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ERM for Strategic Management – Status Report

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History of ERM

- Started with banking regulation
  - Banks were not quantifying risk, going broke
  - Basic risk quantification modeling developed
  - Can't say this has been an unqualified success, as risks have become more complex
- Expanded to insurance regulation
- Attempts for application to strategic management
  - Manufacturing looking at supply chains, etc.
  - Financial institutions model financial risk
    - Basically shifting from policyholder viewpoint to shareholder viewpoint

For Today:

- Two key areas of ERM and strategic management:
  - Capital need
  - Risk adjusted profitability
- Status:
  - Where we were
  - Where we are
  - What hasn't been done
  - What might be done

What ERM Does and What It Does Not Yet Do

- Does
  - Quantify risk level of capital
  - Quantify riskiness of business units
- Does not yet
  - Show optimal level of capital
    - Would like to be able to say what capital maximizes franchise value of the firm
  - Show which business units are most profitable on a risk basis
    - Comparing profit to allocated capital does not necessarily tell which units are adding most value to the firm

Capital Needs of an Insurer

Where We've Been

- Capital = 1/3rd of premium
- As reserves became more important, maybe
  - Capital = ¼ of liabilities, including reserves and UEPR
- But not all liabilities have equal risk, so RBC tried:
  - Capital = sum of factors times income statement and balance sheet items
- Problems
  - These are only very rough measures of risk and capital need
  - Resulting capital not sensitive to many risk variables
  - For instance, increasing adequacy of premium or reserves typically increases the RBC stated capital need

ERM Initial Attempt at Capital Analysis

- Capital = enough to make one-year probability of ruin small enough
- Often called "economic capital"
- Advantages
  - Consistent probabilistically across firms
  - Low enough in information content that public disclosure will not help competitors
    - Good criterion for regulatory measure

Disadvantages of Economic Capital

- Arbitrary choice of probability
- Only one way to measure risk
- Inaccuracy of models in extremes
- Not the capital a company needs in practice
  - Want to optimize value
  - Can be affected by perceptual issues, competitors, quality of risk management, reputation of management …

What ERM Does Well: Quantifies Risk Level of Actual Capital

- Initial attempt: probability of default
  - Problem: models not very accurate at extreme probabilities
- What can be done:
  - Capital at multiples of various risk measures
    - Capital = (perhaps)
      - 4 standard deviations of earnings
      - 3 times 1-in-100 TVaR
      - 4 times 1-in-100 cat occurrence
      - 1.5 times 2 1-in-100 aggregate loss years in a row
  - Useful for comparisons of how different strategies that change risk can be imputed to change capital needs
- Does not tell you how much capital is optimal

Live Examples

- Capital = Multiple of probability of loss at quantifiable levels
- Swiss Re 12/31/2006: Times 99% VaR, 99.5% VaR and 99% TVaR
  - Capital is: 3.6x 2.9x 2.4x
  - Year over year comparisons in annual report
- Munich Re: Base capital = 2 aggregate 1-in-100 years in a row; actual capital is a multiple of base – maybe 1.5x
- Endurance: Maximum capital loss of 25% at 1-in-100 event, or… economic capital is 4 times the 1-in-100 loss
- ERM moves us from ¼ of liabilities to 4 times 1-in-100 loss level
  - A real improvement in probabilistic quantification

Optimal Capital Issues

- Basic
  - You need enough to keep them buying, i.e., enough to support growth
  - Can be affected by perceptual issues, competitors, reputation of management …
- Reputation important
  - Role of risk management, stability, etc.
- Competitive analysis
  - What is capital level of competition?
  - What sectors of business to compete for?
  - How much does capital affect winning or losing quoted-for business?
    - Might have to talk to underwriters

What Might Be Done in Optimal Capital: Flavored Models

- Find capital to optimize franchise value: market – book
- Model value of firm as the expected present value of future cash flows to shareholders (at least since de Finetti in 1957)
  - Look for capital level that maximizes value – capital in this sense
    - That is really finding optimum dividend policy
      - Dividend paid earlier has higher present value
      - But paying it could increase probability of ruin, ending future dividends
- Part of general theory of stochastic control
  - You have a stochastic process (total capital) which you can control to some extent (paying dividends) and seek optimum strategy

Actuarial Progress in Stochastic Control of Insurer Capital

- Gerber and Shiu in NAAJ 2006 assume loss process is compound Poisson and severity is a mixture of exponentials, and find the optimum strategy
  - Turns out to be a barrier strategy
    - Pay out all capital over a certain level in dividends and none below it
- Another possible control is ceding reinsurance
  - Can seek optimal strategy for reinsurance and capital
  - Bather 1969 addressed this for proportional reinsurance
  - Asmusson et al. 2000 try excess reinsurance
  - Pricing rule for excess cover becomes an issue to address
  - Costly reinsurance can be valuable to stave off ruin

Enter Finance

- De Finetti was in late 1950's where finance world (MM) was saying risk transfer is not worthwhile
- One assumption of that is that external finance is always available and not costly
- Actuarial literature did not consider refinancing, so basically had infinite cost of external capital
  - Peura 2003 Univ Helsinki thesis maybe first exception
- Froot and others introduced costly but possible external finance in the financial literature – like new shares 40% below latest price of existing for Societe Generale
- Major adding costly external finance to actuarial approach
  - Calls it Flavored as an acronym for some of the contributors

Risk-Adjusted Profit of Business Units

Traditional Risk Measurement

- Premium volume
- Exposures in force
- Limits in force
- Number of policies
- PML
- These don’t compare well across businesses
- Not really probabilistically based

ERM Risk Measures

- Value at Risk (VaR)
  - $\Pr(Y>VaR_\alpha) = 1 - \alpha$
- Tail Value at Risk (TVaR)
  - $E[Y|Y>VaR_\alpha] = TVaR_\alpha$
- Both give probabilistically consistent ways of comparing units
- Both are tail measures
  - Ignore risk that is probably important, in that you would charge for it
  - Lower α's probably better, like 85% or even 60%

Issues with VaR and TVaR

- Sum of VaR's can be greater than VaR of sum
  - Pool of risks each with loss probability of ½% each has $VaR_{0.99} = 0$, so sum = 0, but $VaR_{0.99}$ of pool > 0
  - Actually not so critical in practice
- TVaR is linear in large losses, which is opposed to usual risk attitudes

Alternative Risk Measures

- Semi-standard deviation (adverse deviations only)
- $E[Ye^{cY/EY}]$ gives weight to tail but measures all risk
- Mean under transformed probabilities
  - Gives more weight to tail but all risk included
  - Financial value measures like CAPM and Black-Scholes can be put in this form
    - Useful for risk measure to give value of risk taken
- Can do TVaR with transformed probabilities
  - No longer linear in large losses

Example of Transformed Mean

- Esscher transform for compound Poisson
- Severity density g(y) transformed to: $g^*(y) = g(y)Ee^{cy/EY} / Ee^{cY/EY}$
- Frequency: $\lambda^* = \lambda Ee^{cY/EY}$
- Constant c chosen to give overall load
- In one test, this fit well to reinsurance prices
- Is minimum entropy martingale transform
- Risk measure: transformed mean – mean

Allocating Risk

- Allocating capital usually done by allocating risk
- Purpose is usually to get risk-adjusted returns by business unit
- Typical approach: proportional allocation
  - Measure risk for each unit and for firm, and allocate firm risk in proportion
- Problems with proportional allocation:
  - Does not show the contribution of each unit to the risk of the firm
  - Probably will not show marginal impact of change in unit on change in firm risk
  - Growing units with higher return on risk will not necessarily increase return on risk for the whole firm

Contribution of Units to Firm

- Use co-measures
  - Prototype: sum of covariances of units with firm is the variance of the firm
- Co-TVaR$_\alpha$ for unit X_j : $E[X_j|Y>VaR_\alpha]$
  - Shows contribution of X_j to TVaR of firm
- Can be defined for any risk measure that can be expressed as a conditional expected value

Riskiness of Business Units

- Real issue is what is the contribution of the unit to the riskiness of the firm
- For homogeneous risk measures (i.e., r[aY] = a r[Y]) this is done by Euler's Theorem
  - Total risk measure for company is a multivariate function of the losses of the business units
  - Euler: derivatives of risk measure with respect to units' volumes sum up to entire risk measure
  - Derivative is marginal impact of unit's volume of business on the entire company risk measure
  - So can allocate by marginal impact and still sum to total
  - Venter, Major, Kreps ASTIN 2006 do the derivatives for many risk measures

Details

- For risk measure ρ, company variable Y = sum of units X_j
- $r(X_j) = \lim_{\varepsilon \to o}[\rho(Y) - \rho(Y - \varepsilon X_j)]/\varepsilon$.
- If $\rho(Y) = StD(Y)$,
  - $r(X_j) = Cov(X_j, Y)/StD(Y)$
- Co-TVaR is also marginal as is co-VaR

Properties of Marginal Decomposition

- Better than separate individual unit measures
- For capital maintains pricing at the margin
- Growing units with higher profit/risk will increase profit/risk for the firm
- But only if growth is proportional, like reducing quota share or increasing shares of business written
- Approximation otherwise – unless risk unit is transformed mean, then exact

Even so, Not Ideal Way to Risk-Adjust Profits

- Arbitrary and artificial
- Not likely to reflect risk pricing principles
  - Risk adjusting profit by allocating capital comes down to quantifying the value of the risk – really increase in firm value
  - Could work if risk pricing were the risk measure used in allocation, but allocation then not really needed
  - A good risk pricing theory is needed to do it right
- A 1st approximation is RTVaR – risk adjust TVaR
  - Conditional mean plus a percent of conditional standard deviation above the TVaR probability level
  - Standard deviation pricing of tail risk
  - Derivative for marginal calculation known
  - Can use at probability of not meeting plan

Possible Next Step

- Model market value of firm
  - Growth prospects, profitability prospects
  - Risks to market value
- Allocate franchise value – market value less capital – to business units
- Stronger basis for strategic planning
- Need better theory of market value:
  - Higher co-moments, impact of jumps, customer attitudes to firm risk

What Might Be Done for Risk Pricing

- Two financial paradigms: CAPM and arbitrage theory
- Venter ASTIN 1991 showed that CAPM can be incorporated into arbitrage theory
  - Transform the probabilities using conditional mean of market given the individual asset being priced to define new probabilities
- If returns are not normally distributed, it has been known since early 1970's that maximizing investor utility requires pricing higher co-moments than just covariance
  - Some evidence of this in market prices
  - Needed in insurance pricing
- Also jump risk may be an additional priced factor

Jump Risk

- In single period model not important
- But in continuous model, its existence can make the market incomplete without hedges for some risks
- You would think this would be of concern to investors
- So seems logical to price jump risk over and above moments
- This is done in many arbitrage-free approaches
- Extending CAPM for jumps may be possible using co-jumps
  - That is jump for the company when there is a market jump
- Still some work needed to have a real pricing model for insurance risk

In Summary

- Economic capital better defined as multiple of loss at lower risk level, but still does not give the true capital need
- Tail risk measures have weaknesses
- If you're going to allocate, be marginal
- Even then not likely to give value of risk
- Strategic risk analysis through ERM has come a long way, but is not nearly done
  - Modeling and optimizing franchise value of firm
  - Measuring value contribution of business units, perhaps through a pricing theory