RCM-3 and 4: Allocating Capital - A Hands-on Case Study

Robert Wolf , FCAS, CERA, MAAA

David Ruhm, FCAS, CERA, MAAA

Casualty Actuarial Society
Ratemaking and Product Management Seminar
March 11, 2015

Agenda

- What capital allocation is and why we do it
- Key considerations in allocating capital
- The Ruhm-Mango-Kreps algorithm
- Representative methodologies
- Case study on allocating capital using the Ruhm-Mango-Kreps algorithm
- Additional considerations in allocating capital

Capital Allocation

- Capital allocation is a theoretical exercise
- Any business segment has access to the entire available capital of the firm
- For some lines capital consumption is more likely
  - Property insurance subject to catastrophic loss
  - Workers compensation in areas with concentration of employees
- Object is to reflect the likelihood of a business segment needing to utilize corporate capital

No method yet developed is ideal for this purpose

Reasons for Allocating Capital

- Pricing
  - Use the capital allocation to determine the investment income generated for rate calculations
- Risk management
  - Determine the risk adjusted rate of return as expected return divided by capital allocation
  - Use the risk adjusted return to decide if a business segment (line or investment) is worth continuing
- Performance evaluation
  - Reward performance based on risk adjusted returns

Key Considerations in Allocating Capital

- Must be accepted within the organization
- Sums to the total capital of the organization
- Stable over time
- Allocation not affected by other business segments
- No negative allocations
- Appropriate for particular application
- Coherent

No single method meets all these considerations

Ruhm-Mango-Kreps Algorithm

- Based on conditional probability
- Incorporates a riskiness leverage factor (RLF)
- Application of Ruhm-Mango-Kreps
  - Simulate a large number of potential outcomes
  - Rank the iterations by aggregate results
  - Determine an RLF for each aggregate outcome
  - Apply corresponding RLF to each segment's result whether it consumes or supplies capital
  - Allocate capital based on total capital charges
- Advantage/disadvantage of Ruhm-Mango-Kreps
  - Flexible enough by choice of RLF to duplicate any other capital allocation method

Ruhm-Mango-Kreps Algorithm
TVaR Example (based on 80% TVaR)

Scenario Number	Property Underwriting	Casualty Underwriting	Investment	Total	80% TVaR Risk Weight
1	-1,200	-500	650	-1,050	1
2	-700	200	-500	-1,000	1
3	-600	-200	700	-100	0
4	100	900	300	1,300	0
5	-100	-200	1,900	1,600	0
6	500	-200	1,400	1,700	0
7	200	-500	2,100	1,800	0
8	100	-600	2,500	2,000	0
9	1,200	800	700	2,700	0
10	1,100	700	2,200	4,000	0
Expected Value	60	40	1,195	1,295	
Risk-Weighted Expected Value	-950	-150	75	-1,025	
Risk Measurement	1,010	190	1,120	2,320	
Capital Allocation	44%	8%	48%	100%	

Capital Allocation Methods to be Considered

- Semi-variance
- Value-at-Risk (VaR)
- Tail Value-at-Risk (TVaR)
- Marginal capital - Myers-Read

Semi-variance

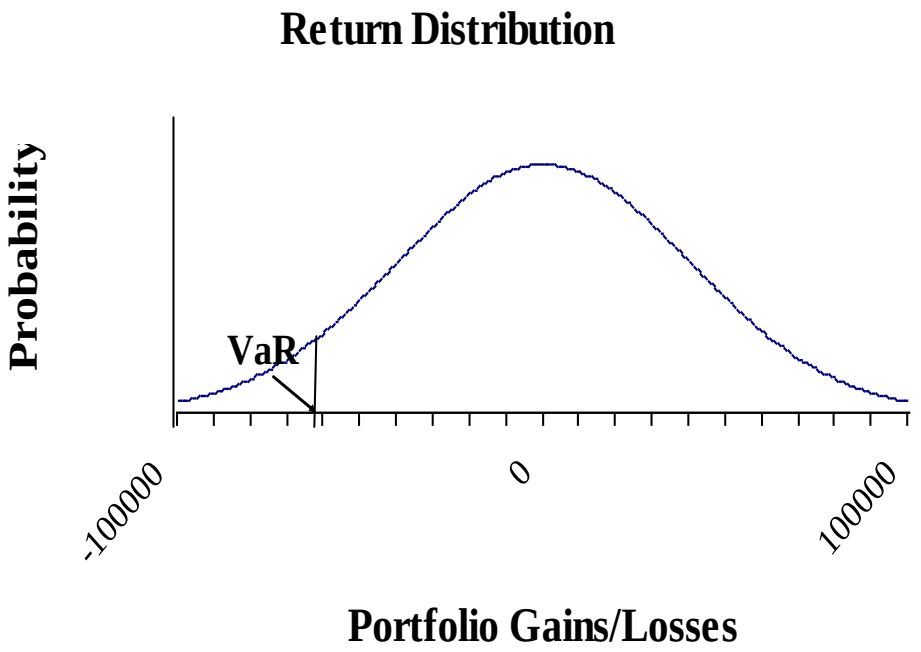
- Only considers downside variance
- Impact of risk is proportional to the square of the difference from the mean
- For RMK approach, RLF = μ-X if μ>X, otherwise 0

Value-at-Risk - A Definition

- Value-at-Risk (VaR) is a statistical measure of possible portfolio losses
  - A percentile of the distribution of outcomes
- VaR is the amount of loss that a portfolio will experience over a set period of time with a specified probability
- Thus, VaR depends on some time horizon and a desired level of confidence

Value-at-Risk - An Example

- 95% probability and one-day holding period
- VaR is the one-day loss that will be exceeded only 5% of the time
- In the example, the VaR is about $60,000
- For the RMK approach, the RLF is 1 if the cumulative probability is within ε of the selected VaR probability level, 0 otherwise



Tail Value-at-Risk

- Tail VaR considers the average loss in iterations that exceed the selected VaR level
  - This gives equal weight to all outcomes in the tail
- For RMK approach, RLF = 1 if cumulative probability is above the selected VaR, otherwise 0

Marginal Models for Capital Allocation

- Marginal models recognize diversification benefits within an organization when allocating capital
- Marginal methodologies (e.g. Myers-Read) rely on option pricing theory to derive the marginal impact of a line on capital
- Marginal models view the equity holders of the insurance company as investors who have a contingent claim (call option) on the firm's assets
  - As liabilities mature, equity holders have a claim on the residual (e.g., Assets - Liabilities)
  - If liabilities exceed assets, the equity holders lose their stake, but no more; this return profile is similar to a call option on the assets

Myers - Read

- Given the firm's assets and the present value of the losses by line, option pricing methods are 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 incremental changes
- For RMK approach, RLF = 1 if cumulative probability is within ε of the ruin probability, otherwise 0

Choice of Method

- Reason for capital allocation should drive the choice of method
- Ease of application
- Ease of interpretation

Applying Capital Allocation to Performance Evaluation

- Dividing actual returns by allocated capital provides a risk adjusted rate of return
- Base performance evaluation on risk adjusted returns
- Compare this approach to having a different hurdle rate for each area

Case Study: Capital allocation for performance evaluation

- Five roles to play
  - VP-Homeowners
  - VP-Auto
  - VP-Investments
  - CRO
  - CEO
- Excel file with 10,000 iterations of economic capital model

- Capital allocation methods
  - TVaR
    - 95%
    - 99%
    - 99.9%
  - VaR
    - 95%
    - 99%
  - Semi-variance
  - Myers-Read
    - $\varepsilon = 1.0\%$
    - $\varepsilon = 0.5\%$
    - $\varepsilon = 0.1\%$

Case Study- Developed by Steve D'Arcy
(30 minutes)

- Form groups of 5
- Read Case Study
- Download Excel file RPM Case Study Data
- Perform capital allocation calculations
- For your role, select one of the capital allocation methods to use for performance evaluations
- Be prepared to justify your choice when the group reconvenes

Case Study Discussion

Which method did each role select?

- VP-Homeowners
- VP-Auto
- VP-Investments
- CRO
- CEO

Other Methods:

- See RCM-2 Presentation

Capital Allocation References

- D. Ruhm and D. Mango, 2003, “A Method of Implementing Myers-Read Capital Allocation in Simulation,” Casualty Actuarial Society Forum, Fall, 451-458. http://www.casact.org/pubs/forum/03fforum/03ff451.pdf
- R. Kreps, 2005. “Riskiness Leverage Models,” *Proceedings of the Casualty Actuarial Society* 91: 31-60. http://www.casact.org/pubs/proceed/proceed05/05041.pdf.
- D. Mango, 2006, “Insurance Capital as a Shared Asset,” Casualty Actuarial Society Forum, Fall, 573-586. http://www.casact.org/pubs/forum/06fforum/577.pdf
- S. P. D’Arcy, 2011, “Capital Allocation in the Property-Liability Insurance Industry,” *Variance*, 5(2):141-157. http://www.variancejournal.org/issues/05-02/141.pdf
- D. Ruhm, D. Mango and R. Kreps, “A General Additive Method for Portfolio Risk Analysis.” Forthcoming, *ASTIN Bulletin.*