asset Allocation of Each Entity



Entities	OAD	OASD	Fixed Income Rating Number ¹	Fixed Income Rating
Entity 1	6.4	6.5	4.1	AA-
Entity 2	7.2	7.5	4.7	A+
Entity 3	5.9	6.9	3.0	AA
Entity 4	7.1	7.2	3.9	AA-
Total	6.3	6.6	3.8	AA-

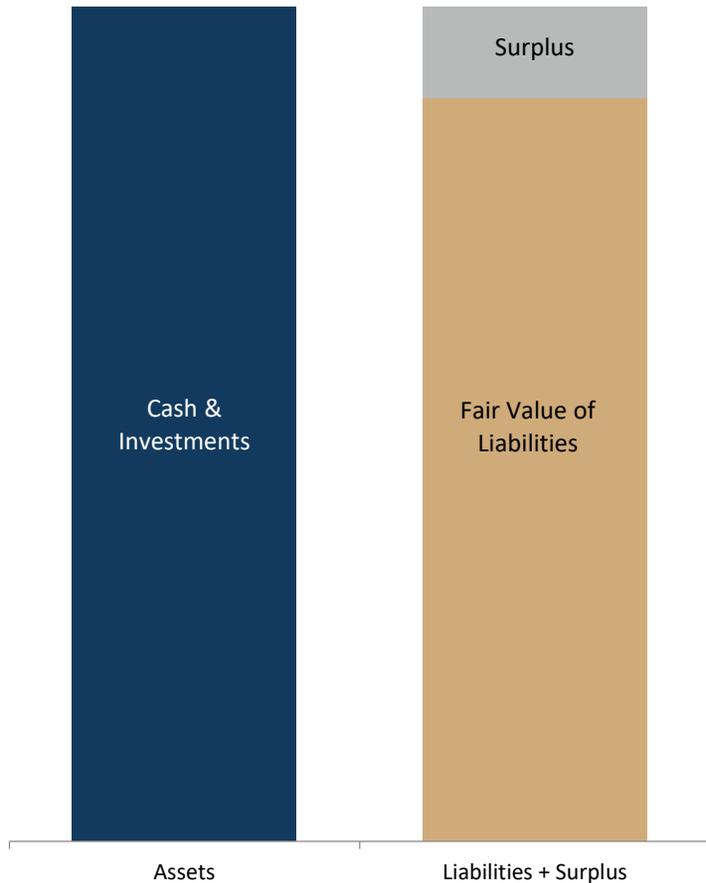
1: Bloomberg-Barclays index rating number is applied: AAA: 1, AA+: 2, AA : 3, AA- : 4, A+ : 5, A: 6

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Sample Economic Balance Sheet

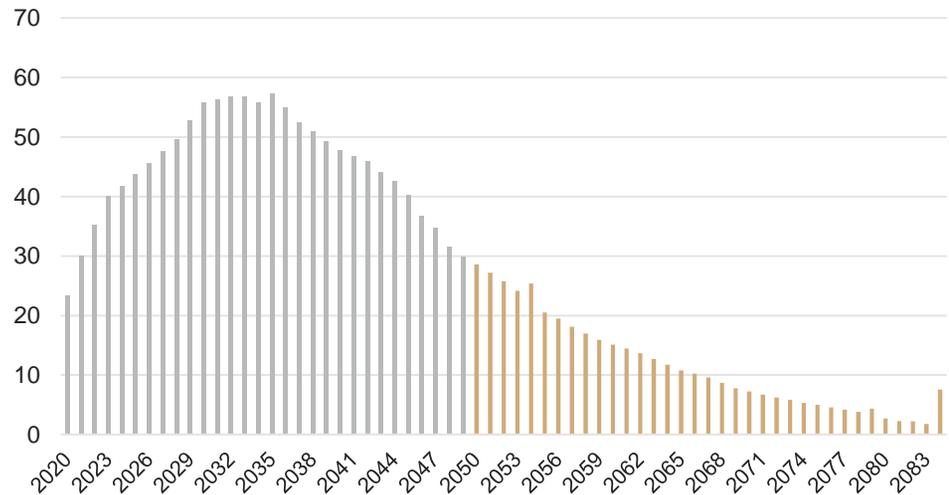
It is important to understand the asset and liability characteristics within each entity to approach ALM more holistically

Economic Balance Sheet (\$ Mil, Core Portfolio)



	Original		Analytics Scaled to Assets	
	Assets ³	Liabilities	Liabilities	Surplus
Market Value/Fair Value (\$ Mil)	XX	XX	XX	XX
Duration	XX	XX	XX	XX
Dollar Duration (\$ Mil-years)	XX	XX	XX	XX

Aggregated Liability Cash Flows (\$ Mil)²



Source: Neuberger Berman, Bloomberg-Barclays, Cambridge Associates, FactSet
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Incorporating Interest Sensitive Liabilities

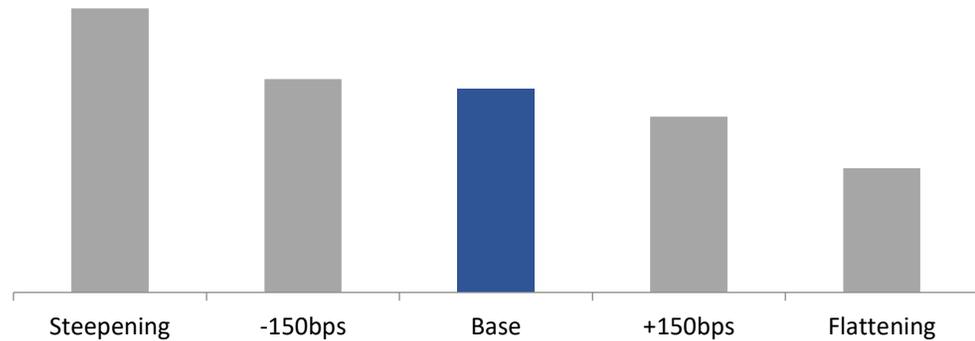
Diving deeper into liability characteristics such as second-order rate effects and interest rate sensitivity add to model accuracy

INTEREST SENSITIVE PRODUCTS

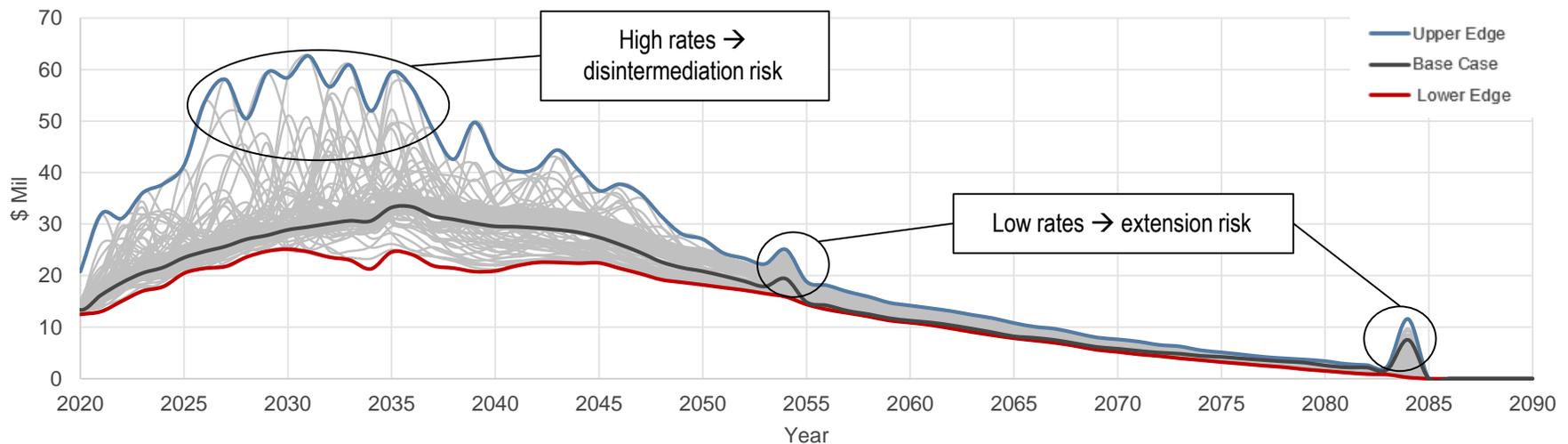
	Option-Adjusted Value and Duration	
	PV (\$ Mil)	OAD
ALM (≤ 30 yrs)	500	11.1
TR (> 30 yrs)	82	39.6
Total	583	15.2

* Assumes the extension/disintermediation risk only influence the core portfolio

SURPLUS UNDER PARALLEL AND NON-PARALLEL RATES SHOCKS



Projected Annual Net Liability Cash Flows (Interest Rate Sensitive Product)



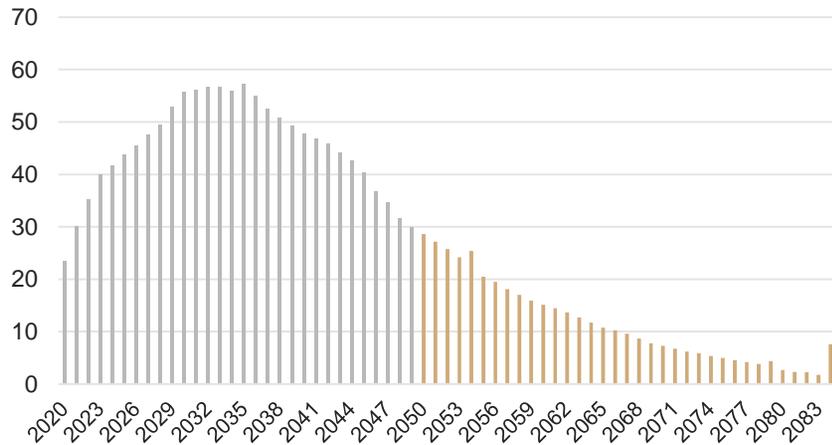
Source: Neuberger Berman, Bloomberg-Barclays; Analytics are as of 2019-06-30

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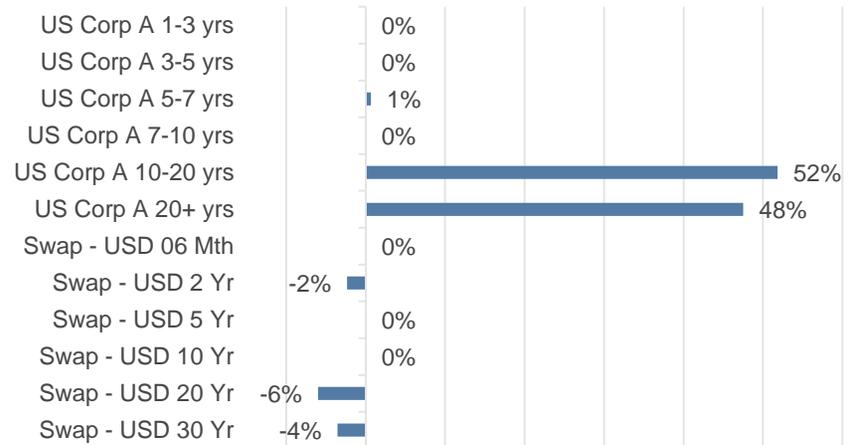
Constructing a Liability Replicating Portfolio

Example of translating liability risks into model inputs

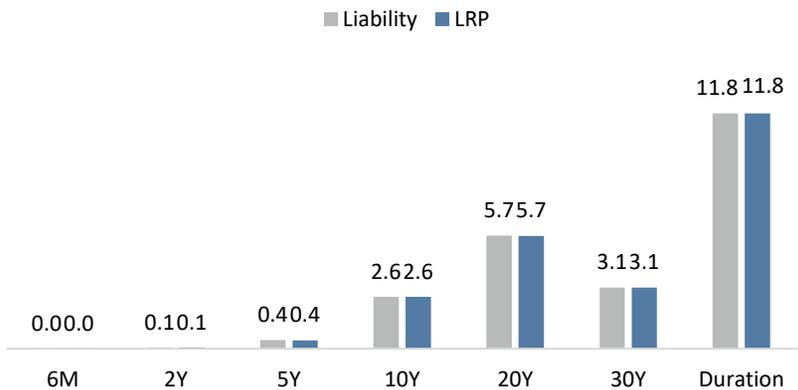
Net Cash Flows (\$ Mil, Base Case)



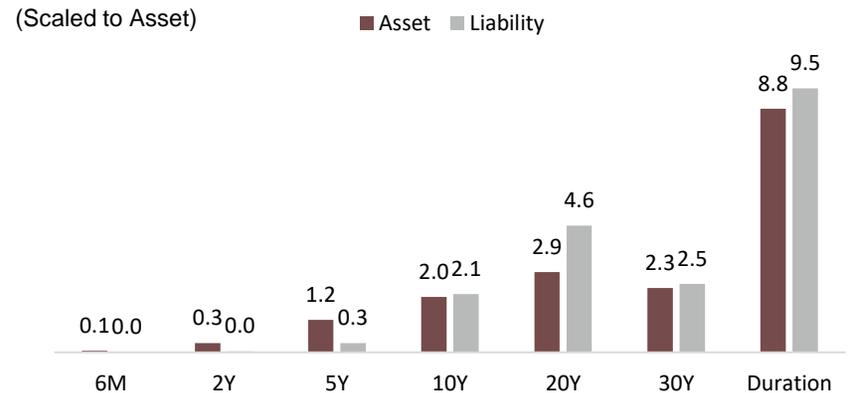
Liability Replicating Portfolio (LRP)



Key Rate Durations, Liability vs. Liability Replicating Portfolio



Key Rate Durations, Liability vs. Asset



* Based on asset mapping

Fair value and duration of liabilities are calculated using US Corp A yield curve as of 2019-06-30

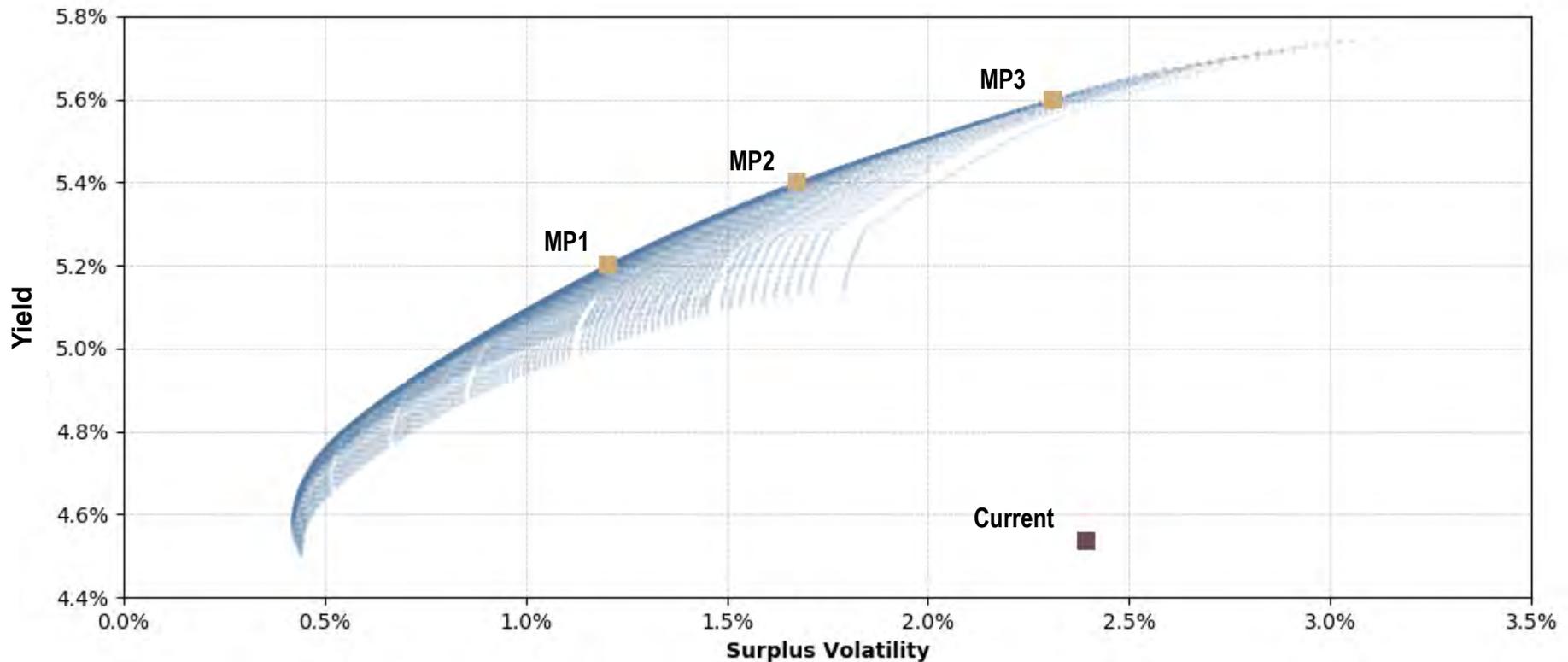
Source: Neuberger Berman, Bloomberg-Barclays, Cambridge Associates, FactSet; Analytics are as of 2019-06-30

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Solving for an Efficient Portfolio by Minimizing Risk—Illustrative Efficient Frontier

Portfolio	Yield (%)	Surplus Volatility (%)	Asset Duration	Surplus Duration	Spread Duration	Interest Rate + Spread SCR (%)	Asset Allocation (%)			
Current	4.54	2.4	9.6	-4.4	9.6	31	3	16	24	57
MP1	5.20	1.2	12.4	-1.6	12.4	32	55			30
MP2	5.40	1.7	11.4	-2.6	12.4	33	54			30
MP3	5.60	2.3	10.2	-3.8	11.8	32	51			26

■ Cash & Short Term
 ■ US Fixed Income
 ■ LatAm Fixed Income
■ EMEA Fixed Income
 ■ Australia Fixed Income
 ■ Asia Fixed Income



Source: Neuberger Berman, Bloomberg-Barclays, Cambridge Associates, FactSet; Analytics are as of 2018-12-31. The interest rate SCR calculation assumes that all non-USD assets are perfectly hedged back into USD; yields assume 3-month currency forwards are used to hedge non-USD assets into USD. The analysis assumes a 7.8 HKD to USD conversion rate. **Estimated yields and estimated volatility (risk) shown are hypothetical and are for illustrative and discussion purposes only. They are not intended to represent, and should not be construed to represent, predictions of future yields or volatility. Actual yields and volatility may vary significantly.** Unlike actual investment performance, hypothetical model results do not represent actual trading and accordingly they may not reflect the impact that material economic and market factors might have had on decision making if assets were actually managed during the relevant period. Investing entails risks, including possible loss of principal. Indexes are unmanaged and are not available for direct investment. Past performance is no guarantee of future results. See Additional Disclosures at the end of this presentation, which are an important part of this presentation.

Illustrative Asset Allocation for a Product Line/Entity

	Current	MP1	MP2	MP3
Cash & Short Term	3%	0%	0%	0%
Cash & Short Term	3%	0%	0%	0%
US Gov/Agency	0%	0%	0%	0%
US Muni Taxable	0%	0%	0%	0%
US Corp A+ 1-10 yrs	2%	0%	0%	0%
US Corp A+ 10-20 yrs	0%	0%	0%	0%
US Corp A+ 20+ yrs	4%	15%	11%	9%
US Corp BBB 1-10 yrs	1%	0%	0%	0%
US Corp BBB 10-20 yrs	1%	0%	0%	0%
US Corp BBB 20+ yrs	8%	35%	33%	27%
US Agency RMBS	0%	0%	0%	0%
US CMBS	0%	0%	0%	0%
US ABS	0%	0%	0%	0%
US IG CLO	0%	6%	10%	15%
US Fixed Income	16%	55%	54%	51%
LatAm Gov/Agency	0%	0%	0%	0%
LatAm IG Corp 1-10 yrs	0%	0%	0%	0%
LatAm IG Corp 10+ yrs	0%	0%	0%	0%
LatAm Fixed Income	0%	0%	0%	0%
Euro Gov/Agency AA/above	0%	0%	0%	0%
Euro Gov/Agency A/below	0%	4%	5%	5%
Euro IG Corp 1-10 yrs	0%	0%	0%	0%
Corporate Hybrids	0%	8%	12%	18%
UK Gov/Agency	0%	3%	0%	0%
UK IG Corp 1-10 yrs	0%	0%	0%	0%
Middle East Gov/Agency	0%	0%	0%	0%
Middle East IG Corp 1-10 yrs	2%	0%	0%	0%
Africa IG Corp 1-10 yrs	0%	0%	0%	0%
EMEA IG Corp 10+ yrs	21%	0%	0%	0%
EMEA Fixed Income	24%	15%	16%	23%
Australia Gov/Agency	0%	0%	0%	0%
Australia IG Corp 1-10 yrs	1%	0%	0%	0%
Australia IG Corp 10+ yrs	0%	0%	0%	0%
Australia Fixed Income	1%	0%	0%	0%
Asia Gov/Agency	2%	0%	0%	0%
China IG Corp 1-10 yrs	3%	0%	0%	0%
HK IG Corp 1-10 yrs	13%	0%	0%	0%
Asia exChina exHK IG Corp 1-10 yrs	7%	0%	0%	0%
Asia IG Corp 10+ yrs	32%	30%	30%	26%
Asia Fixed Income	57%	30%	30%	26%
Yield	4.54%	5.20%	5.40%	5.60%
Surplus Volatility	2.4%	1.2%	1.7%	2.3%
Asset Duration	9.6	12.4	11.4	10.2
Surplus Duration	-4.4	-1.6	-2.6	-3.8
Spread Duration	9.6	12.4	12.4	11.8
Int SCR	17%	15%	16%	17%
Spread SCR	13%	17%	16%	15%
Int + Spread SCR	31%	32%	33%	32%

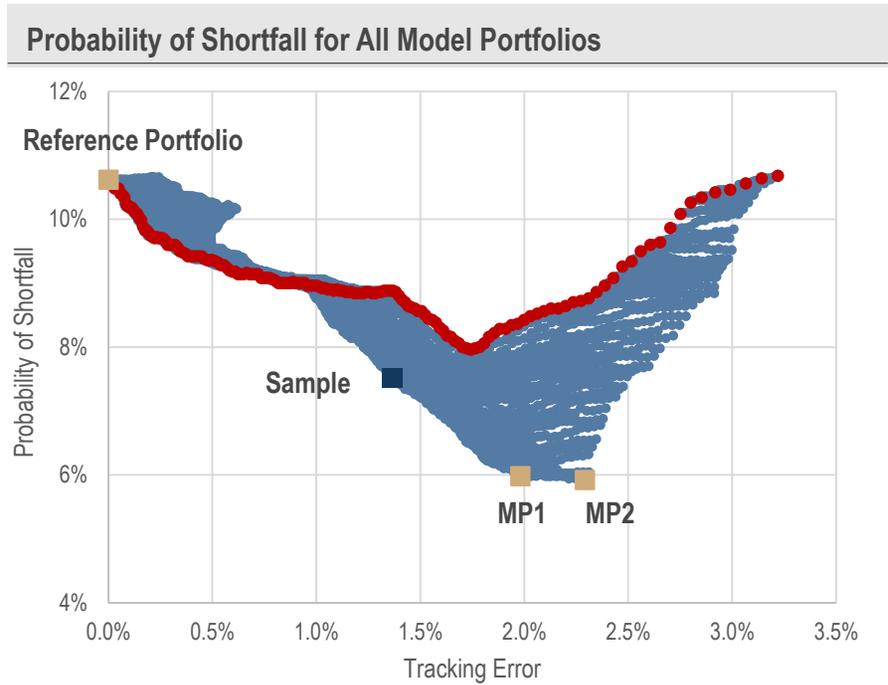
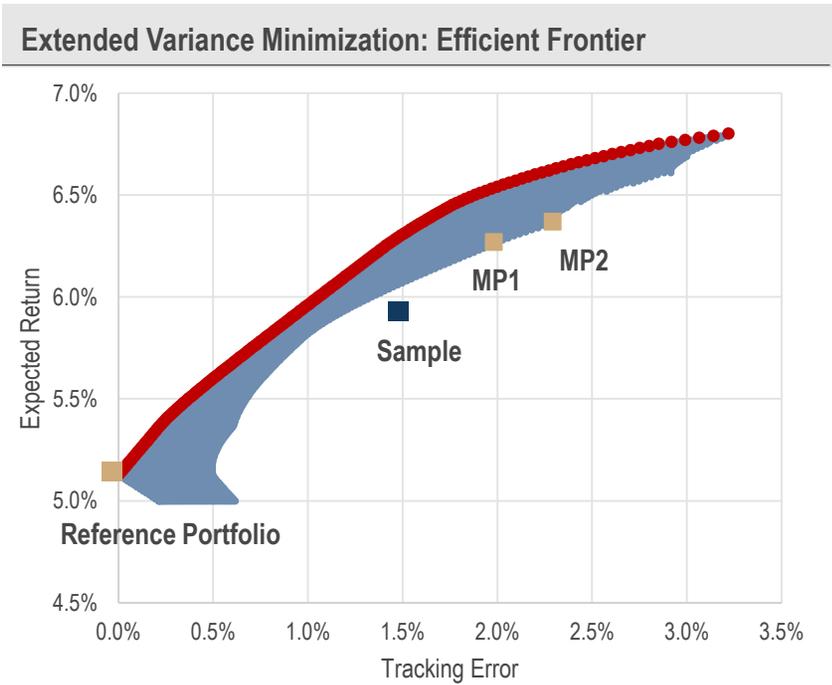
Asset Class	Current	ΔMP1	ΔMP2	ΔMP3
Cash & Short Term	3%	-3%	-3%	-3%
Cash & Short Term	3%	-3%	-3%	-3%
US Gov/Agency	0%	0%	0%	0%
US Muni Taxable	0%	0%	0%	0%
US Corp A+ 1-10 yrs	2%	-2%	-2%	-2%
US Corp A+ 10-20 yrs	0%	0%	0%	0%
US Corp A+ 20+ yrs	4%	10%	7%	5%
US Corp BBB 1-10 yrs	1%	-1%	-1%	-1%
US Corp BBB 10-20 yrs	1%	-1%	-1%	-1%
US Corp BBB 20+ yrs	8%	27%	25%	19%
US Agency RMBS	0%	0%	0%	0%
US CMBS	0%	0%	0%	0%
US ABS	0%	0%	0%	0%
US IG CLO	0%	6%	10%	15%
US Fixed Income	16%	40%	38%	36%
LatAm Gov/Agency	0%	0%	0%	0%
LatAm IG Corp 1-10 yrs	0%	0%	0%	0%
LatAm IG Corp 10+ yrs	0%	0%	0%	0%
LatAm Fixed Income	0%	0%	0%	0%
Euro Gov/Agency AA/above	0%	0%	0%	0%
Euro Gov/Agency A/below	0%	4%	5%	5%
Euro IG Corp 1-10 yrs	0%	0%	0%	0%
Corporate Hybrids	0%	8%	12%	18%
UK Gov/Agency	0%	3%	0%	0%
UK IG Corp 1-10 yrs	0%	0%	0%	0%
Middle East Gov/Agency	0%	0%	0%	0%
Middle East IG Corp 1-10 yrs	2%	-2%	-2%	-2%
Africa IG Corp 1-10 yrs	0%	0%	0%	0%
EMEA IG Corp 10+ yrs	21%	-21%	-21%	-21%
EMEA Fixed Income	24%	-9%	-7%	0%
Australia Gov/Agency	0%	0%	0%	0%
Australia IG Corp 1-10 yrs	1%	-1%	-1%	-1%
Australia IG Corp 10+ yrs	0%	0%	0%	0%
Australia Fixed Income	1%	-1%	-1%	-1%
Asia Gov/Agency	2%	-2%	-2%	-2%
China IG Corp 1-10 yrs	3%	-3%	-3%	-3%
HK IG Corp 1-10 yrs	13%	-13%	-13%	-13%
Asia exChina exHK IG Corp 1-10 yrs	7%	-7%	-7%	-7%
Asia IG Corp 10+ yrs	32%	-2%	-2%	-6%
Asia Fixed Income	57%	-27%	-27%	-31%
Yield	4.54%	0.66%	0.86%	1.06%
Surplus Volatility	2.4%	-1.2%	-0.7%	-0.1%
Asset Duration	9.6	2.8	1.8	0.5
Surplus Duration	-4.4	2.8	1.8	0.5
Spread Duration	9.6	2.8	2.7	2.1
Int SCR	17%	-2%	-1%	-2%
Spread SCR	13%	4%	3%	2%
Int + Spread SCR	31%	2%	2%	2%

Source: Neuberger Berman, Bloomberg-Barclays, Cambridge Associates, FactSet, SNL; Analytics are as of 2018-12-31. The interest rate SCR calculation assumes that all non-USD assets are perfectly hedged back into USD; yields assume 3-month currency forwards are used to hedge non-USD assets into USD. The analysis assumes a 7.8 HKD to USD conversion rate. **Estimated yields and estimated volatility (risk) shown are hypothetical and are for illustrative and discussion purposes only. They are not intended to represent, and should not be construed to represent, predictions of future yields or volatility. Actual yields and volatility may vary significantly.** Unlike actual investment performance, hypothetical model results do not represent actual trading and accordingly they may not reflect the impact that material economic and market factors might have had on decision making if assets were actually managed during the relevant period. Investing entails risks, including possible loss of principal. Indexes are unmanaged and are not available for direct investment. Past performance is no guarantee of future results. See Additional Disclosures at the end of this presentation, which are an important part of this presentation.

Probability of Shortfall

Portfolios	Expected Return	Tracking Error	Probability of Shortfall	Asset Allocation (%)		
Reference Portfolio	5.1%	0.0%	10.2%	20	80	
Sample Portfolio	5.9%	1.4%	7.4%	10	71	19
MP1	6.3%	2.0%	6.0%	5	53	42
MP2	6.4%	2.3%	5.9%	5	54	41

■ Fixed Income
 ■ Public Equity
 ■ Private Markets

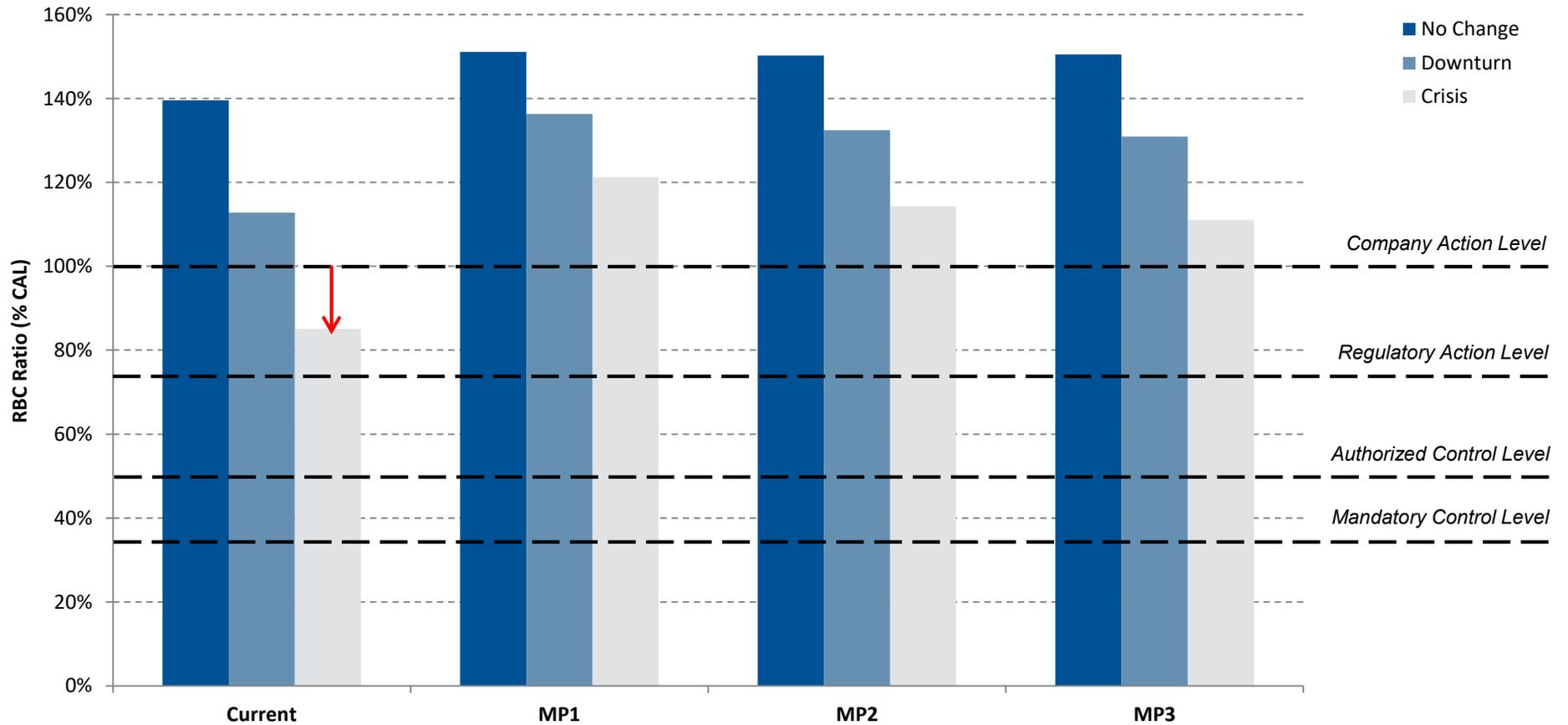


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Sensitivity Analysis

Scenario and sensitivity analyses can expose and quantify underlying factors that contribute to overall portfolio risk

- | No Change | Downturn | Crisis |
|---|--|---|
| <ul style="list-style-type: none"> No losses for any asset class | <ul style="list-style-type: none"> Public and private equity lose 15% of market value Hedge funds lose 10% of market value High yield fixed income loses 5% of market value | <ul style="list-style-type: none"> Public and private equity lose 30% of market value Hedge funds lose 20% of market value High yield fixed income loses 10% of market value |



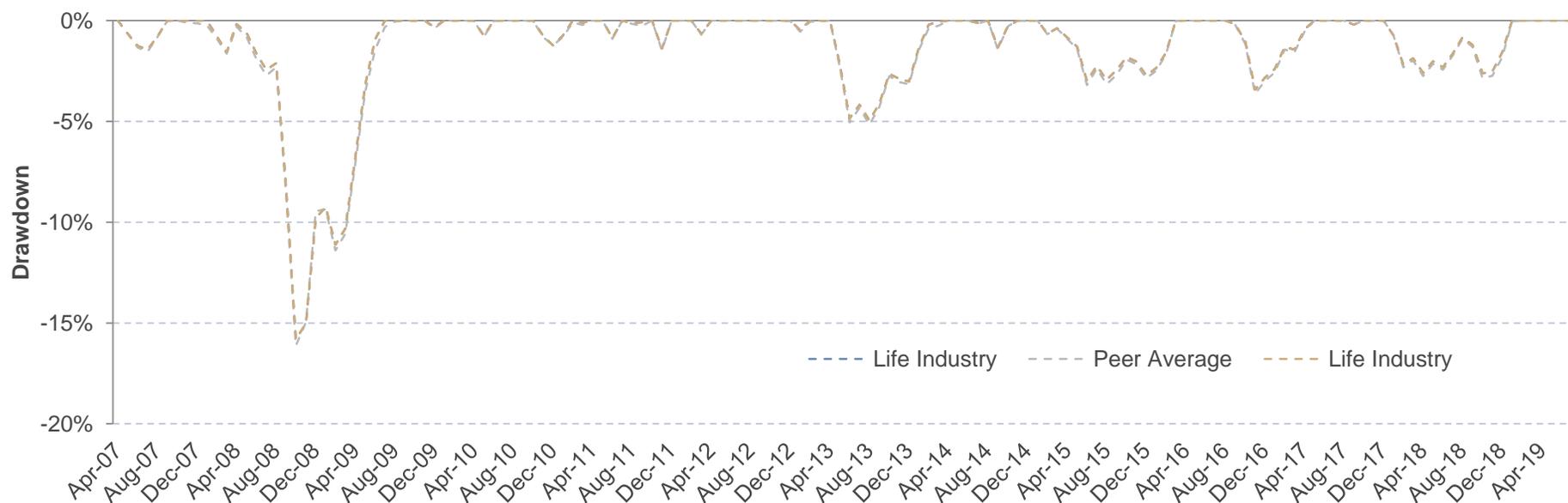
Source: Neuberger Berman; Analytics are as of 2017-6-30

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Tail Risk Analysis

Drawdown tests and non-normality stress tests can help reveal risks beyond those in a mean-variance space

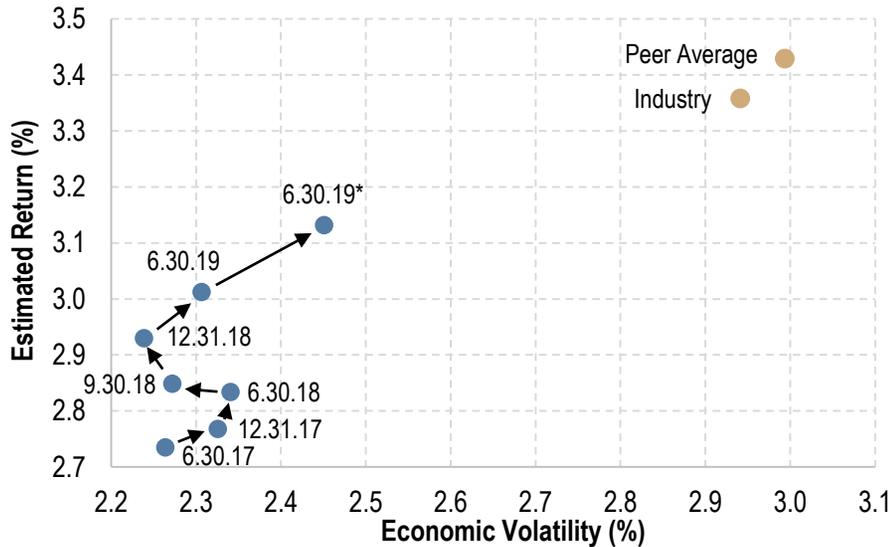
Portfolios	Ann. Return (%)	Ann. Vol (%)	Cumulative Gain (\$)	Max Drawdown (%)	Max Drawdown to Capital (%)	Max Drawdown (expressed in vols)
Life Industry	5.36	5.4	190	-15.8	-163	-2.9σ
Top 10 Average	5.42	5.6	192	-16.2	-167	-2.9σ
MetLife	5.14	5.1	186	-14.8	-152	-2.9 σ
TIAA	5.46	5.3	193	-15.1	-156	-2.8 σ
NY Life	5.06	5.0	184	-15.3	-158	-3.0 σ
Northwestern	5.34	5.2	190	-15.3	-157	-2.9 σ
AIG	5.65	5.9	197	-18.6	-192	-3.2 σ
Prudential	5.06	5.1	184	-14.2	-146	-2.8 σ
MassMutual	5.37	5.6	191	-16.4	-170	-2.9 σ
Allianz	5.54	5.6	194	-14.9	-154	-2.6 σ
Lincoln	5.72	6.3	199	-16.9	-174	-2.7 σ
Manulife	5.84	6.9	201	-20.2	-209	-2.9 σ



Note: Ann.Return & Vol is calculated basing on historical return from 04/2007 to 03/2019 Cumulative Gain is based on \$100 starting value at 07/2007. Sources: SNL, Bloomberg-Barclays POINT, FactSet. Asset holdings are as of 12/31 of each year. This material is provided for informational purposes only. Views expressed herein are as of the date indicated and subject to change. Nothing herein constitutes a prediction or projection of future events or future market behavior. Due to a variety of factors, actual events or market behavior may differ significantly from any views expressed. Please see Additional Disclosures at the end of the presentation.

Monitoring Risk over Time

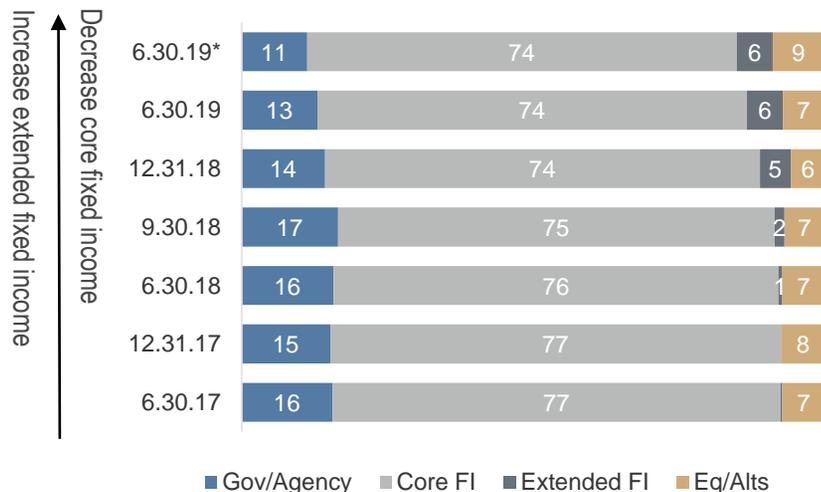
Insurer's Risk and Return Profile



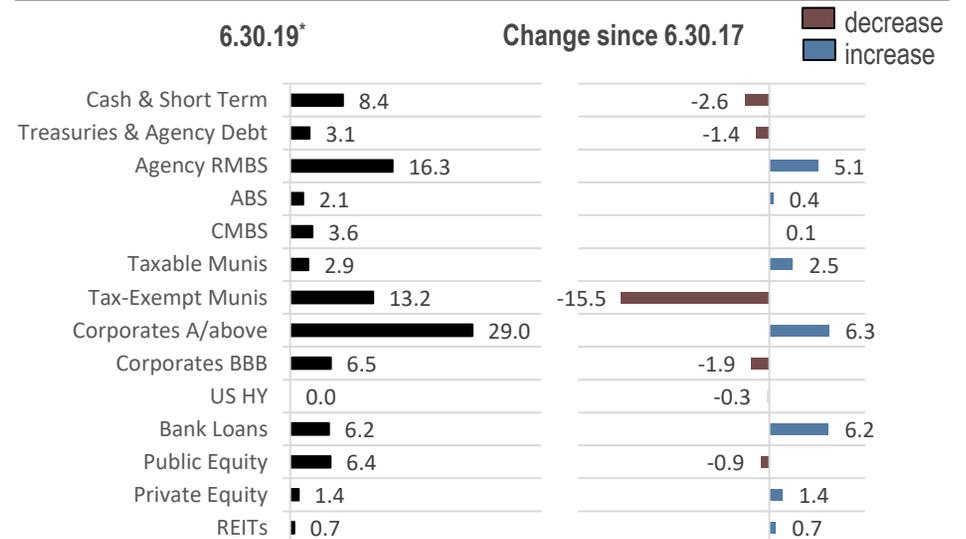
Key Analytics

		6.30.17	6.30.18	12.31.18	6.30.19	6.30.19*	Peer Average	Industry
Analytics, as of 6/30/2019	Exp. Return (%) ¹	2.74	2.83	2.93	3.01	3.13	3.43	3.36
	Economic Vol (%) ²	2.26	2.34	2.24	2.31	2.45	2.99	2.94
	GAAP NII Vol (%) ²	0.99	0.98	0.79	0.91	1.04	1.49	1.44
	Duration	3.6	3.6	3.4	3.3	3.3	4.0	3.9
	Spread (bps)	44	50	69	72	72	81	72
Historical Simulation 2007-2019	Ann. Return (%)	4.10	4.18	4.17	4.24	4.34	4.88	4.81
	Max Δ unrealized loss (%)	-8.22	-8.82	-8.99	-9.51	-10.29	-12.93	-12.98

Insurer's Asset Allocation Evolution Summary (%)



Insurer's Asset Allocation Evolution Details (%)



*Assuming private equity commitment is fully funded

1- Expected return is defined as the default-adjusted yield of fixed income asset classes and NB intermediate term (5-7 year) return assumptions for equity and alternatives

2- Volatility is calculated using last 12 years historical return data. Exponential weighted moving average method is applied, with half life 2 years.

Sources: Insurer, Bloomberg, FactSet, SNL Financial. Estimated returns and estimated volatility (risk) shown are hypothetical and are for illustrative and discussion purposes only.



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2019 Investment Seminar

BOB MCGINLEY

Insurance Company Investment Risk Management – What Remains to be Addressed

10/28/2019



What is Risk Based Capital (RBC)?

- Risk-Based Capital (RBC) is a method of measuring the minimum amount of capital appropriate for a reporting entity to support its overall business operations in consideration of its size and risk profile.
- Capital provides a cushion to a company against insolvency.
- RBC is intended to be a minimum regulatory capital standard and not necessarily the full amount of capital that an insurer would want to hold to meet its safety and competitive objectives.
- RBC is not designed to be used as a stand-alone tool in determining financial solvency of an insurance company.
- The NAIC's RBC regime began in the early 1990s as an early warning system for U.S. insurance regulators
- The formula focuses on the material risks that are common for the particular insurance type. For example, interest rate risk is included in the Life RBC formula because the risk of losses due to changes in interest rate levels is a material risk for many life insurance products.
- Under the RBC system, regulators have the authority and statutory mandate to take preventive and corrective measures that vary depending on the capital deficiency indicated by the RBC result.

https://content.naic.org/cipr_topics/topic_risk_based_capital.htm

RBC – High Level Component Summary

- C0 Asset Risk (Affiliate Charges subject to RBC, Off Balance Sheet Items)
- **C1 Asset risk** ($C1_{CS}$ – Unaffiliated Common Stock; $C1_o$ - Affiliate Charges not subject to RBC, other assets)
- C2 Insurance risk (Net Amount of Risk)
- **C3 Interest rate and market risk** ($C3_a$ -Interest Rate Risk, $C3_b$ - Health Credit Risk , $C3_c$ - Market Risk)
- C4 Business risk (Premiums and Liabilities. $C4_a$ –Non Health, $C4_b$ – Health)

Total RBC after covariance: $C0 + C4_a + \sqrt{(C1_o + C3_a)^2 + (C1_{CS} + C3_c)^2 + C2^2 + C3_b^2 + C4_b^2}$

- The covariance is maximized when the $(C1_o + C3_a) = (C1_{CS} + C3_c)$

C3 Interest Rate and Market Risk

<u>Reserves</u>	<u>Factors</u>	<u>Description</u>
Low Risk	0.63%	Low ALM Duration mismatch. Annuities with MVA, GICs, Life Ins Net of Loans and Reinsurance
Medium Risk	1.27%	High ALM duration mismatch. Annuities without MVA, Structured Settlements,
High Risk	2.53%	

- Single Premium Life and Fixed Annuities are governed by C3P1.
- Variable Annuities with guarantees are governed by C3P2.
- Voluntary reserves can sometimes be included to reduce excess capital charge. Included as “Additional CFT Reserves”.
- Cash Flow Tested reserves essentially can have RBC charges reduced up to 50%.
- Callable/pre-payable assets that support reserves incur an additional charge.

Variable Annuities

- RBC is determined by calculating the greatest PV of accumulated deficiencies (GPVAD) in the worst 10%/2% of scenarios.
 - The starting asset portfolio must be close to reserves and is either implicitly or explicitly projected, so the assets chosen backing the VA portfolio are important.
- C3P2 allows the possible reduction of RBC by allowing not only the runoff of currently held hedge assets, but the projection of future hedge positions (CDHS).
- Hedging typically incurs an overall benefit in low equity return environments to offset VA guarantees.
- In most cases, this decrease in volatility of the VA RBC requirement will come with additional cost.
- Can be categorized as either $C3_a$ or $C3_c$.

C1-Asset Risk

S&P - Corporate Counterparty and Municipal Ratings		
Public Bonds	NAIC	2018 RBC Factor
AAA,AA+,AA,AA-,A+,A,A-	1	0.39%
BBB+,BBB,BBB-	2	1.26%
BB+,BB,BB-	3	4.46%
B+,B,B-	4	9.70%
CCC+,CCC,CCC-	5	22.31%
CC,C,D	6	30.00%

- The table above is an example of the relationship between rating agency and NAIC ratings at issue.
- Rating agency view is based on the probability that the value of cash flows will reach Par Value.
- NAIC view is prescribed based on the probability that the value of cash flows will reach the purchase price. This can lead to the same asset having a different NAIC rating that is dependent on the parameters of the transaction.
- This difference could create a capital arbitrage opportunity, by purchasing bonds at a deep discount with high return rates with a relatively low NAIC RBC Change.
- However, this can also create some basis risk between viewing the risk profile of the portfolio(s).
- Tradeoff between investment return and Capital Charge

¹https://www.naic.org/documents/svo_naic_aro.pdf

Summary of Effects of Affiliates not subjected to RBC

- If an affiliate is not subject to RBC, the RBC charge to the parent company can range from 30-100% of the affiliate's book/carrying value.
- This implies that the greater the affiliate surplus (assets-liabilities), the larger the RBC charge to the parent.
- This RBC charge is now considered an Asset Risk ($C1_o$) if the liability is booked to the affiliate instead of Interest Rate ($C3_a$) or Interest Rate ($C3_c$) Market risk when the liability is booked to the parent.
- For Variable Annuities, excess assets allocated to the liabilities in the parent company can allow for some possible optimization that could help lower the projected deficiencies, hence lowering the RBC.
- For any Captive/Re-Capture analysis, the impact on the covariance must also be taken into account as that will undoubtedly be impacted.

Key Takeaways of RBC considerations

- There are multiple bases which need to be considered when determining the appropriateness of the asset profile of a portfolio
- The ability to have your assets cash flow model tested could help reduce RBC
- Excess surplus of assets backing the liability of an affiliate company could unnecessarily increase the capital charge.

Economic Scenario Generator (ESG) – What and Why?

- Simulates future paths of economies and financial markets, and illuminates the nature of risk elements within the economy that drive financial variability.
- The analysis of a stochastic distribution of possible economic futures, which includes unexpected but plausible outcomes, is critical for testing a business model under a wide variety of economic conditions.
- An ESG can operate in the context of a “real-world” environment that captures market dynamics and risks in a way that a company will experience them.
- Or the context can be a “risk-neutral” environment that enables the pricing of cash flows that depend upon stochastic financial variability, such as would be found with investment guarantees in variable annuities.
- The AAA ESG is a “real-world” generator that will be required under VM-20 (Principle Based Reserves for Life) and VM-21 (Principle Based Reserves for Variable Annuities)

³<https://www.soa.org/globalassets/assets/Files/Research/Projects/research-2016-economic-scenario-generators.pdf>

AAA ESG – Is it ready for low rates?

- The AAA ESG collars the 20 Year UST rate between 1.15% and 18%.
- The current 20 Year rate is less than 1% larger than the VESG 20 Year floor. This is leading to a large interest rate increase in the first quarter after projection in a -1% parallel shock scenario.
- Purpose is to analyze how changing the long rate floor from 1.15% to 0.01% will affect interest rates.
 - This will in turn affect projected interest rate and bond option payoffs in each scenario
 - Also, projected future interest rate liability Greeks (i.e./ rho) will change
- Similar results are presented for the baseline scenarios. However, there appears to be very little change.
- The AAA ESG is capable of producing 10,000 uncorrelated scenarios. The analysis provided is completed using a random subset of 1000 scenarios.

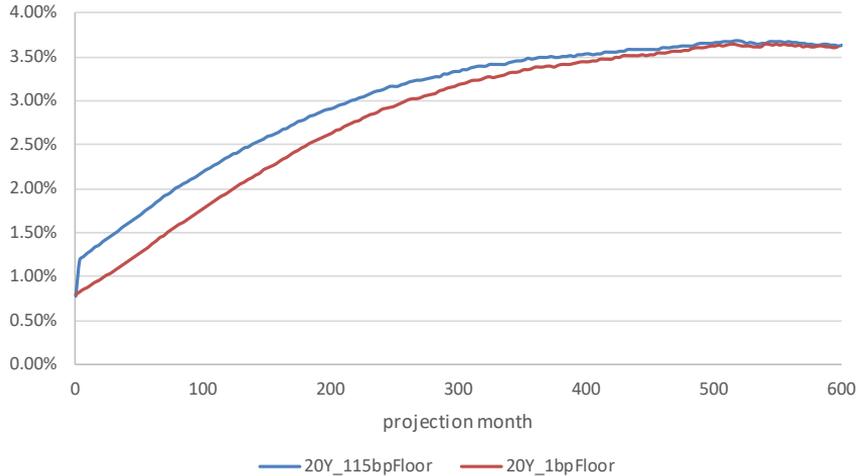
AAA ESG - Interest Rate Calculation Summary

- The ESG uses a Stochastic Log Volatility process to model the interest rates
- The 3 correlated stochastic processes are:
 - 1.Natural log of the long rate (20 Year)
 - 2.Nominal spread between the long and short rate (1 Year)
 - 3.Natural log of the volatility of the long rate
- $LongRate(t) = EXP\{Max[\ln(1.15\%),Min[\ln(18\%),(1-.509\%)* LongRate(t-1) - 1.7\%+25.2\%(1\%-Spread(t-1))]+RandomLongVol(t)\}$
- $GeneratedSpread(t)= (1-2.7\%)*GeneratedSpread(t-1)+(2.7\%*1\%)+0.02\%(LN[LongRate(t-1)]-LN[3.5\%])+SpreadVol(t)$
- There is an implicit dependency between the nominal spread and nominal long rate value, so we should expect to see changes in spread along with changes in the long rate if the 1.15% floor is changed.

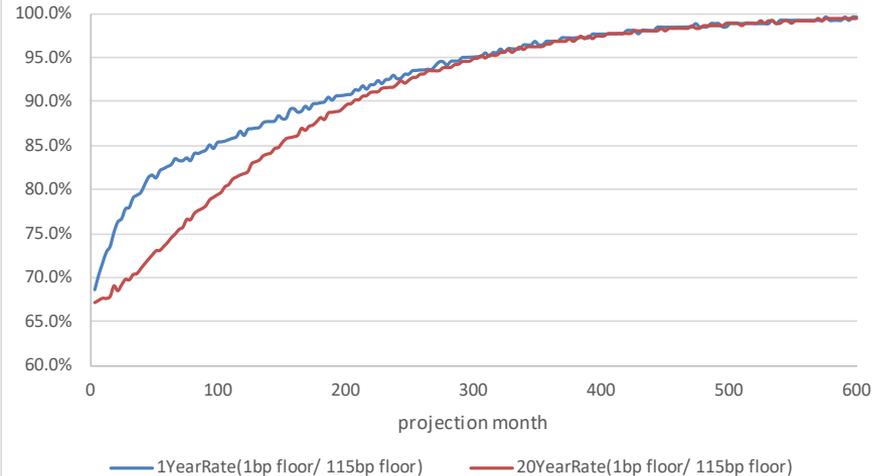
	08/30/2019 Baseline UST Rates	08/30/2019 -1% Shock UST Rates
3 Month	1.99%	0.99%
6 Month	1.89%	0.89%
1 Years	1.76%	0.76%
2 Years	1.50%	0.50%
3 Years	1.42%	0.42%
5 Years	1.39%	0.39%
7 Years	1.45%	0.45%
10 Years	1.50%	0.50%
20 Years	1.78%	0.78%
30 Years	1.96%	0.96%

1% Parallel shock – Effects of Lowering the Floor

Average 20Year Rates



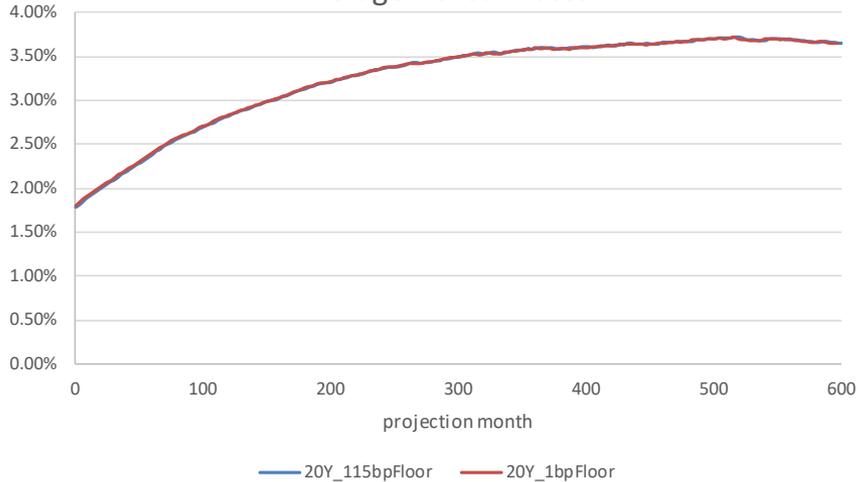
Average Proportion (1bp floor / 115bp floor)



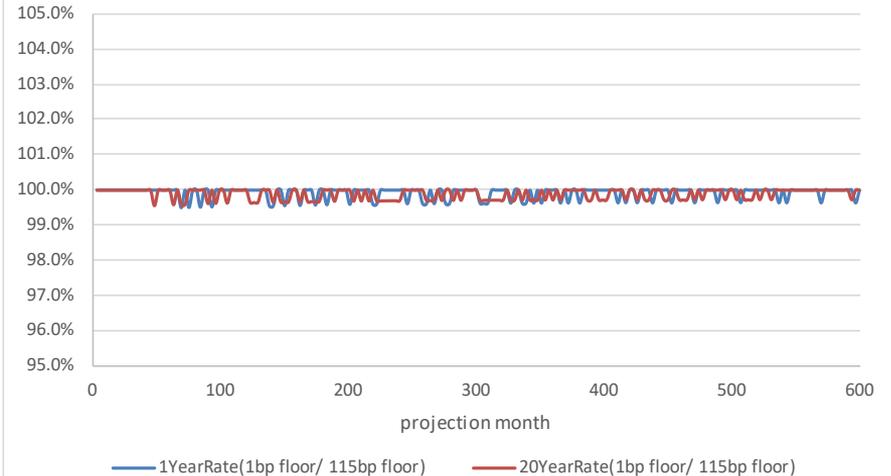
- There is a noticeable increase in the 20 year rate in the first month when the long rate floor is 115bp.
- After this “shock” increase, the average 20 year rate converges toward the long term mean.
- After month 1, the 20 year rate with 115bp floor begins to slowly converge toward the 20 year rate with 1bp floor. It takes about 12 years for the rate with 1bp floor to reach 85% of the rate with 115bp floor
- The 1 year rate converges much quicker than the 20 year rate, only taking about 8 years for the 1 year rate with 1bp floor to reach 85% of the 1 year rate with 115bp floor. This implies that the spread (20 year rate – 1 year rate) is noticeably larger with a 115bp floor.

Baseline – Effects of Lowering the Floor

Average 20Year Rates



Average Proportion (1bp floor / 115bp floor)



- There is some minor differences, but as can be seen in the above charts, the average differences is very small.

Additional Advanced Statistics

%ile	3 Month Rate			10 Year Rate		
	115bp Long Rate Floor	1bp Long Rate Floor	Difference	115bp Long Rate Floor	1bp Long Rate Floor	Difference
5	0.62%	0.62%	0.00%	1.31%	0.95%	-0.35%
10	0.86%	0.81%	-0.05%	1.51%	1.18%	-0.33%
25	1.24%	1.12%	-0.13%	2.00%	1.78%	-0.22%
50	1.80%	1.68%	-0.13%	2.68%	2.51%	-0.17%
75	2.65%	2.51%	-0.14%	3.49%	3.35%	-0.15%
90	3.73%	3.57%	-0.16%	4.46%	4.30%	-0.16%
95	4.61%	4.43%	-0.18%	5.22%	5.05%	-0.16%
Average	2.11%	1.99%	-0.12%	2.89%	2.69%	-0.20%
Std Dev	1.33%	1.29%	-0.04%	1.28%	1.31%	0.04%
Skewness (Normal is Zero)	2.04	2.08	0.04	1.60	1.38	(0.21)
Kurtosis (Normal is Zero)	8.31	8.38	0.07	5.82	4.73	(1.09)

	Long Rate Floor	All Scenarios
Average %Inversion (#Months)	115bp	9.58%
	1bp	12.99%
Max Consec Qtrs	115bp	36
	1bp	68
Avg Spread given Inversion	115bp	-0.25%
	1bp	-0.21%
STDev Spread given Inversion	115bp	0.11%
	1bp	0.09%



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Value of an Insurance Company

SOA Investment Seminar

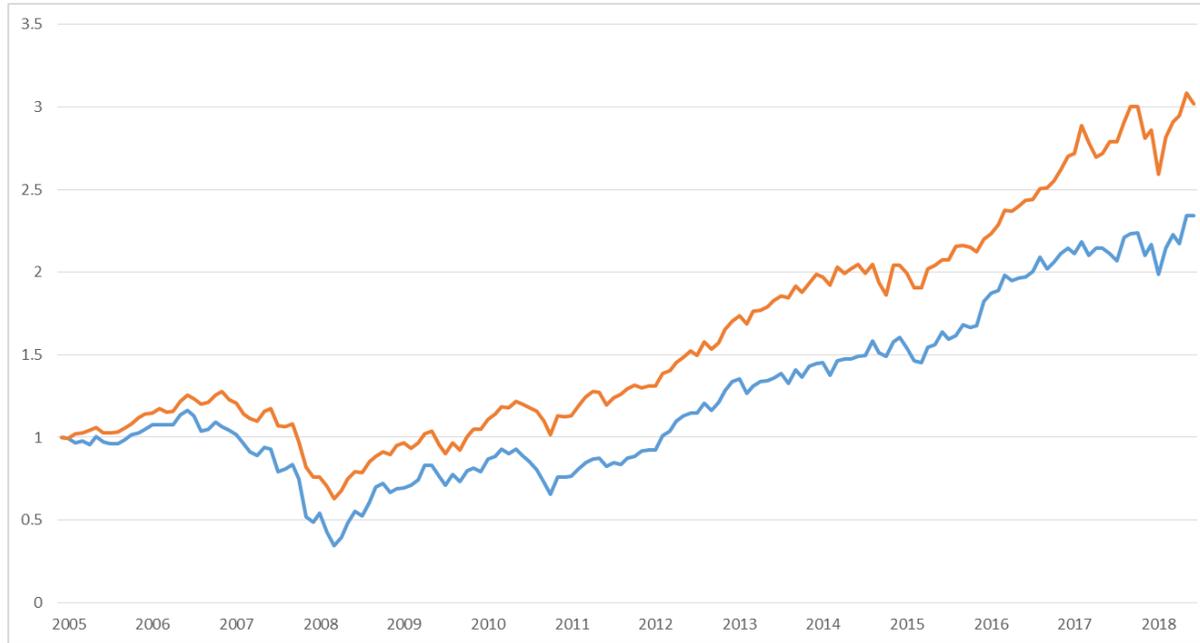
October 27th, 2019

Poojan Shah, FSA, CERA, CFA, MAAA

Background

- Life insurance companies have historically traded below their book values
 - Variable annuity guarantees are perceived by market participants as extremely risky products, resulting in low P/E and high betas
- Risk management (hedging) can reduce earnings volatility quite substantially
 - It appears that market participants do not fully appreciate the value of hedging

A Tale of Two Stocks



The Orange Line is S&P 500

The Blue Line is Insurance Sector ETF (KIE)

	S&P 500	Insurance Sector
Annual Return	8.5%	6.5%
Volatility	14.3%	22.0%

Cost of Equity (COE) vs. Return on Equity (ROE)

- Return on Equity = Net Income/Equity
- Cost of Equity (CAPM and Dividend Growth Model)
 - CAPM
Expected Return = Risk Free Rate + Beta x (Market Return – Risk Free Rate)
 - Dividend Growth Model
Expected Return = Dividend Payout Ratio/Price-Earnings Ratio + growth
- ROE must exceed COE for a company to add value for its shareholders

Life Insurance Company Cost of Equity Example

Let's take a look at the Cost of Equity calculation for a life insurance company.

Stats (Source: Yahoo! Finance)

- P/E: 6.4
- Beta: 1.93
- Payout Ratio: 17.8%
- ROE: 10.4%
- Risk free rate = 2.5%
- Expected Return = 8%

Cost of Equity Calculation

CAPM

- Return = $2.5\% + 1.93 \times (8\% - 2.5\%) = 13.1\%$

Dividend Growth Model

- Step 1: Determine the growth
 - Payout Ratio = $1 - g/\text{ROE}$
 - $g = 8.6\%$
- Step 2: Determine the return
 - Return = $17.8\%/6.4 + 8.6\% = 11.3\%$

Life Insurance Company Valuation

- Fixed Annuity:

- Value = Earned Rate – Crediting Rate

BBB Bond

AA Bond

- Variable Annuity:

- Value = Fees – Expenses – Guarantee

Total Return Swap

Fixed Marketing/Administrative

Short Put Option

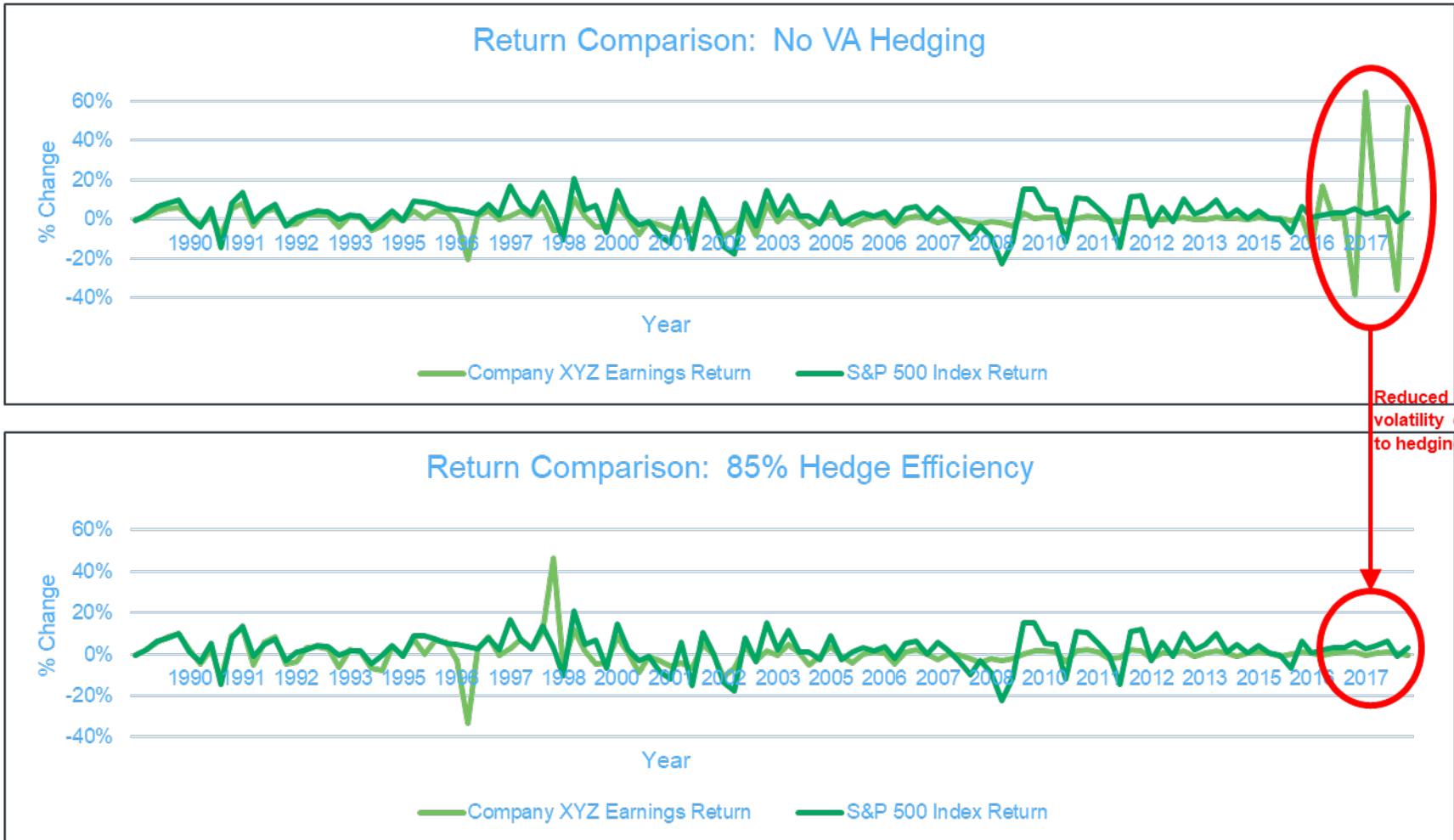
Illustration: Life Insurance Company Valuation

Case Study Details

- Variable Annuity (VA) and Fixed Annuity (FA) allocation is 50%/50%
- Fixed Annuity:
 - The company earns a spread
- Variable Annuity:
 - GLWB 5% partial withdrawals
 - Policyholder invests AV in a fund that is 75% S&P and 25% Bond
 - Annual ratchets
 - 2% rider charge
 - 3% M&E
 - Fixed expenses
 - Dynamic hedging with 85% effectiveness

Life Insurance Company Valuation

Results using Actuarial Valuation Model



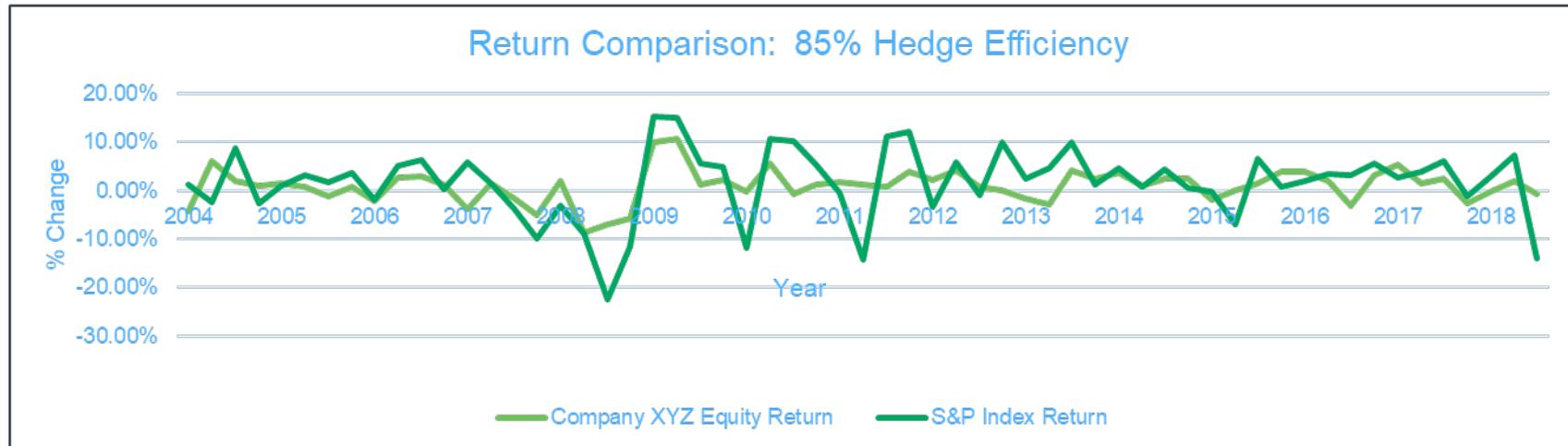
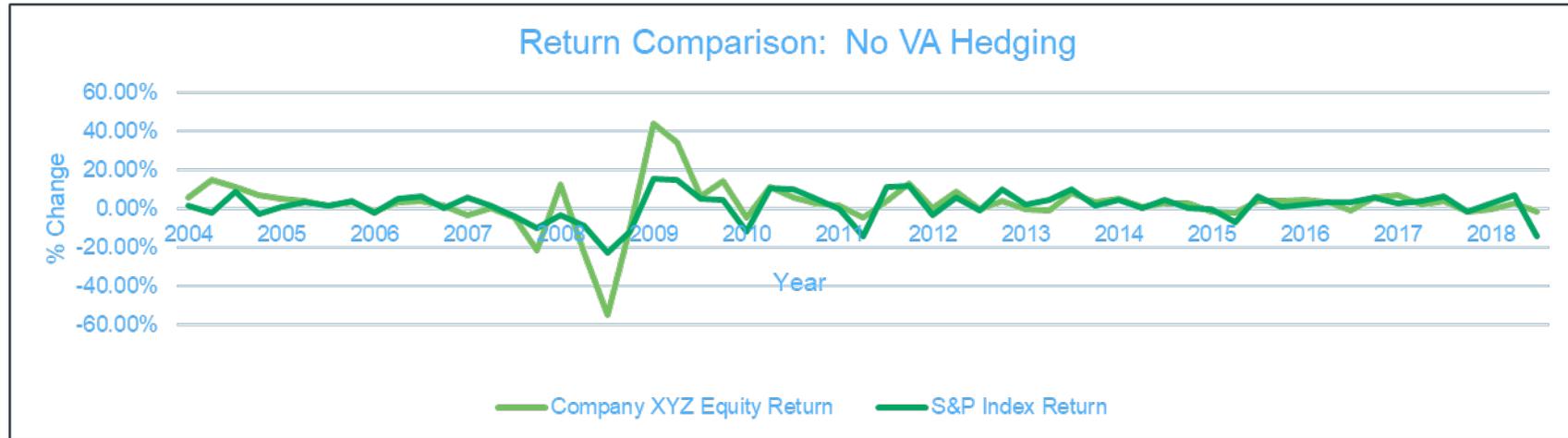
S&P $\sigma = 15\%$

Company No Hedge $\sigma = 20.1\%$

Company with Hedge $\sigma = 13.6\%$

Life Insurance Company Valuation

Results using Market Prices



S&P $\sigma = 18.4\%$

Company No Hedge $\sigma = 21.2\%$

Company with Hedge $\sigma = 15.4\%$

Conclusions/Thoughts

1. Why are life insurance companies mispriced?
2. How can companies modify their risk management practices to correct it?
3. What would the impact on the industry be?

Insurance Company Investment Risk Management – What Remains to be Addressed

SOA Investment Seminar

October 27th, 2019

Liang Zhang, FSA, CERA, MAAA



Managing Capital Market Risks

- \$2 trillion assets in variable annuity industry
- Hedging is a core competency for VA carriers
- Hedging objective:
 - Recover losses resulting from adverse market movements
 - Stabilize earnings
- Discussion Topics:
 - Basis Risk in Dynamic Hedging
 - Managed Risk Funds
 - Product Diversification

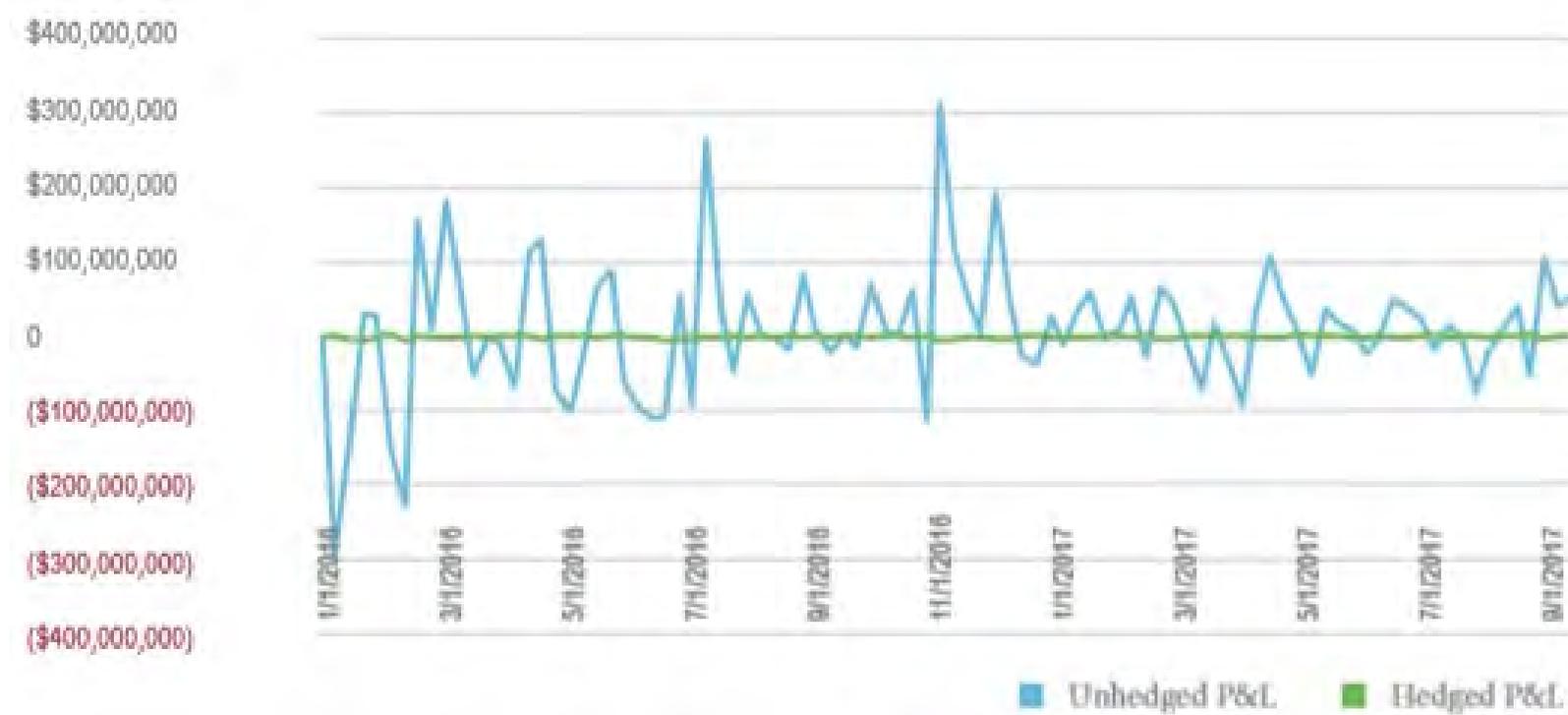
Mapping Investment Portfolio for Dynamic Hedging

- VA products offer policyholders a choice for their investment portfolio
- In a dynamic hedging program, funds in the investment portfolio are mapped to hedgeable indices
- R^2 is a measure to understand the quality of the fund mapping

Fund ID	Fund Name	SecID	S&P 500	RUSSELL 2000	NASDAQ 100	Bond	EAFE	T-Bill	R-Squared
1	Conservative Fund	XXXXXXXXXX	14%	1%	0%	49%	14%	22%	91%
2	Moderate Fund	XXXXXXXXXX	30%	8%	0%	30%	19%	13%	98%
3	Aggressive Fund	XXXXXXXXXX	41%	16%	0%	14%	26%	3%	98%
3	Equity Fund	XXXXXXXXXX	69%	13%	15%	0%	3%	0%	97%
3	Bond Fund	XXXXXXXXXX	3%	0%	0%	81%	10%	6%	87%
5	Real Estate Fund	XXXXXXXXXX	18%	25%	0%	57%	0%	0%	32%
6	Commodity Fund	XXXXXXXXXX	0%	3%	0%	14%	39%	44%	14%

Fund Basis Mismatch

- VA hedging programs are 95% effective at reducing earnings volatility
- Basis risk reduces this to 92%
- Hedge effectiveness is capped at the square-root of the fund mapping R^2

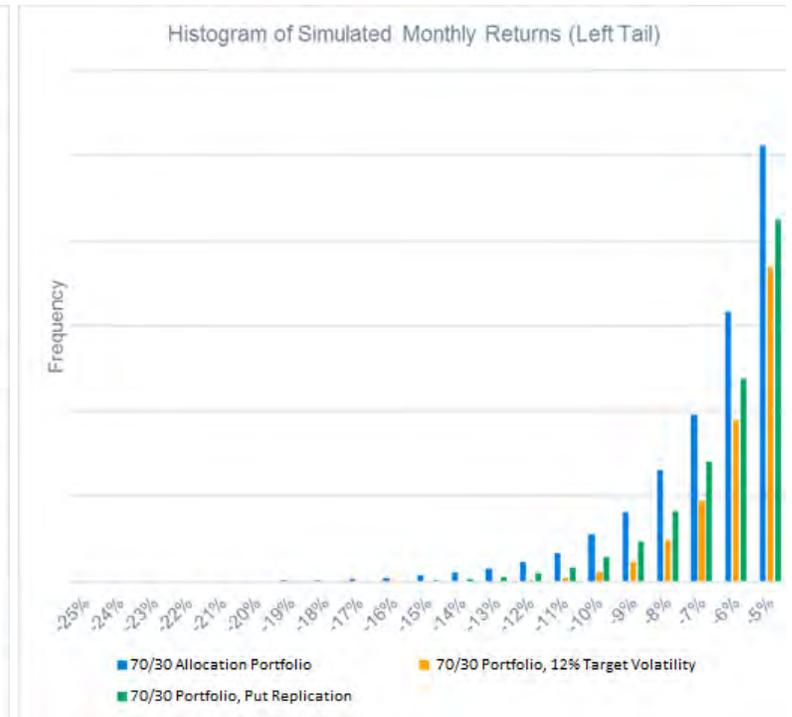
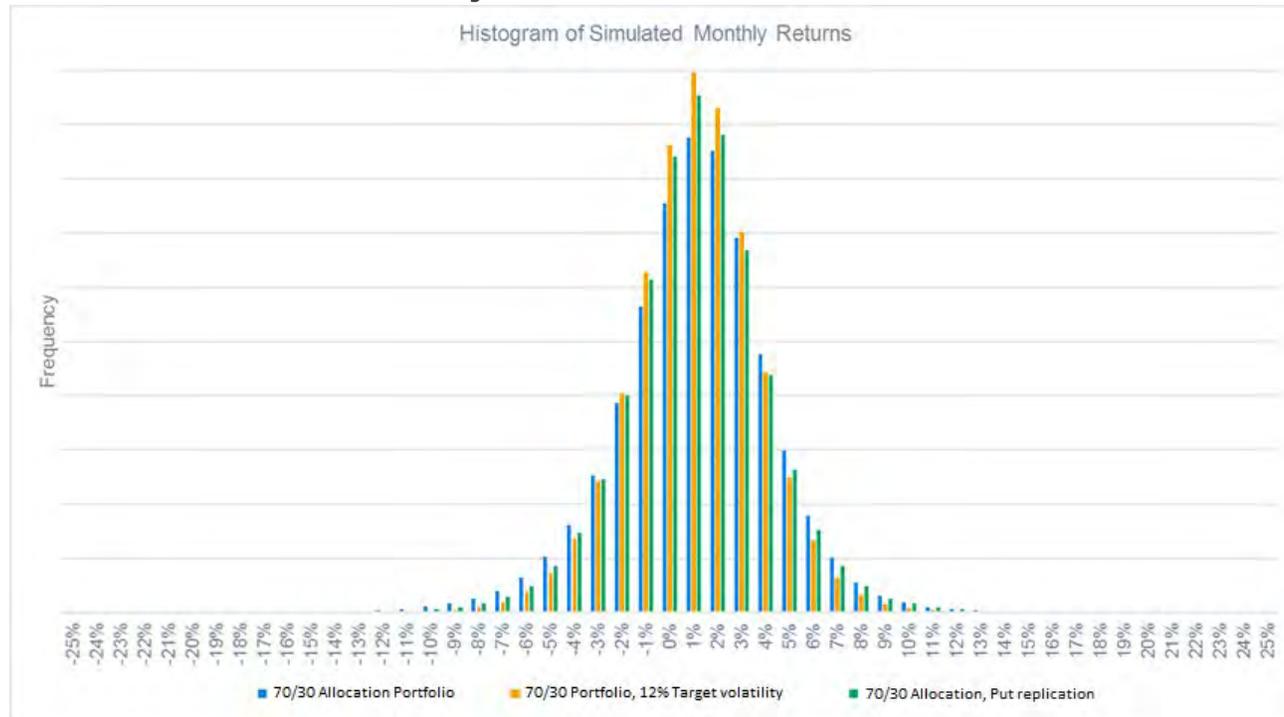


Fund Basis Mismatch

- Increasing the number of indices used for fund mapping
 - Limited by availability of liquid instruments
- Replacing underlying funds with index/passive funds
 - Investor preference for active funds
- Increasing the number of funds available
 - Policyholder chooses riskier funds to maximize value of guarantee

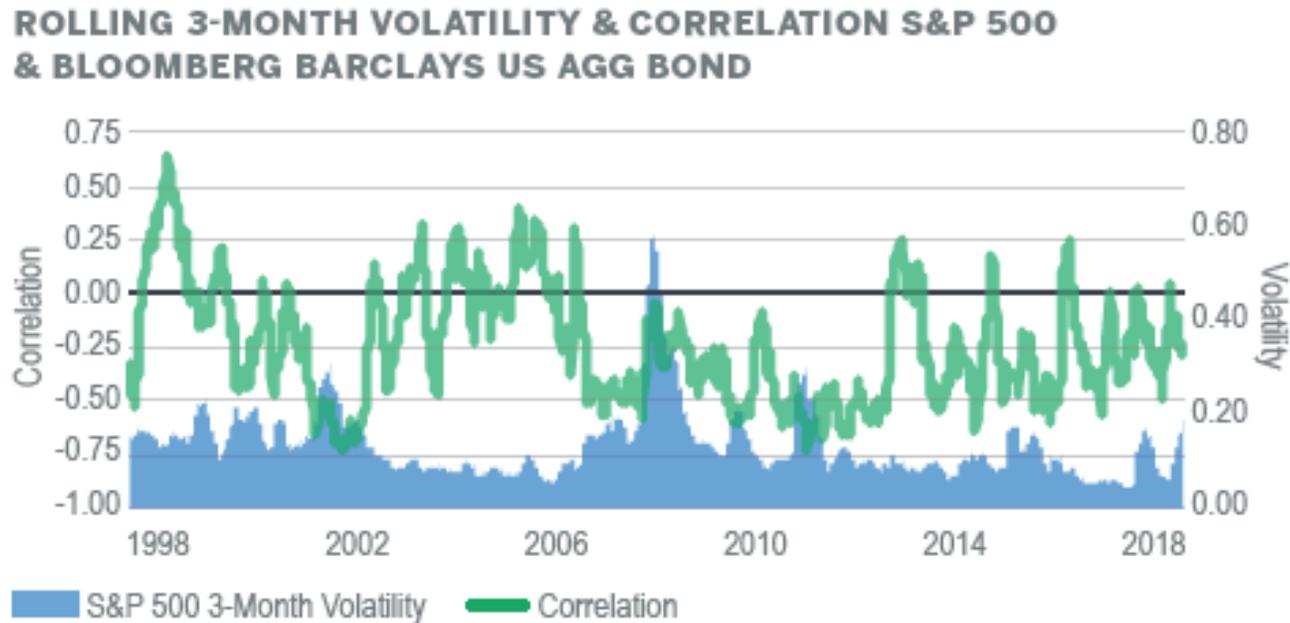
Managed Risk Funds

- Managed risk funds shifts hedging from balance sheet directly into funds
- Reshape the return distribution and alleviate hedging costs while maintaining similar risk objectives



Managed Risk Funds

- Concern that volatility controlled funds will create negative market feedback loop
 - Relative size of volatility controlled funds vs equity AUM
 - Equity market trading volume
 - Fund volatility vs Equity volatility

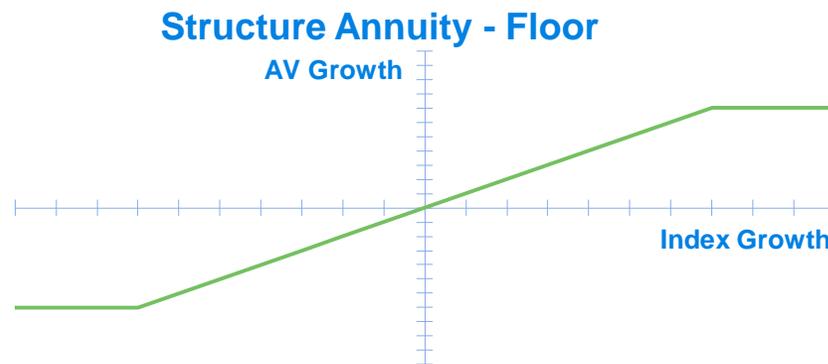
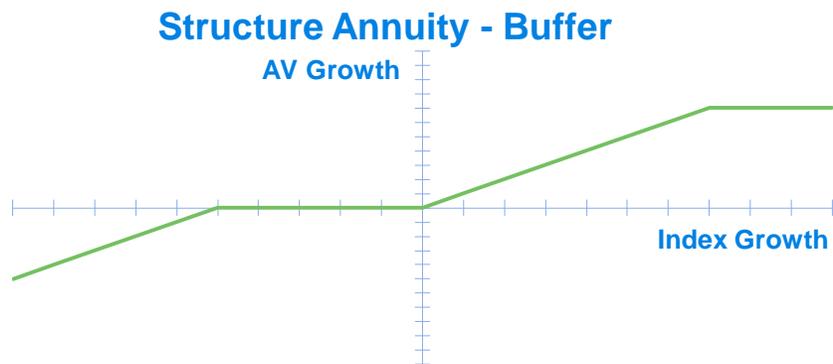
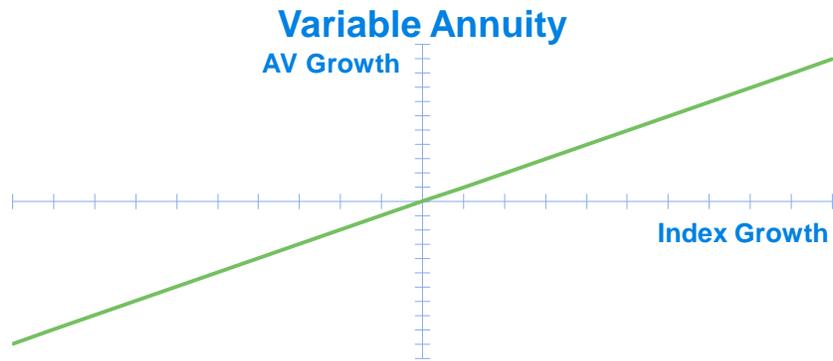


Managed Risk Funds

- Volatility controlled funds have been hurt by V-shaped markets
 - Newer designs are less sensitive to market movements
- Fund benchmark targets not always clear
 - S&P Managed Risk Index
- Difficulties coordinating with balance sheet hedging
 - Derisking in funds cause portfolio to be over hedged

Diversification of Products

- Variable Annuities + Structured Variable Annuity:
 - Innovative crediting structures



Diversification of Products

- Variable Annuities + Structured Variable Annuity:
 - Reduced reserve and capital requirements

	VA standalone	SVA standalone	Aggregate	Aggregation benefit
CTE70	3,100	2,200	3,000	(100)
CTE90	5,700	2,300	5,300	(400)
CTE95	7,000	2,600	6,300	(700)
CTE98	8,000	2,800	7,100	(900)