Capital Allocation in the Property-Liability Insurance Industry

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Overview

- Motivation for study
- Current capital allocation methods
- Market based capital allocation approach
- Example of market based capital allocation
- Conclusions

Motivation for Study

- **Capital adequacy** has been a long been a key issue in insurance
- Development of different approaches
  - Kenney rule and other premium-to-surplus ratios
  - Risk Based Capital (RBC)
  - Use of internal models
    - Companies
    - Rating agencies
    - Solvency II
- But **capital adequacy** deals only with firm level capital needs

Motivation for Study - 2

- **Capital allocation** deals with uses of capital by segments within a firm
- **Capital allocation** is a theoretical exercise
  - Capital is not divided up and assigned to different segments
  - All of a firm's capital could be depleted by a significant loss from any one segment
- **Capital allocation** is critical for several key functions
  - Pricing
  - Risk management
  - Performance evaluation
- No current **capital allocation** method is accepted as the industry standard

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Current Capital Allocation Methods

- Risk Based Capital (RBC)
  - Not designed for capital allocation
  - No consistent treatment of risk
- Variance or covariance approaches
  - Allocate capital based on (co)variability of segment regardless of whether upside or downside
  - General use has been for underwriting, not investments
- Value-at-Risk (VaR)
  - Considers only one point on the probability distribution
- Tail Value-at-Risk (TVaR)
  - Considers only the average values in the tail beyond a particular percentile

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Current Capital Allocation Methods - 2

- Marginal capital allocation
  - Based on option pricing theory
  - Merton-Perold consider adding an entire line
  - Myers-Read consider adding incremental amount of particular line
- Game theory
  - Shapley approach considers all possible combination of segments
  - Aumann-Shapley approach examines marginal impact of adding lines

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Current Capital Allocation Methods - 3

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

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Current Capital Allocation Methods - 4

- Capital Hotel analogy
  - Recognizes two uses of capital
    - Shared (non-consumptive)
    - Consumptive
  - Shared use is similar to renting a hotel room
    - Use is temporary
    - 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

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Market Based Capital Allocation Approach

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

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Cost of Capital

- What would firm pay to raise capital under economic conditions that correspond to simulated outcome?
- Examples
  - Issuing new equity to finance expansion
  - Junk bond financing when firm is facing financial distress
  - Warren Buffet rescues during 2008 financial crisis

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Key Factors in the Cost of Capital

- How much a firm needs to raise
  - The more a firm needs to raise, the more costly the capital
- Why the firm needs capital
  - Idiosyncratic (loss reserve strengthening, single large loss)
  - Industry wide (natural disaster)
- What source of funding is used (debt/equity)
  - Modigliani-Miller capital structure theory
    - Capital structure is irrelevant
    - Firm is worth the same whether all debt or all equity
    - Cost of equity capital equals the cost of debt
  - Equity financing is permanent
- What is the general condition of financial markets
  - Normal
  - Credit crisis

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Simplified Example

- Two line firm
  - Workers Compensation ($100 million premium)
    - Expected UPM 5%
    - 1% chance of unique catastrophic loss of 50% of EP
  - Homeowners ($100 million premium)
    - Expected UPM 7.5%
    - 5% chance of industry wide catastrophic loss of 50% of EP
- Three types of investments
  - Stocks ($150 million) – normal expected return 8%
  - Bonds ($400 million) – expected return 5%
  - Credit Derivatives ($50 million) – normal expected return 15%
  - 10% chance of credit crunch that reduces expected returns of stocks to -12% and credit derivatives to -25%
  - Credit crunch does not affect statutory values of bonds
- Initial capital of firm is $150 million

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Simplified Example - 2

- Cost of capital equals
  - 15% plus ratio of aggregate losses to firm's initial capital ($150 million)
  - Plus 5% if industry has experienced a natural disaster (Homeowners catastrophic loss) but there is no general credit crunch
  - Plus 10% if the market has experienced a general credit crunch
- **Riskiness Leverage Factor** = Scenario Cost of Capital/.15

Table 1 100 Iterations Sorted by Aggregate Results

Scenario	WC Base	WC - Cat	WC Total	Home Base	Home - Cat	Home Total	Stock Base	Stock - CC	Stock Total	Bond	CDS Base	CDS CC	CDS Total	Aggregate	State CC	State II	State	Cost of Capital	R L F
26	-2	0	-2	-8	0	-8	-10	-30	-40	10	-5	-20	-25	-65	2	0	2	0.683	4.56
16	-5	0	-5	2	0	2	-17	-30	-47	11	-5	-20	-25	-64	2	0	2	0.677	4.51
32	-8	0	-8	8	0	8	-14	-30	-44	24	3	-20	-17	-37	2	0	2	0.497	3.31
28	19	0	19	-1	-50	-51	42	-30	12	10	-2	-20	-22	-32	2	1	2	0.463	3.09
41	11	0	11	14	0	14	-14	-30	-44	15	-3	-20	-23	-27	2	0	2	0.430	2.87
77	9	0	9	-6	0	-6	4	-30	-26	25	3	-20	-17	-15	2	0	2	0.350	2.33
25	16	0	16	-3	-50	-53	-11	0	-11	18	19	0	19	-11	0	1	1	0.273	1.82
85	3	0	3	-6	0	-6	23	-30	-7	14	7	-20	-13	-9	2	0	2	0.310	2.07
95	10	0	10	16	0	16	-10	-30	-40	23	9	-20	-11	-2	2	0	2	0.263	1.76
2	8	0	8	18	-50	-32	-1	0	-1	23	3	0	3	1	0	1	1	0.000	0.00
68	-2	0	-2	-5	0	-5	-19	0	-19	28	0	0	0	2	0	0	0	0.000	0.00
34	2	0	2	19	0	19	22	-30	-8	11	2	-20	-18	6	2	0	2	0.000	0.00
69	-8	0	-8	5	0	5	-20	0	-20	12	18	0	18	7	0	0	0	0.000	0.00
59	1	0	1	10	0	10	-9	0	-9	10	-5	0	-5	7	0	0	0	0.000	0.00
9	-4	0	-4	3	0	3	35	-30	5	22	3	-20	-17	9	2	0	2	0.000	0.00
91	-7	0	-7	6	0	6	4	0	4	13	-5	0	-5	11	0	0	0	0.000	0.00

Simplified Example - 3

- Calculate the average return over all iterations for each line and investment
- Calculate the Risk Weighted Expected Value
- Determine how much the Risk Weighted Expectef Value is below the average return
- This difference is the Ruhm-Mango-Kreps capital allocation (consumptive use)
- The shared capital allocation is based on regulatory or other requirements

Simplified Example - 4

- Total capital is the sum of the Ruhm-Mango-Kreps capital and the shared capital
- Total allocated capital is the total capital scaled to the actual capital of the firm
- Total return on capital is:
  - For lines of business: the average return plus the assumed risk free investment return times the actual capital
  - For investments: the average return minus the risk free investment return time the actual capital

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Table 2 Summary Values

Line	Description	WC Base	WC - Cat	WC Total	Home Base	Home - Cat	Home Total	Stock Base	Stock - CC	Stock Total	Bond	CDS Base	CDS CC	CDS Total	Aggregate
1	Average	5.85	-0.5	5.35	7.32	-2	5.32	11.81	-3.9	7.91	20.88	6.37	-2.6	3.77	43.23
2	Risk Weighted EV			4.03			-8.10			-30.19	15.54			-17.79	-36.51
3	RMK Capital Amount			1.32			13.42			38.10	5.34			21.56	79.74
4	Premium-to-Surplus Ratio			3.00			3.00								
5	Duration of Capital Need			3.00			1.00								
6	Regulatory Capital Amount			100.00			33.33								133.33
7	Total Calculated Capital			101.32			46.76			38.10	5.34			21.56	213.08
8	Total Actual Capital			71.33			32.92			26.82	3.76			15.18	150.00
9	Assumed Inv Ret on All Cap			0.05			0.05			0.05	0.05			0.05	
10	Total Return on Capital			0.13			0.21			0.02	0.23			0.08	0.29

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Adjustments to Include in a Complete Model

- Number of iterations should be large
  - Consumed capital cases should represent expected distributions
- Catastrophe risk charge
  - Should be stochastic, not constant
  - Idiosyncratic risk charge may be higher than industry wide value for some causes
- Credit crisis risk charge
  - Should also be stochastic
  - Base values on historical and extrapolated events

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Uses of the Market Based Capital Allocation

- Pricing
  - Use the capital allocation to determine the investment income generated by a line of business 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

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Conclusions

- Firms need to allocate capital in order to manage risk effectively
- Current plethora of methods provides too many choices and no practical guidance
- Market based capital allocation approach produces a single capital allocation that is tied to expected market conditions
- Use of this approach will foster better models that reflect capital costs under a wide variety of economic conditions

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