2018 CAS Ratemaking and Product Management Seminar - March 19-21

Introduction to Profit and Contingency Loads

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Ground Rules

- The purpose of this session is to educate actuaries in various methods used to compute the underwriting profit provision.
- There will be no discussion of the adequacy of the premium charge for any particular consumer or particular class of consumers.
- All attendees should scrupulously follow anti-trust guidelines. Several snipers are ready with laser scopes to terminate offenders.
- Questions of logistics and clarification are welcome anytime.

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- Nothing in this presentation should be taken as a statement of the opinion of current or prior clients or employers.
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- While some methods are similar to those on the CAS Syllabus, students should consult the Syllabus for exact details.
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Cautions

- Examples are for illustrative purposes only.
- Do not use the results from any example in real-world applications.
- The profit load indicated from a model often depends critically on the assumptions and parameters. For ease of presentation, assumptions have been greatly simplified and hypothetical parameters have been selected.
- There may be a quiz at the end – so pay attention!

Overview

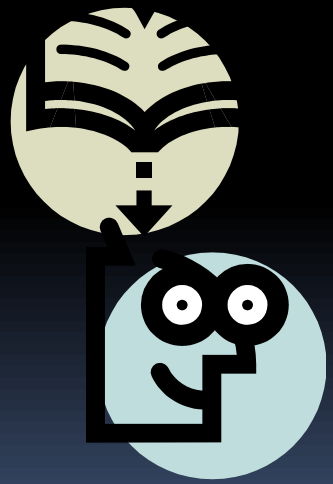
- UW Profit Basics
- Overview of Different Methods
- Corporate and Regulatory Contexts
- Offset Formulas
- ROE Models
- IRR DCF and Risk-Adjusted DCF
- Perspectives

Different Types of UW Profit

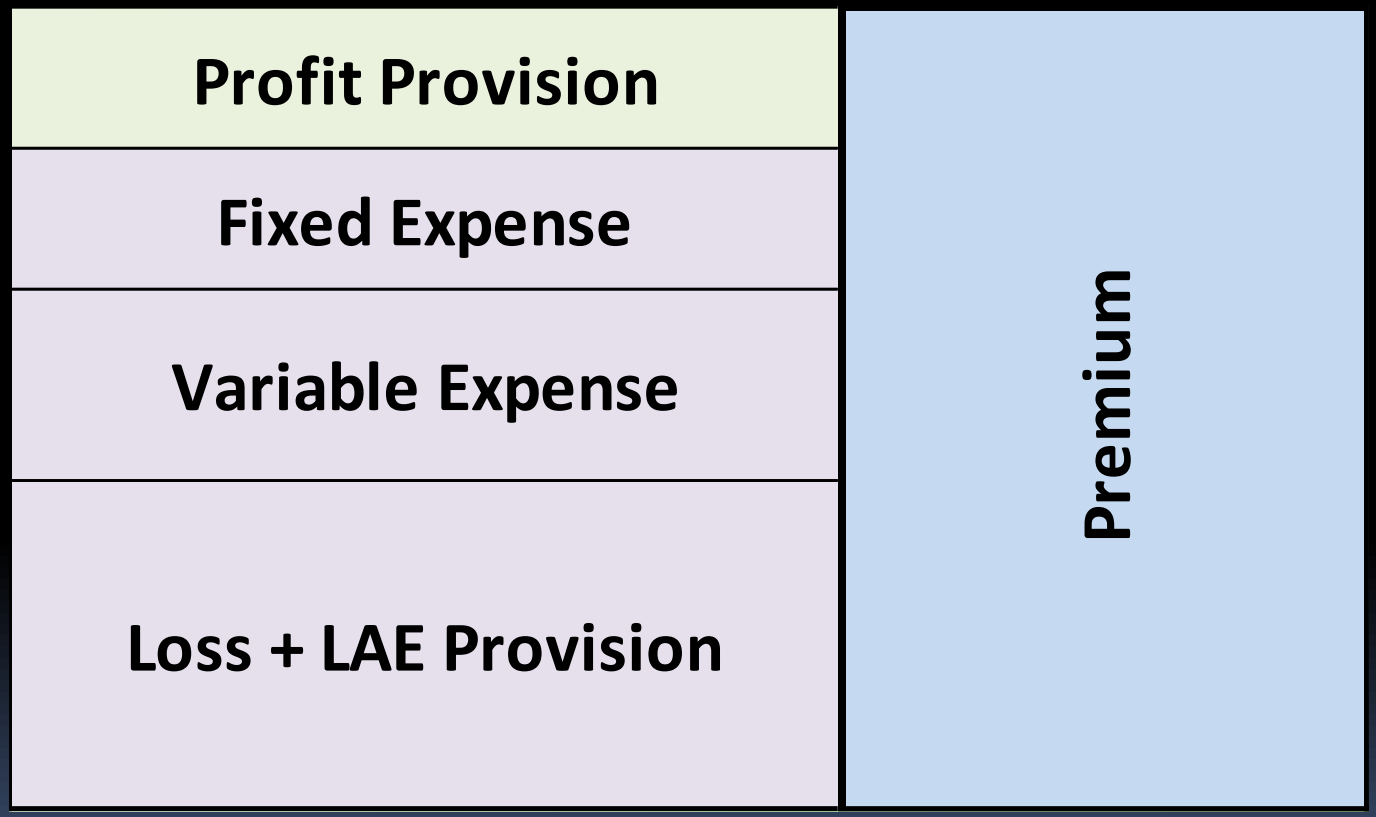
- Actual Achieved
  - Booked to Date vs Ultimate
  - PY, AY, CY
  - Direct, Gross, Ceded, Net
  - Stat vs GAAP
- Provision in Manual Rate
  - Indicated, Filed, Approved
- Per Risk vs Book of Business
- Provision in Charged Premium
  - Competition and Market cycles

UW Profit: Basic Equations

- U = P-L-X = UPM*P
  - L = Loss + LAE
  - X = Expense including premium tax
- CR = (L+X)/P= 1- UPM
  - UPM of –100% yields CR =200%
- X = FX +VXR*P
  - FX = Fixed expense
  - VXR = Variable expense ratio
- P= (L+FX)/(1-VXR-UPM)



UW Profit Provision Chart



UPM Formula Examples

- L=50 FX=30
- VXR = 15% UPM = 5%

$$P = \frac{50 + 30}{1 - .15 - .05} = 100.0$$

- VXR=15% UPM = 10%

$$P = \frac{50 + 30}{1 - .15 - .10} = 106.7$$

- Increasing profit provision 5 points changes premium by more than 5% in this example

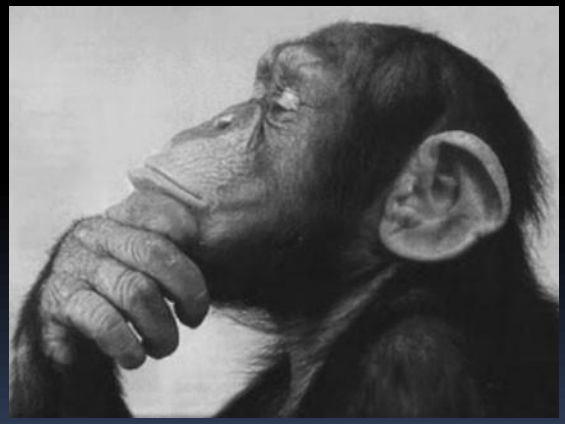
UPM Calculation Approaches

- Investment Income Adjustment
  - Start with traditional profit loads
  - Adjust for investment income
- Total Return
  - Select target return and determine capital
  - Compute total return on capital
  - Find profit needed to hit target return
- Economic Components
  - Needed premium is sum of discounted components
  - Risk reflected in discounting

UW Profit Provision Methods

Investment Income Offset	**1. CY Investment Offset (State X)** **2. PV Differential**
Total Return	**3. CY ROS or ROE** **4. IRR on Equity Flow** **5. PVI/PVE**
Economic Components	**6. DCF** **7. Risk-Adjusted DCF**

What is the right Underwriting Profit Provision ?



Right Method Depends on Context

- Regulatory
  - Philosophy of regulation
    - State controlled vs free market approaches
  - LOB differences: Personal Lines vs Commercial
  - Prior approval/File and use/Use and file
- Corporate
  - UPM targets by LOB or Business Segment
  - Pricing for target return net of risk over cycle
  - Pricing hurdle

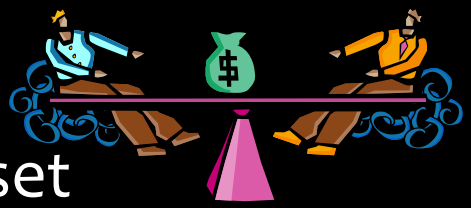
Recap of UW Profit Regulation

- 1920's – 1970's: Low interest rate era
  - No explicit consideration of investment income
  - 5.0% UPM for most lines (2.5% for WC)
- 1970's – 90's: High rate era
  - Investment income offsets
  - CAPM, DCF and Risk-Adjusted DCF
  - IRR on Equity Flows and PVI/PVE
- Late 1990s-2000- …: Low rate era
  - Less interest in Inv Income regulation
  - Lower loss costs
  - Competitive rate reductions
  - More open competition
  - More ads about rate reduction

CY Investment Income Offset (State X)

$$UPM = UPM_0 - IIOffset$$

- UPM_0 = Traditional UPM
- IIOffset = Investment Income Offset



$$IIOffset = i_{AFIT} * PHSF$$

- PHSF = Policyholder supplied funds
- Interest rate after-tax from CY inv inc earned
- Actual portfolio mix of invested assets

Policyholder Supplier Funds
Two Components

$$UEPR(1 - PPACQR) - RECV$$

- UEPR net of Pre-Paid Acquisition Cost
- Reduce for Receivables

$$PLR * {}^{LRES}/_{INCL}$$

- PLR = Permissible Loss Ratio
- CY ratio of L+LAE Reserves to Incurred

Balance Sheet and Income Statement Sources

Bonds	
Common Stocks	
Preferred Stocks	
Real Estate	
Cash and Short Term Investments	
Other Invested Assets	
Total Invested Assets	1,840
Receivables and expected IOUs	260
Total Assets	2,100

Unpaid Loss and Loss Adjustment Expense	1,200
Unearned Premiums	400
Total Promises to Policyholders	1,600
Other Liabilities	-
Total Liabilities	1,600
Surplus	500
Total Liabilities and Surplus	2,100

Earned Premium	1,000	100%
Incurred Loss and LAE	800	60%
Prepaid Acquisition Cost	100	10%
General Expenses	300	30%
Permissible Loss Ratio (no Profit Load)		60%
Premium to Surplus	2.00	

PHSF (as % of Earned Premium)	1.00
UEPR (as % of Earned Premium)	0.40
PPACQR (as% Earned Premium)	0.10
Receivables (as % Earned Premium)	0.26
L&LAE Reserves (as % Incurred Loss and LAE)	1.50
L&LAE Reserves (as % earned premium)	0.90

CY II Offset- Example

UEPR	400	Earned Prem	1,000
LRES	1,200	Inc'd Loss+LAE	800
RECV	260	PPACQR	10.0%
UPM^0	5.0%	PLR	60.0%
		After-tax Yield	2.0%

PHSF = ((400/1000)·(1-.1)-.26) + .6·1.5 =1.00

UPM = .05 - .02·1.00 = 3.0%

Offset for PV Loss Differential

$$UPM = UPM_0 - PVDELLLR$$

- UPM_0 = Traditional UPM

$$PVDELLLR = PLR * (PV(x_0) - PV(x))$$

- PLR = Permissible Loss ratio
- $\mathbf{x}$ = Loss pattern for review LOB
- $\mathbf{x}_0$ = Loss pattern for reference LOB
- PV using risk-free new money rate after-tax

PV Differential Offset- Example

PV(REF Loss Pattern)	99.0%
PV(REV Loss Pattern)	95.0%
Risk-free New Money Rate after tax	2.0%
PLR	60.0%
Traditional UPM	5.0%
PVDELLR = (.99-.95)*.60 = 2.4%	
UPM = .050-.024 = 2.6%	

Risk, Return, and the Cost of Supplied Funds

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?

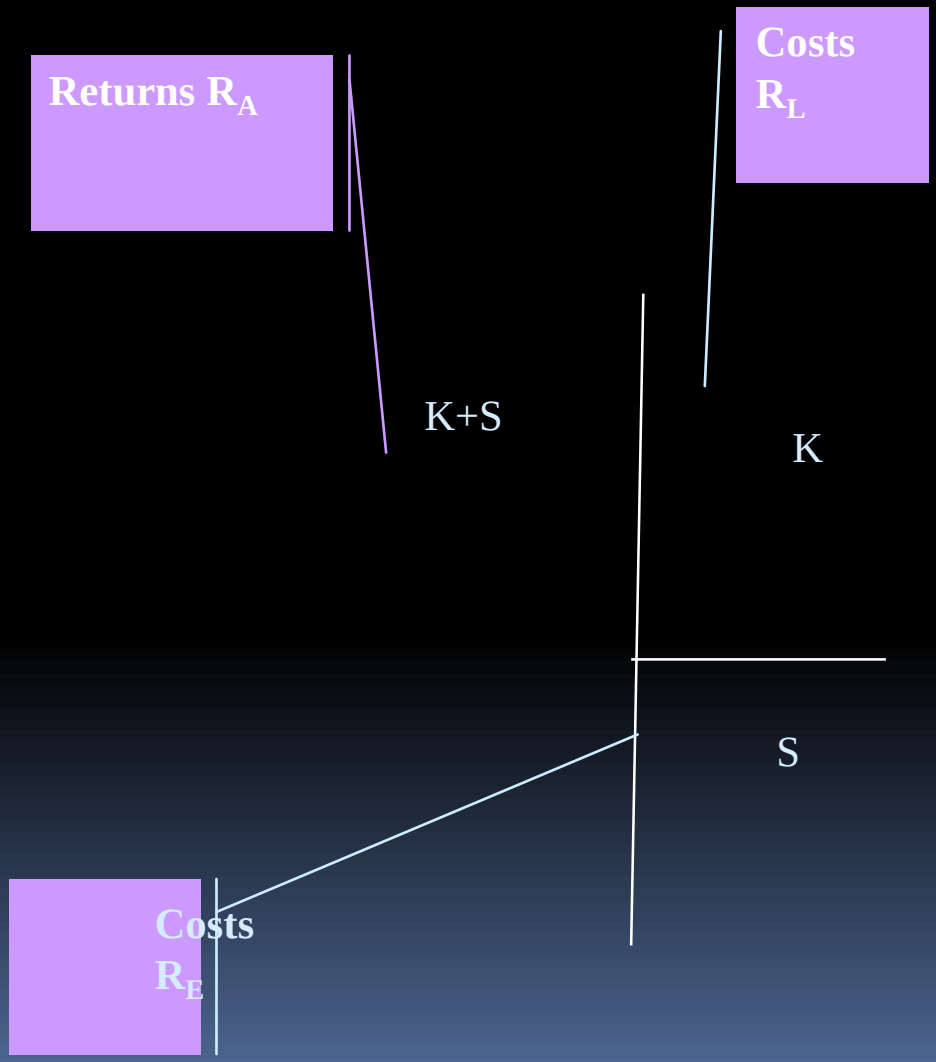
- Two Issues
  - What's *appropriate*?
    - Risk charge for "random variation from the expected costs" must be "consistent with the cost of capital"
    - Included in underwriting profit provision
  - How do you measure *return*?
    - Return on *what*?
      - Typically is has related to the capital attributed to the business that your are pricing
      - So the game plan has been to allocate capital in the interest of getting to or deriving the cost of capital.

Marginal Balance Sheet Impact

Let R_A = Return on Assets supplied by both policyholders and shareholders.

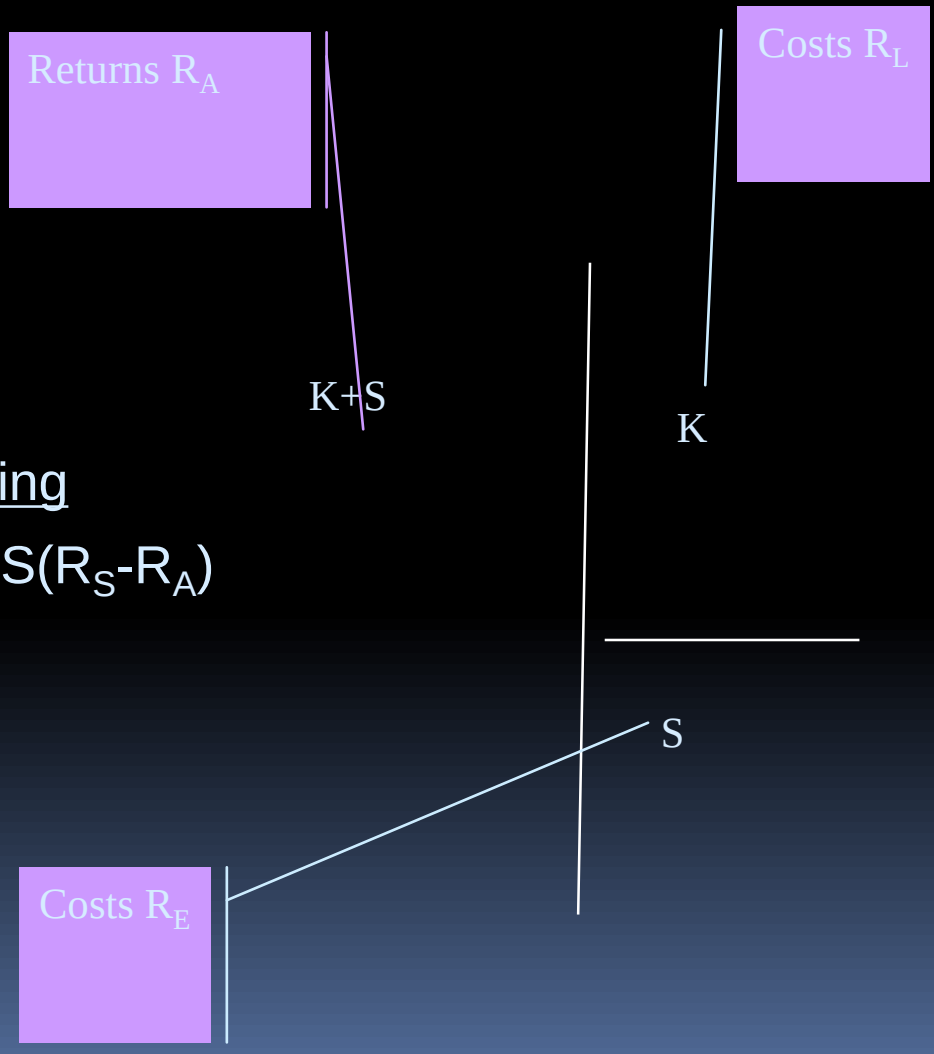
R_L = Cost of Debt. Borrowing From Policyholders. Borrowing PHSF

R_E = Cost of Capital. Using SHSF



Marginal Balance Sheet Impact

This relationship develops into the generally accepted view that an insurance company is a tax disadvantaged leveraged trust.



Levered Trust

$(K+S)R_A = KR_L + SR_E$

Re-Arranging

$K(R_A-R_L) = S(R_S-R_A)$

$R_L = R_A - (S/K)(R_E - R_A)$

Let R_u = Underwriting Profit Margin

Let P = Premium

$R_U = -K R_L/P$

Target CR = $1 - R_U = 1 + K R_L/P$

Cost of Borrowing from Policyholders (i.e. Cost of the Float) Dependent on the Adequacy of Rates

- Insurance Company Earns Positive Economic Returns on Underwriting if $R_A > R_L$ ($R_u > -(K/P) R_A$)
- …so back to "How Much Capital is enough"?

$$\frac{SHSF}{S(R_E - R_A)} = \frac{PHSF}{K(R_A - R_L)}$$

CY ROS Equation

$$ROS = \frac{INC}{S} = \frac{U + INV - T}{S}$$

ROS Decomposition

$$ROS =$$

$$(1-t)\cdot UPM\cdot\lambda$$

$$+i_{AT}\cdot PHSF\cdot\lambda$$

$$+i_{AT}$$

Premium to Surplus Ratio

CY ROS

- ROE vs ROS
- GAAP vs STAT
  - Going-concern vs Solvency
  - STAT defined by state regulation
- Calendar Yr vs Policy Yr
  - ROE is CY
  - Past decisions impact this CY
  - Ratemaking is PY and prospective

Surplus in ROS Equation

- S = Target Statutory Surplus

  $S = P/\lambda$

  λ = Premium-to-Surplus leverage ratio

  λ varies by LOB

- Equity vs Surplus

Solve for UPM

$$UPM = \frac{ROS_{target} - i_{AT} - i_{AT} \cdot \lambda \cdot PHSF}{(1 - t)\lambda}$$

UPM to Hit CY ROS- Example

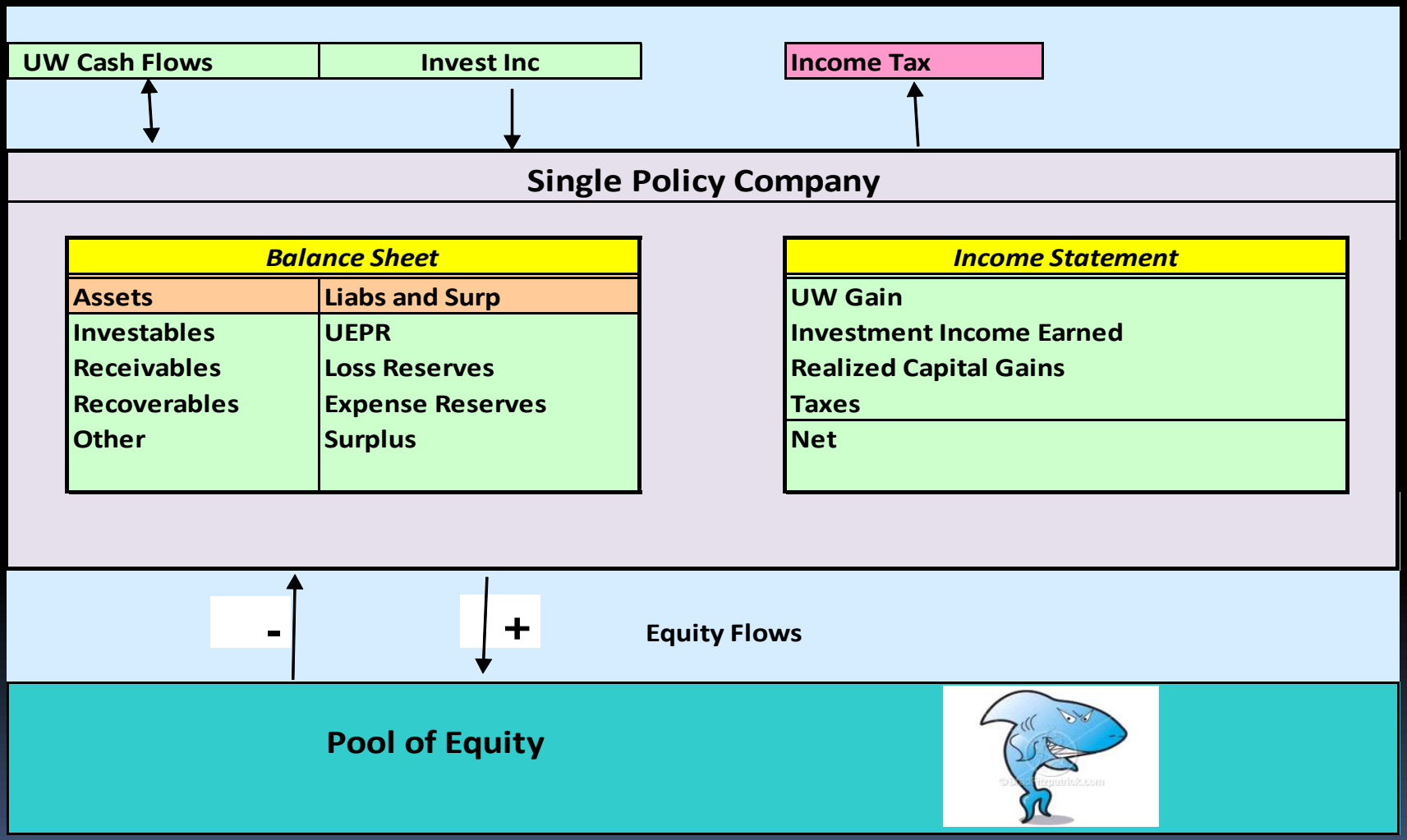
Inputs	
PHSF	110.00%
λ	2.00
After-tax yield	2.00%
tax rate	35.00%
target ROS	12.00%
UPM	4.31%

	% of P
II afit on PHSF	2.20%
II afit on S	1.00%
(1-t)UPM	2.80%
Total	6.00%
Surplus	50.00%
ROS	12.00%

IRR on Equity Flows

- Internal Rate of Return on Individual Policy or Book of Business or LOB
  - Can be used in regulatory or corporate contexts
- Equity flow: flow of $ between an equity investor and the insurance company
  - Model prospective equity flows for hypothetical insurance company writing one policy
- Use accounting rules, capital requirements, and other assumptions to derive income and surplus each time period.
- EQF = INC – ΔS

Equity Flow Diagram



Capital

- Set Surplus = Required Capital
  - Need to specify amount and duration in model
  - Reflect UW, CAT, and Reserving risk
- Not an Actual Allocation of Capital
- Regulatory: RBC, RDS, Solvency II
- Rating Agencies: S&P, A.M. Best, etc.
- Book of Business Variation
  - Should high layer excess casualty and primary low limit casualty use the same Other Liab factors?
- Individual Large Risk or Treaty Variation
  - Adjust for treaty features (e.g. reinstatements, agg caps)

Income and Cash Flow

- UW Gain = EP –IncLoss –IncExpense
  - Defined by accounting rules
  - Does not depend on UW cash flows
- Inv Inc = II on Invested Assets
- Invested Assets
  - Assets- Recvbl's -Recovs
- Assets = Reserves + Surplus
  - Balance sheet must balance
  - Amounts defined by accounting rules
  - UW Cash flows impact Invested Assets

Single Policy Company: UW Income and Cash Flow

time	Earned Prem	Paid Prem	Inc'd Loss	Paid Loss	Inc'd Expense	Paid Expense	UW Income
0	0	50	0	0	30	16	-30
1	100	50	62	20	5	10	33
2	0	0	0	30	0	5	0
3	0	0	0	12	0	4	0
total	100	100	62	62	35	35	3

Single Policy Company: Assets and Investment Income

time	UEPR	Loss Rsv	Expense Rsv	Surplus	Total Liab and Surplus	Recv'ble	Inv'stble Assets	Inv Income
0	100	0	14	40	154	50	104	
1	0	42	9	10	61	0	61	5.2
2	0	12	4	4	20	0	20	3.1
3	0	0	0	0	0	0	0	1.0

Single Policy Company: Equity Flow and IRR

				Pre-tax IRR	14.2%
time	UW Income	Inv Income	Total Income	Change in Surplus	Equity Flow
0	-30	0.0	-30.0	40	-70.0
1	33	5.2	38.2	-30	68.2
2	0	3.1	3.1	-6	9.1
3	0	1.0	1.0	-4	5.0
total	3	9.3	12.3	0	12.3

IRR

- Given flows , x_t , IRR is the interest rate, y, (if it exists) which solves:

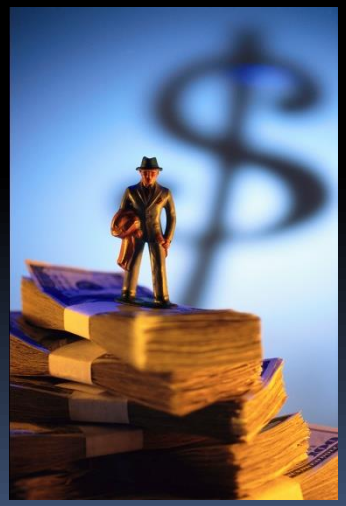
$$0 = \sum_{t=0} v^t \cdot X_t$$

$$v = (1+y)^{-1}$$

  - IRR extends the concept of the interest rate on a loan to a more general situation

IRR on Equity Flows

- Typical EQ Flows in P/C insurance
  - First flow is negative
  - Later flows are positive
  - One sign change
- IRR on EQ Flow well-defined
- Solve for premium to hit IRR target



Discounted Cash Flow

- Prospective cash flow approach based on application of 1950-2005 era economic theory

$$UPM = -kr_f + \beta(E[r_m] - r_f)$$

  - k = funds generating coefficient
  - r_f = risk-free new money rate
  - r_m = market return
  - β = systematic covariance

Applying CAPM to Insurance

- CAPM risk–reward concept
  - Reward for taking systematic risk
  - No reward for diversifiable risk
  - Beta =Cov of Company Stock with Market
- Insurance Betas by LOB?
  - Few single LOB insurance companies
  - Beta=Cov of LOB UPM with stock market?
  - Backward results not same as forward-looking prices?
- Tax Adjustment of UPM
  - Add in tax on investment income on (assets offsetting) Surplus

DCF - Example

Risk-free rate	2.0%
Funds Generating Coefficient	1.30
Beta for LOB	1.25
E[Market yield]	6.0%

UPM = -1.30*.02+ 1.25(.06-.02) = 2.4%

Risk-Adjusted DCF

- Solve for UPM so that:

$$PV(P, r_f) = PV(L, r_A) + PV(X, r_f) + PV(FIT, r_f)$$

r_f = risk-free new money rate

r_A = risk-adjusted rate

FIT = income tax including tax on inv inc on Surplus

- Loss discounted at risk-adjusted rate

Risk-Adjusted Rate

- $r_A = r_f + \beta\,(E[r_m] - r_f)$
- β = Cov of liabilities with market
- While $\beta > 0$ for assets, the β here is for liabilities. Thus:
  - $\beta < 0$ and $r_A < r_f$
- How to get β by LOB?
- When r_f is low, we can get a risk-adjusted rate less than 0 since $\beta < 0$.

Risk-Adjusted DCF Example

	Computed with Risk-free Rate	Computed with Risk-Adjusted Rate
PV Factor for Loss	0.98	1.01

	FV	PV Factor	Discounted
Loss	60.00	1.01	60.60
Fixed Expense	25.00	1.00	25.00
Variable Expense	15.00	1.00	15.00
Total	100.00		100.60
Premium	100.60	1.00	100.60

Combined Ratio	99.4%
UPM	0.6%

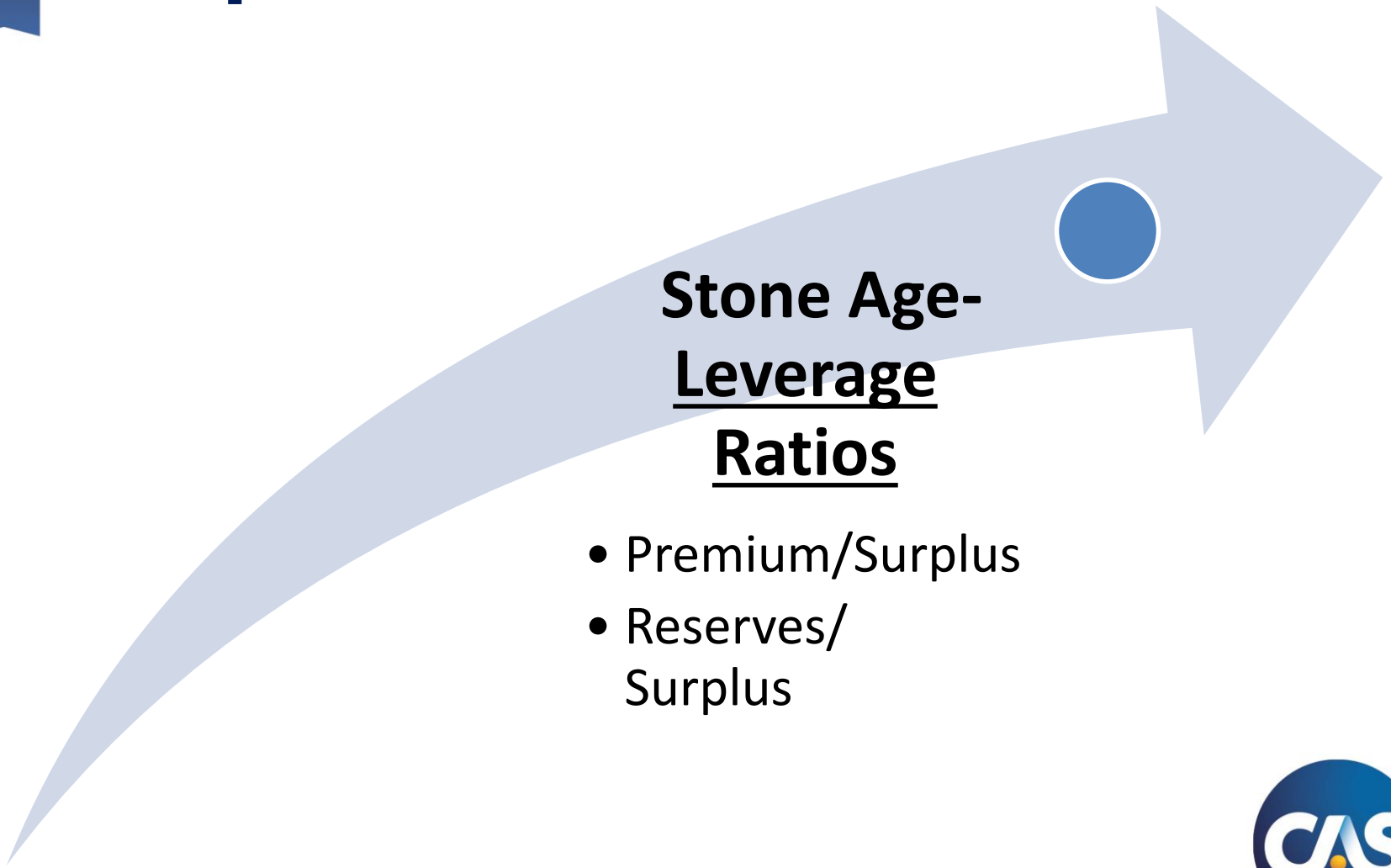
Interest Rate and Surplus Considerations

Methods	Interest Rate	Surplus
CY Invesment Offset	CY Inv Earned	N/A
PV Loss Differential Offset	Risk-free New Money	N/A
CY ROE	CY Inv Earned	P/S Ratio
IRR on Equity Flows	Risk-free New Money	Required Capital
PVI/PVE	Risk-free New Money	Results Highly Dependent on Surplus assumption
DCF	Risk-free New Money	P/S Ratio or Capital Model
Risk-adjusted DCF	Risk Adjusted New Money	Results marginally dependent on Surplus assumtions

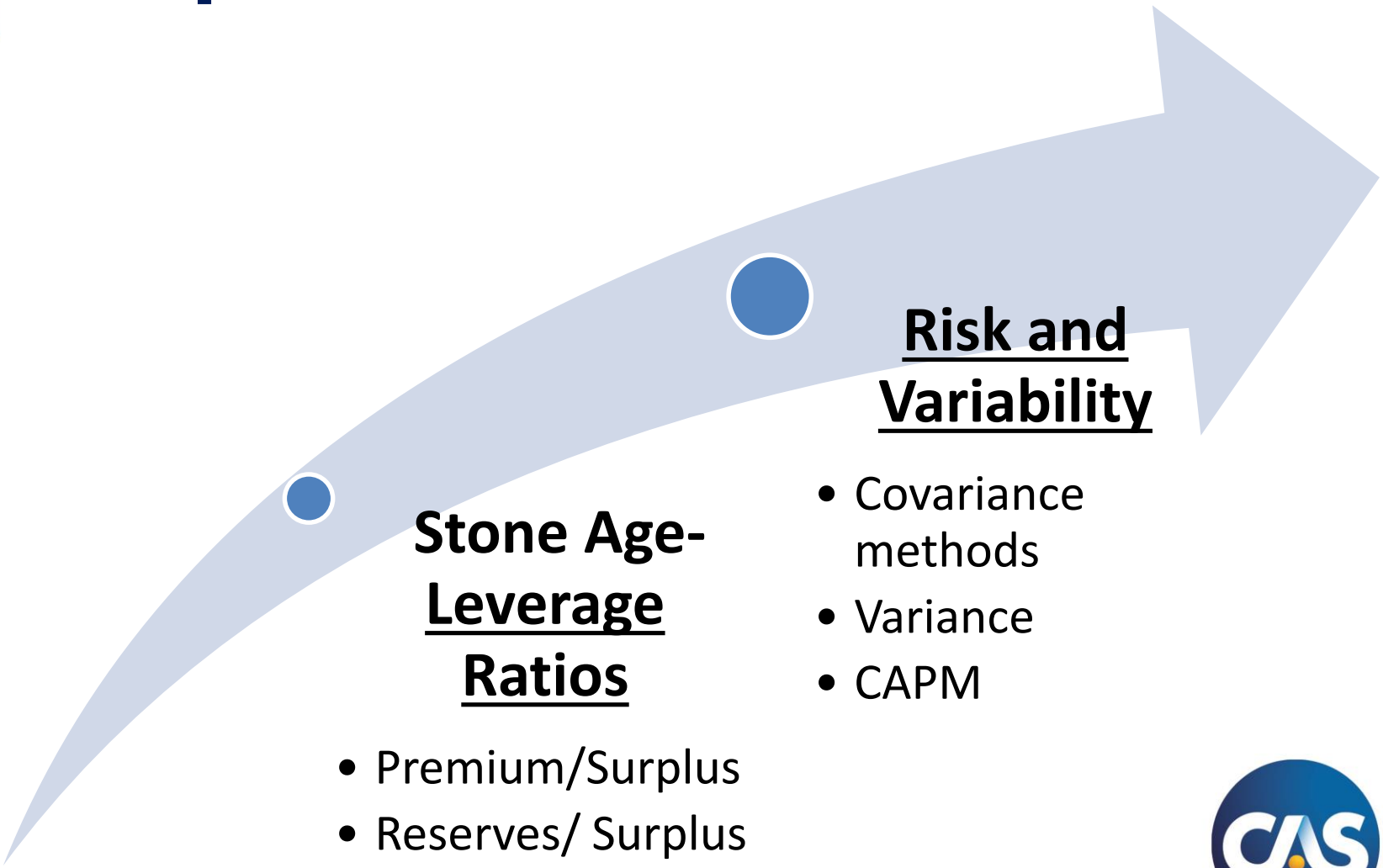
Common Denominator – Assumptions on Capital

PERSPECTIVES- GETTING TO THE COST OF CAPITAL

Capital Allocation Evolution



Capital allocation evolution



Stone Age- Leverage Ratios

- Premium/Surplus
- Reserves/ Surplus

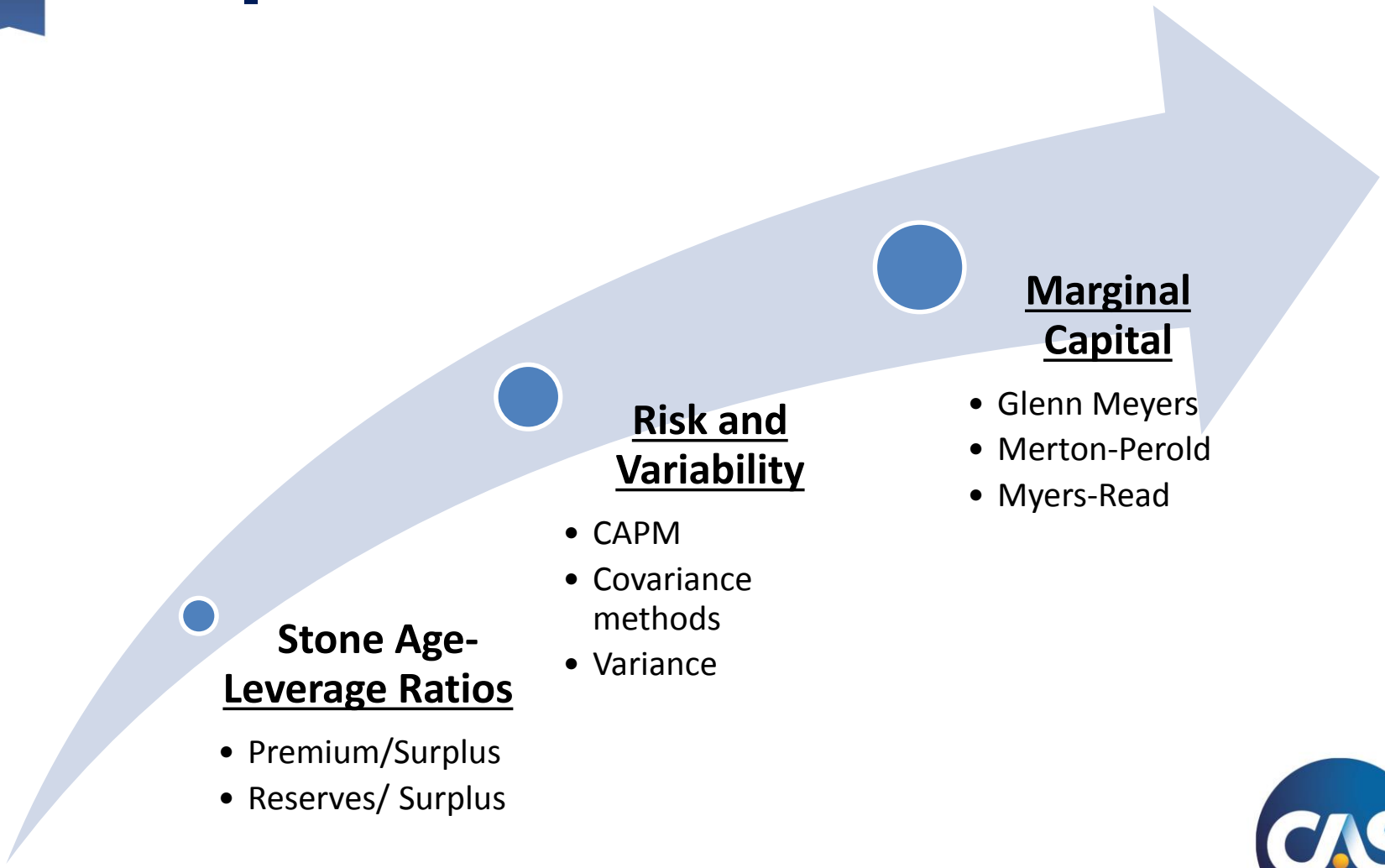
Risk and Variability

- 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

Capital allocation evolution



Marginal Risk and Return……..

Let P = Return and C = Capital. Then we are better off by adding a line/policy/strategy if:

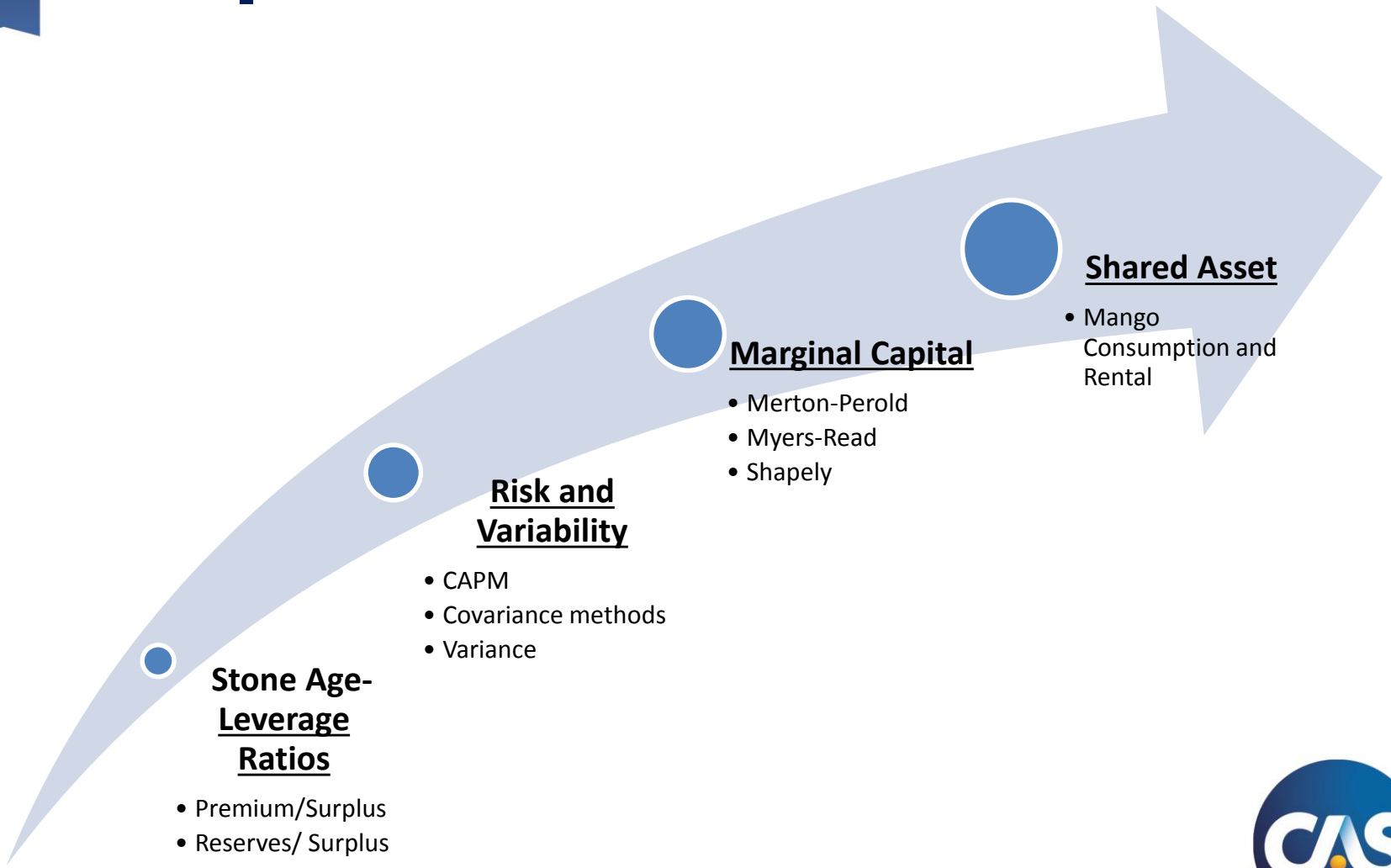
$$\frac{P + \Delta P}{C + \Delta C} \geq \frac{P}{C}$$

$$\Leftrightarrow \cancel{P \cdot C} + C \cdot \Delta P \geq \cancel{C \cdot P} + P \cdot \Delta C$$

$$\Leftrightarrow \frac{\Delta P}{\Delta C} \geq \frac{P}{C}$$

 Marginal return on new strategies > Current Return

Capital allocation evolution



Shared Assets Can Be Used Two Different Ways

- **Consumptive Use**
  - Example: RESERVOIR
  - ***Permanent*** Transfer To The User
- **Non-Consumptive Use**
  - Example: GOLF COURSE
  - ***Temporary*** Grant Of Partial Control To User For A Period Of Time

- **Both Consumptive and Non-Consumptive Use**
  - Example: HOTEL
  - ***Temporary*** Grant Of Room For A Period Of Time
  - Guest could destroy room or entire wing of hotel, which is ***Permanent Capacity Consumption***

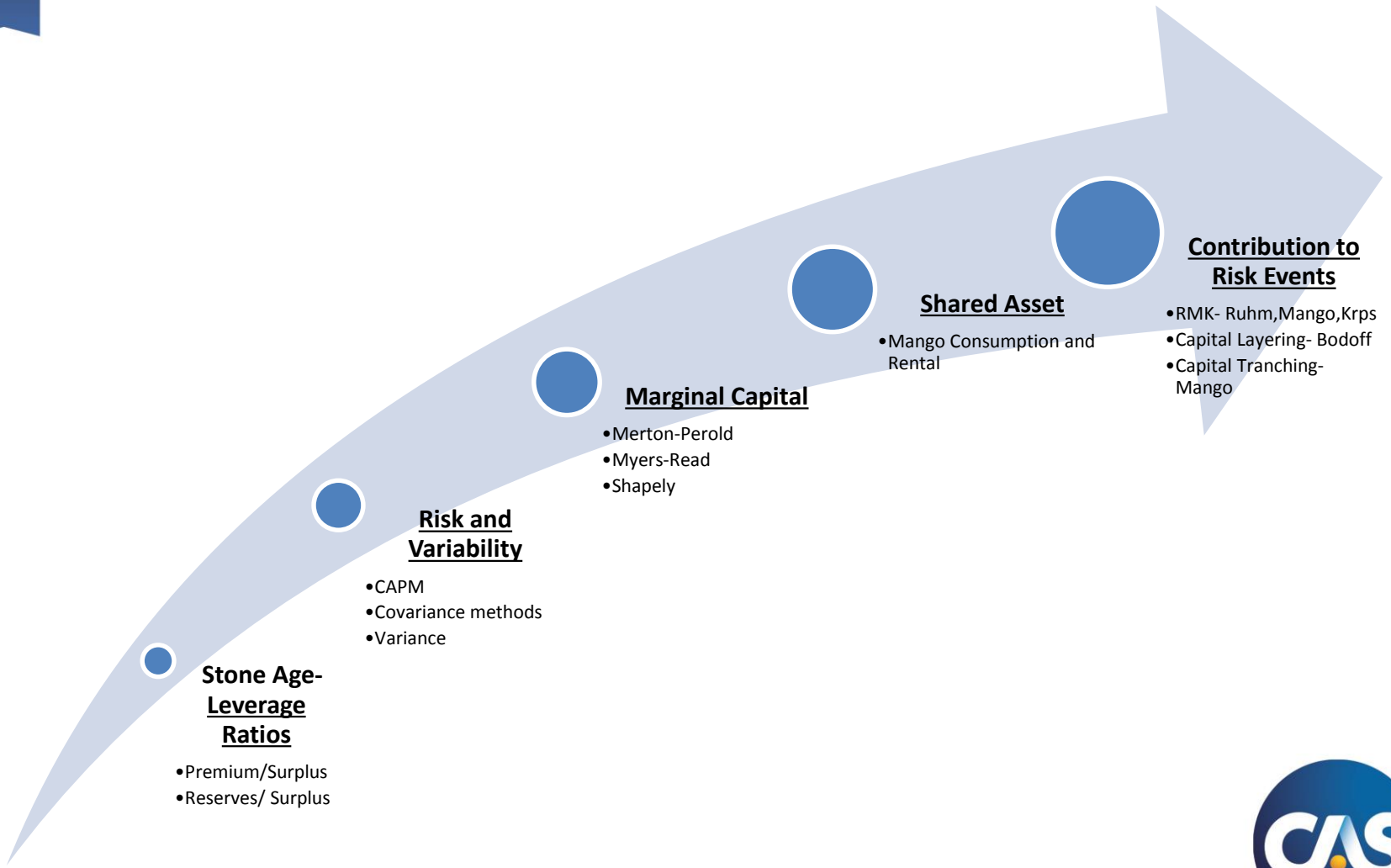
The Bi-Polar Capital Hotel

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

Let the Evolution continue



Discussion

- Use appropriate method and select parameters consistent with method
- Role of capital in ROE
  - Cost of Capital vs Fixed Hurdle Rate
  - Duration of capital – reserve risk
- Marginal Pricing vs Portfolio Optimization
- Questions