Enterprise Risk Management, Insurer Pricing, And Capital Allocation

University of Cologne Topic 5 Thursday 17th July 2008 3:00-4:30pm

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Economic capital is central to enterprise risk management for insurers and reinsurers.

Value-at-Risk (VaR) is widely used to determine economic capital and methods of capital allocation are used to price lines of business.

We will consider a single-period model of a multiple-line property-liability insurer incorporating:

- Taxes, agency costs of capital, and bankruptcy costs
- Policyholder preferences for financial quality
- Price elasticities by line of business

Capital and pricing strategies are evaluated by maximising shareholder value.
Pricing, Capital and Risk Management

Major insurance risk is pricing risk
- Loss variability, economic factors

Capital held to manage risk of insolvency
- Adverse loss development, inadequate pricing

Insurance market pricing must attract capital

Capital can be managed through risk management strategies – reinsurance, derivatives
Many insurance markets are regulated – US Workers Comp, Australia CTP

Initially were tariffs – companies agreed profit load in premium rates (Workers Compensation 5% loading)

Major issue was allowance for investment income
Insurer Profit margin

In a competitive market, insurers are “price takers” and actual profit margins are residuals – market premiums less expenses.

In a regulated market that aims to be competitive, prices are set to reflect the price formation process in competitive markets.

Other factors may influence prices such as gaming the regulator, recouping managerial perquisites, extracting rents and political issues.
Regulation and CAPM

Mid 70’s – US Massachusetts Commissioner of Insurance used CAPM for profit margins

Premium rates should provide an appropriate expected return to capital allowing for risk

CAPM is a widely used basis for expected returns

Ignores risk of insolvency
Myers-Cohn DCF Model

Myers-Cohn model used in regulating automobile and workers compensation rates in Massachusetts

Myers-Cohn models cash flows that relate directly to a policy – premiums, claims, expenses, taxes (assumes taxes paid by policyholder)

Surplus (capital is assumed committed at time policy is issued and released as losses are paid)

No theory of capital structure used – premium to surplus ratio for the industry used to determine capital structure
NCCI or IRR Model

Takes a shareholder perspective and considers cash flows to equity from the policy

Considers a specific surplus (capital) amount and the return to equity in the form of investment income, taxes, underwriting profit

Sets the premium to provide a targeted expected return to equity (could be determined using CAPM)
Fundamental Pricing Equation

Fundamental Theorem of Asset Pricing - in an arbitrage-free market

Price is expected discounted value of random cash flow $X$ where $m$ is stochastic discount factor

CAPM is one form of the stochastic discount factor

$$P_t = E_t \left[ m_{t+1} X_{t+1} \right]$$
NPV of multi-period cash flows

NPV for multi-period cash flows

\[ ^tNPV_t = \sum_{j=1}^{T} E_t \left[ m_{t+j} X(t + j) \right] - I(t) \]

\[ NPV_t = \sum_{j=1}^{T} \frac{E_t \left[ X(t + j) \right]}{1 + E_t \left( R_{t+j}^j \right)} - I(t) \]
M & M Assumptions

Under M & M assumptions risk and capital management do not impact on value of cash flows

Need to relax these assumptions to include costs of capital
  • Costs of financial distress, agency costs of debt and equity, tax, information asymmetries

Risk and capital management can manage and minimise these costs
M & M Assumptions

Under M & M firms do not have utility functions

They are not risk averse and do not undertake risk management because of this

Their value function is linear – that of a risk neutral investor

Frictional costs make them appear to be risk averse
Pricing Issues

Pricing insurance contracts (ignoring tax, expenses – which are discounted at risk free rate) – is determined by the liability risk (not directly by capital or assets)

Cost of capital/Capital structure enters through the insolvency put (and taxes and frictional costs such as insolvency, agency, underinvestment)

Pricing using capital and return on equity – need for capital allocation to line of business (and fair pricing requires this to allow for insolvency put)
Insurer Value Maximizing Model

Single-period model of a P&C insurer:
  • Insurer writes *multiple* lines of business with claims paid at the end of the period.
  • Similar model set up to Zanjani (2002) and value maximisation similar to Panning (2006)

Includes frictional costs.

Imperfectly elastic demand.

Policyholders care about financial quality.

Assets and liabilities are joint log-normal (Sherris and van der Hoek, 2006).
Economic model of a property-liability insurer

Model insurer has a large, mature portfolio with approximately 10% market share

- Business portfolio includes 5 lines – motor, household, fire & ISR, liability, and CTP
- Asset mix fixed – 15% cash, 65% bonds, and 20% equities

Insurance markets are relatively competitive

- Price elasticities are assumed according to personal, commercial, or compulsory lines

Default risk is the value of the option to default on liabilities

- Assets and liabilities are assumed to be joint log-normally distributed (Sherris and van der Hoek, 2006)

Solved and optimised using MATLAB and a direct search method

Data sources

- APRA’s Half Yearly General Insurance Bulletin – business volumes and expenses
- Tillinghast Risk Margin Analysis – CVs and correlations by line of business
Capital and prices are chosen to maximise shareholder value

\[
\max_{R_0,p_{i,0}} \{ EV A_0 \} = \max_{R_0,p_{i,0}} \left\{ \sum_{i=1}^{N} \left[ p_{i,0} - c'_{i,0} - e^{-r} \mu_{i,1} (1 - d_0) \right] q_{i,0} - \delta R_0 \right\}
\]

At time 0 the insurer chooses optimal capital \( R_0 \) and prices \( p_{i,0} \)

\[ q_{i,0} = q \left( p_{i,0}, d_0, f \right) = \alpha_i \max \left[ 1 + \beta_i p_{i,0} + \gamma_i (1 + f) d_0, 0 \right] \] is the quantity of business sold in the \( i \)th line where \( f \) denoted bankruptcy costs

\[ d_0 = e^{-r} E^Q \left[ \max \left( 1 - \frac{V_i}{L_i}, 0 \right) \right] \] is the default value per dollar of liabilities

\( c'_{i,0} \) and \( \mu_{i,1} \) denotes marginal expenses and expected losses for the \( i \)th line of business

\( r \) denoted the risk-free rate

\[ \delta = \frac{(1-e^{-r})\tau_1 + e^{-r}\tau_2}{1-\tau_1} \] represents frictional costs where \( \tau_1 \) and \( \tau_2 \) denote taxes and agency costs of capital
Four strategies for capitalisation and pricing are considered

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Capital Strategy</th>
<th>Pricing Strategy</th>
<th>Cost of Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>V Maximise EVA</td>
<td>• Optimal capital and prices that maximise shareholder value added</td>
<td>• Not applicable</td>
<td>• Not applicable</td>
</tr>
<tr>
<td>A VaR Strategy A</td>
<td>• VaR at 99.5% confidence level</td>
<td>• Capital allocated proportionally • By-line returns must meet the cost of capital</td>
<td>• 15%</td>
</tr>
<tr>
<td>B VaR Strategy B</td>
<td>• VaR at 99.5% confidence level</td>
<td>• Capital allocated proportionally • By-line returns must meet the cost of capital</td>
<td>• 20%</td>
</tr>
<tr>
<td>C VaR Strategy C</td>
<td>• VaR at 99.5% confidence level</td>
<td>• Capital allocated proportionally • By-line returns must meet the cost of capital</td>
<td>• 15% commercial lines • 25% personal and compulsory lines</td>
</tr>
</tbody>
</table>

Note: VaR at the 99.5% confidence level is consistent with APRA’s minimum solvency requirements
### Assumed Elasticities

<table>
<thead>
<tr>
<th>Lines</th>
<th>Price Elasticity of Demand</th>
<th>Default Risk Elasticity of Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>15.6</td>
<td>0.48</td>
</tr>
<tr>
<td>Household</td>
<td>16.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Fire &amp; ISR</td>
<td>26.1</td>
<td>0.78</td>
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<td>Liability</td>
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<tr>
<td>CTP</td>
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*Table 10: Elasticities of demand by line of business.*
Using a firm-wide cost of capital significantly reduces shareholder value

Enterprise value added (EVA) for different strategies (% of liabilities)
VaR-based strategies incorrectly prices individual lines of business...

By-line economic profit margins for different strategies

Prices are strongly influenced by-line price elasticities rather than the volatility of a line of business
...creating a sub-optimal portfolio mix

Business portfolio mix for different strategies

Strategies that ignore price elasticities sell lower volumes of risky business
VaR at the 99.5% confidence level creates additional frictional costs by over-capitalising the insurer...

Economic capital vs. frictional costs for different strategies

**Capital (% of liabilities)**

- Max EVA: 29.7
- A: 41.8
- B: 43.4
- C: 40.9

**Frictional costs ($m)**

- Max EVA: 2.5
- A: 6.4
- B: 5.2
- C: 4.3

- Frictional costs
- Economic capital
...lowering default risk below optimal levels across all lines of business

By-line default value for different strategies

## Price elasticity and volatility assumptions by line of business

<table>
<thead>
<tr>
<th>Line of business</th>
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<th>Default elasticity</th>
<th>CVs</th>
</tr>
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Source: CVs based on results of the Tillinghast Risk Margin Analysis on the Australian General Insurance Industry
Key findings

When policyholders have imperfectly elastic demand, capitalisation and pricing are strongly influenced by their sensitivity to price and preferences for financial quality

**VaR must be carefully implemented to be consistent with maximising shareholder value**
- Minimum solvency requirements may over-capitalise the firm and create additional frictional costs

**Using a firm-wide cost of capital may significantly reduce shareholder value**
- The cost of capital should differ by line of business incorporating by-line price elasticities
Summary

Prices are strongly influenced by policyholder sensitivity to price by line of business and firm-wide default risk

Using VaR and a firm-wide cost of capital may significantly reduce shareholder value

- Over-capitalises the firm creating additional frictional costs
- Incorrectly prices lines of business resulting in a sub-optimal portfolio mix

Other applications

- Price elasticities by line of business and preferences for financial quality
- Determining the cost of capital by line of business