GUY CARPENTER

Assessing Strategic Decisions in a Weighted Co-TVaR Framework
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Contents

Two Costs

Managing a Department Store

• As store manager, you would like to allocate overhead to departments in the store.

• Your goal is to provide an equitable way to evaluate the profitability of individual departments.

• Each department is essential to your business model of being a 'one-stop shop.'

• But each department has different kinds of costs:

  • Appliances sell infrequently for higher prices, and require warehousing to maintain full supply. Dedicated retail floor space is relatively small.

  • Clothing turns over quickly and generates lower margins, but occupies the majority of your retail floor space.

• You conclude there are two kinds of costs:

  • A **rental charge** incurred by occupation of floor space

  • A **risk charge** incurred from maintaining inventory for unpredictable sales

The Rental Charge

Interpretation

• The **rental charge** for floor space is akin to **regulatory** or **rating agency capital requirements** in insurance. There is unavoidable cost to make your products available.

• Allocating the rental charge is a straightforward proportion of floor space. In the insurance context, we use either **BCAR** or **RBC** to compute the charge.

• The rental charge recognizes the brand value of the firm, the fact that policies are sold in packages, and that firm value reflects the multi-line product offering.

• In general, the **rental charge** is **proportional** to the **volume** (i.e. premium and reserve level) of the individual lines of business.

Implementation
Simple Example

- Our business is comprised of three segments

- Premium and reserve charges are defined by formula (BCAR or RBC).

- Business segments are priced at different expected loss ratios due to market conditions and differences in risk.

- Total rental charge is the sum of the charge for the individual parts: A*D+B*C*E

- The resulting allocation is highly related to business volume, with minor adjustments from the risk factors.

		Business Segment			Total
		A	B	C	
(A)	Premium Charge	0.40	0.50	0.30	
(B)	Reserves Charge	0.35	0.35	0.20	
(C)	Sum of Pmt Patterns	1.50	0.90	0.50	
(D)	Premiums	5,000	1,500	25,000	31,500
(E)	Expected Losses	3,196	908	12,064	16,168
	Total Rental Charge	3,678	1,036	8,706	13,421
	Allocation %	27%	8%	65%	100%

Descriptive Statistics

	A	B	C	Total
ELR	64%	61%	48%	51%
CV	1.9	1.3	2.0	1.5

The Risk Charge

Risk Model Output: The Scenario View

- We have ten realizations from a stochastic model for the overall business

- Sort the realizations in ascending order on total loss.

- The average total loss is the sum of the average loss for each segment.

- If we have zero aversion to risk, we could allocate capital to these lines of business based on the broken-out average.

- Equivalently, we are allocating capital based on the weighted average scenario, where the weights are each one.

Realization	Business Segment Losses			Total
	A	B	C	
1	498	595	-	1,093
2	241	1,718	104	2,064
3	2,125	684	226	3,035
4	417	97	2,546	3,061
5	535	3,742	-	4,278
6	6,978	122	93	7,193
7	158	143	11,788	12,089
8	19,027	98	-	19,125
9	1,476	192	29,386	31,053
10	508	1,689	76,494	78,691

	A	B	C	Total
Average	3,196	908	12,064	16,168
Percentage	20%	6%	75%	100%

VaR (Value-at-Risk) and Contribution Measures

- We may decide to assign the 'most-important' pain point a weight of one, and zero weight to all other realizations.

- That point would be called VaR (Value-At-Risk), in this case at the 90th percentile.

- The contributions to VaR from individual segments add up to the total VaR, because the realization is one complete scenario.

- The contributing average amounts are called co-VaR.

- The Risk Charge is the excess of the weighted average over the straight average.

- Co-VaR is generally an unstable measure for capital allocation.

Realization	Weight	Business Segment Losses			Total
		A	B	C	
1	0.0	498	595	-	1,093
2	0.0	241	1,718	104	2,064
3	0.0	2,125	684	226	3,035
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8	0.0	19,027	98	-	19,125
9	1.0	1,476	192	29,386	31,053
10	0.0	508	1,689	76,494	78,691

	A	B	C	Total
Straight Ave	3,196	908	12,064	16,168
Wght Ave	1,476	192	29,386	31,053
Percentage	5%	1%	95%	100%
Risk Charge				14,885

Probability Transforms
An easy way to define smooth weights

• One way to define the weights is with a probability transform. The weights are defined by a curve *that effectively makes adverse realizations more likely*.

• The weights are a smooth way to recognize that the worst results are even more painful than the proportional size of their losses.

• Curve shape can be altered by changing parameter values, but only so much.

• In this example, we show a Wang transform. There are other curves.

Realization	Weight	Business Segment Losses			Total
		A	B	C	
1	1.0	498	595	-	1,093
2	1.9	241	1,718	104	2,064
3	2.7	2,125	684	226	3,035
4	3.7	417	97	2,546	3,061
5	4.8	535	3,742	-	4,278
6	6.1	6,978	122	93	7,193
7	8.0	158	143	11,788	12,089
8	10.7	19,027	98	-	19,125
9	15.4	1,476	192	29,386	31,053
10	34.6	508	1,689	76,494	78,691

	A	B	C	Total
Straight Ave	3,196	908	12,064	16,168
Wght Ave	3,353	993	36,050	40,397
% Allocation	8%	2%	89%	100%
Risk Charge				**24,228**

Wang Transform
Graphical View

• Increasing 'Alpha' in the Wang transform implies more pain for the increasingly adverse realizations.

• For example, if Alpha=1.0, Realization 10 is 34.6 times as painful as Realization 1 *per dollar*.

• Choosing alpha is arbitrary, but when the curve is viewed under the scenario view, management can clearly understand its effect.
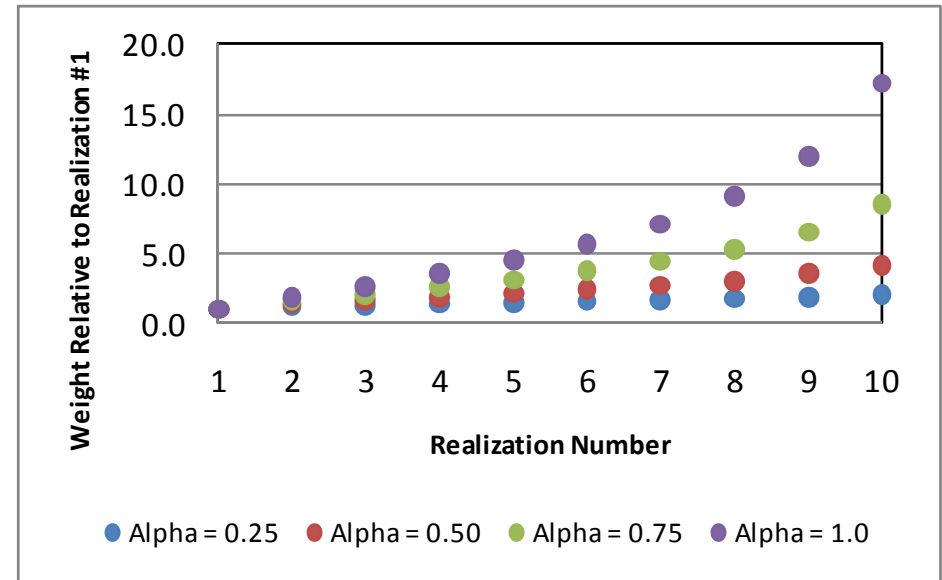
Alpha:	0.25	0.50	0.75	1.00
Scenario	Weight	Weight	Weight	Weight
1	1.0	1.0	1.0	1.0
2	1.2	1.4	1.6	1.9
3	1.3	1.7	2.2	2.7
4	1.4	1.9	2.7	3.7
5	1.5	2.2	3.3	4.8
6	1.6	2.5	3.9	6.1
7	1.7	2.9	4.8	8.0
8	1.8	3.3	6.0	10.7
9	2.0	4.0	7.9	15.4
10	2.4	5.8	14.1	34.6

Utility Transforms
Another way to define weights using total loss

• Another family of weighting schemes defines the curve with formulas that depend on total loss, *in other words the pain-per-dollar is explicitly changing*.

• It's still just a way to calculate this realization weights.

• These weights are an Esscher transform with h=.45.

• The curve has a different shape than that of the Wang transform, but we chose h=.45 to provide the same risk loading overall.

Realization	Weight	Business Segment Losses			Total
		A	B	C	
1	1.0	498	595	-	1,093
2	1.0	241	1,718	104	2,064
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	A	B	C	Total
Straight Ave	3,196	908	12,064	16,168
Wght Ave	2,537	1,120	36,739	40,397
% Allocation	6%	3%	91%	100%
Risk Charge				24,228

Weighted TVaR
Explanation of the Statistic

- $TVaR_{50}$ (Tail Value at Risk at the 50th Percentile) is the average total loss for all realizations larger than the 50th percentile.

- The arbitrary threshold of the 50th percentile is chosen to quantify risk preferences.

- $Co\text{-}TVaR_A$ is the average losses from business segment A over the same realizations. Note that these realizations are not in strict ascending order for segment A losses.

Business Segment Losses

Realization	A	B	C	Total
1	498	595	-	1,093
2	241	1,718	104	2,064
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$TVaR_{50}$

	A	B	C	Total
$Co\text{-}TVaR_{50}$	5,629	449	23,552	29,630
Percentage	19.0%	1.5%	79.5%	100.0%

TVaR Thresholds (Return Periods)

- If we chose the 80th percentile (i.e. 1 in 5 Return Period), the TVaR is larger.

- In this example, the tail risk is driven by Business Segment C. The allocation to C is more at the higher threshold.

- To allocate capital to support different levels of adverse loss events, we can weight the two TVaRs together. We will have to choose the weights.

Business Segment Losses

Realization	A	B	C	Total
1	498	595	-	1,093
2	241	1,718	104	2,064
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10	508	1,689	76,494	78,691

$TVaR_{80}$

	A	B	C	Total
Co-$TVaR_{80}$	992	940	52,940	54,872
Percentage	1.8%	1.7%	96.5%	100.0%

$TVaR_{50}$

	A	B	C	Total
Co-$TVaR_{50}$	5,629	449	23,552	29,630
Percentage	19.0%	1.5%	79.5%	100.0%

TVaR Weighting

- Let's assign a weight of 43% to Co-TVaR$_{80}$ and 57% to Co-TVaR$_{50}$. The resulting weighted total TVaR is 40,397, producing the the same risk charge as in the previous examples.

Weight		A	B	C	Total
0.43	Co-TVaR$_{80}$	992	940	52,940	54,872
	Percentage	1.8%	1.7%	96.5%	100.0%
0.57	Co-TVaR$_{50}$	5,629	449	23,552	29,630
	Percentage	19.0%	1.5%	79.5%	100.0%
Weighted	Co-TVaR$_{Wgt}$	3,651	658	36,087	40,397
Total	Percentage	9.0%	1.6%	89.3%	100.0%

Weighted TVaR Under the Scenario View

• By using two TVaR measures we describe our preferences between different 'zones' of the loss distribution.

• The preferences 1 and 2.9 over the two zones can be directly calculated from the 43%/57% weights and the thresholds of 50th and 80th percentile.

• The realization weights are a step function. Each step (there can be more than two) occurs at an important capital management point, (e.g. earnings miss, single downgrade, solvency impairment).
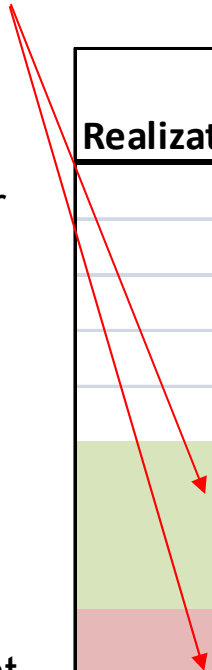
Realization	Weight	Business Segment Losses			Total
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	A	B	C	Total
Straight Ave	3,196	908	12,064	16,168
Wght Ave	3,651	658	36,087	40,397
% Allocation	9%	2%	89%	100%
Risk Charge				**24,229**

Summary of What We Have Done

- We have allocated Risk Charge to individual business segments using multiple approaches which can often be non-transparent.

- We have done so under the scenario view, making the difference in risk preferences clear between the approaches.

- The risk preference curve affords management the understanding of which realizations are driving allocation decisions. Defining different pain points on the sorted realization tally is straightforward.

Weighting	Business Segment Allocation			Weighted Average	Risk Charge
	A	**B**	**C**		
Straight Average	20%	6%	75%	16,168	-
VaR$_{90}$	5%	1%	95%	31,053	14,885
Wang (Lambda = 1.0)	8%	2%	89%	40,397	24,228
Esscher (h=0.45)	6%	3%	91%	40,397	24,228
TVaR$_{50}$ (43%) and TVaR$_{80}$ (57%)	9%	2%	89%	40,397	24,228

The Weighted Total Charge

Completing the Example

- Our management decides to adopt the weighted TVaR framework for risk charge.

- The overall weight to risk charge allocation is set at 50%.

- The resulting allocation is a representation of the cost to both maintain the multi-line P&C insurance business as a going concern, as well as the volatile cost to maintain solvency in the short term.

Weight to Risk Charge: 0.5

Risk Charge (Weighted TVaR)	9%	2%	89%	100%
Rental Charge	27%	8%	65%	100%
Weighted Total Allocation	18%	5%	77%	100%

Key Concepts

- Allocation of risk charge can be viewed in the common framework of the <u>Scenario View</u>, where a weight is assigned to each realization and co-measures are computed as weighted averages.

- <u>Probability transforms</u> make adverse realizations effectively more likely by assigning larger weights to these realizations.

- <u>Utility transforms</u> stipulate that the pain-per-dollar increases with increasingly adverse realizations, and calculate a curve which is also expressed as set of weights over realizations.

- In principle, the risk manager could define any set of weights across the realizations. We call the weights the <u>Risk Preference Function</u>.

- Weighting Co-TVaR at different thresholds together creates a step function comparable to the smoother curves. This approach to the Risk Preference Design has the following strengths:

    - Ease of calculation, explanation, and interpretation

    - Reliance on a common metric in risk management (TVaR)

    - Compatibility with prevalent practice of defining zones of operating loss impact: missing earnings, losing enough to warrant a downgrade, destruction of solvency.
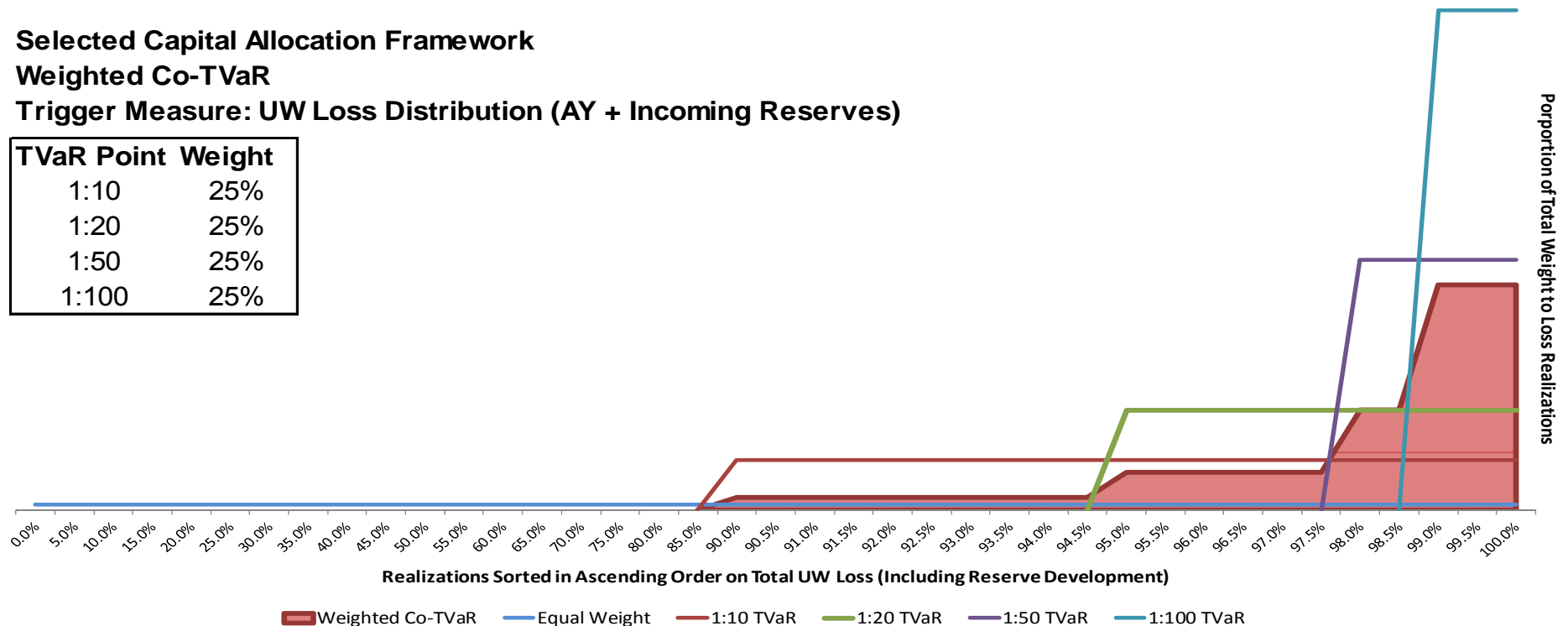
Practical Example – Risk Charge

Allocation of Capital Cost: The Co-TVaR Framework

Selected Capital Allocation Framework
Weighted Co-TVaR
Trigger Measure: UW Loss Distribution (AY + Incoming Reserves)

TVaR Point	Weight
1:10	25%
1:20	25%
1:50	25%
1:100	25%

Porportion of Total Weight to Loss Realizations

Realizations Sorted in Ascending Order on Total UW Loss (Including Reserve Development)

Legend: Weighted Co-TVaR — Equal Weight — 1:10 TVaR — 1:20 TVaR — 1:50 TVaR — 1:100 TVaR

- We can **define risk preferences explicitly** by assigning a weight to losses on each realization of the model
- Common ways to compute the weights include:
  - Probability transforms
  - Utility transforms
  - Weighted Co-TVaR
- The risk manager can define any **Risk Preference Function**.
- Weighted Co-TVaR is a step function with several strengths:
  - **Ease** of calculation, explanation, interpretation
  - Reliance on a **common metric** in risk management
  - **Intuitive application** to defining zones of operating loss impact: missing earnings, losing enough to warrant a downgrade
  - Destruction of solvency

Example – ABC Insurance Company
Capital Allocation

Capital Allocation ($M)

LOB	2016 Plan NWP	2015 YE Net Reserve	AY UW Capital	AY Cat Capital	NWP / Capital	Reserve Capital	Net Res / Capital	Total Capital
Homeowners	916.0	377.6	198.9	1,174.9	0.7	49.3	7.7	1,423.2
Personal Auto	592.5	377.0	113.2	21.1	4.4	63.3	6.0	197.6
Commercial Auto	1,093.2	1,811.6	249.0	39.0	3.8	436.2	4.2	724.2
Commercial Property	3,775.3	2,742.3	1,736.4	2,823.3	0.8	168.6	16.3	4,728.4
Commercial General Liability	5,929.6	12,979.0	1,268.0	0.0	4.7	3,242.9	4.0	4,510.9
Workers Compensation	2,436.1	7,765.3	594.4	0.0	4.1	1,577.9	4.9	2,172.2
Medical Malpractice	360.1	1,302.1	92.4	0.0	3.9	633.6	2.1	726.0
Products Liability	57.5	1,410.5	25.4	0.0	2.3	561.9	2.5	587.3
Casualty Portfolio (Under Review)	766.3	Not Modeled	320.8					320.8
Total	15,926.7	28,765.5	4,598.5	4,058.3	1.8	6,733.8	4.3	15,390.6

- **2%** of total risk capital is allocated to **Casualty Portfolio**, which is currently under review.

- Largest consumers of risk capital are **commercial property** underwriting (**30%**) and **reserve** exposure from **GL** (**21%**) and **WC** (**10%**) LOB's .

- In this framework, we can analyze the marginal impact of portfolio decisions in a holistic context.

- Decisions made on a going forward basis will not effect reserve runoff risk, but will effect exposure to future reserve risk:
  - Therefore, whenever possible try and model impact to subject portfolio on an **AY** basis – **not** a **CY** basis.

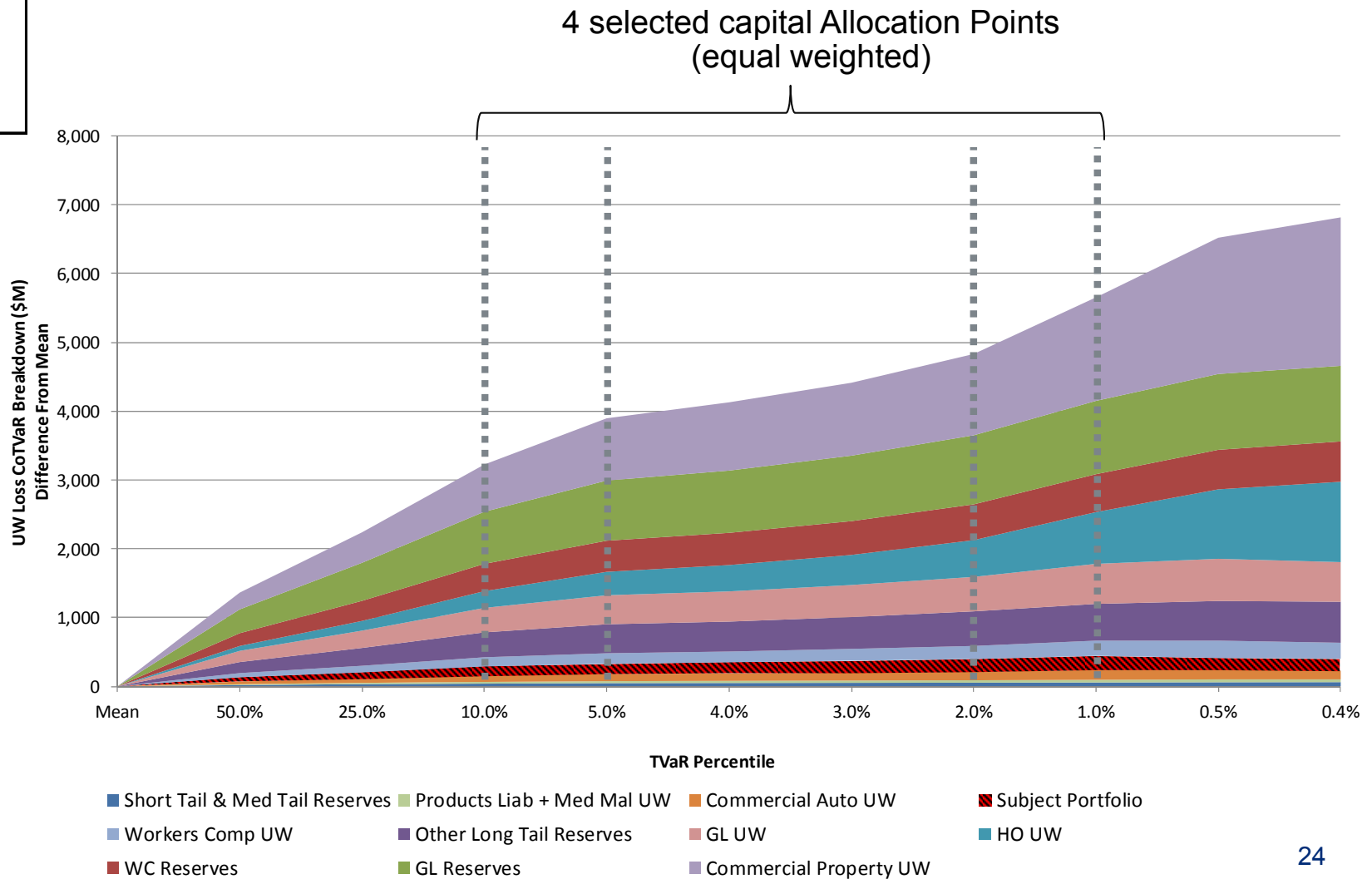# Company ABC Capital Model Output
UW Loss Co-TVaR Distribution

Selected Capital Allocation Framework

Weighted Co-TVaR

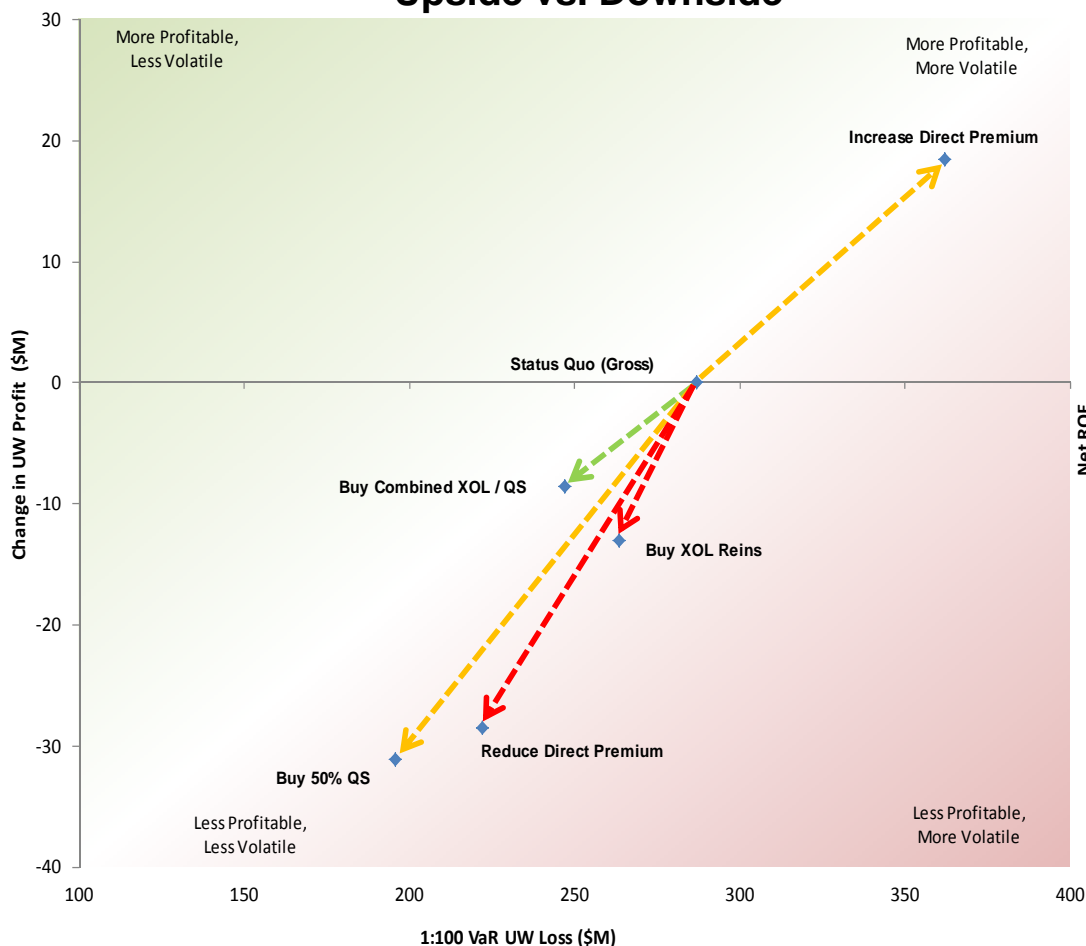**Trigger Measure: UW Loss Distribution (AY + Incoming Reserves)**

TVaR Point	Weight
1:10	25%
1:20	25%
1:50	25%
1:100	25%

Analytics Framework for Assessing Strategic Decisions
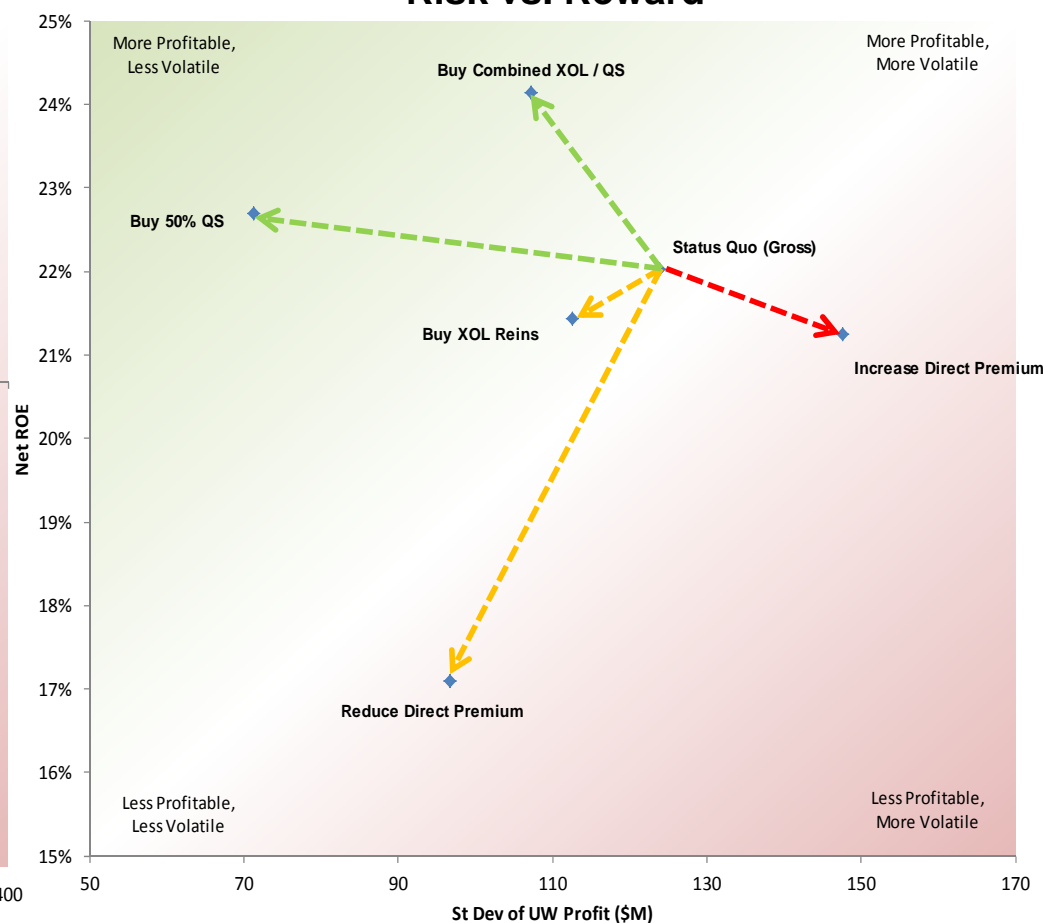
- Increasing premium maximizes net profit
- Combined QS / XOL program provides best ROE
- Reducing direct writings for a profitable book is less efficient than purchasing quota share reinsurance
- Purchasing XOL reinsurance is not as capital efficient as QS *unless* the reinsured line is one of the most important contributors to overall company risk. (i.e. – **for a diversifying LOB, QS is generally more capital efficient that XOL**)

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Applying the Framework

Company ABC

Example Casualty Portfolio

($M)

	Status Quo (Gross)	Reduce Direct Premium	Increase Direct Premium	Buy XOL Reins	Buy Combined XOL / QS	Buy 50% QS
Change in Net Premium	0.0	(200.0)	200.0	(34.2)	(100.0)	(383.1)
Change in Net Profit	0.0	(28.5)	18.5	(13.0)	(8.6)	(31.1)
"Opportunity Cost" CR*	N/A	85.8%	90.8%	61.9%	91.4%	91.9%
Year 1 Capital Relief	0	-83.7	(99)	43.1	44.8	122.1
Net Premium	766	566	966	732	666	383
Net Profit	70.7	42.2	89.1	57.7	62.1	39.6
Net CR	90.8%	92.5%	90.8%	92.1%	90.7%	89.7%
Net CV	16.2%	17.1%	15.3%	15.4%	16.1%	18.6%
Net 1:100 UW Loss	(287)	(222)	(362)	(264)	(247)	(196)
Net 1:250 UW Loss	(361)	(277)	(455)	(326)	(310)	(251)
Net Capital Allocated	321	247	420	269	257	174
Net ROE	**22.0%**	**17.1%**	**21.2%**	**21.4%**	**24.1%**	**22.7%**

A company with a credible capital allocation framework which has management buy-in is able to make strategic decisions in a consistent, unbiased framework.

In addition to actuarial analysis, management must consider:
- company **risk tolerance**
- **future prospects** for the business unit
- **relationship** with **distribution partners** / **reinsurers**
- **strategic importance** of product offering to **customers**

* - *Opportunity Cost CR* is the CR of the marginal premium ceded, grown, or non-written.