

## Session RR4: Allocating Capital - A Hands-on Case Study

Stephen P. D'Arcy, FCAS, MAAA, Ph.D.  
Robitaille Endowed Chair in Risk and Insurance  
California State University - Fullerton

Casualty Actuarial Society  
Ratemaking and Product Management Seminar  
March 12, 2013

---

---

---

---

---

---

---

---

## 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% VaR)

Scenario	U/W Prop	U/W Cas	Invest	Total	Risk Wt.
1	-1200	-500	650	-1050	1
2	-700	200	-500	-1000	1
3	-600	-200	700	-100	0
4	100	900	300	1300	0
5	-100	-200	1900	1600	0
6	500	-200	1400	1700	0
7	200	-500	2100	1800	0
8	100	-600	2500	2000	0
9	1200	800	700	2700	0
10	1100	700	2200	4000	0
Exp. Val.	60	40	1195	1295	
Risk-W EV	-950	-150	75	-1025	
Risk Mea	-1010	-190	-1120	-2320	
Cap. All	0.435345	0.081897	0.482759		

---

---

---

---

---

---

---

---

---

---

---

---

### 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,  $RLF = \mu - X$  if  $\mu > X$ , 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

---

---

---

---

---

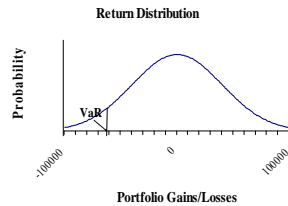
---

---

---

## 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  $\epsilon$  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  $\epsilon$  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
    - $\epsilon = 1.0\%$
    - $\epsilon = 0.5\%$
    - $\epsilon = 0.1\%$

---

---

---

---

---

---

---

---

## Case Study (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: Capital Hotel Analogy

- Recognizes two uses of capital
  - Shared (non-consumptive)
  - Consumptive
- Shared use is similar to renting a hotel room
  - Use is temporary but varies by line (loss payout patterns)
  - Use does not affect the future use of this room
- Consumptive use destroys capital
  - In hotel example, smoking in bed damages room, or even burns down hotel
  - Use is measured by loss frequency and severity
- Charge for renting hotel room reflects both shared and consumptive uses

---

---

---

---

---

---

---

---

## Other Methods: Market Based Capital Allocation Approach

- Combines Ruhm-Mango-Kreps and Capital Hotel
- Recognizes underwriting and investment risk
- Uses market cost of capital to determine the RLFs
- Yields a single capital allocation for the firm that is tied to expected market conditions

---

---

---

---

---

---

---

---

## 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*.

---

---

---

---

---

---

---

---