SOCIETY OF ACTUARIES

ERM Symposium
April 2010

5G - Call for Papers: Alternative Approaches to ERM

Neil Allan
Neil Bodoff
Noel Harewood

Moderator
Al Weller

ENTERPRISE RISK MANAGEMENT
ERM
Symposium

Concurrent Session 5
Alternative Approaches to ERM

- **"Phylogenetic Approaches" by Neil Allan, Neil Cantle, and Yun Yin**
- **"Discarding Risk Avoidance and Embracing Risk Optimization : Managing Reinsurance Credit Risk" by Neil Bodoff**
- **"Rethinking Fixed Deferred Annuities Applying A Risk-Based Economic Value Approach" by Noel Harewood, Dominique Lebel, and Mark Scanlon**

ENTERPRISE RISK MANAGEMENT
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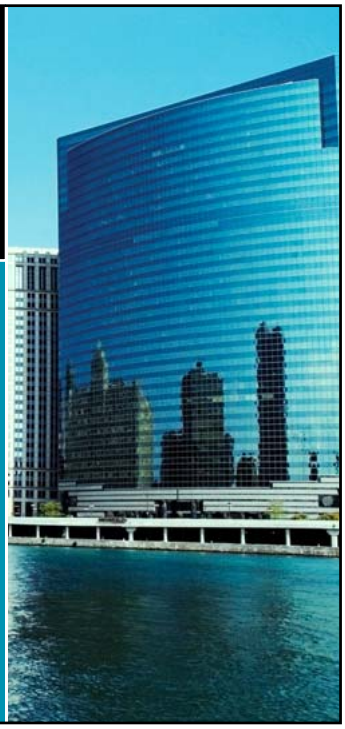
Where Cutting Edge Theory Meets State of the Art Practice

Phylogenetic analysis

Presented by Neil Allan

Co-Authors Neil Cantle, Milliman

Dr Yun Yin, Systemic Consulting



Three interconnected principles

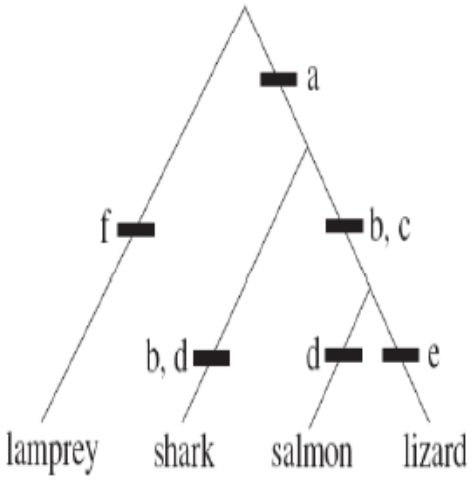
- Risks behave as complex adaptive systems not as an aggregation of events.
- Evolution is a signature of complex adaptive systems and hence risks, should by definition, evolve and follow evolutionary principles.
- Connectivity is a fundamental property of any system.

Advantages

- Risks have a unique sequence, very much like a DNA.
- Collective risk systems evolve and co-evolve.
- The path-dependency is an important aspect of a risk.
- A risk's evolutionary progression can be analysed and predictions made about how they may most likely develop.
- It is a powerful and unique way to classifying risks.

Biological Example

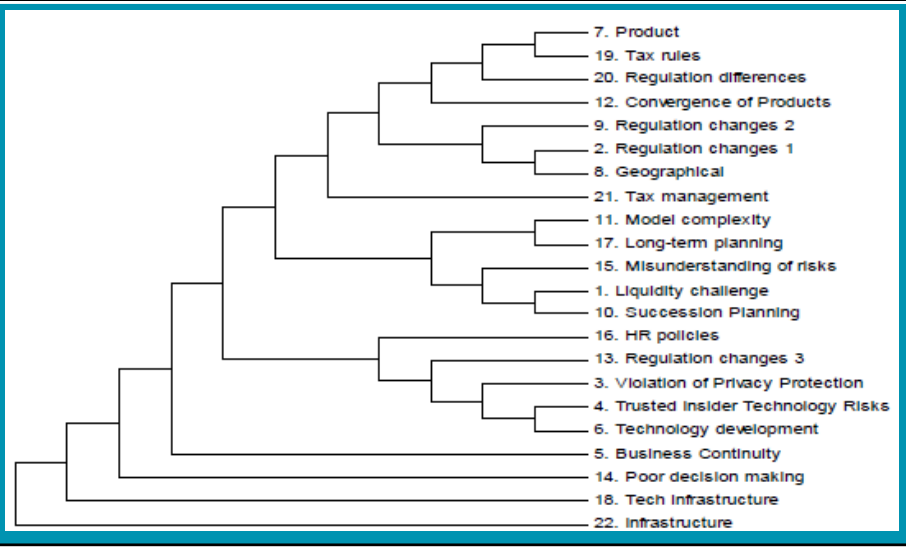
	a	b	c	d	e	f
lamprey	0	0	0	0	0	1
shark	1	1	0	1	0	0
salmon	1	1	1	1	0	0
lizard	1	1	1	0	1	0



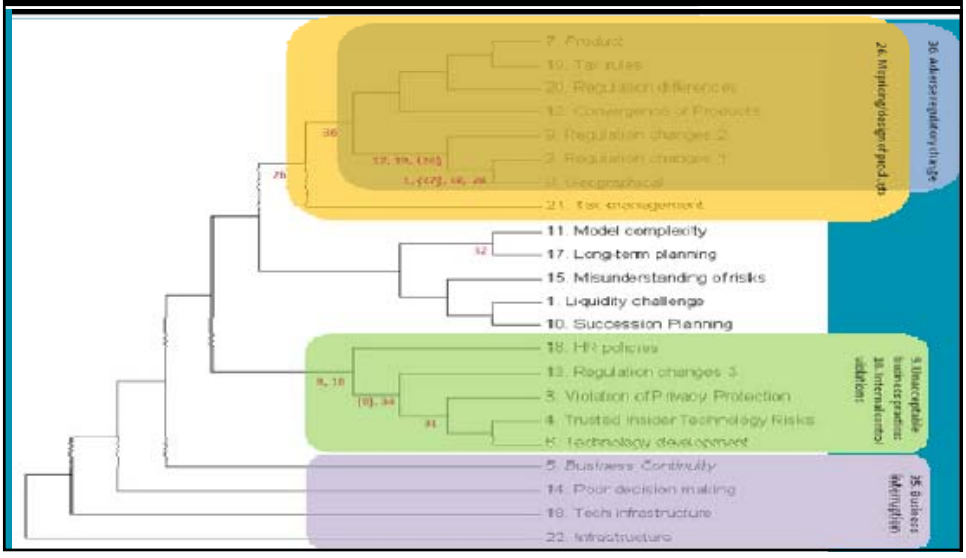
Insurance example

Strategic	1	Strategy		
Equity	2	Asset Allocation	3	Concentration
Credit	4	Investments	5	Reinsurance
Insurance	6	Insurance		
Operational	7	Unacceptable business practices	21	Mishandling of complaints
	8	Internal control violations	22	Mishandling of investment transactions
	9	Project failures	23	Liquidity needs unmet
	10	Communication failure	24	Mispricing/design of products
	11	Brand abuse	25	Mishandling of underwriting
	12	Violation of reporting regulations	26	Inadequate reinsurance
	13	Solvency	27	Inadequate claims management
	14	Violation of disclosure requirements	28	IT systems failure
	15	Customer due-diligence	29	Unauthorized access to data
	16	Product compliance	30	Inadequate functionality
	17	Mis-selling	31	Inappropriate skills
	18	Mishandling data	32	Staff act outside authority/competence
	19	Incomplete documentation	33	Business interruption
	20	Systemic reporting error	34	Adverse legal/regulatory change

The risk DNA tree

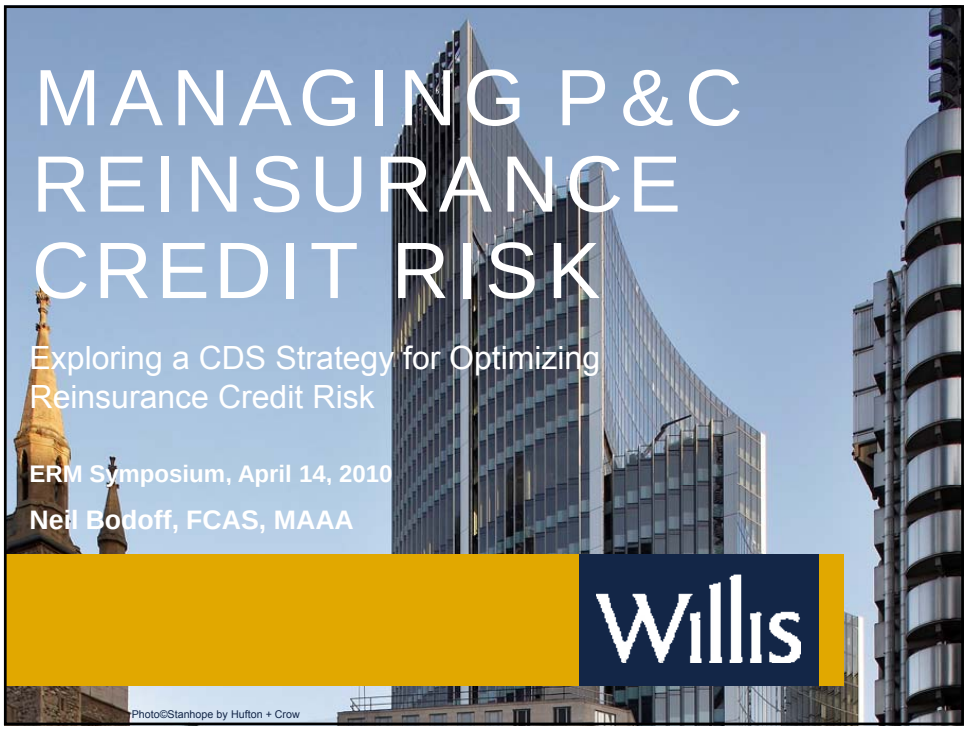


Interpreting the tree



Evolutionary Distance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Liquidity challenge																					
2. Regulation changes 1	2.955																				
3. Violation of Privacy Protection	2.955	3.319																			
4. Trusted Insider Technology Risks	0.168	3.093	0.455																		
5. Business Continuity	0.168	3.093	2.955	0.455																	
6. Technology development	0.258	3.154	2.576	0.029	0.258																
7. Product	0.109	2.576	3.028	0.258	0.258	0.455															
8. Geographical	2.762	0.455	3.319	2.955	2.955	3.028	0.258														
9. Regulation changes 2	0.168	0.455	2.955	0.455	0.455	2.576	0.109	0.455													
10. Succession Planning	0.065	2.762	2.955	0.168	0.168	0.258	0.109	2.762	0.168												
11. Model complexity	0.168	3.093	2.955	0.455	0.455	2.576	0.258	2.955	0.455	0.168											
12. Convergence of Products	0.168	0.455	3.093	0.455	0.455	2.576	0.029	0.168	0.168	0.168	0.455										
13. Regulation changes 3	0.258	3.028	2.576	0.109	2.576	0.168	0.168	2.870	0.258	0.258	2.576	0.258									
14. Poor decision making	0.168	2.955	3.093	0.455	0.168	0.258	0.258	2.762	0.455	0.168	0.455	0.168	2.576								
15. Misunderstanding of risks	0.168	3.093	2.955	0.455	0.168	2.576	0.258	2.762	0.455	0.168	0.455	0.455	2.576	0.455							
16. HR policies	0.258	3.154	2.576	0.258	0.258	0.455	0.455	3.028	2.576	0.258	2.576	2.576	0.168	0.258	0.258						
17. Long-term planning	0.258	2.576	3.154	2.576	2.576	2.762	0.168	2.576	0.258	0.109	0.258	0.109	0.455	0.258	2.576	2.762					
18. Tech infrastructure	0.168	3.093	3.093	0.455	0.065	0.258	0.258	2.955	0.455	0.168	0.455	0.455	2.576	0.065	0.455	0.258	2.576				
18. Tax rules	0.168	0.455	3.093	0.455	0.455	2.576	0.029	0.455	0.168	0.168	0.455	0.065	0.258	0.455	0.455	2.576	0.258	0.455			
20. Regulation differences	0.168	0.455	3.093	0.455	0.455	2.576	0.029	0.168	0.168	0.168	0.455	0.065	0.258	0.455	0.455	2.576	0.258	0.455	0.065		
21. Tax management	0.065	2.762	2.955	0.168	0.168	0.258	0.029	0.455	0.168	0.065	0.168	0.065	0.258	0.168	0.168	0.258	0.258	0.168	0.065	0.065	
22. Infrastructure	0.168	3.093	3.093	0.455	0.065	0.258	0.258	2.955	0.455	0.168	0.455	0.455	2.576	0.065	0.455	0.258	2.576	0.000	0.455	0.455	0.168



Disclaimer

OUTLINE

- Motivation
- Existing strategy
  - pros and cons
- New strategy proposal
  - numerical examples
  - pros and cons
- Summary

MOTIVATION

- Reinsurance credit risk
  - risk that reinsurers will not pay ceded losses
- P&C insurance companies are exposed to reinsurance credit risk
  - property cat
    - material amount of limit and PML with reinsurers
  - casualty
    - material amount of recoverables with reinsurers

EXISTING STRATEGY

- Create “approved reinsurers list”
  - cons
    - no differentiation among approved reinsurers
    - no differentiation among unapproved reinsurers
    - risk avoidance mentality
    - no framework for evaluating price tradeoffs among various reinsurers of differing creditworthiness
    - “approval list” doesn’t help when a reinsurer suffers financial distress after you’ve already placed business with it
      - significant risk for long tail casualty business

NEW STRATEGY

- Use Credit Default Swaps (CDS) to
  - quantify cost of default risk
  - measure prices on “apples-to-apples” basis
  - evaluate tradeoffs
  - broaden choices of reinsurers
  - achieve better reinsurance price
  - hedge risk

NEW STRATEGY

- Define new metric:
  - “credit risk adjusted reinsurance price”

Credit risk adjusted reinsurance price =

reinsurance price + cost of credit default protection

NUMERICAL EXAMPLE

Company Name	1Y CDS Spread bps (as of 28-Sep-2009)
Munich Re	13.25
Hannover Rueckversicherung AG	15.00
SCOR SE	26.00
Ace Ltd	49.30
Everest Reinsurance Holdings Inc	65.24
Swiss Reinsurance Company Ltd	73.50
RenaissanceRe Holdings Ltd	95.03
Berkshire Hathaway Inc	102.37
XL Capital Ltd	131.22
Society of Lloyd's	273.24

Source: Thomson Reuters

Table of CDS prices for illustrative purposes throughout the presentation

NUMERICAL EXAMPLE #1

	1	2	3 = 1 * 2	4	5	6 = 4 / 10k * 5	7 = 3 + 6	8 = 7 / 1
Reinsurer	Reinsurance Occurrence Limit	Quoted Reinsurance Rate on Line (RoL)	Quoted Reinsurance Price	Price of CDS (in basis points)	Notional amount of CDS protection	Price of one year CDS protection	Credit risk adjusted reinsurance price	Credit risk adjusted reinsurance RoL
Munich Re	100,000,000	6.00%	6,000,000	13.250	100,000,000	132,500	6,132,500	6.13%
XL Capital Ltd	100,000,000	5.50%	5,500,000	131.220	100,000,000	1,312,200	6,812,200	6.81%

- upfront nominal price quotes
- CDS spreads highlight the divergent "cost of credit default risk" of the two reinsurers
- "apples-to-apples" basis
- incorporates cost of credit risk
- implies that the truly best price quote is not necessarily the lowest upfront price

NUMERICAL EXAMPLE #2

		1	2	3 = 1 * 2	4	5	6 = 4 / 10k * 5	7 = 3 + 6	8 = 7 / 1	9
Reinsurer	Status	Reinsurance Occurrence Limit	Quoted Reinsurance Rate on Line (RoL)	Quoted Reinsurance Price	Price of CDS (in basis points)	Notional amount of CDS protection	Price of one year CDS protection	Credit risk adjusted reinsurance price	Credit risk adjusted reinsurance RoL	Share authorized by reinsurer
Hannover	Approved	100,000,000	8.50%	8,500,000	15.000	100,000,000	150,000	8,650,000	8.65%	50.00%
Renaissance Re	Approved	100,000,000	7.00%	7,000,000	95.030	100,000,000	950,300	7,950,300	7.95%	50.00%
XL Capital Ltd	Not Approved	100,000,000	6.50%	6,500,000	131.220	100,000,000	1,312,200	7,812,200	7.81%	50.00%

- current approach
- excludes unapproved reinsurer
- creates higher market clearing price

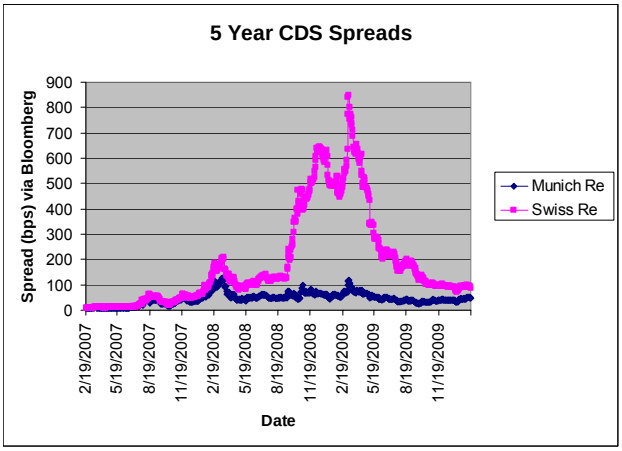
- proposed approach
- incorporates CDS data
- includes more reinsurers
- evaluates tradeoff of higher credit risk but lower price

- "apples-to-apples" basis
- incorporates cost of credit risk
- including more reinsurers lowers the market clearing price

NUMERICAL EXAMPLE #3

- Long tail casualty business
  - contract incepts today
  - claim payments occur years in the future
  - down the road, your reinsurers could encounter financial distress
- Consider buying CDS protection on reinsurers
  - could serve as hedge against reinsurer financial distress

NUMERICAL EXAMPLE #3



NUMERICAL EXAMPLE #3

- Multi-year horizon
  - compounds the cost of credit risk across many periods
    - amplifies small differences in spreads into significant price differences

NUMERICAL EXAMPLE #3

Reinsurer #1

1	2	3	4	5	6	7	8	9	10	11	12
Time	% Paid	Expected Loss	NPV Expected Loss	Incremental VaR (t)	NPV Incremental VaR(t)	CDS spread (bps): annual price for cover through time t	Number of years need to hold CDS	Interest rate	Discount Factor from time (t) to t=0	Total NPV CDS cost	Total NPV CDS cost (bps) as % of total VaR
1	5%	1,250,000	1,245,268	5,000,000	4,981,072	15.00	1	0.38%	99.62%	7,472	0.75
2	10%	1,250,000	1,227,800	5,000,000	4,911,201	21.50	2	0.90%	98.22%	21,118	2.11
3	25%	3,750,000	3,602,491	15,000,000	14,409,963	22.25	3	1.35%	96.07%	96,186	9.62
4	45%	5,000,000	4,656,854	20,000,000	18,627,418	28.50	4	1.79%	93.14%	212,353	21.24
5	70%	6,250,000	5,594,687	25,000,000	22,378,749	32.25	5	2.24%	89.51%	360,857	36.09
6	85%	3,750,000	3,244,233	15,000,000	12,976,934	33.45	6	2.44%	86.51%	260,447	26.04
7	90%	1,250,000	1,041,014	5,000,000	4,164,056	34.65	7	2.65%	83.28%	100,999	10.10
8	95%	1,250,000	998,178	5,000,000	3,992,713	35.60	8	2.85%	79.85%	113,712	11.37
9	99%	1,000,000	762,677	4,000,000	3,050,707	36.55	9	3.06%	76.27%	100,353	10.04
10	100%	250,000	181,392	1,000,000	725,569	37.50	10	3.26%	72.56%	27,209	2.72
				-							
Total		25,000,000	22,554,595	100,000,000	90,218,380					1,300,707	130.07
									% of NPV Expected Loss	5.8%	

Notes
1 Column 11 = Column 6 * Column 7 /10k * Column 8
2 Column 12 = Column 11 / (Column 5 total / 10k)

- reinsurer #1 has low annual CDS spreads
- but risk cost accumulates across years

- total multiyear cost is much larger than single year cost

NUMERICAL EXAMPLE #3

Reinsurer #2

1	2	3	4	5	6	7	8	9	10	11	12
Time	% Paid	Expected Loss	NPV Expected Loss	Incremental VaR (t)	NPV Incremental VaR(t)	CDS spread (bps): annual price for cover through time t	Number of years need to hold CDS	Interest rate	Discount Factor from time (t) to t=0	Total NPV CDS cost	Total NPV CDS cost (bps) as % of total VaR
1	5%	1,250,000	1,245,268	5,000,000	4,981,072	73.50	1	0.38%	99.62%	36,611	3.66
2	10%	1,250,000	1,227,800	5,000,000	4,911,201	87.00	2	0.90%	98.22%	85,455	8.55
3	25%	3,750,000	3,602,491	15,000,000	14,409,963	101.00	3	1.35%	96.07%	436,622	43.66
4	45%	5,000,000	4,656,854	20,000,000	18,627,418	109.50	4	1.79%	93.14%	815,881	81.59
5	70%	6,250,000	5,594,687	25,000,000	22,378,749	123.50	5	2.24%	89.51%	1,381,888	138.19
6	85%	3,750,000	3,244,233	15,000,000	12,976,934	125.55	6	2.44%	86.51%	977,552	97.76
7	90%	1,250,000	1,041,014	5,000,000	4,164,056	127.60	7	2.65%	83.28%	371,933	37.19
8	95%	1,250,000	998,178	5,000,000	3,992,713	129.23	8	2.85%	79.85%	412,793	41.28
9	99%	1,000,000	762,677	4,000,000	3,050,707	130.87	9	3.06%	76.27%	359,312	35.93
10	100%	250,000	181,392	1,000,000	725,569	132.50	10	3.26%	72.56%	96,138	9.61
				-							
Total		25,000,000	22,554,595	100,000,000	90,218,380					4,974,186	497.42
									% of NPV Expected Loss	22.1%	

Notes
1 Column 11 = Column 6 * Column 7 /10k * Column 8
2 Column 12 = Column 11 / (Column 5 total / 10k)

- reinsurer #2 has modestly higher annual CDS spreads

- risk cost compounds across years
- creates material difference in reinsurance price quote between reinsurer #2 and reinsurer #1

CDS PROS AND CONS

- Pros
  - achieve lowest price on reinsurance deals
  - hedge reinsurance risk
- Cons
  - basis risk
  - counterparty credit risk
  - availability and liquidity
  - cost

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BASIS RISK

- Basis risk arises because CDS pays off when a “credit event” occurs
  - usually when company defaults on debt
    - but default on debt ≠ default on reinsurance claims
  - usually based on the holding company
    - but default by holding company ≠ default by reinsurance operating company

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BASIS RISK

- Factors that lessen basis risk
  - reinsurer financial distress likely leads to offsetting gain and loss for the ceding company
    - loss:
      - reinsurer commutes, ceding company receives only cents on the dollar
    - gain:
      - market value of CDS likely increases during reinsurer's financial distress
- Ceding company's CDS gains would probably offset reinsurance losses, but some basis risk lingers

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COUNTERPARTY CREDIT RISK

- Buying CDS
  - hedges the reinsurance credit risk
  - but generates counterparty credit risk
- Seller of CDS protection may not be able to pay you when it matters most
- CDS protection only as good as who you buy it from

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COUNTERPARTY CREDIT RISK

- Actions that can lessen counterparty credit risk
  - require the CDS seller to post collateral
    - frequently (e.g. daily)
    - and/or when CDS value changes by a specified amount
    - but “jump risk” via sudden moves in value still a concern
  - select counterparty whose financial strength is uncorrelated with P&C insurance losses

SUMMARY

- Consider using CDS
  - to quantify the cost of credit default risk
  - to improve reinsurance buying decisions
  - to hedge reinsurance credit risk
- Cons
  - CDS give rise to additional issues such as basis risk, counterparty credit risk, and availability and liquidity
- Pros
  - achieve lowest price on new reinsurance transactions
  - potentially enhance firm’s ERM
  - explore risk optimization rather than risk avoidance
- CDS strategy not necessarily suitable for all companies

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ENTERPRISE RISK MANAGEMENT

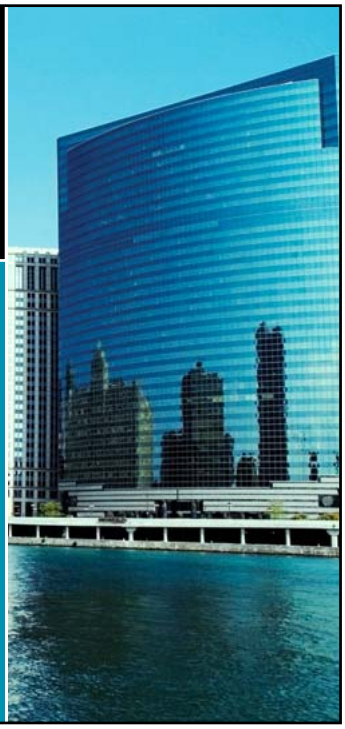
ERM

Symposium

Where Cutting Edge Theory Meets State of the Art Practice

Rethinking Fixed Deferred Annuities: Applying a Risk-Based Economic Value Approach

2010 ERM Symposium
Noel Harewood
April 14, 2010



Agenda

- Risk Based Economic Value Framework
- High Level Analysis of Risks Inherent in Fixed Deferred Annuity Products
- Methodology and Modeling Issues
- Bringing it All Together

Risk Based Economic Value Framework

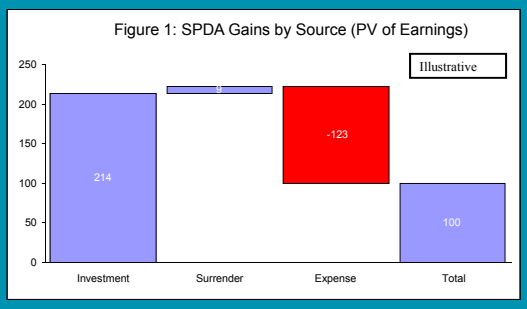
- Increasing use of market-based metrics to reflect risk in valuations
  - FASB, IASB, CFO Forum, Solvency II prescribe varying levels of use of market-based metrics
- Cash flows should be in line with prices of similar cash flows traded on the open market
  - Maintain principal of no arbitrage
  - Valuation must be performed in a manner to reproduce observable prices for traded instruments

Risk Based Economic Value Framework

- Benefits of market-based approaches
  - Assets and liabilities are valued using economic principals, preventing distortions driven by regulations and accounting
  - Risk is incorporated explicitly based on observable market prices, thus providing objective assessment of risks
  - Approach provides information on the cost of hedging and transferring risks
- Market consistent value of assets is market value of assets where available or mark-to-model approach
- Market consistent value of liabilities is sum of best estimate liability (BEL) and market value margin (MVM)

Risks Inherent in Fixed Deferred Annuity Products

- Under "real world" expectations, the most significant source of earnings for FDAs is the investment margin



- Market-based valuations can result in lower values placed on investment margins and thus the product

Risks Inherent in Fixed Deferred Annuity Products

- Credit risk
  - Risk of loss due to asset defaults
  - An FDA is effectively selling credit protection to the policyholder (equivalent of being short a credit default swap)
- Investment risk
  - Risk of loss as a result of movements in interest rate curves
  - Option to surrender can be considered put option on family of interest rate curves
- Liquidity Risk
  - Risk of loss due to inability to meet cash requirements
  - No general accepted definition for liquidity for liabilities. Extent to which an FDA is liquid depends on many factors (i.e., product design and how it influences predictability of liability cash flows)

Risk Management Levers

- Three basic tools to manage risks:
  - Product Design (e.g. minimum interest rate guarantees and market value adjustments on surrender)
  - Investment Strategy (e.g. the degree of credit risk undertaken)
  - Crediting Strategy (i.e. the ability to adjust credited rates)

Methodology and Modeling Issues

- Challenges with a market consistent valuation stem from fact that assets on average earn the risk free rate
- In addition, behavior of management, policyholders, and competitors are all interrelated and can all have a significant impact on the projected cash flows that drive the value of the business

Crediting Strategy

- Stochastic modeling of spreads and defaults
  - Significant asymmetries that are present in FDA products ask for the use of stochastic simulation approaches; not only for interest rates, but also for credit spreads and defaults
- Asset Returns
  - Assets earn the risk free rate on average across all scenarios but “reality” occurs along one (deterministic) path
  - Future expected returns for the purposes of determining projected credited rates should consider only what has actually occurred along that particular scenario path to date.

Crediting Strategy

- Credit Spreads and Defaults
  - Traditional approaches do not reflect additional cost of asymmetry
  - If stochastic modeling is impractical then deterministic approaches to setting defaults rates maintaining term structure of credit spreads are superior
- Target Spread
  - Adjustments may be needed to reflect the fact that management's long term assumptions is not be borne out in market consistent projection.
- Policyholder and Competitor Behavior
  - Behavior should be based on each scenario path with neither competitors nor policyholders assumed to have access to more information than they would have in practice

Liability Discount Rate

- Liquidity Premiums & Own Credit Risk
  - Discount rate should include a liquidity premium (if liabilities are less liquid) and the insurer's own credit spread (depending on the type of valuation)

Bringing it All Together

- Many FDA products today would result in a negative MCEV, meaning companies are undercharging for and not fully aware of the risks they are assuming
- Market value metrics highlight various levels of risks and provide useful information about potential risk exposures on different product features

Questions,

Comments,

And

Discussion