Risk Based Capital and Capital Allocation in Insurance

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Introduction – What Is Capital?

• Financial capital
  – Funding of productive assets (real capital), expected claims cost in insurance

• Risk based capital
  – Providing financial solvency and managing volatility in business outcomes

• Focus on Risk Based Capital
  – Most significant for financial intermediaries
  – Prudential/solvency regulation (Basel II, Solvency II)
  – Economic capital (based on risk) used for pricing and financial management
Capital Structure

• Is there an optimal capital structure?
  – Mix of debt and equity, dividend policy?
• Does this generate wealth for shareholders or debtholders?
• M&M – Modigliani and Miller (1958) – capital structure irrelevance
• Financing decisions do not impact the firms’ value – determined by real assets
Capital Structure - Modigliani and Miller

- Perfect capital markets
  - No taxes, no transaction costs, no costs of financial distress, no bankruptcy costs (no frictions)
- Symmetric information
- Fixed investment decisions in real assets (independent of financing)
- Complete markets – anyone can hedge claims with traded instruments
Capital Structure – Limited Liability

- Assets – end of period $A(T)$
- Liabilities – Equity $E(T)$ and Debt obligation value $D(T)$ with $FV$ (face value)
- Balance sheet – $A(T) = E(T) + D(T)$ in fact
  - $D(T) = \min(FV, A(T)) = FV + \min(A(T) - FV, 0)$
  - $E(T) = \max(A(T) - FV, 0)$
- Debt – risk free + sold put option on assets
Capital Structure – Option Payoffs

Option Payoffs

- Value of Underlying
- Payoff

<table>
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<tr>
<th>Long Call</th>
<th>Long Put</th>
<th>Short Call</th>
<th>Short Put</th>
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Graph showing the payoffs for various option positions as the value of the underlying asset changes.
Capital Structure – Limited Liability

Debt and Equity Payoffs

- Debt FV
- Equity Payoff (Residual)
- Debt Payoff

Value of Assets vs. Value of Debt/Equity

Graph showing the payoffs for debt and equity in a capital structure context.
Capital Structure - Insurance

- Debt is equivalent to liability to policyholders
- Fair pricing of liabilities, along with leverage will determine an expected return to equity for an insurer
- Expected return on equity does not influence insurance prices (directly)
Capital Allocation

- Capital allocation used for many purposes:
  - Determining actual or expected return on capital by line of business
  - Assessing value of acquiring and divesting businesses/assets
  - Determining line management compensation based on return on capital
  - Pricing allowing for costs of capital
  - Risk quantification using risk based and economic capital
Current Practice

- Economic capital
  - Risk measure used to allocate capital to lines of business
    - VaR in banking, TailVaR in insurance
  - Capital is aggregated (allowing for diversification) to determine enterprise wide risk based capital
    - Diversification, dependence (copula, conditional dependent factor models)
- Pricing in multiline/multiproduct insurer or bank
  - Capital allocation to risk or line of business
  - Expected return on capital (RAROC).
Var and TailVar

Illustration of VaR and TailVar

Probability distribution function

VaR

TailVaR > VaR
TailVar represents the average of all losses exceeding the VaR

99.5% confidence level

Loss
Banks - VaR for Market Risk

\[ \text{Capital} = \text{Max}\{\text{VaR}_{-1}(M+P) \times \frac{1}{60} \sum_{t=1}^{60} \text{VaR}_t\} + \{\text{IDRC or SRC}\} \]

- \text{VaR}_t = \text{the value-at-risk (VaR) calculated } t \text{ trading days earlier}
- \text{VaR}-1 = \text{the VaR calculated for the preceding trading day}
- \text{M} = \text{the multiplication factor set by regulator, subject to a minimum of three}
- \text{P} = \text{the plus factor, which depends on the ex post performance of the internal model, as determined by back-testing, subject to a minimum of zero and a maximum of one}
- \text{IDRC} = \text{the incremental default risk charge, to be applied when the VaR includes an estimation of specific risk}
- \text{SRC} = \text{the specific risk charge, to be calculated according to the standard method when the VaR does not include an estimation of specific risk}
Current Practice

• Fair rate of return for regulated lines of insurance business
  – Allocation of capital to line of business
  – “Fair” rate of return on capital - Enterprise wide or varying by-line
  – Frictional costs (tax, agency, financial distress)

• Regulatory solvency requirements
  – Based on risks such as market, credit, insurance, operational and aggregated for enterprise wide solvency
  – Risk models varying for different risks (multivariate normal, frequency and severity, extreme value)
Current Practice

- Many different risk measures
  - VaR, ruin probability, TailVaR,
  - Expected Policyholder Deficit, Insolvency Default Put Option.
- Which measure makes most economic sense?
- Many different approaches to allocating capital to line of business
  - proportional to risk measure, proportional to liabilities, marginal allocations, equal expected returns to capital, covariance of losses.
- How to determine an economically sensible measure?
Current Practice

• Capital allocation generally considers lines of business or risks on an individual basis (which may be assets or liabilities)
  – no direct allowance for dependence between risks or business lines
  – Diversification benefit considered later at the aggregated level
• Yet, capital is available to support all lines of business.
  – How to allow for this in allocating capital to line of business?
Current Practice

Surplus Allocation with Different Risk Measures - Normal Assumption

Lines of Liabilities

Percentage

Lines 1 to 10
Capital Allocation Irrelevance

• Famous Corporate Finance Theory on Irrelevance of Capital Structure (Modigliani and Miller)
  – Perfect market assumptions, no frictional costs of capital

• Under these assumptions similar result (almost) holds for capital allocation to line of business/division
  – Different capital allocations are consistent with different expected returns on capital by line and an infinite number of alternatives are possible
  – No value maximising optimum (without market imperfections)

• Qualification – risk based insolvency put must be allocated based on payoffs by line (contribution to insolvency risk has financial impact)
Why do insurers hold so much capital?

- On average capital held by Australian Insurance companies is 2 - 3 times the MCR

Graph 3: General insurance capital 2000-2005
Approaches To Capital Allocation

• Allocate capital to each line based on a risk measure and derive an expected return on capital
  – Choice of risk measure VaR, TailVaR?
  – Expected return on capital – same for all lines? adjusted for risk?
  – No agreement. Is there an optimal approach?

• Use an ERM value maximising (cost minimising) objective and derive implied capital allocations consistent with value maximisation
  – Costs of capital (tax, agency and financial distress) minimisation produces an enterprise VaR target for capital
  – Price elasticity of demand produce value maximising optimum
  – Equity or debtholder perspective? (shareholder or policyholder in insurance)
Capital Allocation and Pricing In Multi-line Businesses

• Risk based capital should be determined at an enterprise level
  – Minimisation of (expected) tax, agency and financial distress costs
  – Maximisation of shareholder value added (allowing for price elasticity of demand)

• Pricing of lines of business
  – Cost based on risk-adjusted discounted expected values of cash flows (income minus expenses)
  – No need to allocate capital (except for by-line contribution to insolvency risk)
  – Market price reflects market factors such as price elasticity, profit margins on sales
Topics to be Covered In Lecture Series

• Pricing and allowing for insurers insolvency
• Option pricing model for insolvency put in a multi-line insurer
• Frictional costs and impact on risk and capital management
• Value maximisation model for an insurer (EVA) allowing for frictional costs and policyholder demand elasticity
• Current approaches and possible alternatives
Pricing and Insolvency

- Framework for fair pricing, capital allocation and insolvency put option value
  - Sherris, M., (2006), Solvency, Capital Allocation and Fair Rate of Return in Insurance, Journal of Risk and Insurance, Vol 73, No 1, (March 2006), 71-96. (this paper awarded the Casualty Actuarial Society (CAS) 2007 prize for the most valuable contribution to casualty actuarial science published in American Risk and Insurance Association (ARIA) literature in the preceding year)

- Practical model based on dependent log-normal risks
Risk Based Capital – Frictional Costs

• Australian Prudential Regulations and Risk Based Capital using an Internal Model

• Minimising frictional costs of insurer capital produces an optimal capital level based on VaR at much lower levels than observed
Risk Based Capital

VaR Probability for Insurer Liability

Frictional costs of capital (%)

Financial distress costs (%)

Probability (L>A+C)
Value Maximisation with Frictional Costs and Demand Elasticity

- Value maximising approach compared to economic capital and VaR approaches incorporating frictional costs of capital and price elasticity

- Value maximising approach to risk based capital and by-line pricing
Overview of Topics

• The science of capital allocation has made significant advances in our understanding of allocation and use of risk based capital, yet
  – limited theoretical guidance on which risk measure is consistent with value maximisation and no well developed economic theory underlying the risk measures
  – different firms use different risk measures
  – no agreement on the appropriate risk measure
  – risk measures are applied inconsistently for different risks, different lines of business, products and divisions
  – for insurer pricing the price of risk should vary with the type of risk under consideration yet most risk based capital approaches implicitly use a common price of risk based on a firm wide expected cost of capital for pricing.
Overview of Topics

• Recent developments in capital allocation for risk capital for solvency and by-line pricing
  – Importance of risk measure – insolvency default option value
  – Allocation by line and fair pricing
  – Frictional costs and market imperfections
  – Value maximising and demand elasticity