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Investment Capital Charges:

A Top-Down Observable Price Approach

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Objectives

- Highlight Solvency II latest developments
- Share the “Observable Price” approach to evaluate investment capital charges (VaR)
- Consider implications for portfolio management & asset allocation

Agenda

- Context
- Solvency II Standard Formula Overview
- GR-NEAM Observable Price Approach
- Case Study – US Life Industry
- De-mystify Correlations

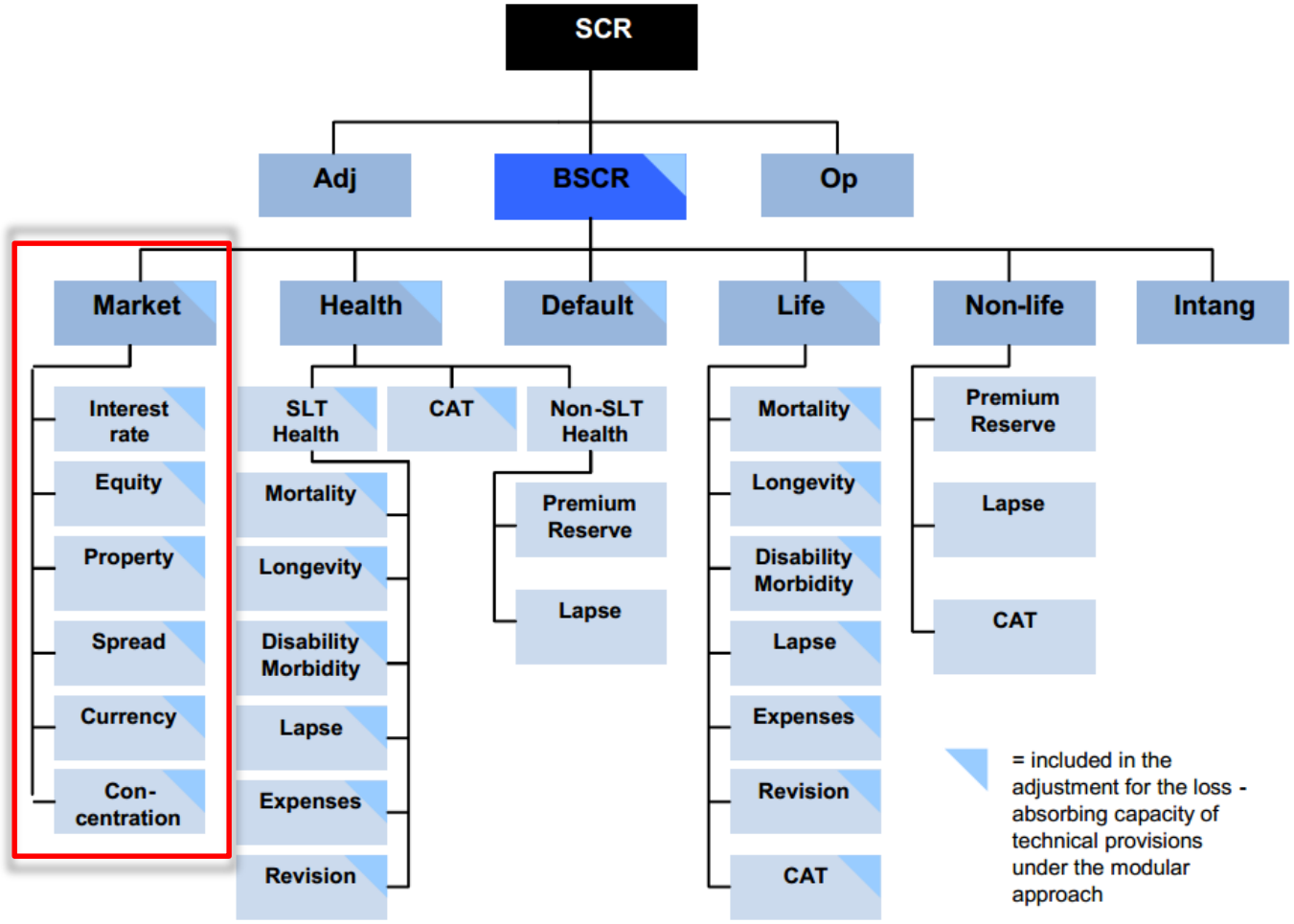
Context

- Various views of capital requirement: regulatory vs. rating agency vs. economic
- Solvency II capital requirement (one-year 99.5% VaR):
  - Standard model formula vs. internal capital model
  - Asset risk charge

➢ **Motivation – Understand why the clearly-defined "1-year 99.5%" VaR estimate can vary significantly among different methods?**

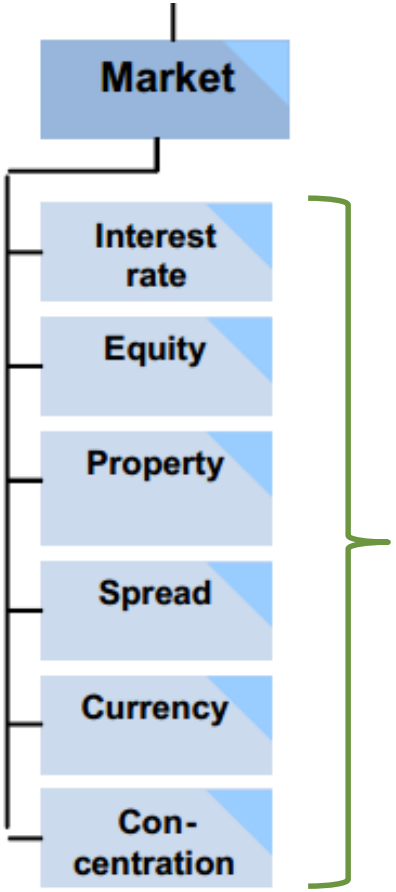
Solvency II Standard Formula Approach (Bottom-Up)

The Solvency II Standard Formula – Refresh



Source: EIOPA "The underlying assumptions in the standard formula for the Solvency Capital Requirement calculation"; July 25, 2014; p.6

Solvency II: “Bottom Up” Approach



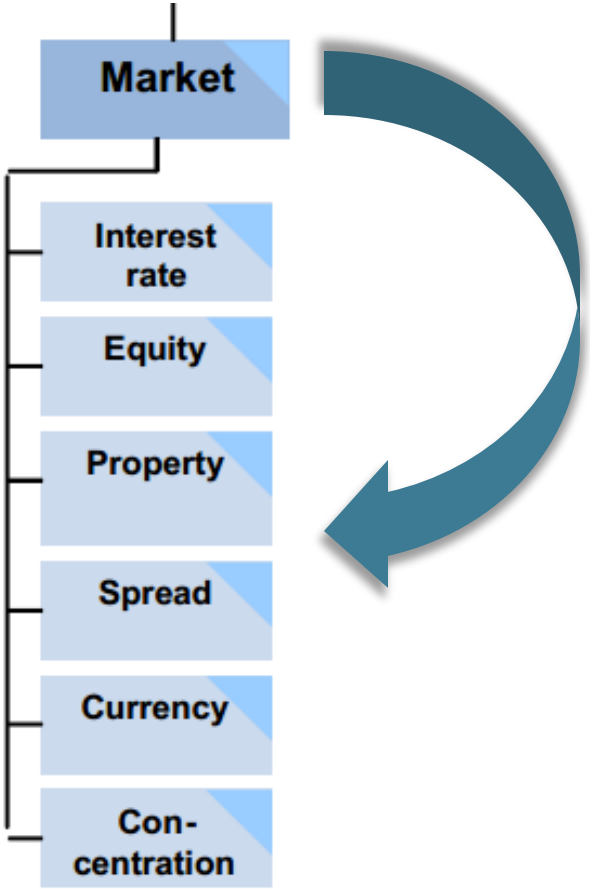
Step2: Portfolio Risk charges aggregated via correlation matrix

Assumed Correlation Matrix

Factor	Interest Rate	Spread	Equity	Currency	Property	Concentration
Interest Rate	1.00					
Spread	0.50	1.00				
Equity	0.50	0.75	1.00			
Currency	0.25	0.25	0.25	1.00		
Property	0.75	0.75	0.75	0.25	1.00	
Concentration	0.00	0.00	0.00	0.00	0.00	1.00

Step1: Risk charges calculated separately for each factor

Observable Price: “Top Down” Approach



Step 1: Portfolio VaR calculated via either historically observed or forward-looking prospective returns

Step 2: Portfolio VaR further decomposed into various risk factors

GR-NEAM Observable Price Approach (Top-Down)

Underlying Data – Historical Observable Total Return Time Series

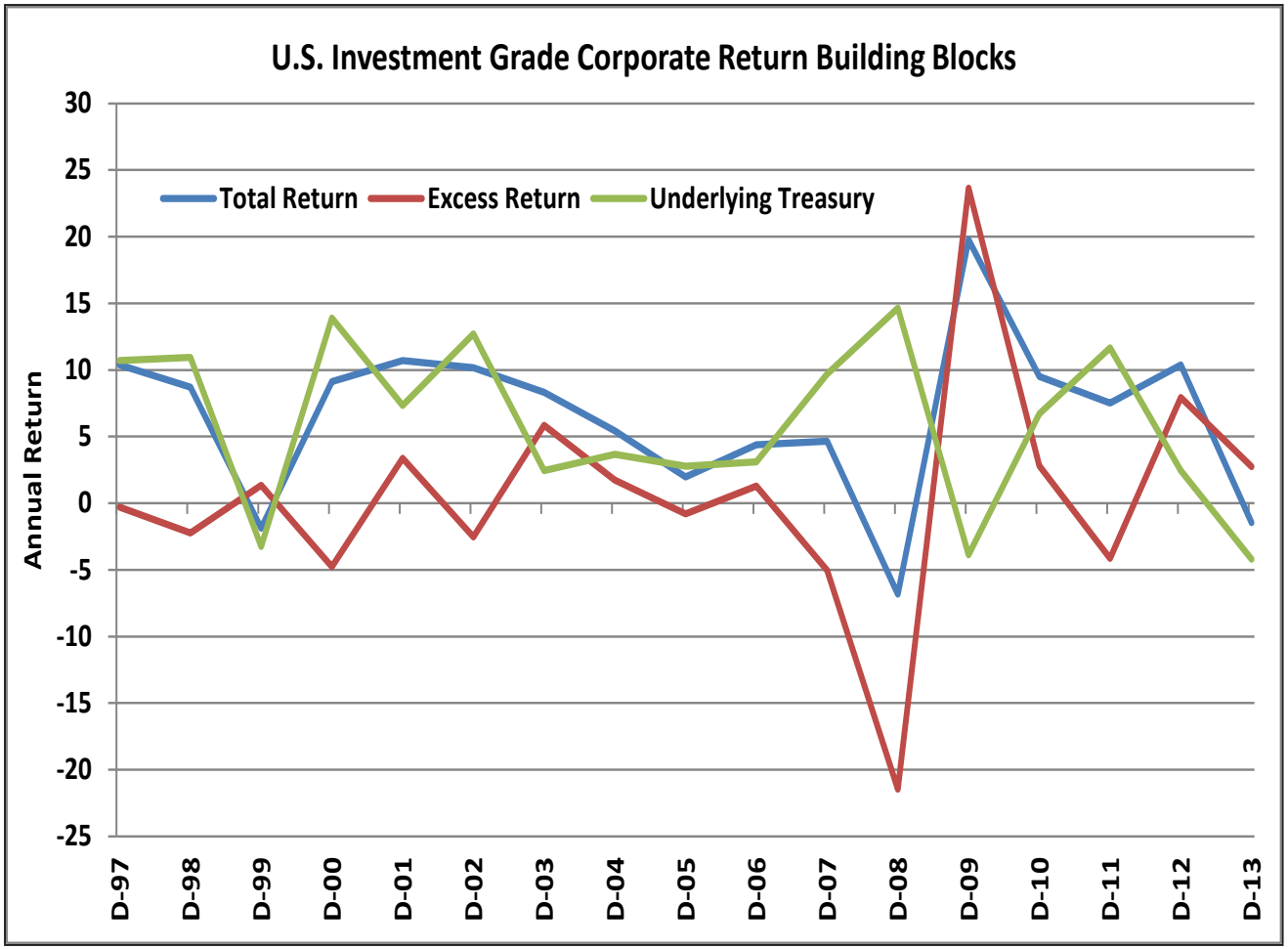
Structure

- Index-based construction
- Daily observable prices & market statistics of underlying constituents (~55,000 fixed income securities, 55 trillion $US)
- Fixed income metrics: total/*excess* return & market yields/spreads
- Equity metrics: total return (Income/price)
- Equity cusip level modeling possible

Considerations

- Strengths
  - Observable prices and correlations
  - Not simulated / calibrated estimates or values
  - Independent third party providers
  - Global coverage/multi-currency
  - Intra-Period Estimates
- Weaknesses
  - Infrequent lack of granularity
  - Seventeen years of daily fixed income returns/statistics
  - Dependent on providers data rules

Fixed Income Security - Total Return and Excess Return



Total Return Attribution:

- Interest rates
- Others
  - Credit
    - Default
    - Perception of Default
    - Liquidity
  - Optionality
  - Currency

Value-at-Risk (VaR) Decomposition – Top Down Approach

1. Portfolio's total return time series (TRR) selected and aggregated based on underlying individual securities and indices
2. Portfolio's overall VaR is quantified
3. Each asset class is further assigned with following risk components (US view):

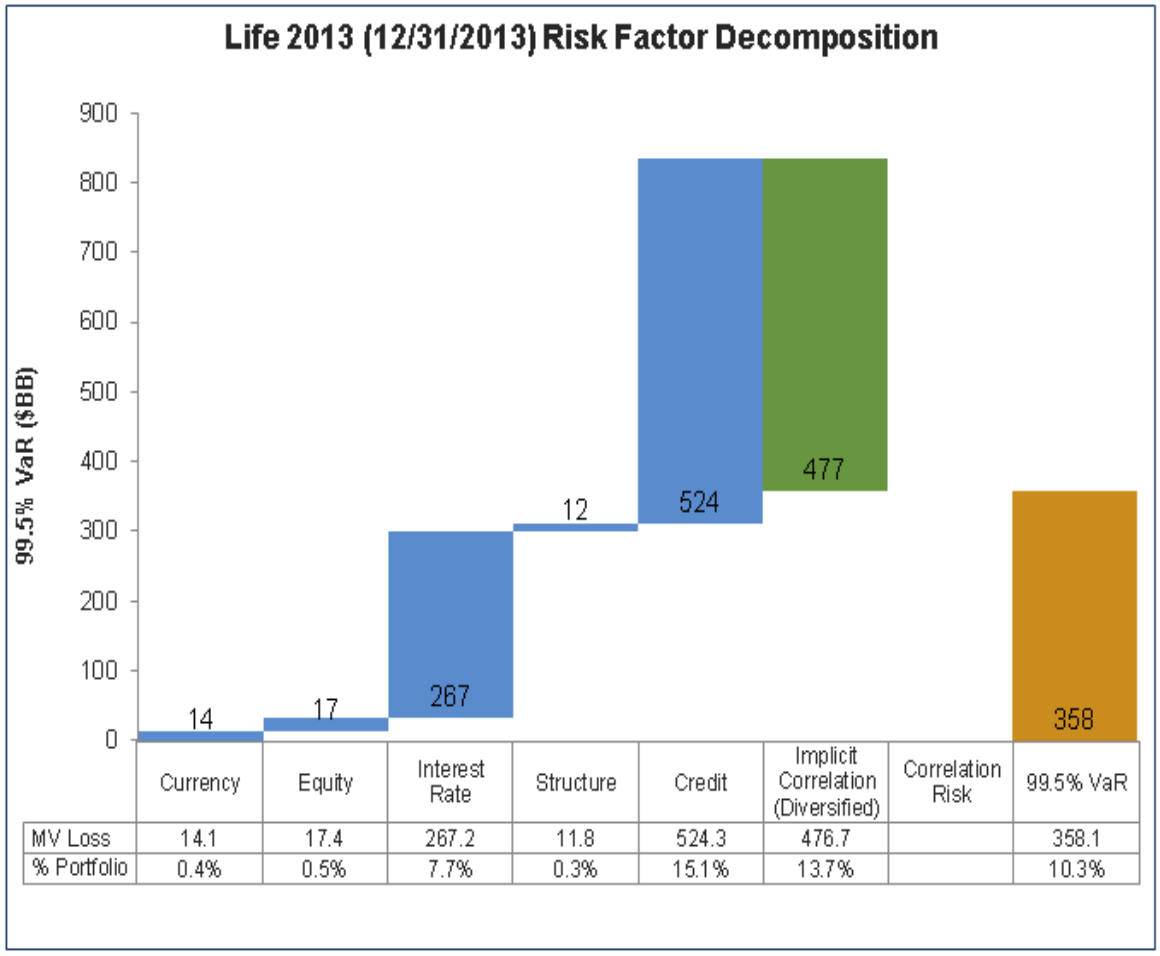
Asset Class	Risk Factor Exposure				
	Currency	Equity	Interest Rate	Credit	Structure
US Government Bonds			X		
Foreign Government Bonds / Sovereigns	X		X	X*	
US Corporate Bonds			X	X	
Foreign Corporate Bonds	X		X	X	
Mortgage Backed Securities (MBS)			X		X
Commercial Mortgage Backed Securities (CMBS)			X	X	
Asset Backed Securities (ABS)			X	X	
Municipal Bonds			X	X	
Equity-like		X			

**For countries issuing their own currencies, we assume no credit risk associated with their government issued bonds in our VaR decomposition framework*

Value-at-Risk (VaR) Decomposition – Top Down Approach (cont'd)

4. For fixed income securities,
    a. interest rate risk is first determined using the TRR of the "duration-matched" government securities
    b. the excess return then is attributed to either "credit" or "structure" risk, depending on the asset class
5. Each risk component for the portfolio is quantified individually
6. The difference between the portfolio's overall VaR and the sum of individual VaR from each risk component is attributed as "diversification" benefit
7. Correlation risk is an add-on VaR (+/-) by changing the observed correlations among securities and indices

Marked-to-Market Observable Price-Based Portfolio Risk Decomposition: *Top Down vs. Bottom Up*



	Currency	Equity	Interest Rate	Structure	Credit	Implicit Correlation (Diversified)	Correlation Risk	99.5% VaR
MV Loss	14.1	17.4	267.2	11.8	524.3	476.7		358.1
% Portfolio	0.4%	0.5%	7.7%	0.3%	15.1%	13.7%		10.3%

Traditional Bottom-Up Approach

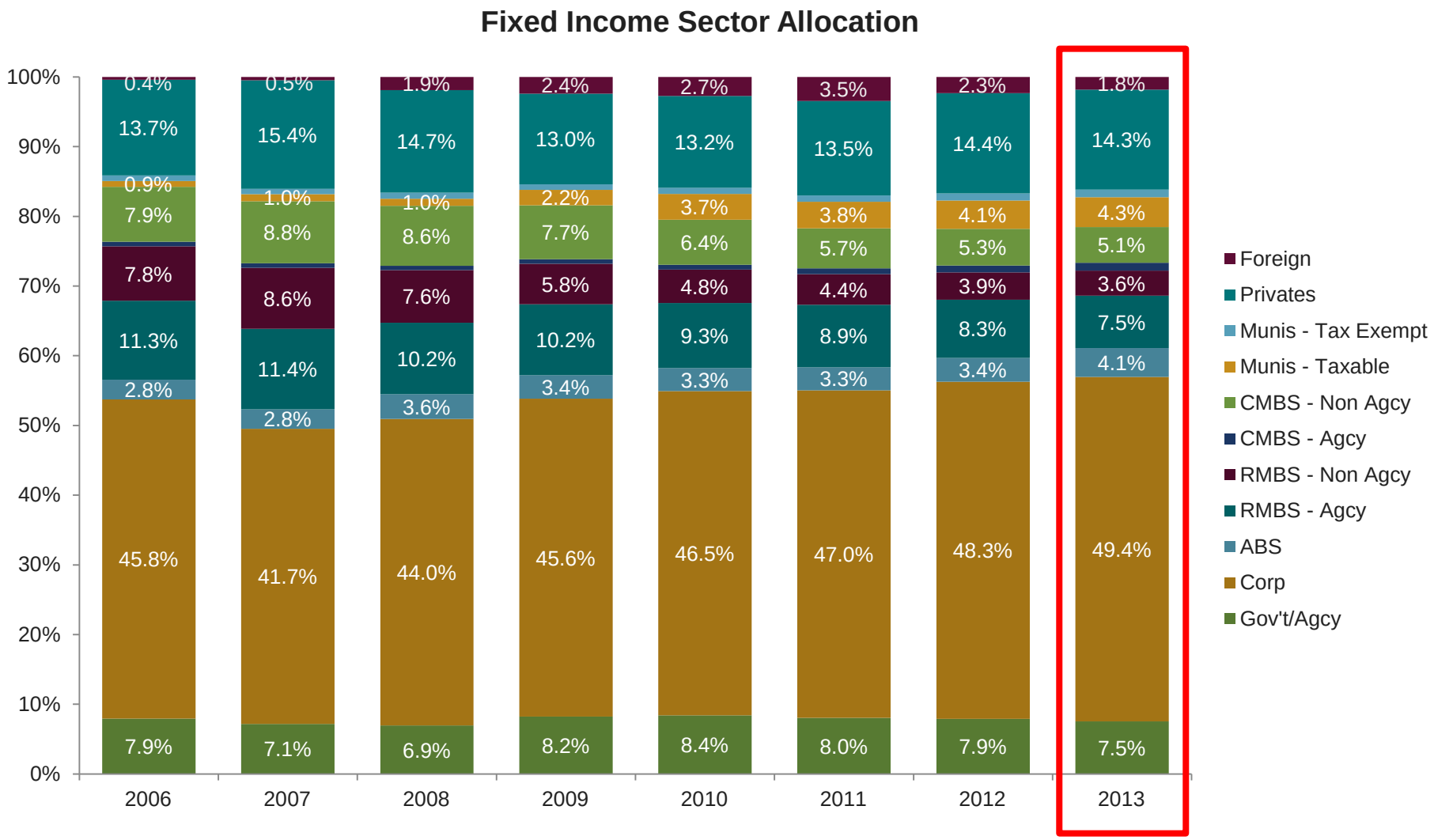
- *Risk impact by key risk factor evaluated separately and independently*
- *Explicitly assumed correlation matrix among risk factors*
- *Portfolio risk results aggregated via assumed correlation matrix*

GR-NEAM's Top-Down Approach

- *Portfolio level risk impact evaluated holistically*
- *Not sensitive to correlation assumptions*
- *Risk factor impacts assessed marginally*

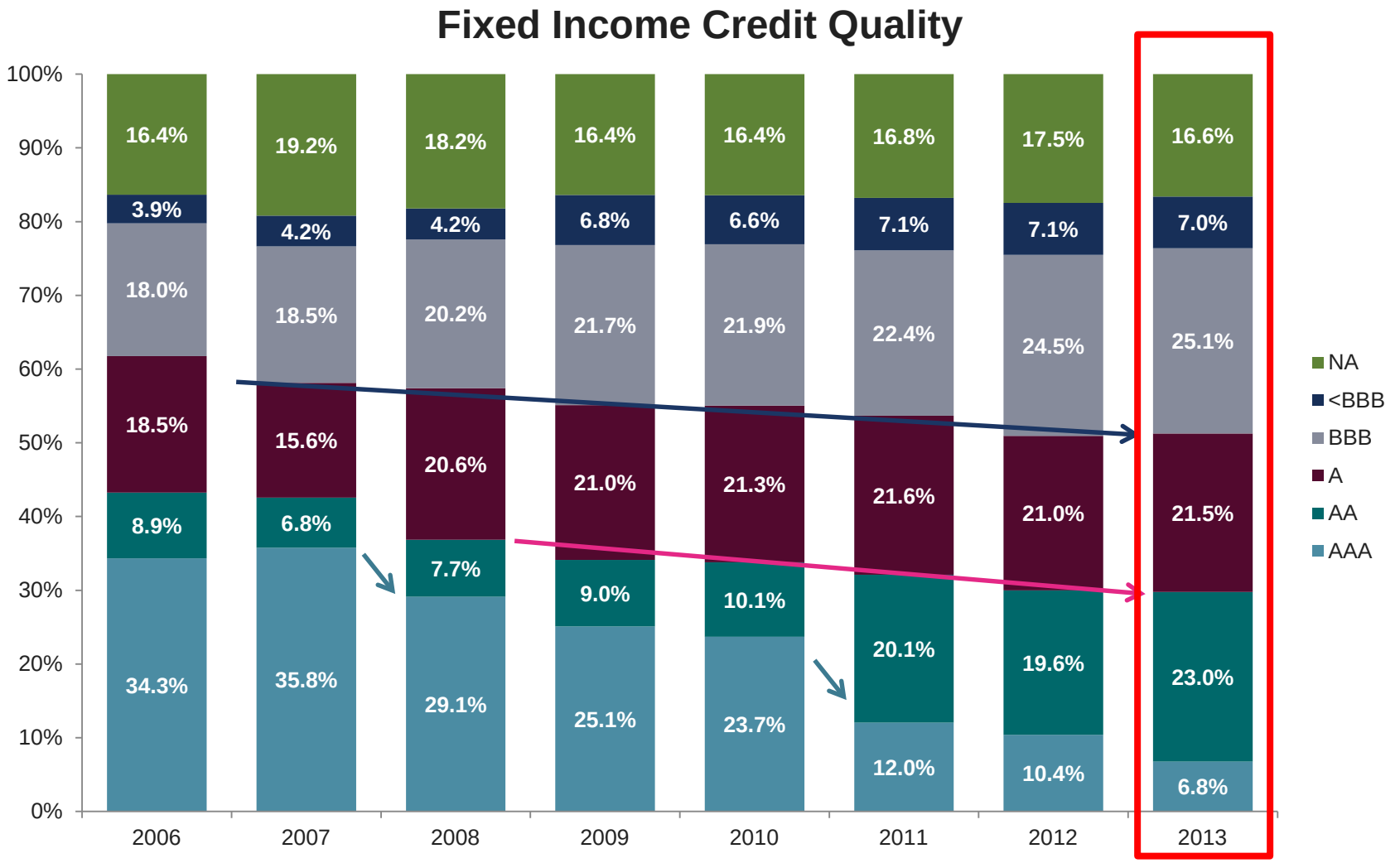
Case Study: U.S. Life Industry

Life Industry: Fixed Income Sector Allocation (Trends)



Source: GR-NEAM Analytics, SNL, Bloomberg

Life Industry: Asset Allocation by Credit Rating (Trends)



Source: GR-NEAM Analytics, SNL, Bloomberg

Life Industry: Duration (Trends)

Fixed Income OAD								
Sector	2006	2007	2008	2009	2010	2011	2012	2013
Gov't/Agcy	7.77	8.19	9.38	9.86	10.01	10.46	10.82	11.19
Corp	6.10	6.45	6.08	6.61	6.91	7.10	7.44	7.39
ABS	2.40	2.48	2.72	2.24	2.49	2.71	3.15	3.14
RMBS - Agcy	4.52	4.31	2.03	3.59	3.85	1.73	2.53	6.31
RMBS - Non Agcy	3.37	4.01	2.68	6.13	6.32	4.41	4.37	2.69
CMBS - Agcy	5.83	6.45	3.07	5.04	5.24	4.76	6.76	6.93
CMBS - Non Agcy	4.69	4.64	3.85	3.78	3.49	3.22	3.29	3.62
Munis - Taxable	9.57	9.68	9.43	10.19	10.60	10.71	10.68	10.00
Munis - Tax Exempt	7.55	7.41	8.69	8.50	8.25	8.23	8.11	9.19
Foreign	7.84	7.32	7.72	8.18	9.47	11.80	14.63	14.34
Other	5.48	4.70	2.06	5.85	5.04	3.10	2.05	3.23
Grand Total	**5.66**	**5.81**	**5.53**	**6.37**	**6.79**	**6.88**	**7.27**	**7.41**

Source: GR-NEAM Analytics, SNL, Bloomberg

Life Industry Holdings Capital Charges: Solvency II "Bottom Up" vs Observable Price "Top Down"

	"Bottom Up" Solvency II	"Top Down" Observable Prices
Life Industry Holdings @ Year End 2013		
Market Value ($BB)	3,482.2	
Industry Capital ($BB)	331.8	
Risk Factor Charges ($BB) calibrated to 99.5 % VaR*		
Currency	13.2	14.1
Equity	20.2	17.4
Interest Rate "Down"	384.8	267.2
Structure	-	11.8
Credit	553.8	524.3
Concentration**	119.2	-
Diversification	(246.5)	(476.7)
Net Total (Capital Charge, $BB)	**844.7**	**358.1**
Percent of Portfolio	24.3%	10.3%
Percent of Capital	245.5%	107.9%

* Results based on index mapped holdings

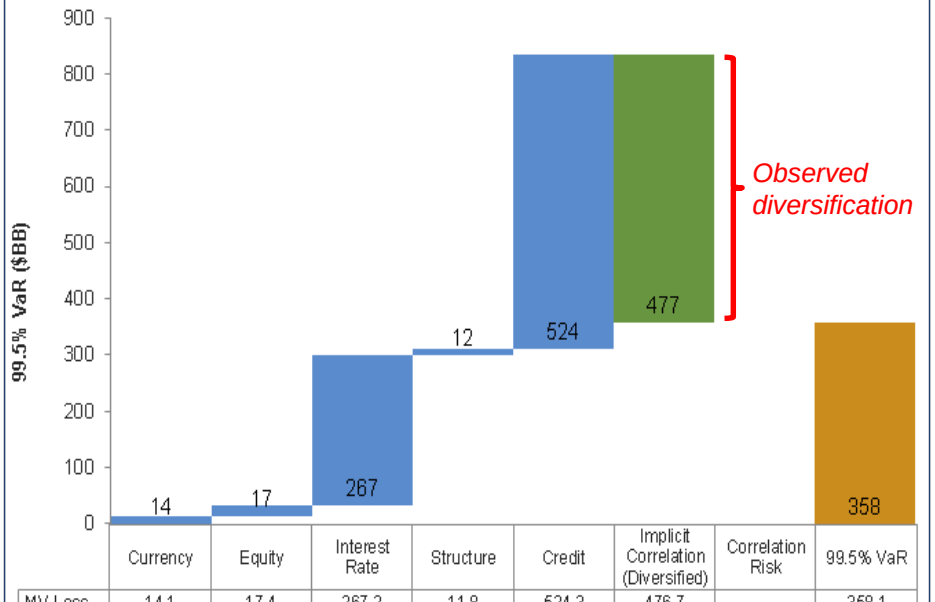
** Results approximated as exposures to individual names masked by index mapping

Source: GR-NEAM Analytics

The Assumed "Correlation" Creates SIGNIFICANT Differences

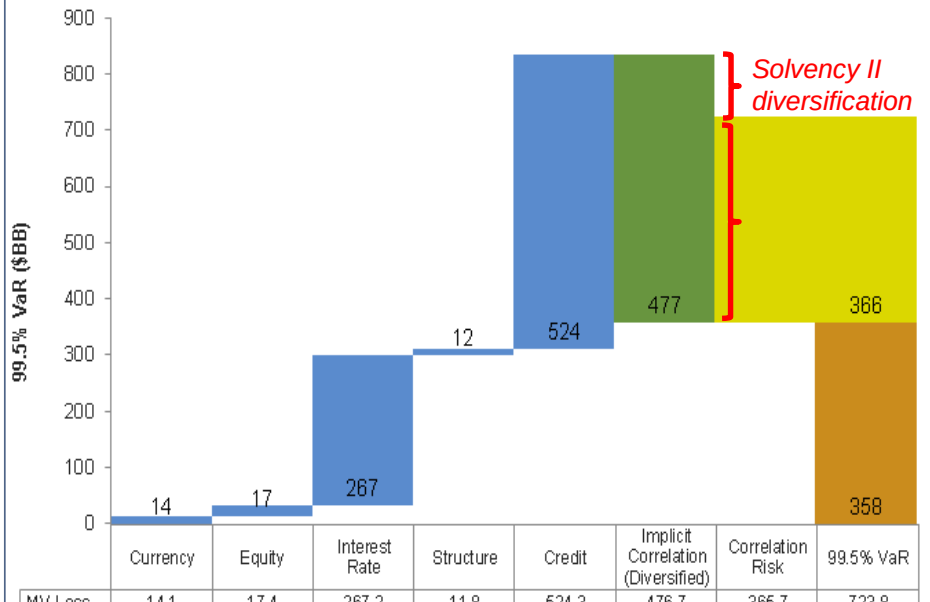
Life Industry Year End 2013 Holdings "Observable Prices" Capital Charges ($BB)

Observed Correlation



	Currency	Equity	Interest Rate	Structure	Credit	Implicit Correlation (Diversified)	Correlation Risk	99.5% VaR
MV Loss	14.1	17.4	267.2	11.8	524.3	476.7		358.1
% Portfolio	0.4%	0.5%	7.7%	0.3%	15.1%	13.7%		10.3%

Solvency II Assumed Correlation



	Currency	Equity	Interest Rate	Structure	Credit	Implicit Correlation (Diversified)	Correlation Risk	99.5% VaR
MV Loss	14.1	17.4	267.2	11.8	524.3	476.7	365.7	723.8
% Portfolio	0.4%	0.5%	7.7%	0.3%	15.1%	13.7%	10.5%	20.8%

Source: GR-NEAM Analytics

De-mystify Correlations

Understand Historical Correlations - Assumptions

Analysis of historic correlations:

- Rate Risk (when contrasted to Equity Risk): Total return volatility of 10-year constant maturity U.S. Treasury bond
- Rate Risk (when contrasted to Spread Risk): Total return volatility of 20-year constant maturity U.S. Treasury bond
- Spread Risk: Volatility of Moody's BBB 20-year corporate bond **excess returns**
- Equity Risk: Volatility of S&P total return index

Analysis Horizon: 1962 to 2013, rolling 20-year window on annual returns

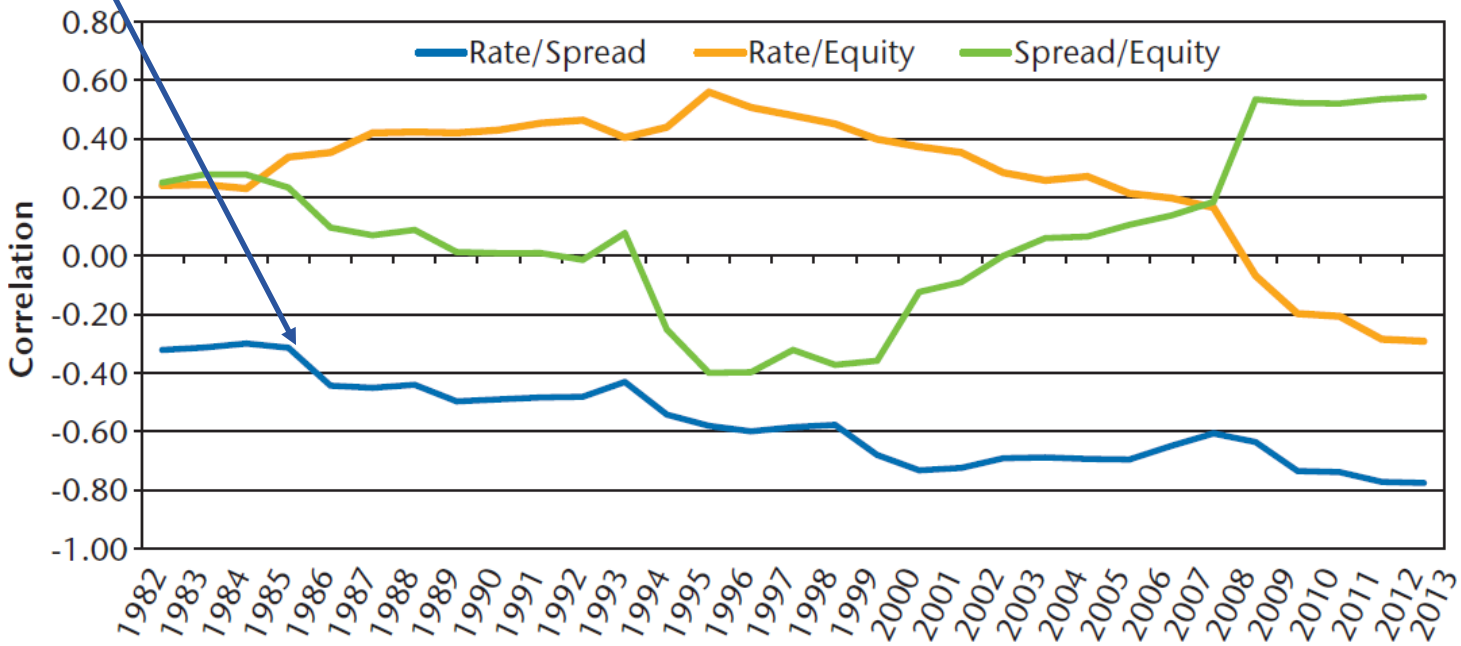
Compare and Contrast: Assumed vs. Historically Observed Correlations

Factor	Interest Rate	Spread	Equity	Currency	Property	Concentration
Interest Rate	1.00					
Spread	0.50	1.00				
Equity	0.50	0.75	1.00			
Currency	0.25	0.25	0.25	1.00		
Property	0.75	0.75	0.75	0.25	1.00	
Concentration	0.00	0.00	0.00	0.00	0.00	1.00

Solvency II Interest Rate Shock "Down" matrix*

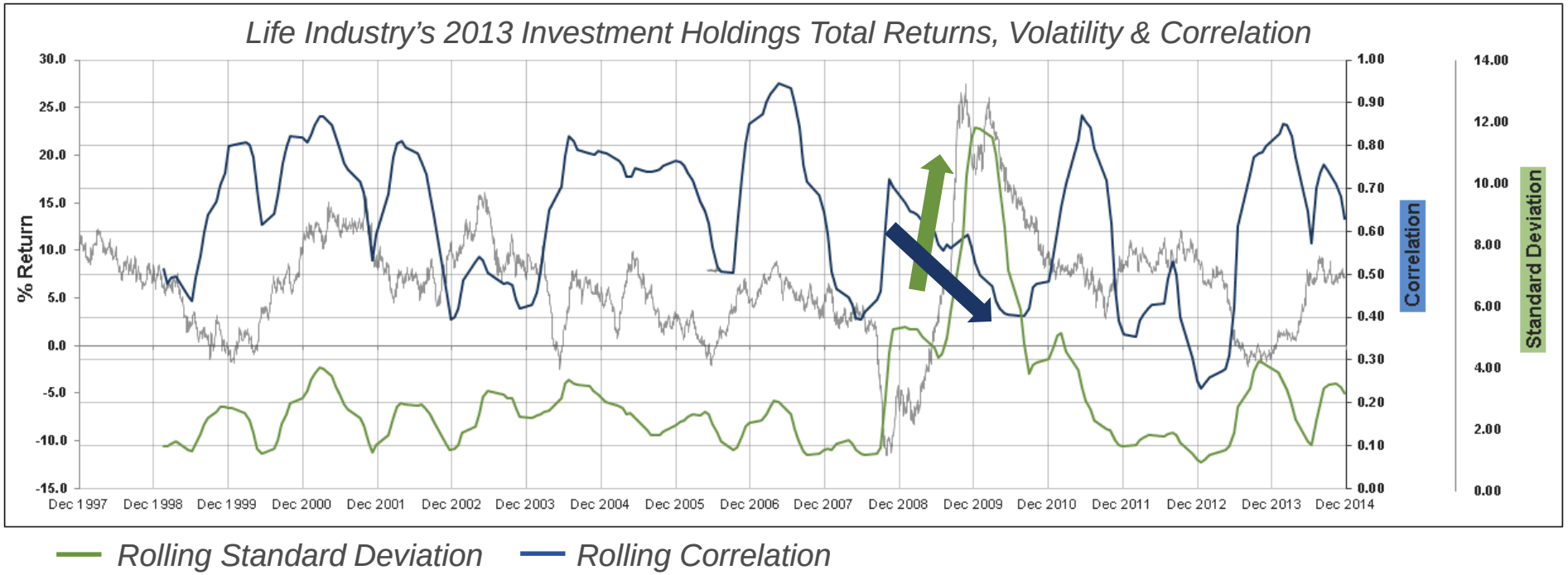
** Source "Technical Specification for the Preparatory Phase (Part I), EIOPA, April 2014, SCR.5.5.*

Historically Observed Rolling Correlations



Source: GR–NEAM Analytics

Correlations in Diversified Portfolios



Conventional wisdom: "In periods of stress, (all) asset valuations become highly correlated" – Historically not supported.

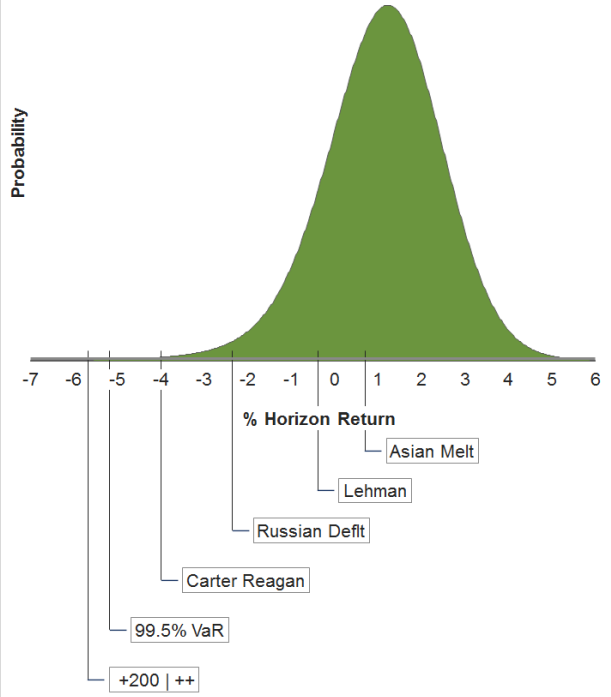
→ High quality assets' valuations might very well increase while lesser credits' valuations' might collapse ("Flight to Quality")

Source: GR-NEAM Analytics

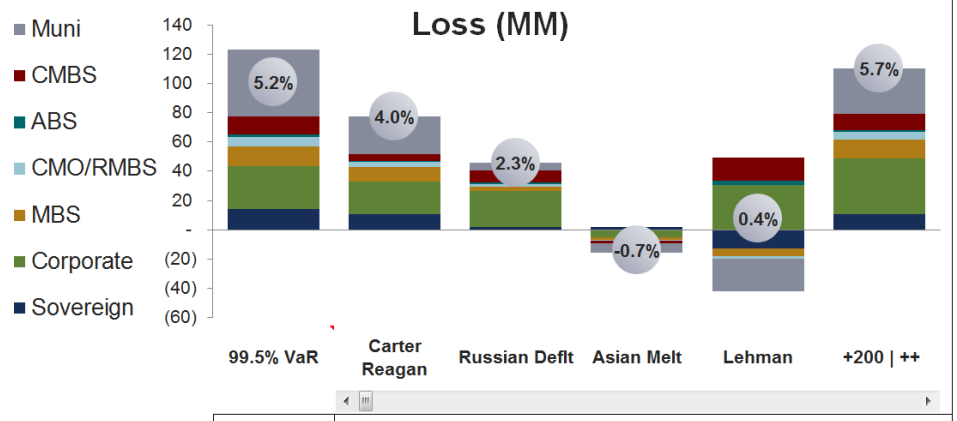
Application – Comprehensive Asset Stress Test

Portfolio Stress Test | ABC Company

Return Distribution with Stress Events



VaR / T-VaR & Portfolio Stress Test



	99.5% VaR	Carter Reagan	Russian Deflt	Asian Melt	Lehman	+200 | ++
% Loss	**5.2%**	**4.0%**	**2.3%**	**-0.7%**	**0.4%**	**5.7%**
Loss (MM)	**100.6**	**77.6**	**45.7**	**-13.7**	**7.6**	**110.3**
Loss by Sector (MM):			Negative sign indicates gain			
Sovereign	14.1	10.8	1.7	1.7	-13.0	10.8
Corporate	29.4	22.2	24.7	-4.9	30.7	38.0
MBS	13.2	9.7	3.3	-1.7	-4.9	12.7
CMO/RMBS	6.9	3.8	1.7	-0.6	-1.8	5.2
ABS	1.8	0.4	1.0	-0.4	2.6	1.3
CMBS	12.0	4.5	8.1	-1.7	16.0	11.1
Muni	46.0	26.1	5.1	-6.2	-21.9	31.2
Loss by Risk Factor (MM):			Negative sign indicates gain			
Rate	50.5	55.3	-13.7	-13.7	-104.3	55.3
Spread	50.1	22.2	59.4	0.0	111.9	55.0

- Contrast prospective VaR/T-VaR with historical stress events
- Estimate potential prospective losses by asset class and risk factors

Source: GR-NEAM Analytics

Summary

Summary

- VaR: “Observable Price” vs. “Solvency II” approaches result in material differences in capital charges
- The role of correlation/choice of dependency structure is significant
- Multiple approaches to risk measurement and stress testing in line with ORSA best practice
- “Observable Price” methodology can serve as an unbiased benchmark for fine-tuning internal models

Parting Thoughts

→ **Significant differences in VaR estimates will impact investment risk assessments, asset allocations and capital management as they are woven into internal decision making processes.**

Q&A

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