CAS Ratemaking and Product Management Seminar - March 2015

RCM-1 Risk and Return Considerations in Ratemaking- Calculating the Profit Provision

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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.

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- While some methods are similar to those in the Study Note on the CAS Syllabus, students should consult the Study Note 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

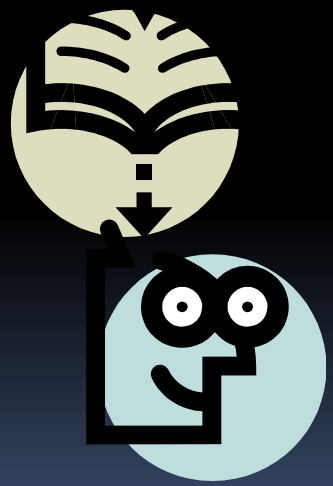
- UW Profit Basics
- Overview of Different Methods
- Corporate and Regulatory Contexts
- Offset Formulas
- ROE Models
- DCF and Risk-Adjusted DCF
- Conclusion

Different Types of UW Profit

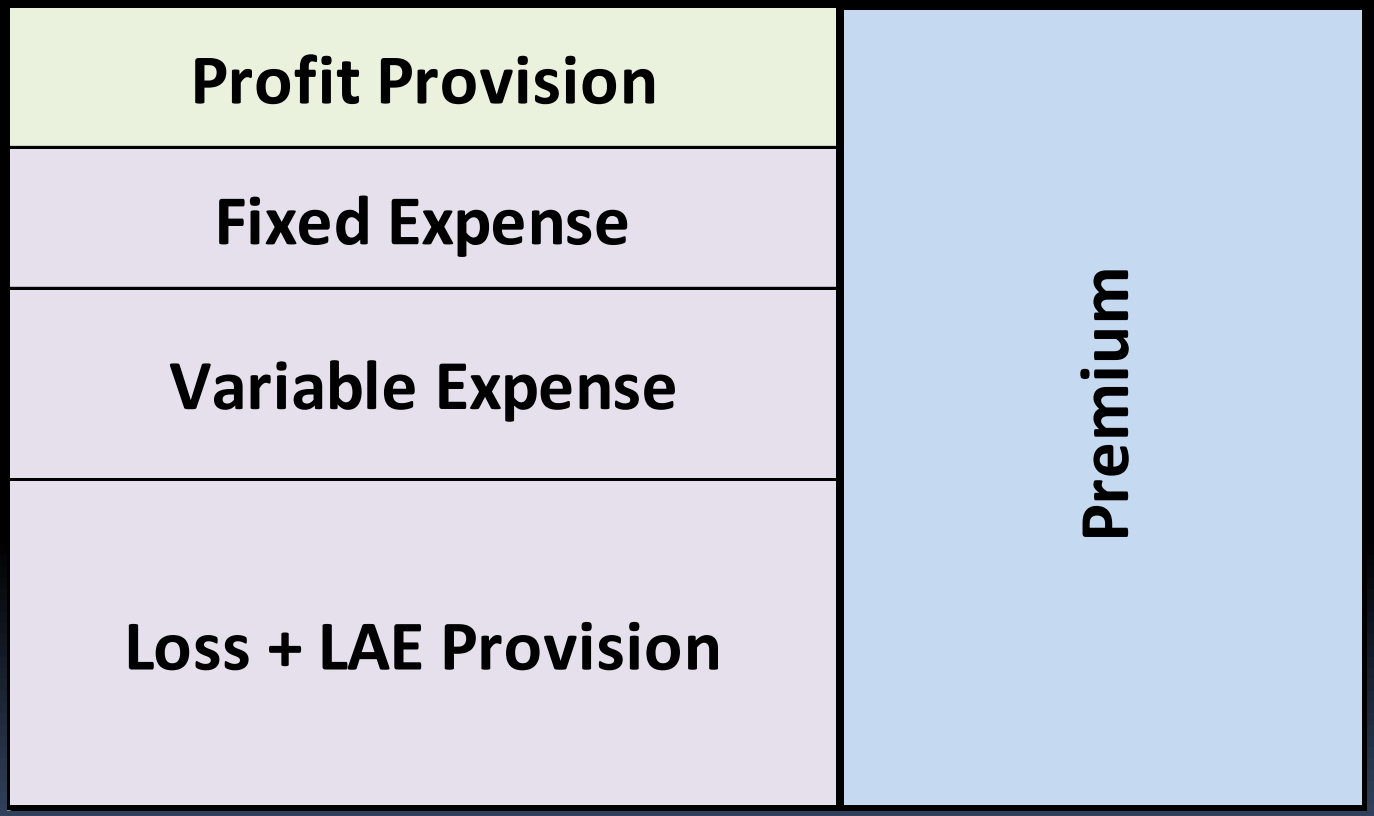
- Actual Achieved
  - Booked to Date vs Ultimate
  - PY, AY, CY
  - Direct, Gross, Ceded, Net
  - Stat vs GAAP
- Provision in Manual Rate
  - Indicated, Filed, Approved
- Per Risk vs Book of Business
- Provision in Charged Premium
  - Competition and Market cycles

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%

$$P = \frac{(50+30)}{1-.15-.05} = 100$$

- VXR=15% UPM = -1%

$$P = \frac{(50+30)}{1-.15-(-.01)} = 93$$

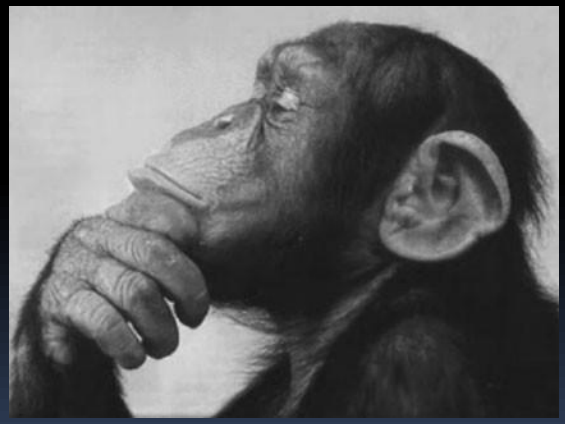
UPM Calculation Approaches

- 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

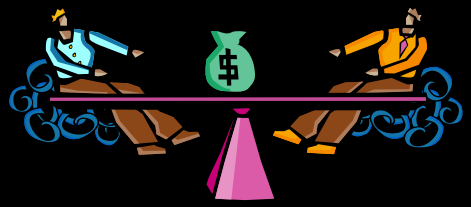
- Regulatory
  - Philosophy of govt price regulation
  - Personal Lines and WC vs Commercial
  - Prior approval/File and use/Use and file
- Corporate
  - UPM targets by LOB or Business Segment
  - Pricing for target return net of risk over cycle
  - Pricing hurdle

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

$$PLR \cdot \left(LRES / INCL \right)$$

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

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

$$UPM = UPM_0 - PVDELLR$$

- UPM_0 = Traditional UPM

$$PVDELLR = PLR \bullet \left(PV(\mathbf{x}_0) - PV(\mathbf{x}) \right)$$

  - 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%	

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

UW Cash Flows | Invest Inc | Income Tax

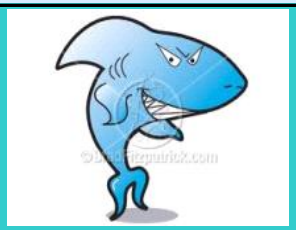
Single Policy Company

Balance Sheet	
Assets	**Liabs and Surp**
Investables	UEPR
Receivables	Loss Reserves
Recoverables	Expense Reserves
Other	Surplus

Income Statement
UW Gain
Investment Income Earned
Realized Capital Gains
Taxes
Net

\- + Equity Flows

Pool of Equity



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

PVI/PVE

- ROE on Individual Policy, Book of Business or LOB
  - Can be used in regulatory or corporate contexts

$$PVI/PVE = \frac{PV(INC, r_f)}{PV(EQB, r_f)}$$

Equity Balance

- Generalizes ROE = Income/Equity to apply to multi-year model
  - PV of income at end of year 1
  - PV of balance sheet account (Equity 'Balance)

Single Policy Company: PVI/PVE

PVI/PVE = 9.60 / 53.15 = **18.1%**

time	Income	PV t =1 Income	year	Equity balance	PV Equity balance
0	-30.00	-31.50			
1	37.20	37.20	1	40.00	40.00
2	3.10	2.95	2	10.00	9.52
3	1.05	0.95	3	4.00	3.63
total	11.35	9.60	total	54.00	53.15

PVI/PVE Approximation

- Compute PVI /PVE as sum of:
  - PV of UW Cash Flows at immunized risk-free rate +
  - Risk-free rate
  - Then net out taxes (ignores true tax pattern under Tax Reform Act of 86)

$$PVI/PVE = (1-t)\cdot\left(\frac{PV_1(UWCF, r_f)}{PV(EQB, r_f)} + r_f\right)$$

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

- $r_A = r_f + \beta (\mathbb{E}[r_m] - r_f)$
- 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 Comparison

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 Mone	Results marginally dependent on Surplus assumptions

Quiz

- 1. When using the CY Investment Income Offset method, selection of the appropriate surplus requirement is critical.
- 2. The risk-adjusted rate for discounting losses is exceeds the risk-free rate.
- 3. The Discounted Cash Flow Method gives the same answer as the IRR on Equity Flow Method if the IRR is equal to the risk –free rate for discounting.
- 4. The CY ROE method is dependent on the surplus requirement and the target ROE, but not the new money rate.

Conclusion

- Use appropriate method for situation
- Select parameters consistent with method used
- Questions