# RCM-2: Cost of Capital and Capital Attribution- A Primer for the Property Casualty Actuary

## CAS Ratemaking and Product Management Seminar

## March 10, 2015

**Moderator/Tour Guide:**

- Robert Wolf, FCAS, CERA, MAAA, CAS Board of Directors

**Speakers:**

- Glenn Meyers, FCAS, CERA, MAAA, Researcher and Volunteer
- David Ruhm, FCAS, CERA, MAAA, President-Title Actuary Consultants, LLC
- Neil Bodoff, FCAS, MAAA, Executive Vice President, Willis Re. Inc.

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# Welcome to a guided tour

## Capital Allocation- An Evolving History of Thought

March 3, 2015

# Why are we having this session?

- CAS *Statement of Principles*

"The underwriting profit and contingency provisions are the amounts that, when considered with net investment and other income, provide an appropriate total after-tax return."

# What is Our Goal?

- Two Issues
  - What's *appropriate*?
    - Risk charge for "random variation from the expected costs" must be "consistent with the cost of capital"
    - Included in underwriting profit provision
  - How do you measure *return*?
    - Return on *what?*
      - Capital attributed to what your are pricing
      - So we have been allocating capital in the interest of getting to or deriving the cost of capital.

# The “We can’t allocate capital” debate

- The Allocation argument we have been debating over the last 20 years at the ratemaking seminar.

- Where are we at in this argument?

# Can Capital Be Meaningfully broken down?

$$\sum(\mathrm{Promises To Pay}) \neq \mathrm{Promise To Pay}\left(\sum\ \right)$$

**"*Every Dollar of Capital Stands Behind Each and Every Risk*"**

**Chuck McClenahan, FCAS, MAAA Mercer Oliver Wyman Testimony at Proposition 103 Hearings**

***"However, reasons for not allocating capital go beyond the fact that it is difficult to do so. For example, allocating could lead to violations of the economic principle of marginal pricing"***

*……..Gary Venter, "Allocating Capital- Not!", Actuarial Review*

# The “Allocating Capital “ Paradox

## Why Do it?

- Capital Allocation is necessary
- The best way to make risk-based portfolio composition decisions
- Critical element of financial product pricing
- Standard language of management

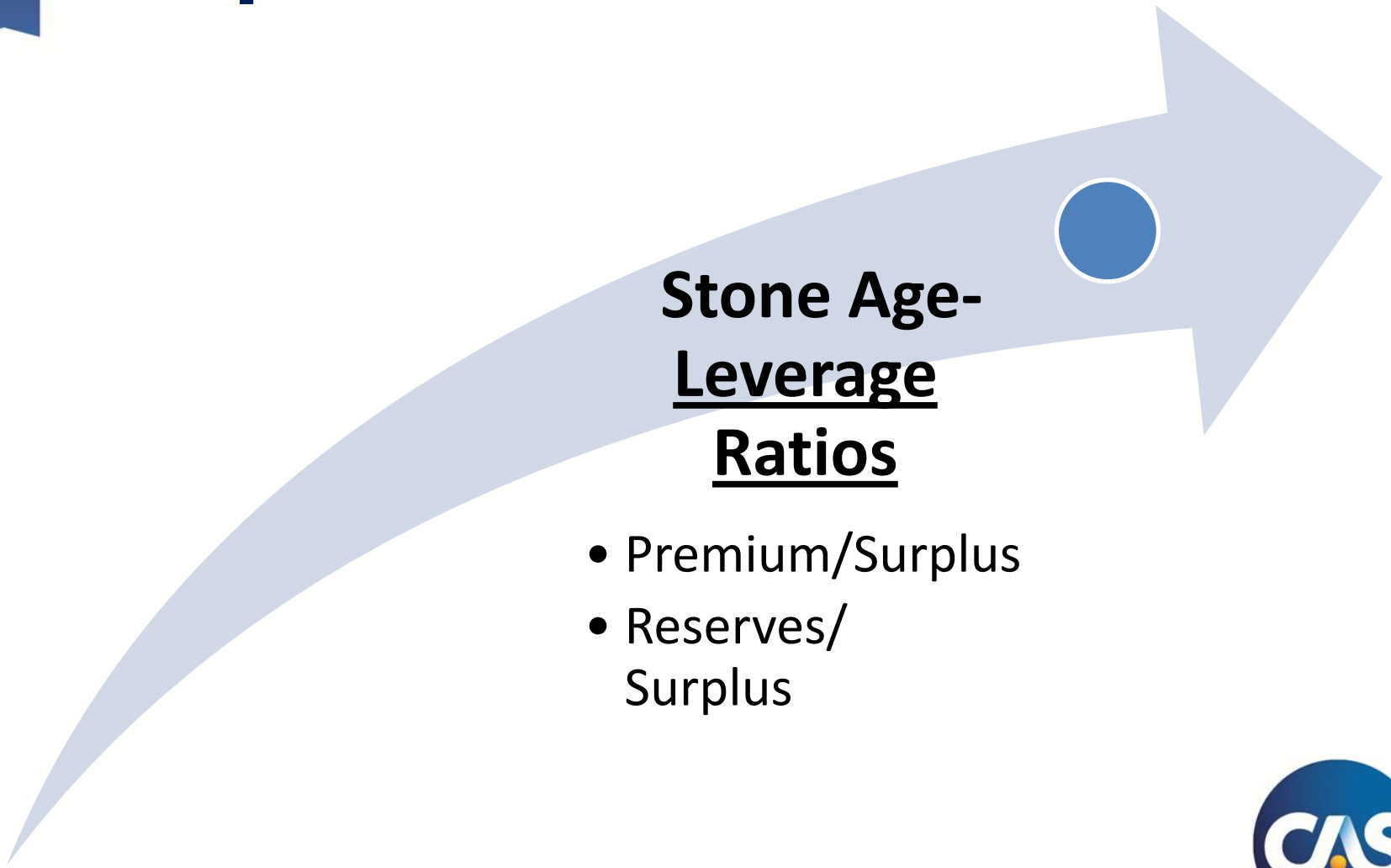
## Why Not To Do it?

- Capital Allocation is artificial and arbitrary
- All of the company’s capital is available to support each policy
- No capital is transferred at policy inception
- Capital is transferred via reserve strengthening

# The “Allocating Capital “ Paradox

- We seem to have sighed, and said….
- “All good.  If we must we must.  Let’s at least do it so that it gets the right results.”
- Let’s look at where we were and where we have gone

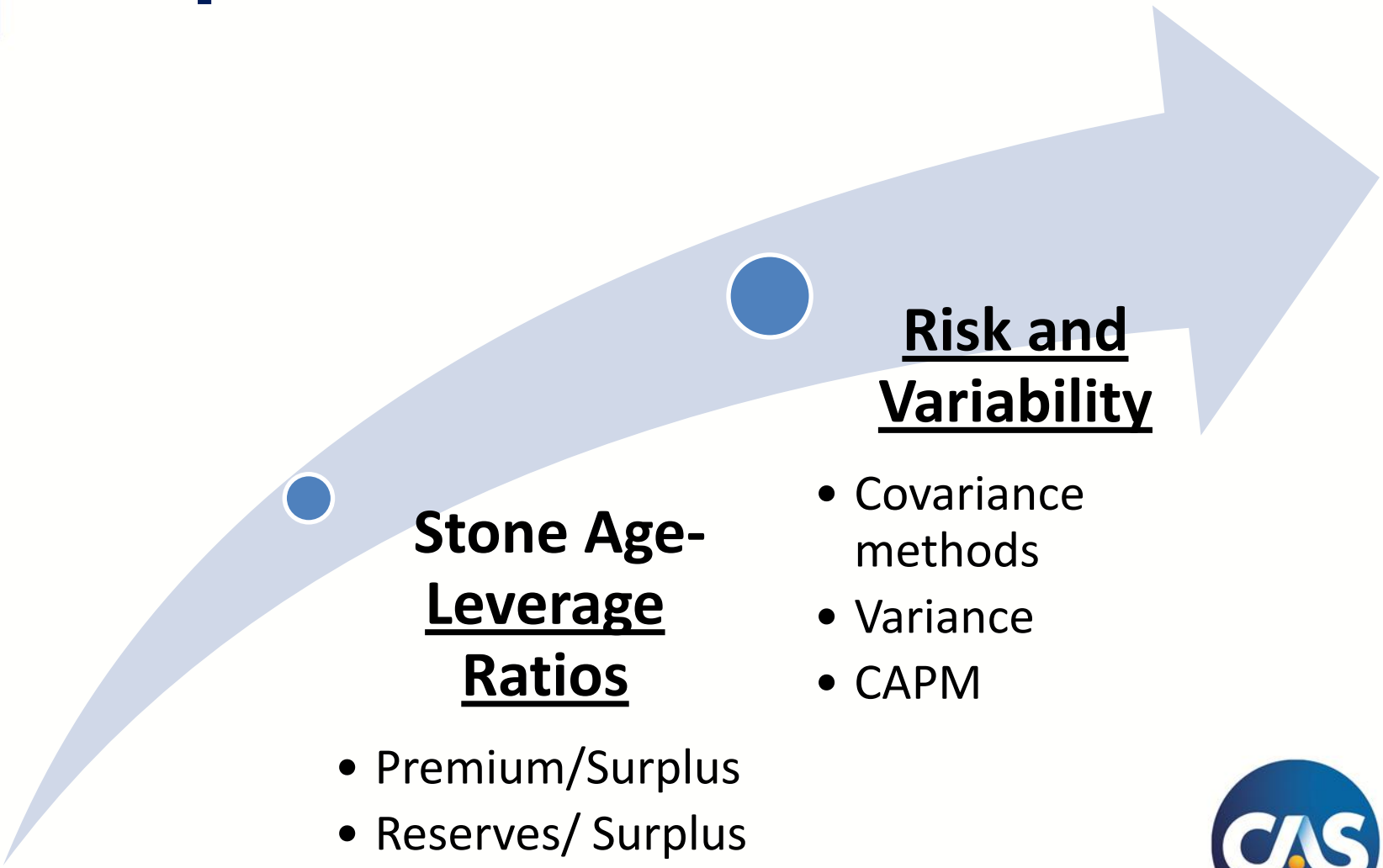
# Capital allocation evolution



# The Stone-age of leverage ratios

- Premium to Surplus
  - Advantages
    - More volume, hence more capital allocation
  - Disadvantages
    - Too many to list here
    - Time horizon
    - Uhhhh  Risk ??????
- Reserves to Surplus
  - At least an improvement as it considers time horizon
  - Uhhhhh  Risk??

# Capital allocation evolution



**Stone Age-**
**Leverage Ratios**

- Premium/Surplus
- Reserves/ Surplus

**Risk and Variability**

- Covariance methods
- Variance
- CAPM

# Covariance Approach

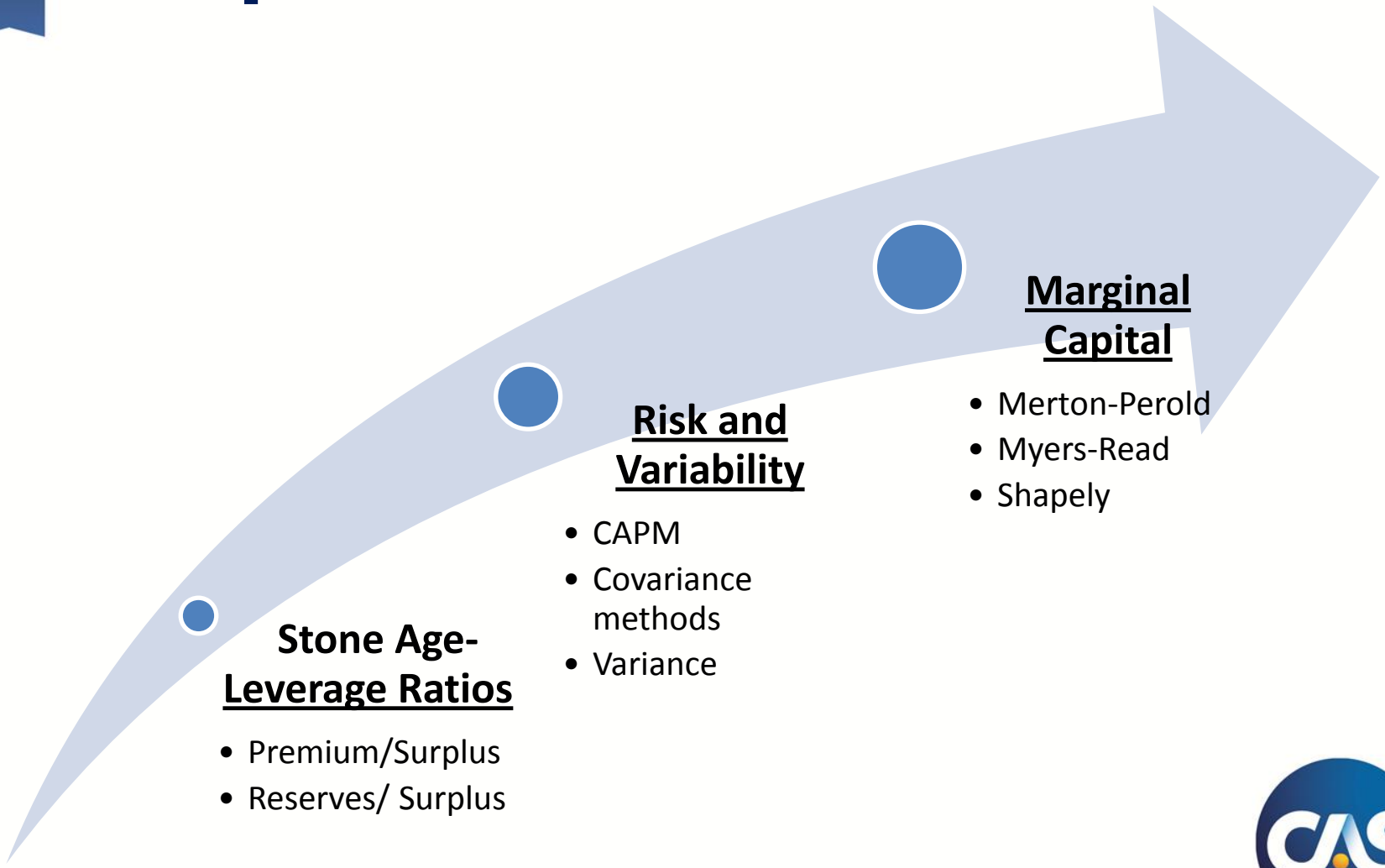
- The covariance methodology
  - Derives the covariance between each line's profitability and total underwriting profitability
  - Sum of the by-line covariances equals the total underwriting variance, capital is allocated to each line based on the ratio of the line's covariance to total variance
- Issues
  - Does not differentiate downside risk from overall variability
  - capital allocation is only being done on an underwriting basis

# CAPM Approach

- CAPM states that the cost of capital for a firm is equal to the risk-free rate plus a risk premium
  - $R_e = R_f + B_e(R_M - R_f)$
- Decomposing the equity beta to a by- line of business beta
- Subsequently the required underwriting return on each line becomes
  - $R_i = -kR_f + B_i(R_M - R_f)$ where k is the liability leverage ratio

- Issue
  - Can Line of business betas really be estimated well?
  - By the way, what is a line of business beta?

# Capital allocation evolution



**Stone Age-**
**Leverage Ratios**

- Premium/Surplus
- Reserves/ Surplus

**Risk and**
**Variability**

- CAPM
- Covariance methods
- Variance

**Marginal**
**Capital**

- Merton-Perold
- Myers-Read
- Shapely

# Marginal Models

- Explicitly recognize diversification benefits
- If the firm cannot pay its liabilities and defaults, the equity holders lose only their stake;
- If the firm defaults, the equity holders get to put the assets to the policyholders / debt holders

# Merton-Perold – Summary

Now we're talking my language…..

- Capital allocation to segments is meaningless
- Capital is held at the company level
- Each segment receives a guarantee from the parent company
- Price of guarantee could be observable in market

- Cost of guarantee represents **risk capital**
- Opposed to allocation exercises:
  - **Guarantee only has meaning at company level**
  - **Order dependence**

# Merton - Perold

- "Risk Capital" = the cost of an option that insures the value of the firm's net assets (assets less liabilities) against a loss in value relative to the risk-free investment of those net assets

- Marginal capital by line = marginal impact on "Risk Capital" attributed to including and excluding the line of business from the portfolio

# Merton-Perold

- Allocation of overall capital is based on changes to the value of the insolvency put option when shifts on LOBs are made

- It s a Discrete Marginal Capital Allocation

# Discrete Marginal Allocations

- Advantages
  - Simple
- Disadvantages
  - Discrete Marginal Allocations Can overstate Diversification Benefits
  - “Last in” Assumptions

# Myers -Read

- Given the firm's assets and the present value of the losses by line, option pricing methods is used to calculate the firm's default value
  - Default value is the premium the company would have to pay to guarantee payment of the losses if the company defaults
- Surplus is then allocated to each line so that the marginal default value is the same in all lines.
- M-R evaluates small incremental changes in a book of business whereas M-P evaluates entering and  exiting the complete book

# Myers-Read – Critiques

- **Time period for option = ?**
- **Sensitive to extreme tail – difficult to estimate**
- **Homogeneity Issues**
- **Again,,,,,,,Last-in**

# Game Theory

## Shapley Method

- Each unit of allocation is a hypothetical company allowed to form coalitions with other units and hence the allocation is the average impact on the unit in such coalitions
- Considers all combinations  (not just last in)
- Issues-  Cumbersome and non-intuitive for audience

# Evolution of Marginal Capital Concept

Panelist: Glenn Meyers, FCAS, MAAA, CERA

Researcher, Writer, Volunteer

March 3, 2015

# Allocating Capital

Glenn Meyers

# An Insurer's Economic Environment

- Diminishing Returns
  - Increased exposure leads to
  1. Increased capital requirements, and
  2. Decreased return on capital
- Diversification
  - Increasing positively correlated exposure takes more capital than increasing uncorrelated (or negatively correlated) exposure.

# An Insurer's Economic Environment

- Prices for insurance products are given
  - By a competitive market
  - By regulation

# Insurer Strategy

- Increase exposure in lines of insurance that get the best return on capital.
- Long-run result of that strategy
  - Return on marginal capital is the same for all lines of insurance.
  - See Meyers “The Competitive Market Risk Load Formula for Increased Limits Ratemaking”
    - PCAS – 1991

# Allocating Capital

- Why not?
  - Capital supports all insureds
- Why?
  - "Insurers demand it"
    - Rodney Kreps – Originator of "MetaRisk"
  - "Use for setting incentive compensation targets"
    - Russ Bingham – Hartford Insurance Group
- Both sides are right – Allocating capital is a useful convenience, not a fundamental economic necessity.

# How Do We Allocate Capital to Promote the Best Economic Behavior?

- Answer – Allocate in proportion to Marginal Capital
- But!
  - Sum of marginal capitals is less than the total capital.
- So what!
  - That indicates that the insurer is benefitting from diversification.
  - That is what they do!
  - Can adjust with a Lagrange multiplier
    - Or a fudge factor

# Consider the Time Dimension

- How long must insurer hold capital?
  - The longer one holds capital to support a line of insurance, the greater the cost of writing the insurance.
  - Capital can be released over time as risk is reduced.
- Investment income generated by the insurance operation
  - Investment income on loss reserves
  - Investment income on capital

# The Cost of Financing Insurance

| | |
|---|---|
| Capital invested in year $y+t$ | $C(t)$ |
| Capital needed in year $y+t$ if division $k$ is removed | $C_k(t)$ |
| Marginal capital for division $k$ | $\Delta C_k(t)=C(t)-C_k(t)$ |
| Sum of marginal capital | $SM(t)$ |
| Allocated capital for division $k$ | $A_k(t)=\Delta C_k(t)\times C(t)/SM(t)$ |
| Profit provision for division $k$ | $\Delta P_k(t)$ |
| Insurer's return in investment | $i$ |
| Insurer's target return on capital | $r$ |

# The Cost of Financing Insurance

| Time | Financial Support Allocated at time $t$ | Amount Released at time $t$ |
|---|---|---|
| 0 | $A_k(0)$ | 0 |
| 1 | $A_k(1)$ | $Rel_k(1) = A_k(0)(1+i) - A_k(1)$ |
| --- | --- | --- |
| t | $A_k(t)$ | $Rel_k(t) = A_k(t-1)(1+i) - A_k(t)$ |
| --- | --- | --- |

Then $$\Delta P_k(0) = A_k(0) - \sum_{t=1}^{\infty} \frac{Rel_k(t)}{(1+r)^t} = (r-i)\sum_{t=1}^{\infty} \frac{A_{k-1}}{(1+r)^t}$$

Note the similarity with the EU and SST risk margin formulas

# Conclusion

- Allocating capital is a convenient way to express an insurer's economic goals.
- Allocating capital in proportion to marginal capital leads to a more efficient use of capital.
- We should also allocate capital to reserves from prior years as well as the current year.

# Evolution of marginal Capital
# Our Evolution Continues

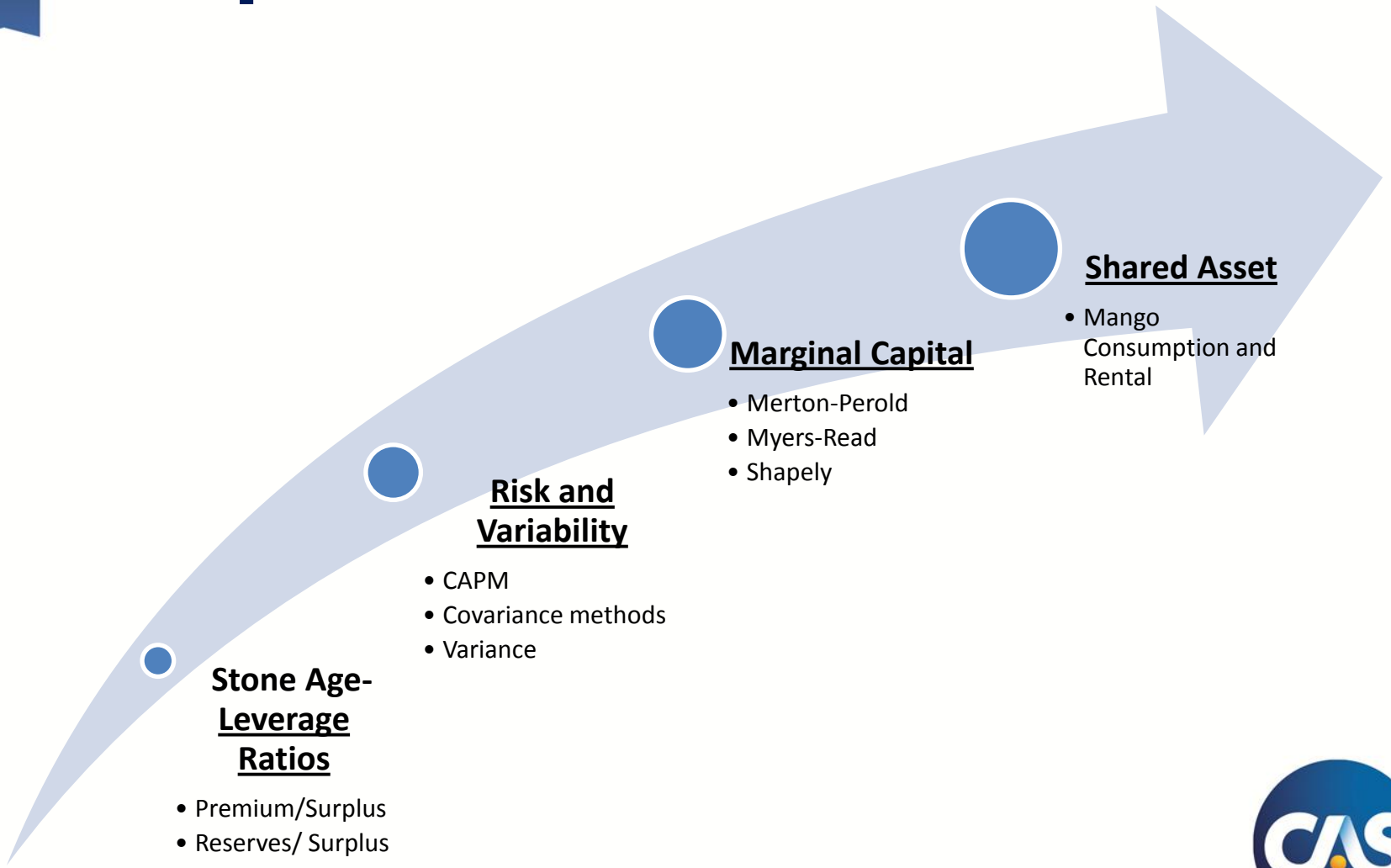
Robert Wolf, FCAS, CERA, MAAA

March 3, 2015

# Alternatives to Allocating Capital

- Follow set-up by Merton-Perold
- No Allocation
- Value the Unit's right to access capital of firm
- Firm implicitly provides each business unit with stop-loss reinsurance with retention at break-even
- Cost for the unit = Value (stop-loss)
- Subtract from the unit's profit to get value-added
- …done.

# Capital allocation evolution



# Allocation vs. Consumption

| *Question 1: What happens to the total capital?* | |
|---|---|
| **Allocation** | **Consumption** |
| • Divided up among the segments.<br>• Either by explicit allocation, or assignment of the marginal change in the total capital requirement from adding the segment to the remaining portfolio | • Left intact<br>• Each segment has the right to "call" upon the total capital to pay its operating deficits or shortfalls |

*Simultaneous, Overlapping Rights to a Single Capital Pool*

# Allocation vs. Consumption

| *Question 2: How are the segments evaluated?* | |
|---|---|
| **Allocation** | **Consumption** |
| • Give the allocations to each segment<br>• Evaluate each segment's return on their allocated capital<br>• Must clear their hurdle rate | • Give each segment "access rights" to the entire capital<br>• Evaluate each segment's potential calls (both likelihood and magnitude) on the total capital<br>• Must pay for the likelihood and magnitude of their potential calls |

*Decentralized vs. Centralized Capital Management*

# Allocation vs. Consumption

| *Question 3: What does being in a portfolio mean?* | |
|---|---|
| **Allocation** | **Consumption** |
| • Being standalone with less capital<br>• But still having access to all the capital if necessary, although it is unclear how this is reflected | • Being standalone with potential access to all the capital<br>• But all other segments have similar access rights |

# The Bi-Polar Capital Hotel

Two distinct different types of insurance capital usage:

1. **Non-Consumptive or "Rental"**
   > Returns are at or above expectation
   > Capital is occupied, then returned undamaged

2. **Consumptive**
   >Results deteriorate
   > Reserve strengthening is needed

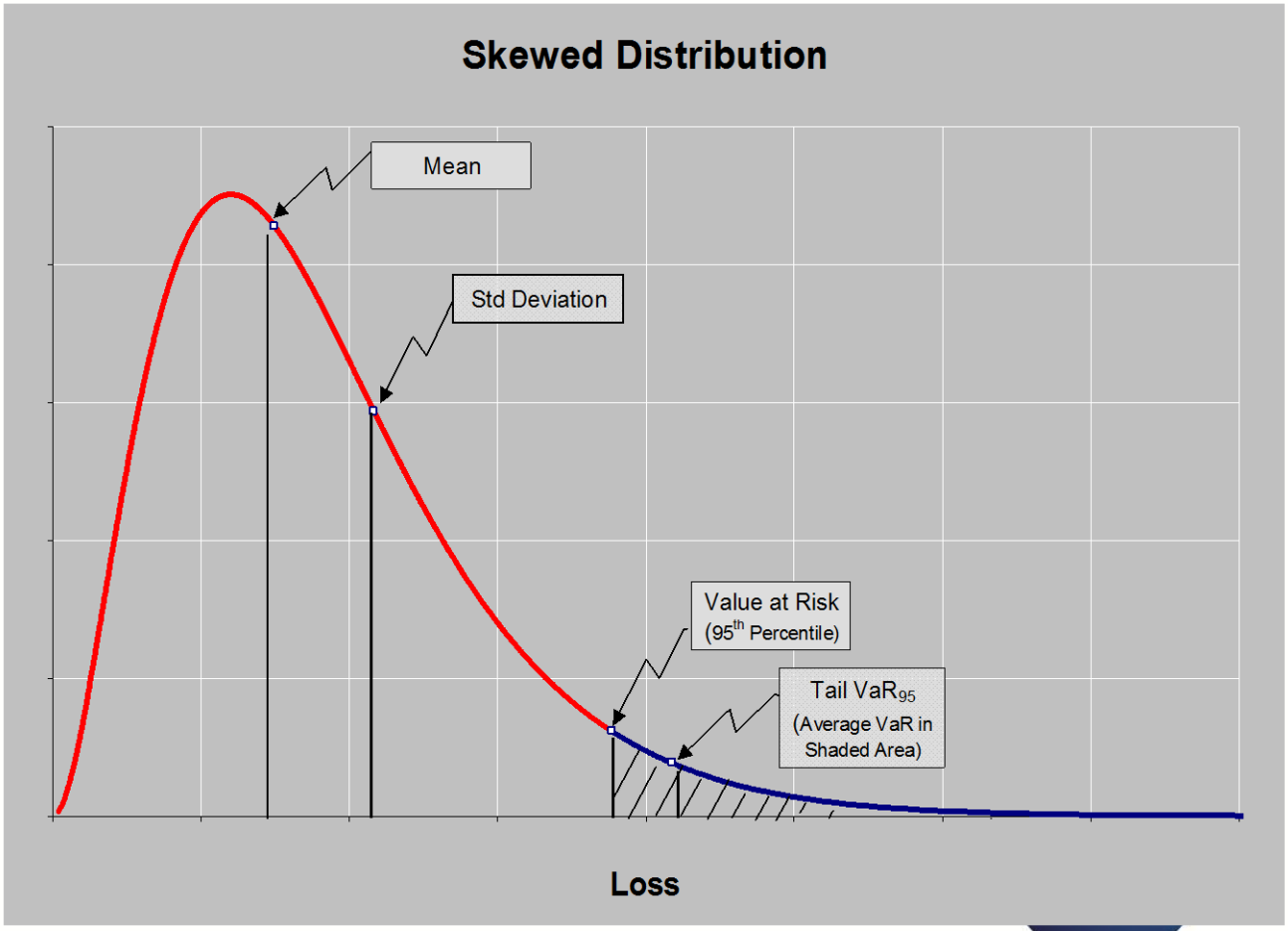
# Which Risk Metric? – Eye of the Beholder

CVs, in general are more responsive to gauging volatility from expected results, while VaR defines the edge of the cliff and stops there, while TVaR steps further in considering how bad it could be beyond the edge of the cliff.

**Value at Risk (VaR)**
VaR measures a percentile of a probability distribution (e.g. the 95th percentile of the distribution is the value for which there is a probability of 5% for exceeding that value)

**Tail Value at Risk (TVaR)**
Is similar to VaR but considers all possibilities beyond the VaR threshold (e.g. TVaR 95% is the arithmetic average of all possible VaRs beyond the 95th percentile of the distribution.

**Coefficient of Variation (CV).**
The CV basically measures the degree of uncertainty of a probability distribution (i.e. the fatness of the distribution). All other things equal, the fatter the distribution or the greater the uncertainty, the greater the capital need



# My Favorite Risk Metric

- How much capital consumption can I afford and stay operationally healthy
  - If a National Writer, I need A - or better Best's Rating
- Also…taking risk is ok, as long as I am getting reimbursed accordingly.

# RMK Algorithm- A very practical

- Pick a Risk Metric
- Model the risks holistically
- Of the scenarios/iterations that fall that contribute to that risk category, gauge the contribution each risk (underwriting units, lines of business, etc.) provides in those scenarios
- The relative contributions form the basis of how much capital is allocated
- I like it.

# Capital Allocation using the RMK Algorithm

*David L. Ruhm, FCAS, CERA, CFA*

*CAS 2015 RPM Seminar*

*March 10, 2015*

*Dallas, TX*

# Capital Allocation: The Problem

- How can total capital (and costs) be allocated to sources of risk, so that:
  - Components add up to subtotals and the total
  - Capital is in proportion to risk contributed
  - Diversification is attributed to its sources
  - The user specifies the risk metric
  - Theory behind the method is connected to financial pricing theory

# An algorithm

"RMK" has these properties, plus:

- Relatively simple – it's weighted averages
- Can be explained fairly easily
- Evaluates risk from the total-company, "top-down" view
  - Vs evaluating each line's stand-alone risk

# RMK Algorithm

## Central principle

Each component is evaluated to measure its contribution to total-company risk.

# RMK Algorithm: Steps

- Simulate possible outcomes by component & total.
- Calculate expected values E[x] of everything
- Select a risk measure on total company outcomes
- Express the risk measure as leverage factors (higher factors for worse outcomes)
- Calculate risk-adjusted expected values E[Rx]
  - These are the weighted averages
- Allocate capital in proportion to risk, by:

Risk ~ Risk-Adjusted Expected Value – Expected Value

**Risk ~ E[Rx] – E[x]**

# RMK Algorithm: A Capital Allocation Example

| Scenario | Underwriting | Investment | Total Company | Risk Leverage | Actual Probability | Risk-Adjusted Probability |
|---|---|---|---|---|---|---|
| 1 | -1,700 | 700 | -1,000 | 3.50 | 10% | 24% |
| 2 | -300 | -700 | -1,000 | 3.50 | 10% | 24% |
| 3 | -800 | 1,100 | 300 | 1.50 | 10% | 10% |
| 4 | 1,000 | 0 | 1,000 | 1.10 | 10% | 8% |
| 5 | -300 | 1,800 | 1,500 | 0.90 | 10% | 6% |
| 6 | 200 | 1,400 | 1,600 | 0.90 | 10% | 6% |
| 7 | -200 | 2,100 | 1,900 | 0.85 | 10% | 6% |
| 8 | -500 | 2,600 | 2,100 | 0.80 | 10% | 6% |
| 9 | 2,000 | 800 | 2,800 | 0.70 | 10% | 5% |
| 10 | 1,800 | 2,200 | 4,000 | 0.60 | 10% | 4% |
| | | | | | 100% | 100% |
| **Expected Income** | **120** | **1,200** | **1,320** | 1.44 | | |
| **Risk-Weighted Expected Income** | -368 | 716 | 348 | | | |
| **Risk Measurement** | 488 | 484 | 972 | | | |
| **Capital Allocation** | **50%** | **50%** | **100%** | | | |
| **Capital** | 5,020 | 4,980 | 10,000 | | | |
| **Return on Risk-Adjusted Capital** | **2.4%** | **24.1%** | **13.2%** | | | |
| **Hurdle Rate for Value Creation** | 9.7% | 9.7% | 9.7% | | | |
| **Value Creation** | **-368** | **716** | **348** | | | |

# RMK Algorithm: A Capital Allocation Example

| Scenario | Underwriting | Property | Casualty | Total Company | Risk Leverage |
|---|---|---|---|---|---|
| **1** | -1,700 | -500 | -1,200 | -1,000 | 3.50 |
| **2** | -300 | -700 | 400 | -1,000 | 3.50 |
| **3** | -800 | -600 | -200 | 300 | 1.50 |
| **4** | 1,000 | 100 | 900 | 1,000 | 1.10 |
| **5** | -300 | -100 | -200 | 1,500 | 0.90 |
| **6** | 200 | 500 | -300 | 1,600 | 0.90 |
| **7** | -200 | 300 | -500 | 1,900 | 0.85 |
| **8** | -500 | 100 | -600 | 2,100 | 0.80 |
| **9** | 2,000 | 800 | 1,200 | 2,800 | 0.70 |
| **10** | 1,800 | 700 | 1,100 | 4,000 | 0.60 |

| | | | | | |
|---|---|---|---|---|---|
| **Expected Income** | **120** | 60 | 60 | **1,320** | |
| **Risk-Weighted Expected Income** | **-368** | -231 | -137 | **348** | |
| **Risk Measurement** | **488** | 291 | 197 | **972** | |
| **Capital Allocation** | **50%** | 30% | 20% | **100%** | |
| **Capital** | **5,020** | 2,994 | 2,026 | **10,000** | |
| **Return on Risk-Adjusted Capital** | **2.4%** | 2.0% | 3.0% | **13.2%** | |
| **Hurdle Rate for Value Creation** | **9.7%** | 9.7% | 9.7% | **9.7%** | |
| **Value Creation** | **-368** | -231 | -137 | **348** | |

# RMK Algorithm: A Capital Allocation Example

| Scenario | Investment | Equities | Fixed Income | Other Invested | Total Company | Risk Leverage |
|---|---|---|---|---|---|---|
| **1** | 700 | 1,100 | -400 | 0 | -1,000 | 3.50 |
| **2** | -700 | -400 | -100 | -200 | -1,000 | 3.50 |
| **3** | 1,100 | 100 | 1,300 | -300 | 300 | 1.50 |
| **4** | 0 | -700 | 800 | -100 | 1,000 | 1.10 |
| **5** | 1,800 | 500 | 1,800 | -500 | 1,500 | 0.90 |
| **6** | 1,400 | 400 | 400 | 600 | 1,600 | 0.90 |
| **7** | 2,100 | -100 | 1,700 | 500 | 1,900 | 0.85 |
| **8** | 2,600 | 200 | 1,300 | 1,100 | 2,100 | 0.80 |
| **9** | 800 | 200 | 200 | 400 | 2,800 | 0.70 |
| **10** | 2,200 | 100 | 1,600 | 500 | 4,000 | 0.60 |
| | | | | | | |
| **Expected Income** | **1,200** | **140** | **860** | **200** | **1,320** | |
| **Risk-Weighted Expected Income** | 716 | 203 | 463 | 50 | 348 | |
| **Risk Measurement** | 484 | -63 | 397 | 150 | 972 | |
| **Capital Allocation** | **50%** | **-6%** | **41%** | **15%** | **100%** | |
| **Capital** | 4,980 | -650 | 4,084 | 1,545 | 10,000 | |
| **Return on Risk-Adjusted Capital** | **24.1%** | **-21.6%** | **21.1%** | **12.9%** | **13.2%** | |
| **Hurdle Rate for Value Creation** | 9.7% | 9.7% | 9.7% | 9.7% | 9.7% | |
| **Value Creation** | **716** | **203** | **463** | **50** | **348** | |

# RMK Algorithm: A Capital Allocation Example

| Scenario | Underwriting | Property | Casualty | Investment | Equities | Fixed Income | Other Invested | Total Company | Risk Leverage |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **-1,700** | -500 | -1,200 | **700** | 1,100 | -400 | 0 | **-1,000** | 3.50 |
| 2 | **-300** | -700 | 400 | **-700** | -400 | -100 | -200 | **-1,000** | 3.50 |
| 3 | **-800** | -600 | -200 | **1,100** | 100 | 1,300 | -300 | **300** | 1.50 |
| 4 | **1,000** | 100 | 900 | **0** | -700 | 800 | -100 | **1,000** | 1.10 |
| 5 | **-300** | -100 | -200 | **1,800** | 500 | 1,800 | -500 | **1,500** | 0.90 |
| 6 | **200** | 500 | -300 | **1,400** | 400 | 400 | 600 | **1,600** | 0.90 |
| 7 | **-200** | 300 | -500 | **2,100** | -100 | 1,700 | 500 | **1,900** | 0.85 |
| 8 | **-500** | 100 | -600 | **2,600** | 200 | 1,300 | 1,100 | **2,100** | 0.80 |
| 9 | **2,000** | 800 | 1,200 | **800** | 200 | 200 | 400 | **2,800** | 0.70 |
| 10 | **1,800** | 700 | 1,100 | **2,200** | 100 | 1,600 | 500 | **4,000** | 0.60 |
| | | | | | | | | | |
| **Expected Income** | **120** | 60 | 60 | **1,200** | 140 | 860 | 200 | **1,320** | |
| **Risk-Weighted Expected Income** | **-368** | -231 | -137 | **716** | 203 | 463 | 50 | **348** | |
| **Risk Measurement** | **488** | 291 | 197 | **484** | -63 | 397 | 150 | **972** | |
| **Capital Allocation** | **50%** | 30% | 20% | **50%** | -6% | 41% | 15% | **100%** | |
| **Capital** | **5,020** | 2,994 | 2,026 | **4,980** | -650 | 4,084 | 1,545 | **10,000** | |
| **Return on Risk-Adjusted Capital** | **2.4%** | 2.0% | 3.0% | **24.1%** | -21.6% | 21.1% | 12.9% | **13.2%** | |
| **Hurdle Rate for Value Creation** | **9.7%** | 9.7% | 9.7% | **9.7%** | 9.7% | 9.7% | 9.7% | **9.7%** | |
| **Value Creation** | **-368** | -231 | -137 | **716** | 203 | 463 | 50 | **348** | |

# Selecting a risk measure

- Many standard risk measures (such as TVaR) can be expressed in the form of weights.
- See Kreps, PCAS 2005 for major examples.
- Example: Net loss outcomes > 1, net gain outcomes = 1.
  - Measures tail of distribution where losses occur.
- In general, risk measure weights are:
  - Non-negative,
  - Higher for worse (“riskier”) outcomes, lower for better outcomes.

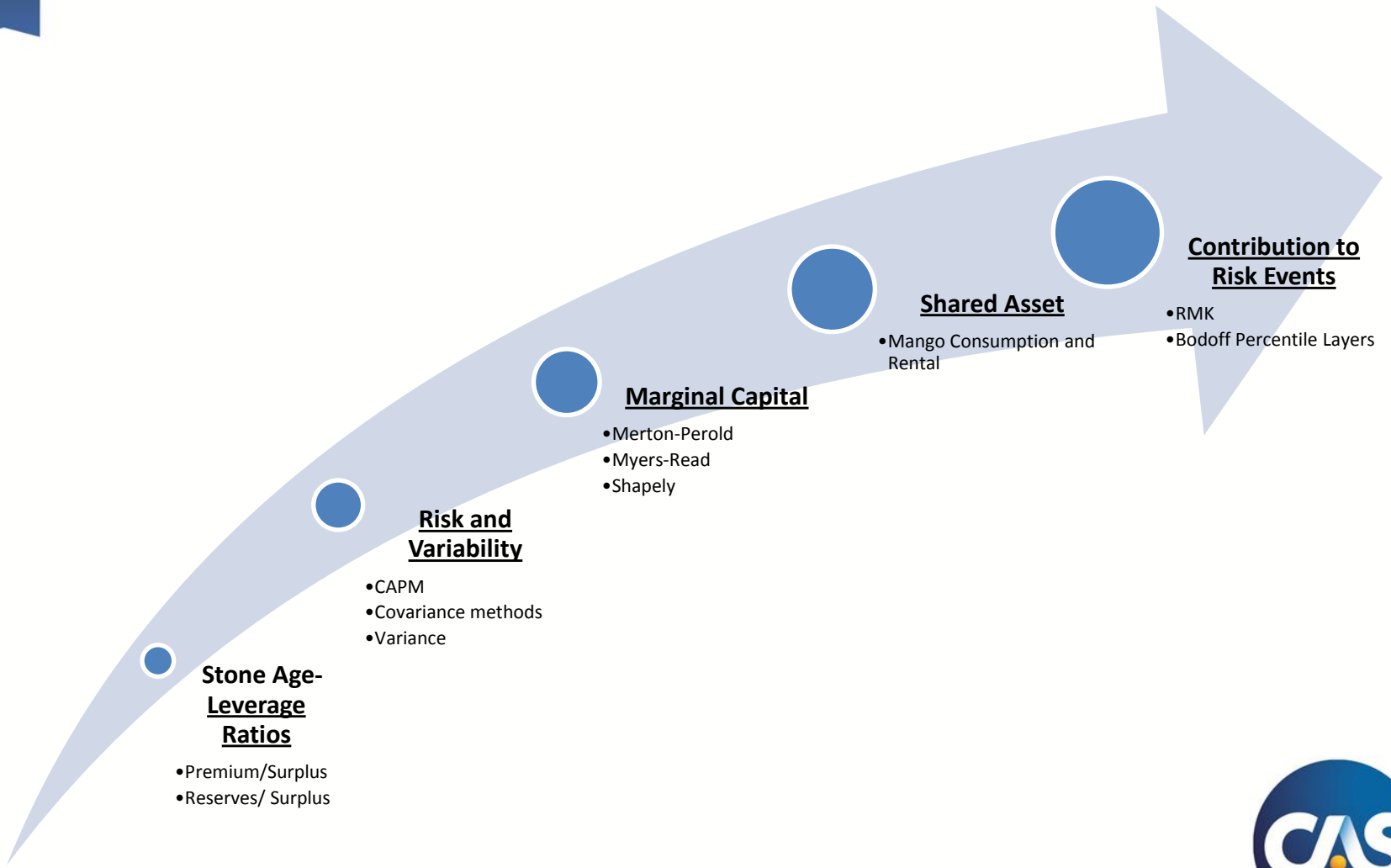
# Summary of useful properties

- General framework for applying additive capital allocation methods
- Flexible choice of risk measure – can experiment
- Allocates risk down to detail level (state, tier)
- Consistent with financial theory
  - Can be used to generate risk-neutral prices
- Relatively simple / transparent

# Selected References


- Halliwell, “Conjoint Prediction of Paid and Incurred Losses,” *CAS Forum,* Summer 1997, volume 1 (thank you Dave Clark for this one)
- Ruhm / Mango, “A Risk Charge Calculation Based on Conditional Probability,” Bowles Symposium, Atlanta, April 2003
- Kreps, “Riskiness Leverage Ratios,” *Proceedings of the CAS,* 2005
- Clark, “Reinsurance Applications for the RMK Framework,” *CAS Forum,* Spring 2005

# Let the Evolution continue



MANAGING EXTREMES Willis Re

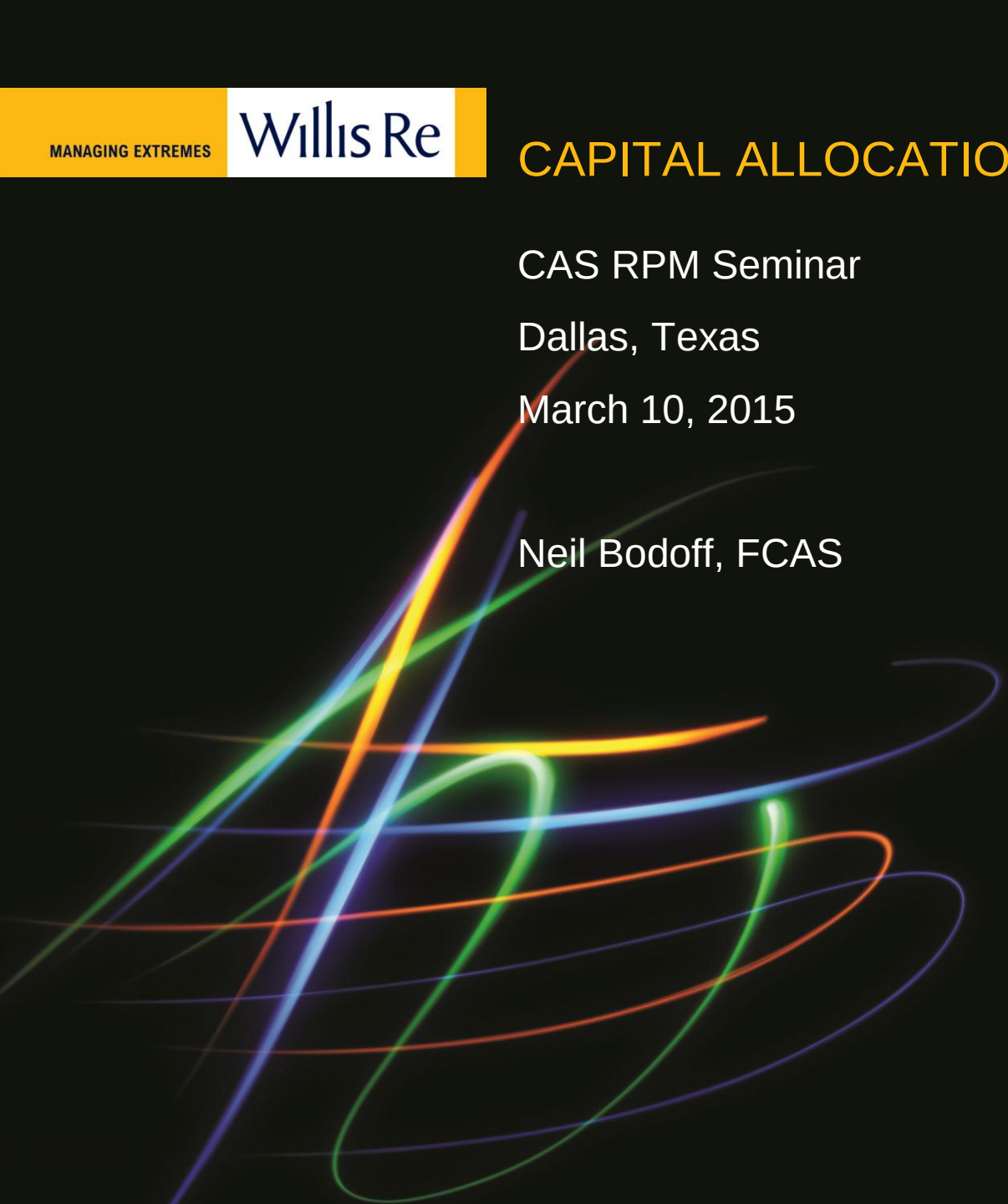
# CAPITAL ALLOCATION

CAS RPM Seminar

Dallas, Texas

March 10, 2015

Neil Bodoff, FCAS



# Actuarial research

- “Half the work is figuring out what the hell the problem really is”
  - Professor Piet de Jong
  - 2009 ASTIN Colloquium, Helsinki
  - Back of the bus, en route to group excursion

# Capital allocation

- Why allocate capital or cost of capital?
- To set risk-adjusted target pricing
- Less obvious than it sounds; we often forget!

# CAPITAL ALLOCATION BY PERCENTILE LAYER

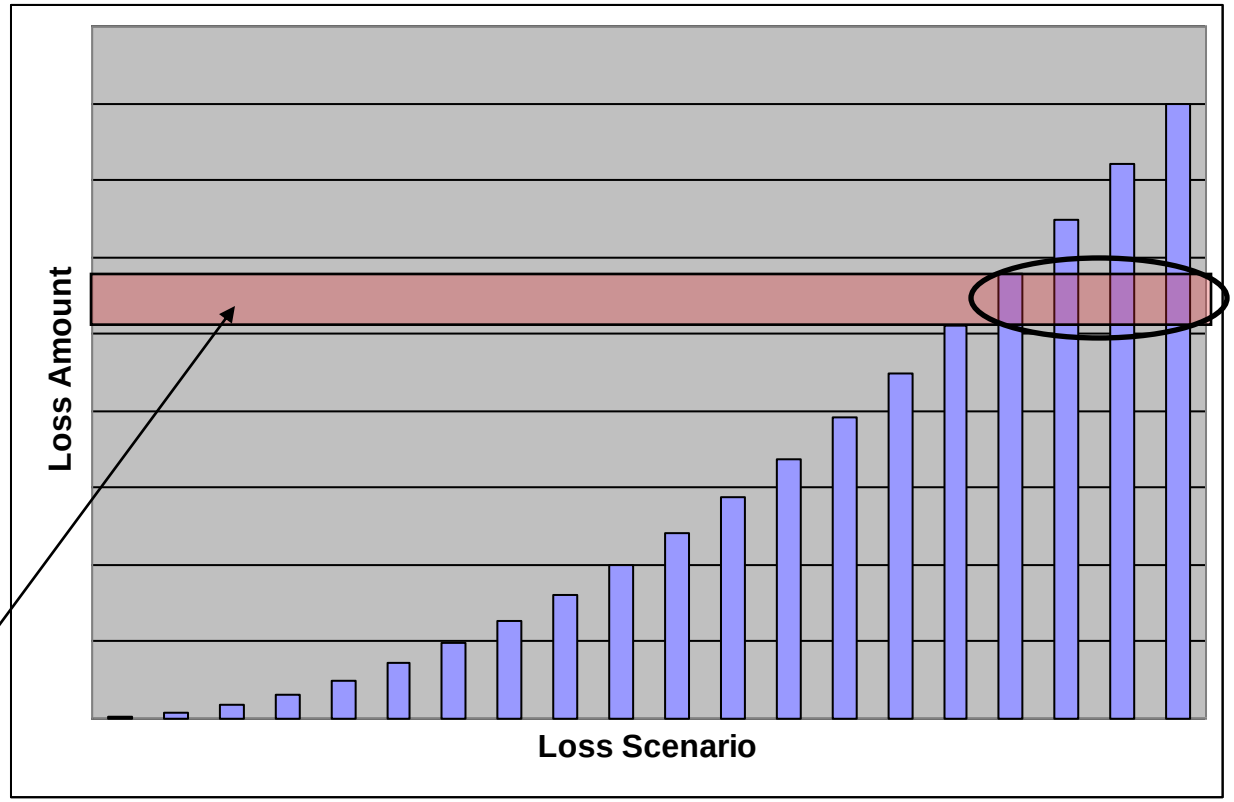
Willis Re MANAGING EXTREMES

Methodology

# Capital allocation by percentile layer

- Rooted in equitable cost allocation
- Which losses cause the firm to hold each dollar of capital?

# Capital allocation by percentile layer

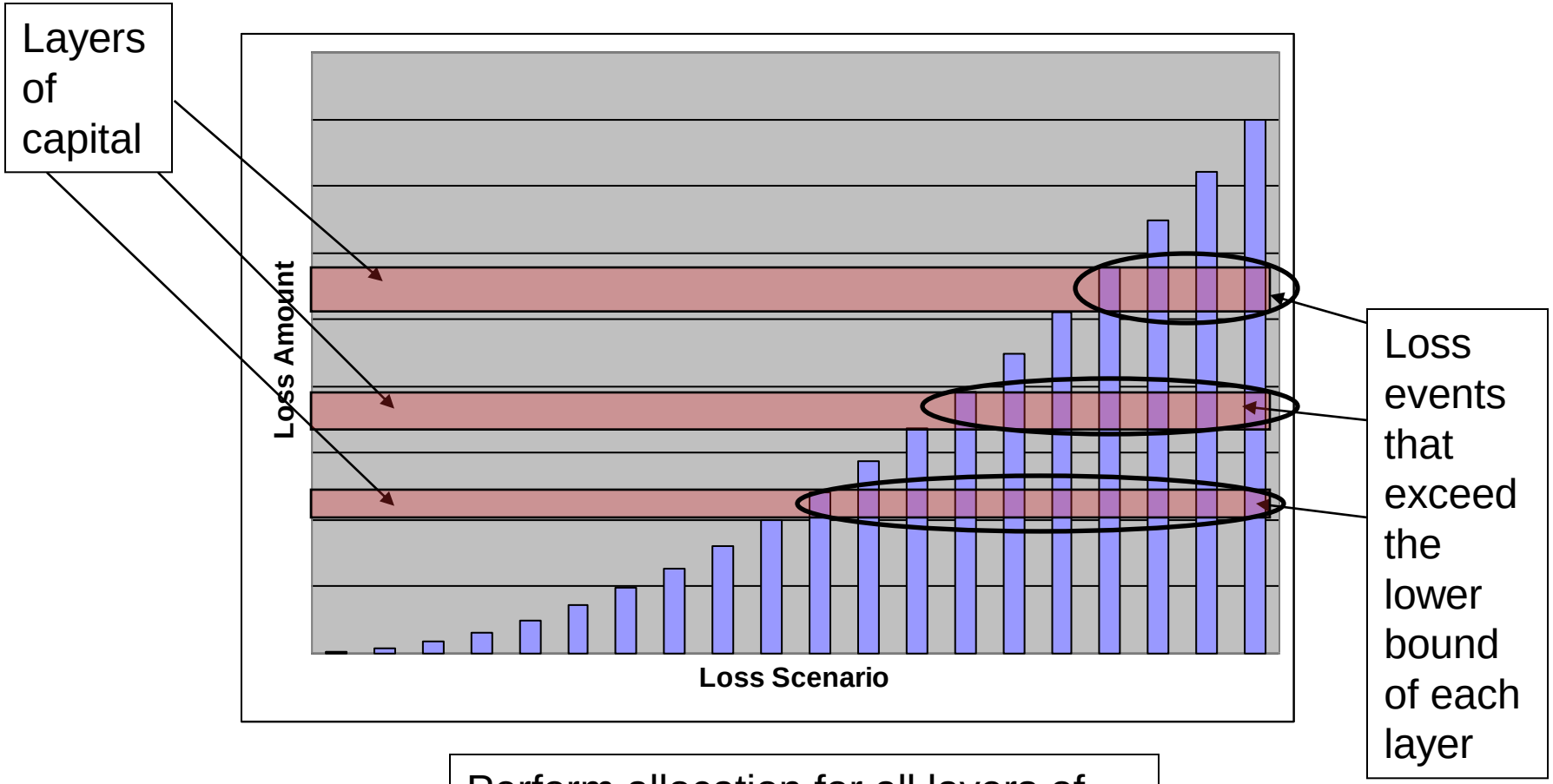



Layer of capital

Loss events (scenarios) that exceed the lower bound of the layer of capital

Allocate the cost of this layer of capital only to losses that cause the firm to hold this layer of capital

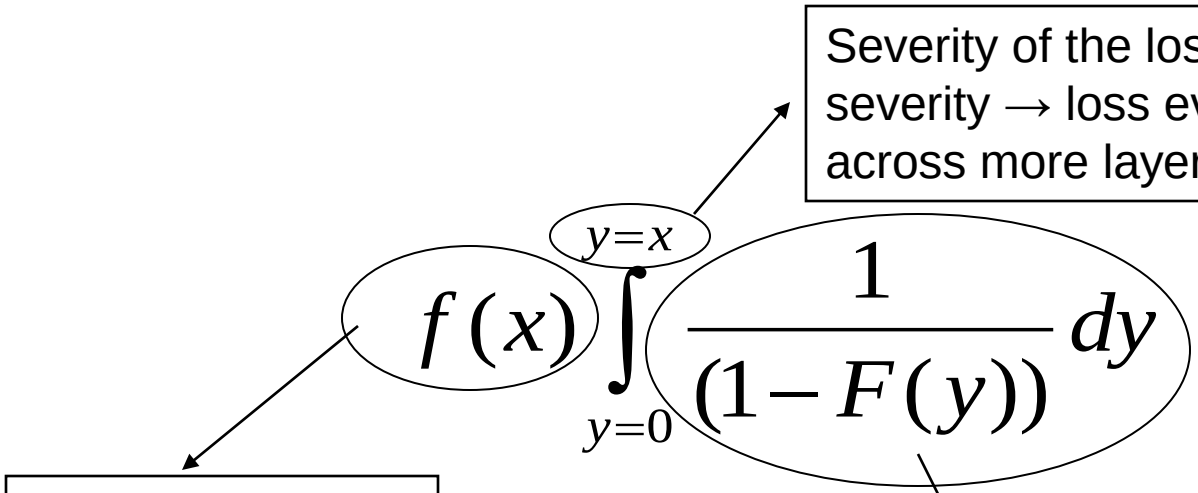
# Capital allocation by percentile layer




Perform allocation for all layers of capital (up to required VaR capital)

# Actuarial cliché: unhelpful slide with continuous math

- A loss event's allocated capital thus depends upon:




Severity of the loss event (i.e., greater severity → loss event receives allocation across more layers of capital)

Probability (or "frequency") of the loss event

Loss event's inability to share capital burden with other loss events (on each layer of capital).

Or, measure of loss event's "dissimilarity" to other loss events.

# Actuarial value: helpful slide with discrete math

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Required Capital Rule = VaR(250 Year Loss)

| | | LOB 1 | LOB 2 | LOB 3 | Total |
|---|---|---|---|---|---|
| 1 | Expected Company Loss | 1,009,165 | 991,712 | 979,685 | 2,980,562 |
| 2 | Gross Allocated Capital | 2,079,742 | 2,173,608 | 5,861,266 | 10,114,617 |
| 3 | Allocated Margin | 97,325 | 107,445 | 443,780 | 648,550 |
| 4 | Allocated Margin % of Total Margin | 15.0% | 16.6% | 68.4% | 100.0% |
| 5 | Calculated Premium | 1,106,491 | 1,099,158 | 1,423,465 | 3,629,113 |
| 6 | Calculated Premium % of Total Premium | 30.5% | 30.3% | 39.2% | 100.0% |
| 7 | Net Allocated Capital | 973,252 | 1,074,451 | 4,437,801 | 6,485,504 |
| 8 | Margin % of Net Allocated Capital | 10.0% | 10.0% | 10.0% | 10.0% |
| 9 | Target LR % [no expenses] | 91.2% | 90.2% | 68.8% | 82.1% |
| 10 | Target Profit Margin % [no expenses] | 8.8% | 9.8% | 31.2% | 17.9% |
| 11 | Margin % of Expected Loss | 9.6% | 10.8% | 45.3% | 21.8% |

Allocating capital adds value if it generates suitable risk-adjusted target pricing

# CAPITAL ALLOCATION BY PERCENTILE LAYER

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Evaluation

# Capital allocation by percentile layer

- Allocates to whole distribution, not just tail
- More realistic allocations
- Stable / robust
- Meaningful; contrast to Esscher, Wang transforms etc
- No arbitrary parameters; contrast to many methods
- Non-marginal, by design
- Can allocate cost of reinsurance capital in addition to cost of equity capital

# TOP TEN UNRESOLVED QUESTIONS IN CAPITAL ALLOCATION

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In my opinion

# Top ten unresolved issues in capital allocation

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- Whole distribution vs tail
- Company portfolio versus market portfolio
- Risk aversion / risk weights: calculated vs chosen
- Change in volatility that leaves capital unchanged
- Cost of capital: several types of “cost”?
- Price loading: just cost of capital or other pieces?
- Principal-agent
- Long-tail casualty across multiple calendar years
- Underwriting portfolio: one year horizon vs several
- Cost: pre-event funding versus post-event pain

# CONCLUSION

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MANAGING EXTREMES

# Capital allocation by percentile layer

- I am looking forward to continued debate in the
  - Dining room
  - Hallway
  - Gym
  - Bar
  - Airport terminal

# Capital allocation by percentile layer

- Workbooks with calculations available upon request

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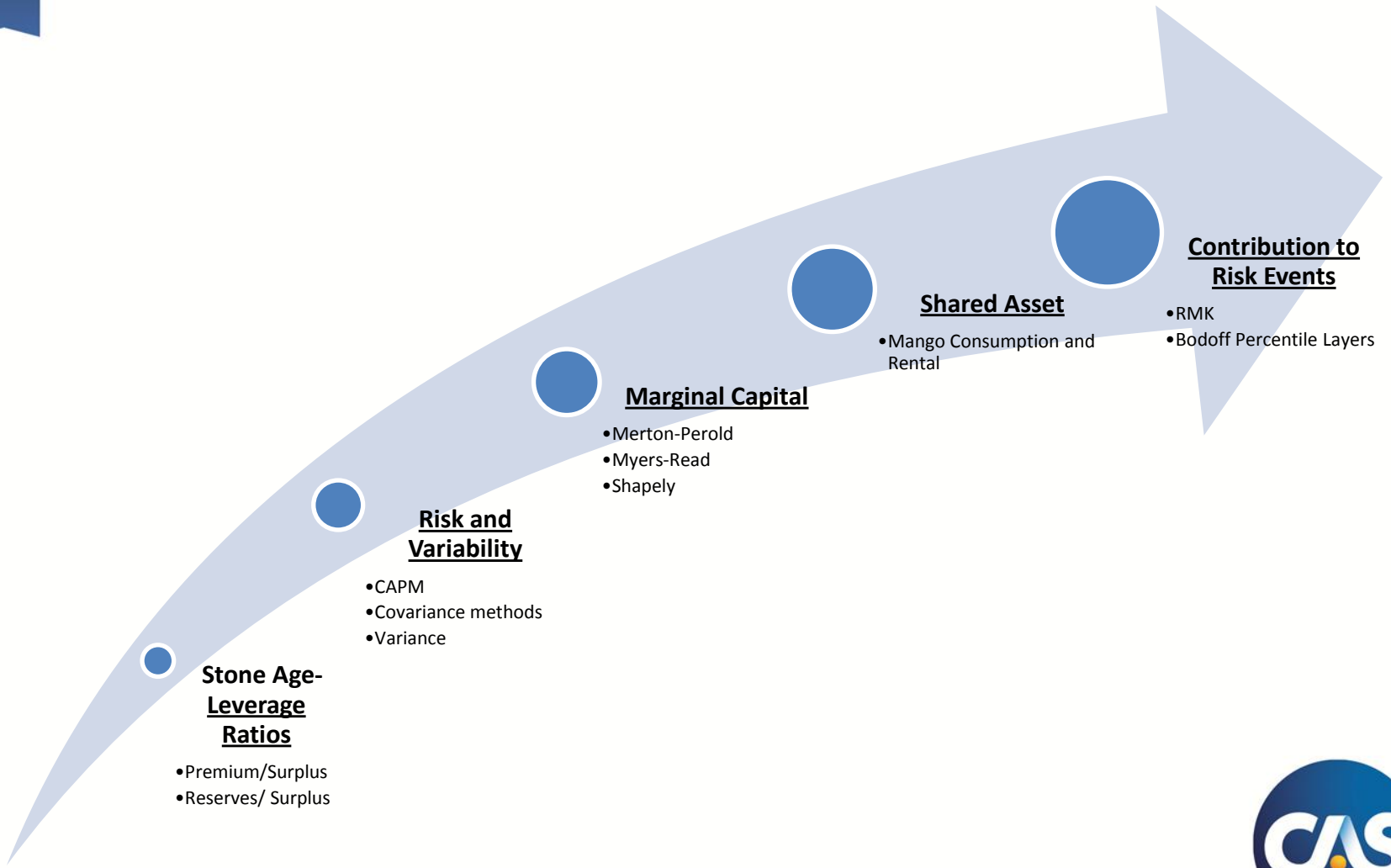
# Summary

Results of Bodoff proposal for capital allocation

- Allocate capital to all loss events, not just in the tail
- Smaller loss events below the tail percentile receive some allocation
- Largest loss events still receive large allocation
  - But less than “tail based” allocation methods
- Can alter the profitability of various lines of business

# Let the Evolution continue



# Thank You !

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