Biennial Convention 2007
Adventures in Risk
23-26 September 2007 • Christchurch, New Zealand
Institute of Actuaries of Australia

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 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).

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)

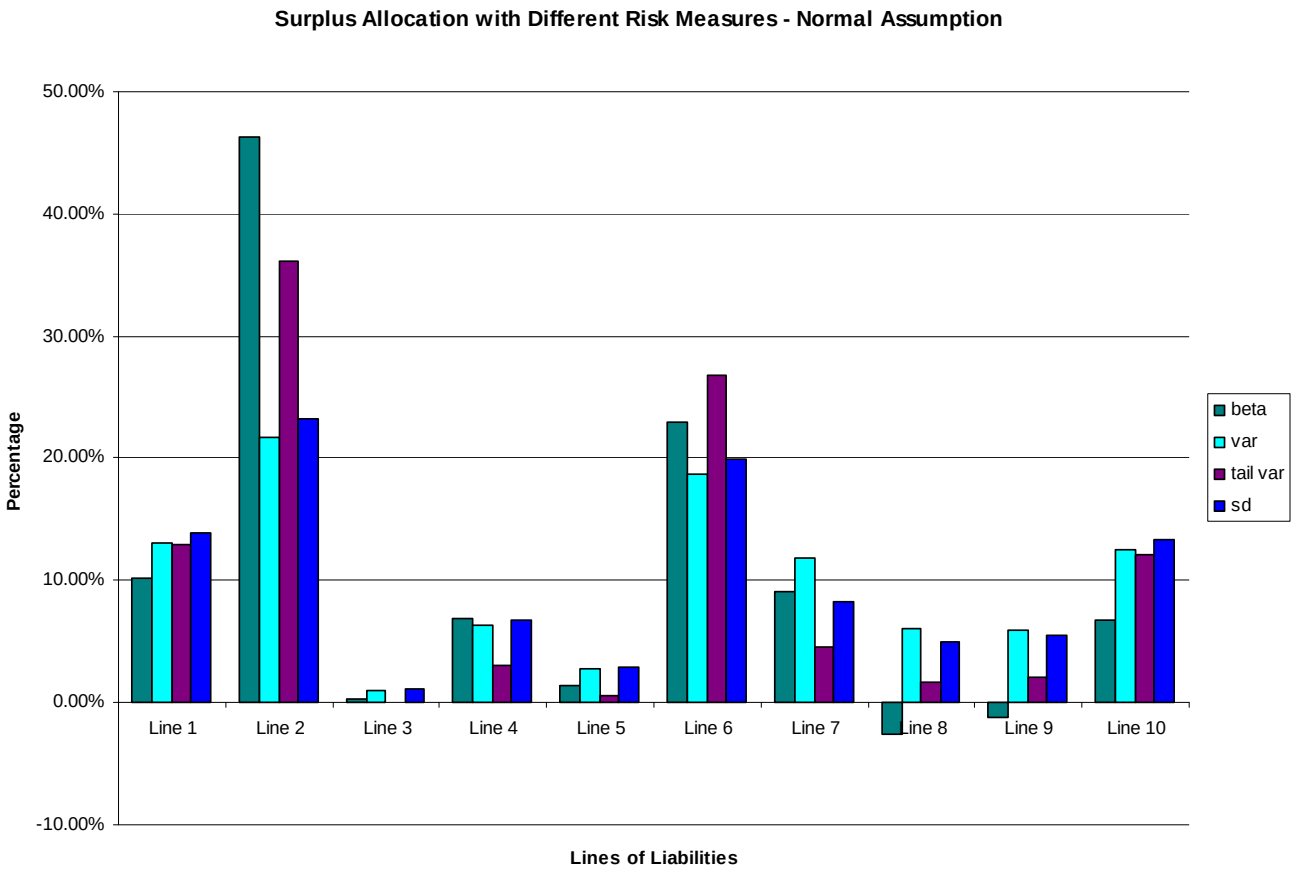
Current Practice

- 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



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)

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

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
  - Sherris, M. and John van der Hoek, (2006), Capital Allocation in Insurance: Economic Capital and the Allocation of the Default Option Value, North American Actuarial Journal, April, Volume 10, Number 2, 39-61.

Simple Insurance Example

- Single period example
  - emphasise main concepts
  - Two lines of business - Liability 1 and Liability 2
  - 4 outcomes or states
- Which liability line is the most risky?
- VaR or economic capital compared with the insolvency put option value
- Is capital allocation required for pricing?

Simple Insurance Example

TABLE 1
Probabilities and Payoffs for Example Insurer

			Time 1 Payoffs			
State	*P*-probs	*Q*-probs	Risky Asset	Risk-Free Asset	Liability 1	Liability 2
1	0.1	0.1	0.6	1.05	200	40
2	0.6	0.4	1.1	1.05	4	10
3	0.2	0.4	1.0	1.05	2	4
4	0.1	0.1	1.5	1.05	0	310
Time 0 value			1.0	1.0	21.3333	38.6667

Payoffs By Line

TABLE 2
Insurer Balance Sheet Payoffs

	Time 1 Insurer Balance Sheet Payoffs				
State	Assets	L_1	L_2	Total L	max $(L - A, 0)$
1	120	200	40	240	120
2	220	4	10	14	0
3	200	2	4	6	0
4	300	0	310	310	10
Time 0 value	200	21.3333	38.6667	60	12.381

Default Put Risk Measure

TABLE 3
Liability Shortfalls in the Event of Insolvency

	Time 1 Liability Shortfalls	
State	$D_1 = L_1 \max(1 - \frac{A}{L}, 0)$	$D_2 = L_2 \max(1 - \frac{A}{L}, 0)$
1	100	20
2	0	0
3	0	0
4	0	10
Time 0 value	9.5238	2.8571

Equity Payoffs

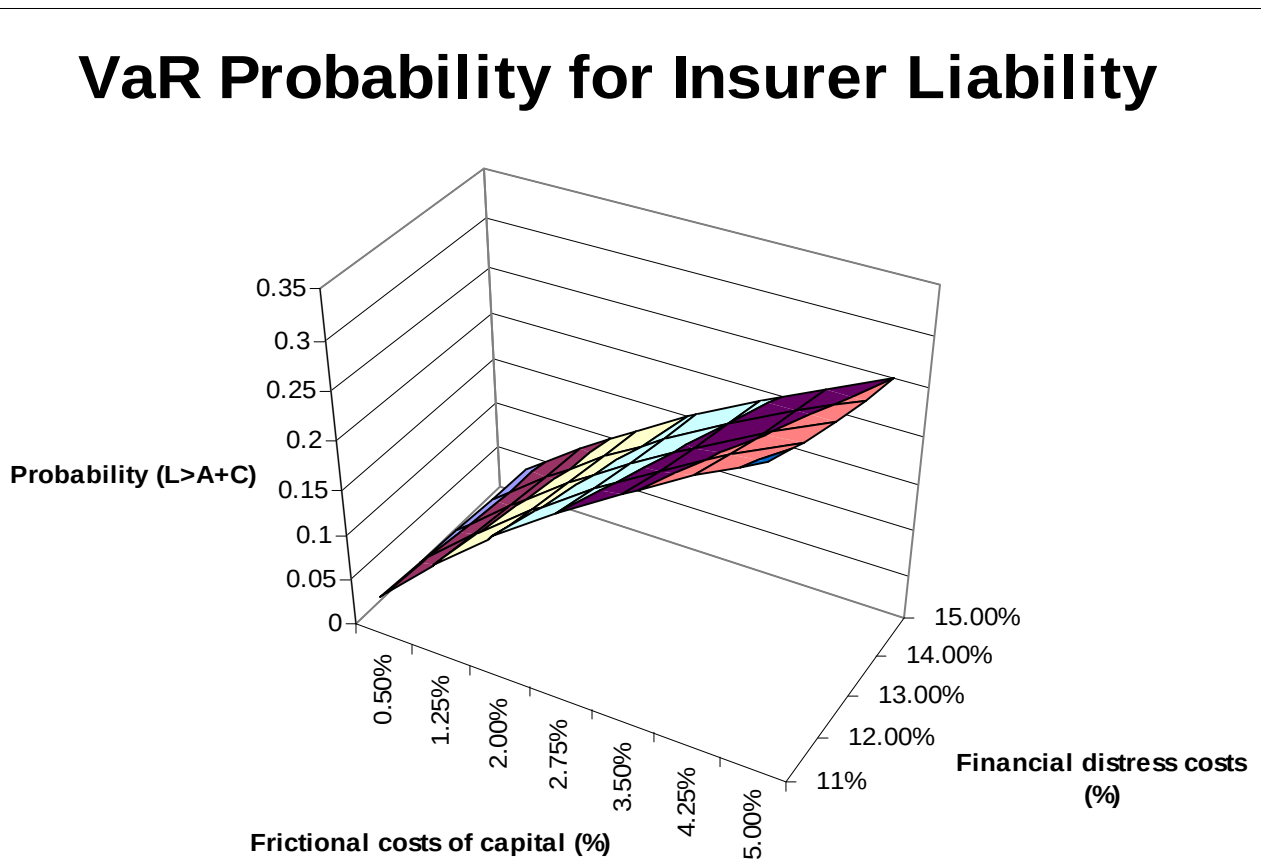
TABLE 4
Insurer Equity Payoffs

	Time 1 Insurer Equity Payoffs			
State	*P*-probs	Assets	Total L	Equity = max $(A - L, 0)$
1	0.1	120	240	0
2	0.6	220	14	206
3	0.2	200	6	194
4	0.1	300	310	0
Time 0 value		200	60	152.3810

Risk Based Capital – Frictional Costs

- Australian Prudential Regulations and Risk Based Capital using an Internal Model
  - Sutherland-Wong, C. and Sherris, M., (2005), Risk-Based Regulatory Capital for Insurers: A Case Study, Journal of Actuarial Practice, Vol 12, 2005, 5-46.
- Minimising frictional costs of insurer capital produces an optimal capital level based on VaR at much lower levels than observed
  - Chandra, V. and M. Sherris (2007), Capital Management and Frictional Costs in Insurance, Australian Actuarial Journal, February 2007, Volume 12, Issue 4.

Risk Based Capital



Value Maximisation with Frictional Costs and Demand Elasticity

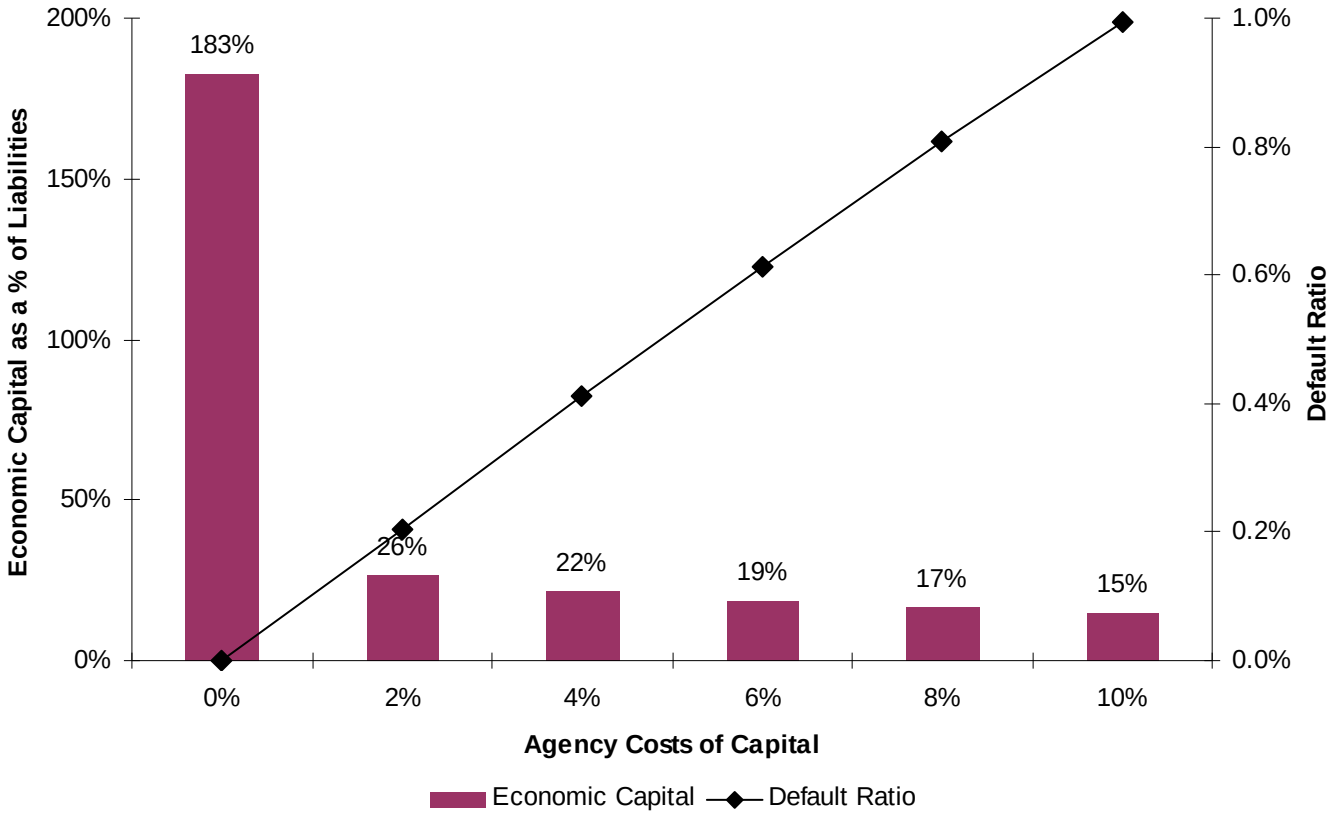
- Value maximising approach compared to economic capital and VaR approaches incorporating frictional costs of capital and price elasticity
  - Yow, S. and Sherris, M. (2007), Enterprise Risk Management, Insurer Pricing and Capital Allocation, Geneva Association/IIS Prize winning paper to appear in Geneva Papers on Risk and Insurance
- Value maximising approach to risk based capital and by-line pricing
  - Yow, S. and Sherris, M. (2007), Enterprise Risk Management, Insurer Value Maximisation, and Market Frictions, Invited Paper 5th Annual Enterprise Risk Management Symposium and 9th Bowles Symposium: The ERM Research Track, Chicago, March 28-30, 2007

Maximizing Enterprise Value Added (EVA)

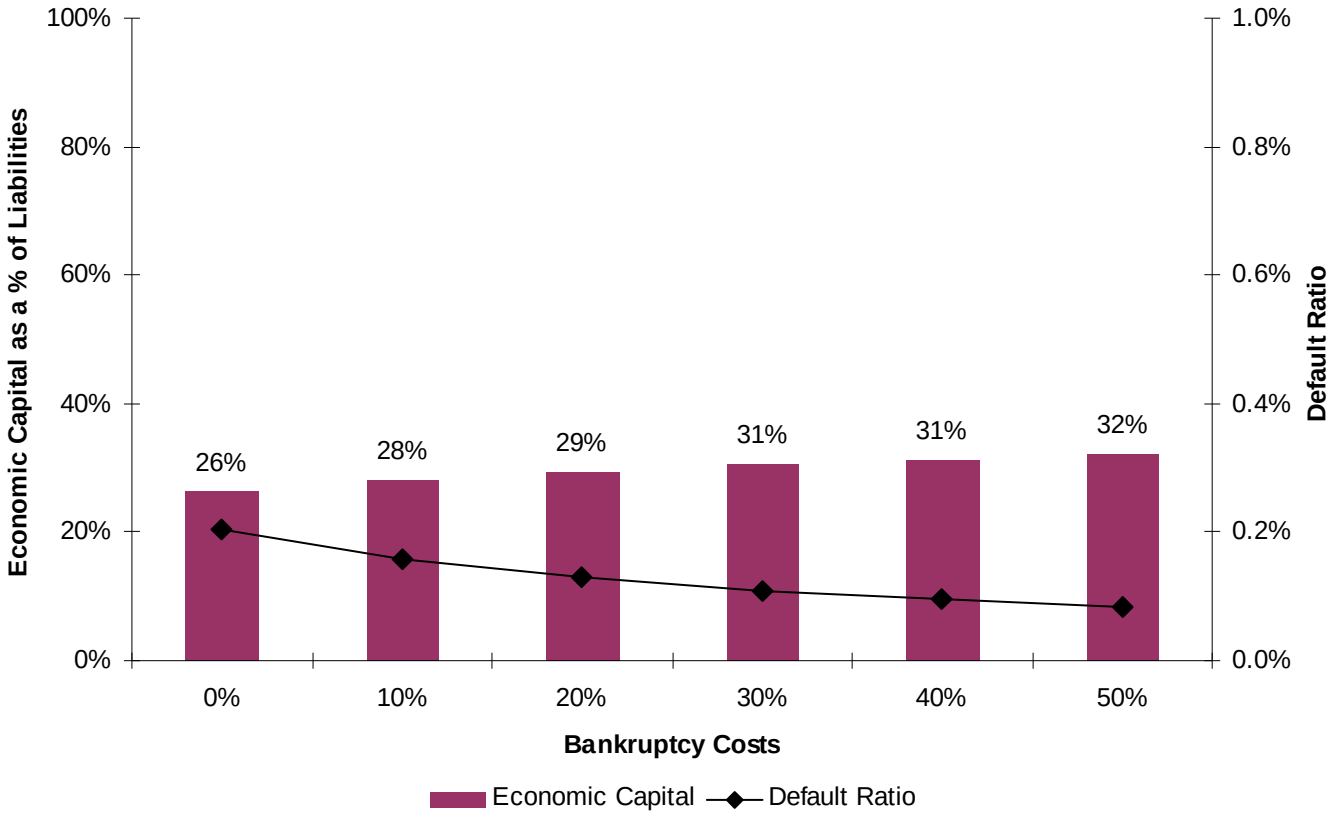
$$\max_{R_0,p_{i,0}} \{EVA_0\} = \max_{R_0,p_{i,0}} \left\{ \sum_{i=1}^{N} \left[p_{i,0} - c'_{i,0} - (1-d_0)\, e^{-r} \mu_{i,1} \right] q_{i,0} - \delta R_0 \right\}$$

- Optimize prices $p_{i,0}$ and capital R_0.
- $q_{i,0} = q\left(p_{i,0}, d_0, f\right)$ = quantity of business sold in the ith line.
- $d_0 = e^{-r} E^Q \left[\max\left(1 - \frac{V_1}{L_1}, 0\right) \right]$.
- $c'_{i,0}$ = marginal expenses.
- $\mu_{i,1}$ = expected loss at time 1.
- r = risk-free rate.
- $\delta = \frac{(1-e^{-r})\tau_1 + e^{-r}\tau_2}{1-\tau_1}$, where τ_1 = taxes and τ_2 = agency costs of capital.

Lower optimal capital for higher agency costs



Higher optimal capital for increasing bankruptcy costs

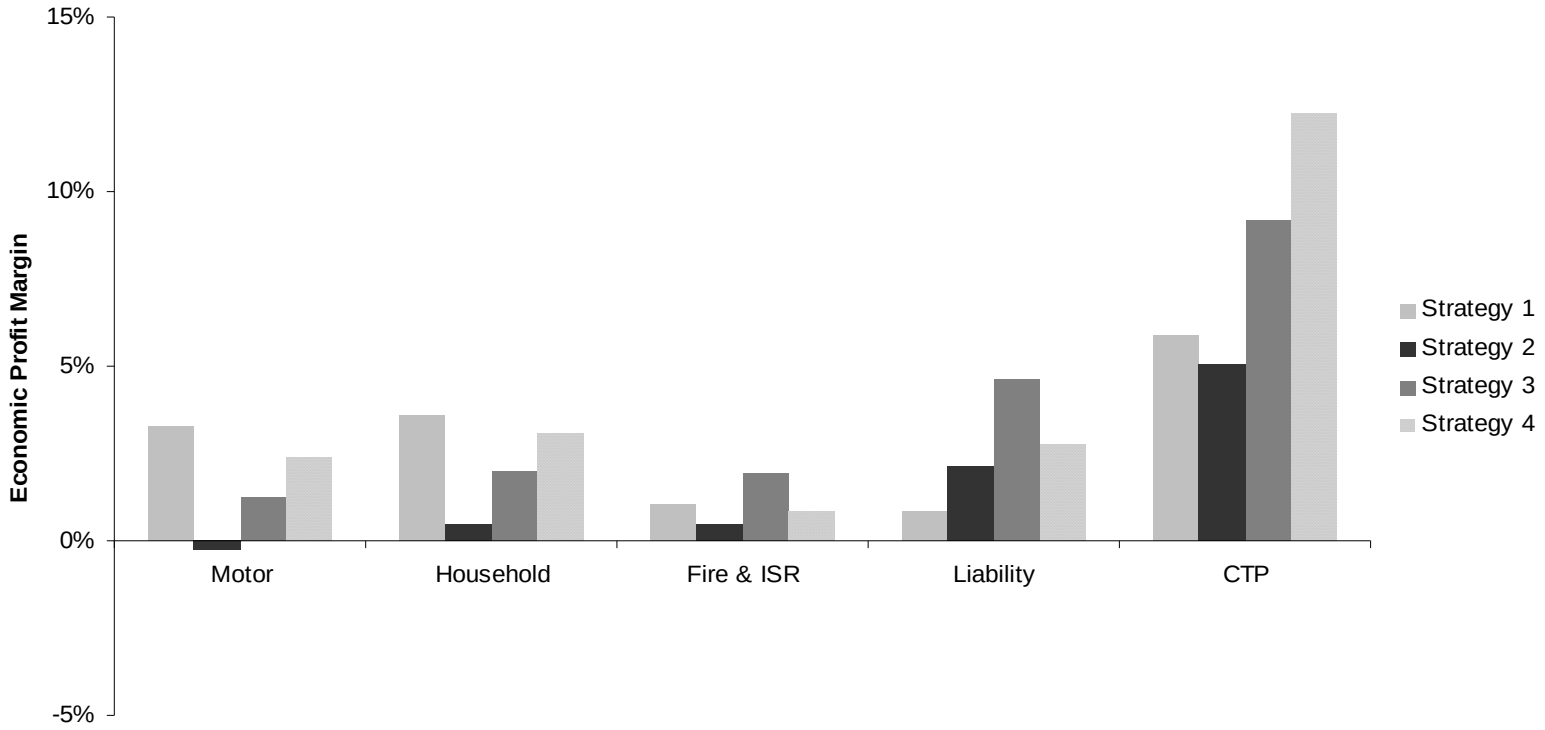


Pricing Strategies

Strategy	Approach	Method of Allocation	Assumed Cost of Capital
1	Maximize EVA	None	None
2	VaR at 99.5%	Proportional	15%
3	VaR at 99.5%	Proportional	20%
4	VaR at 99.5%	Proportional	15% (Commercial) and 25% Personal/Compulsory)
5	Maximize Firm Value	None	None

Table 8: Strategies for insurer pricing and capitalization.

Economic Profit Margins



Based on assumed price elasticity (not actual market data)

Conclusions

- 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.

Conclusions

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