The Intersection of Finance and Insurance

Stephen Mildenhall
May 2000
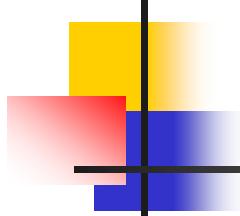
Overview

1. Theory and General Discussion
- 50 mins

2. Non-Securitized Solutions
- 40 mins

3. Securitized Solutions
- 60 mins

1. Theory and General Discussion
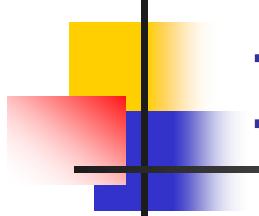
1.1 Introduction

"Insurer, reinsurer, guarantor, counter-party, investor—these terms can be used interchangeably to describe the 'reinsurance' company of today"

A.M. Best, Special Report on Reinsurance
September 1999
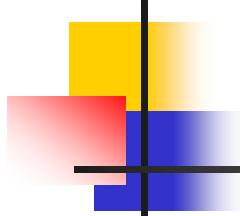
1.1 Introduction

- Reform of insurance and banking laws
- Integration of banking and insurance
  - Partnerships (P/C) and Mergers (Life) with banks
  - Banks as P/C intermediaries rather than risk bearers
- Industry over- *and* under-capitalized
  - Low ROE, very low leverage ratios
    - Driven by conservative rating agency models
  - But, inability to cope with large cats
  - Industry using capital inefficiently?
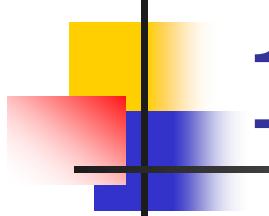
1.1 Introduction

Paradigm	Capital Markets	Insurance Markets
Risk and Return	Systematic risk	Price non-systematic risk
Diversification	CAPM, APT, CIR, Partial & General Equilibrium Models	Risk Bearing through pooling
Hedging	Options pricing, Comparables, No-arbitrage	Traditionally impossible, Reinsurance!
Efficient Markets	Long/short positions, liquid, transparent markets, standardization	Insurable interest, unique products
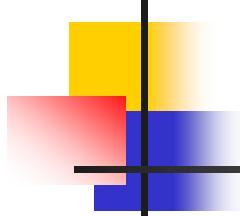
1.1 Introduction

When it comes to the valuation of Insurance liabilities, the driving intuition behind the two most common valuations approaches – arbitrage and comparables – fails us. This is because, for the vast majority of insurance liabilities, there are neither liquid markets where prices can be disciplined by the forces of arbitrage and continuous trading, nor are there close comparables in the market.

We are left in a predicament, but not an impasse. If we can refocus our attention from "market value" to "present value," progress can be made. In doing so we need not descend the slippery slopes that surround the quagmire of equity valuation. The pseudo-scientific methods typically used there impart only a thin veneer of respectability.

David F. Babbel
Discussion of "Two Paradigms for the Market Value of Liabilities"
by Robert Reitano
NAAJ 1(4), 1997
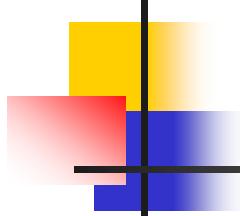
1.1 Introduction

- Insurance capital intensive
  - Capital is the scarce commodity
- Insurer risk management operations provide an interesting microcosm of enterprise risk management
  - Reinsurance is an alternative source of financing for insurance companies
  - Provides field for direct insurance-capital market competition
- Actions fit well with predictions of Froot, Scharfstein, Stein paper
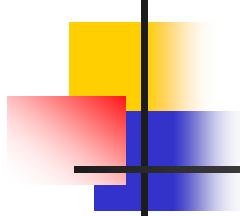
1.2 Complete Markets and Insurance

- **Complete Market**: every pattern of cash flows can be replicated by some portfolio of securities that are traded in the market
- Insurance products are not redundant: they add to the set of available securities
- Cannot use arbitrage-free pricing techniques to determine price of non-redundant securities
  - Cannot construct replicating / hedging portfolio
- Incompleteness is a selling point
  - Obvious benefit to insured
  - Creates assets uncorrelated to the market for investor
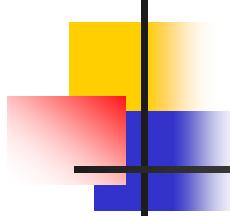
1.2 Complete Markets and Insurance

Financial option pricing methodologies since Black and Scholes (1973) define option prices as the hedging cost to set up a riskless hedge portfolio. Financial options are treated as redundant contracts, since they can be replicated by trading the underlying assets. The so-called "relative valuation" method prices financial options in the world of the risk-neutral measure. On the actuarial side, there is no liquid secondary market for insurance contracts; thus, insurance and reinsurance contracts are viewed as non-redundant, primary contracts to complete the market. Actuarial risk models that price insurance liability contracts are not based on an assumption of hedging, instead considering the present value of future losses (loss theory) and the cost of allocated capital. The pricing is done in the world of the objective measure.

Portfolio-Based Pricing of Residual Basis Risk
with Application to the S&P 500 Put Options
Sergei Esipov and Dajiang Guo
2000 Discussion Paper Program
Casualty Actuarial Society
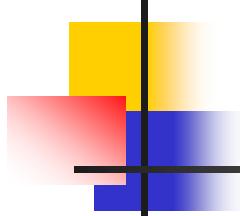
1.2 Complete Markets and Insurance

- Econophysics
  - New slant on applying statistics to economics time series
  - Recognize short-comings of Gaussian based models
  - Price options by minimizing non-zero residual basis risk
    - Consider variation in total wealth from writing option
    - Consider impact of "thick-tails"
    - Alternatives to variance based risk measures
    - Alternatives to multivariate normal distribution for correlation
  - Theory of approach more clearly applicable to insurance
    - Fruitful area for future research
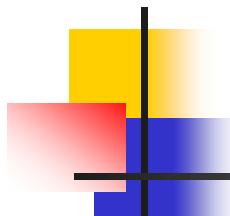
1.2 Complete Markets and Insurance

In our opinion, mathematical finance in the past decades has over focused on the concept of arbitrage free pricing, which relies on very specific models where risk can be eliminated completely. This leads to a remarkably elegant and consistent formalism, where derivative pricing amounts to determining the risk-neutral probability measure, which in general does not coincide with the historical measure. In doing so, however, many important and subtle features are swept under the rug, in particular the amplitude of the residual risk. Furthermore, the fact that the risk-neutral and historical probabilities need not be the same is often an excuse for not worrying when the parameters of a specific model deduced from derivative markets are very different from historical ones. … In our mind, this rather reflects that an important effect has been left out of the models, which in the case of interest rates is a **risk premium effect**.

Back to Basics: historical option pricing revisited
J-P Bouchaud and M Potters
1998
xxx.lanl.govcond-mat/9808206
Emphasis added
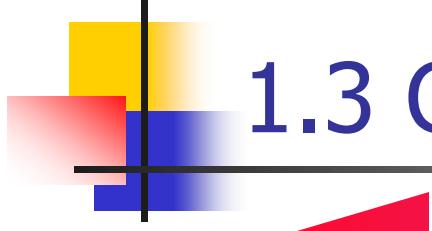
1.3 Comparison of Pricing Methods

Trade to Manage ← → **Diversify to Manage**

Hedge Black-Scholes idealization Adjust probabilities	Real world financial option	Dual-trigger financial/ insurance instrument	**Diversify** Stock Bond Insurance Cat Bond

No arbitrage / comparables determine unique price

No general theory to determine unique price
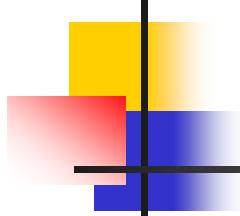
1.3 Comparison of Pricing Methods

- Insurance shares concepts and structures with finance
  - Swaps and Options $\leftarrow\rightarrow$ Excess of Loss Insurance
- Actuarial Pricing
  - No consensus on risk and profit loads
  - Searching for general equilibrium theory
  - Risk-Adjusted interest rates
    - Related to CAPM / APT arguments
    - Correlations with existing book of business
  - Wang and adjusted probabilities
    - Related to risk neutral, no-arbitrage theories
    - Additive in layers
  - Numerous risk-load approaches used in industry
  - Insurers (must) price non-systematic risk
    - Costly for insurers to raise capital
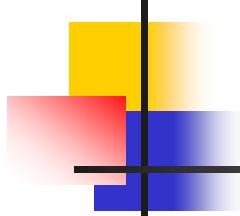
1.4 ERM

- **E**nterprise **R**isk **M**anagement
  - Latest buzz-phrase in actuarial circles
- Practitioner approach to demand for business insurance
  - Non-insurance / all enterprises
  - Insurance companies
  - Demand for business insurance
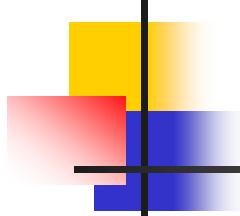
1.4 ERM: Non-Insurers

- What are the large events that could impact the company?
  - "Keep you up at night" events
  - Large exposures often first party rather than third party
    - Damage to property
    - Rogue trading
- ERM framework essential for understanding and managing risk
  - You cannot manage what you cannot measure
- Risk to shareholders is from entire enterprise
  - Investors certainly indifferent to arbitrary compartmentalization of risk
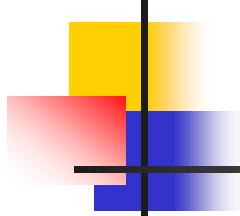
1.4 ERM: Non-Insurers

- Operational flexibility
  - Pricing
  - Relative competitive advantage
  - Focus on core-competencies
- Lower cost of capital
  - Credit enhancement
  - Greater leverage
- Internal capital budgeting and project planning

- Higher stock market valuation multiples
  - Deliver consistent earnings
- Protect franchise value
  - Capitalize on market opportunities
- Tax benefits
- Bonus protection and job security
  - Would you work for an uninsured entity?

1.5 Who is the CRO?

Treasury / CFO
- Manage financial risks
- May have more corporate-wide view

Risk Manager
- Manages traditional insurance coverages
- Less comfortable with financial risks

Risk Manager

Treasury   HR

Op. Depts   Legal

Turf-war mentality and inter-departmental nature of problem seen as major stumbling block for ERM. Cited as major obstacle in Honeywell/AIG integrated deal.
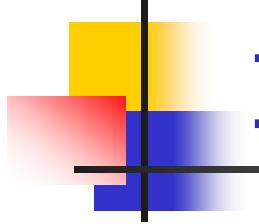
1.6 ERM: Insurers

- ERM most common amongst financial companies
- Insurer ERM *similar* to non-insurer ERM
- ERM clearly essential to insurer:
  - Maintaining strong balance sheet mission-critical
  - Volatile portfolios
- Insurer-reinsurer relations good laboratory for studying enterprise-insurer relations
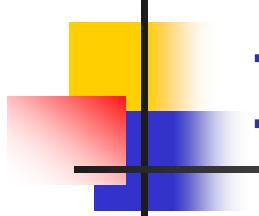
1.6 ERM: Insurers

- Insurer is selling a promise
  - Higher price for more secure product
- Capital: an expensive way to manage risk
  - Double taxation of investment earnings
  - Lower ROE
  - Perils of corporate bloat
- Capital: expensive to replace
  - Asymmetric information in new equity issues
  - Insurer reluctance to release proprietary information
  - Easy to change portfolio
 - High costs and taxation discourage dividends
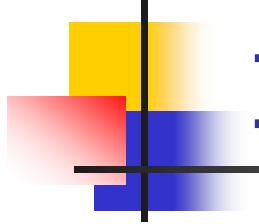
1.6 ERM: Insurers

- Asset Risks
    - Credit, market, interest rate, counter-party, inflation
- Liability / Actuarial Risks
    - Cat, non-cat, reserve development, APMT, ALAE, legal, coverage reinterpretations
- Operating / Management Risks
    - Compliance, systems, business environment, regulation
- Event Risk
    - Front page risk

1.6 ERM: Insurers

- Managing asset risk
  - Impossible on risk-adjusted basis?
  - Insurers hold conservative investment portfolios
- Managing total risk of liabilities

Diversification
UW Expense
Loss Cost Expense

D* optimal diversifi-
cation, balancing cost
of doing business &
leveraging uw expertise

LOB / Geographical
Diversification

D*
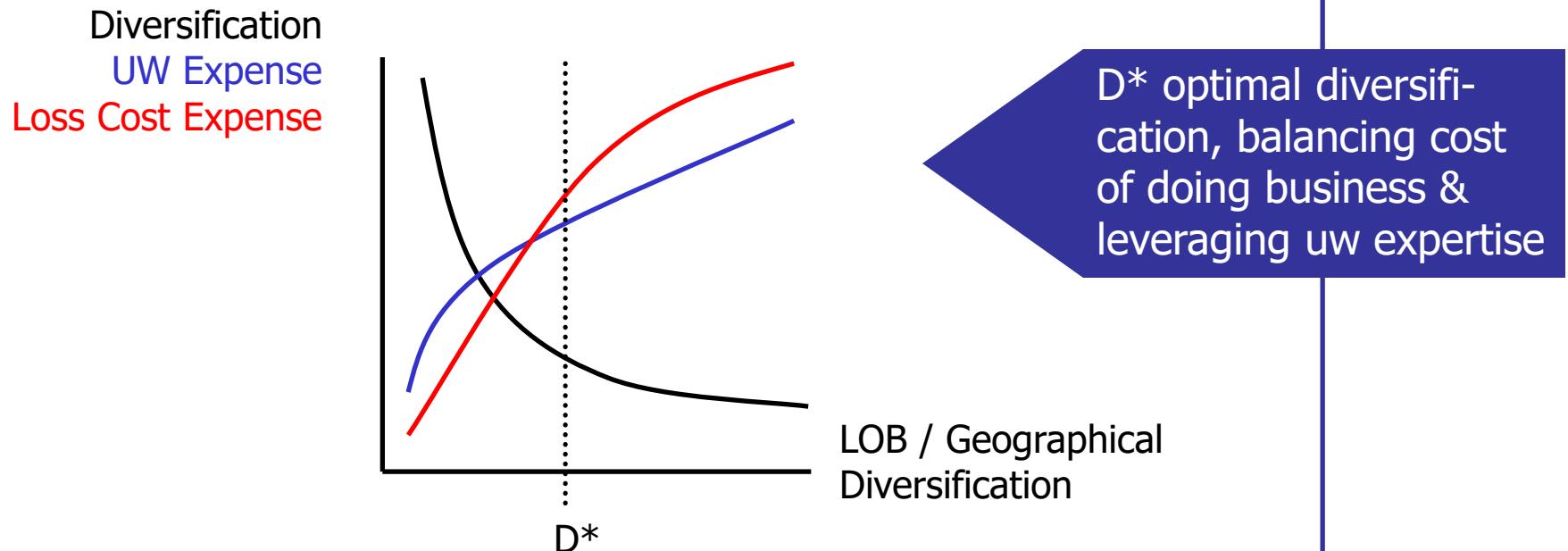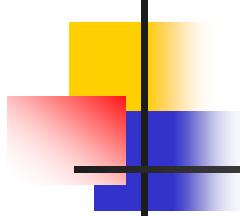
1.7 Business Demand for Insurance

- Insurance below economic cost is always a good investment
- Information asymmetries can hinder development of insurance markets
  - Business purchasers have informational advantage or can influence market
    - Weather derivatives and energy companies
    - Lease residual value and original manufacturers
    - Names and Lloyds in 1980s
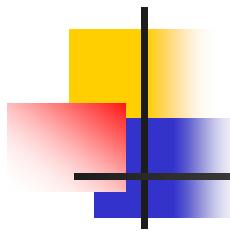
1.7 Business Demand for Insurance

- Miller-Modigliani
  - Tax
  - Contracting costs
  - Impact of financing policy on firm's investment decisions (!)
- Mayers and Smith
  - Comparative advantage in risk bearing
  - Transaction costs of bankruptcy
  - Real service efficiencies (claims expertise)
  - Monitoring and bonding management decisions
  - Tax
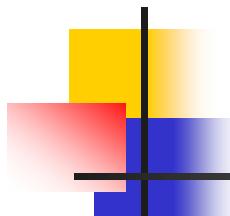
1.7 Business Demand for Insurance

- Froot, Scharfstein, Stein
  - Key to creating corporate value is making good investments
  - Need to generate enough cash internally to fund investments
    - Companies tend to cut investments rather than use external capital when they do not raise enough internally
    - Informational opacity of insurer operations makes raising capital expensive
  - Managing cash flow becomes key
- Other
  - "Be there" when the "market turns"
  - Protecting franchise
    - PV(income from future business)

1.7 Business Demand for Insurance

Quarterly Earnings

Rogue Trading

Rainfall Temperature

Professional Liability

Fire at plant

Auto Losses

New Product Revenue

Chip Prices

Products Liability

WC & Health Care

Pensions

Oil, Gas, Grain Prices

Political Risk
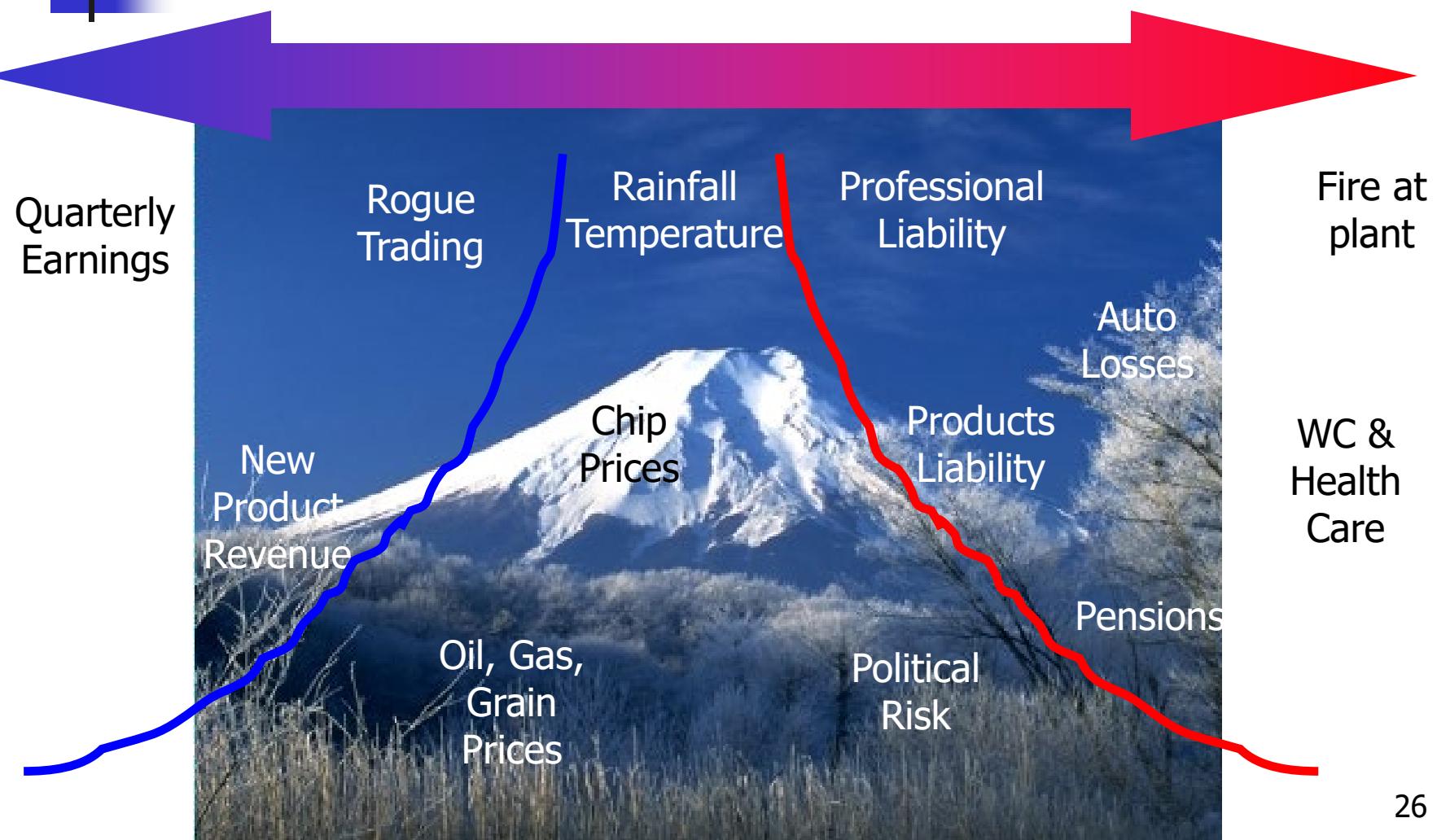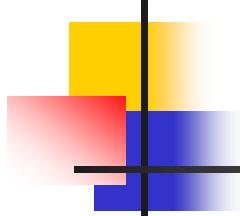
1.8 FASB

- Dual accounting standards for insurers
  - GAAP (Income) and Statutory (Solvency)
- FASB 113 - Risk transfer
  - Assume significant insurance risk
  - Reasonably possible that reinsurer may realize a significant loss from transaction
    - Loss determined using PV(cash flows)
    - 10% chance of 10% loss
- D54 Exception for Loss Reserve Guarantees
- FASB 133 – Derivatives and Hedging Activities
  - Details being worked out

2. Non-Securitized Solutions
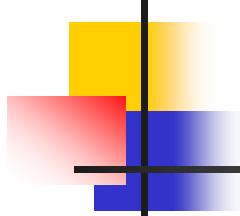
2.1 Integrated Risk

- Multiple lines of insurance risk in one policy
  - Beware "Three for the price of two" mentality
  - Means are additive!
- Multi-year/multi-line contracts
- Double trigger: combine insurable and non-insurable exposures
  - Cost savings from more efficient purchasing
  - Less coverage – but still enough
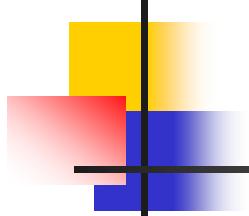
2.1 Integrated Risk: Multi-Line Aggregate

- Large, diverse operation
- Replace AL, GL, WC, Property policies with **one** policy
- Large aggregate retention
  - Within "normal expected losses"
- Paradigm shift for traditional insurers and reinsurers

Advantages:

- Underwriting expense savings
- Even risk retention across lines
- No gaps in coverage
- No coverage disputes

Disadvantages:

- Allocating expense to BUs
- Confusing to claims personnel
- Invites deep pockets claimants
- Hard to get done
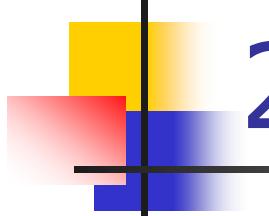
2.1 IR: Multi-Line Aggregate

- Hypothetical Pricing, $55M xs $50M cover
  - Traditional actuarial analysis determines

Line	Expected Loss	Max. Loss
WC	$25M	$15M
AL	$10M	$10M
GL	$15M	$10M
Property	$12M	$5M
Total	**$62M**	$105M (agg)

  - Need to generate aggregate loss distribution for all lines combined
  - Determine cost savings from retention
    - Possibility of partial losses means (Savings < Deductible)
  - Considerable loss discount, paying "last" losses

File Edit Tools Window Help Local

Company | AutoCalc

Diversified | ☑

Active | **Line**

☑ | WC

☑ | AL

☑ | GL

☑ | Property

☐ |

☐ |

☐ |

☐ |

☐ |

>> More | << Back

Param: CV/Min

☐ Stoch | 1 | .75

Loss vs. Return Period (Years)

120M
100M
80M
60M
40M
20M
0

1 10 100 1000 10K 100K 1M 10M

Probability Density vs. Loss

0.012
0.01
0.008
0.006
0.004
0.002
0

40M 50M 60M 70M 80M 90M 100M 110M

Buckets
1024

Precision
2

Recompute
☐ ShowCorr

Exit
Export to XL
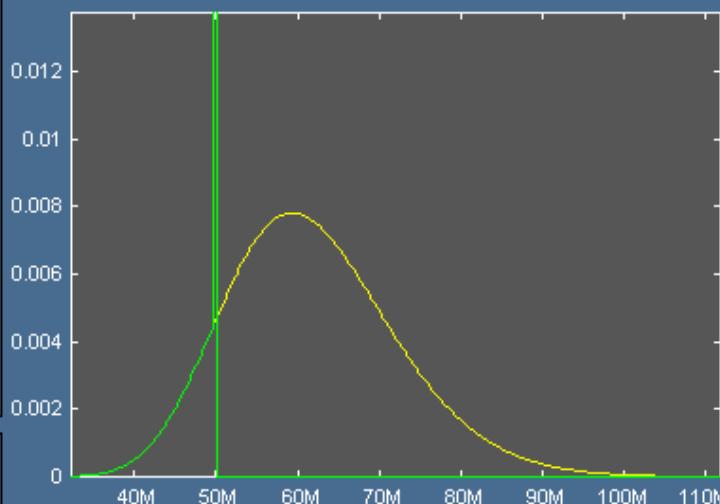
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COMPANY STATISTICS FOR DIVERSIFIED

Item       Net       Gross      ThGrs     Freq      Sev
Mean     49.548M    61.971M    62.000M   4597.5   13.486K
CV        0.0337     0.1696     0.1648   0.1035    0.0000
Skew     -4.9065     0.4787     0.4986   0.2296      NaN

Line              Net      Gross    ThGross  %Tot    %Err
WC             24.975M    24.975M   25.000M   40%   0.10%
AL             10.000M    10.000M   10.000M   16%   0.00%
GL             14.998M    14.998M   15.000M   24%   0.01%
Property       12.000M    12.000M   12.000M   19%   0.00%
Diversified    49.548M    61.971M   62.000M  100%   0.05%
```

```
REINSURANCE
Subject    Layer Attach Placed Type    AAD  Restmts
Diversifi    55M    50M 100.0%  Agg
```

```
PERCENTILES
  Percentile            Net $            Gross $
      10.0%            49.109M           49.109M
      50.0%            49.887M           61.013M
      55.0%            49.898M           62.329M
      60.0%            49.910M           63.695M
      65.0%            49.921M           65.138M
      70.0%            49.932M           66.692M
      80.0%            49.955M           70.369M
      90.0%            49.977M           75.773M
      95.0%            49.989M           80.500M
      97.5%            49.994M           84.790M
      99.0%            49.998M           89.994M
      99.5%            49.999M           93.669M
      99.9%            50.000M          101.580M
       1.0%            41.157M           41.157M
```

```
COMPANY TREE FOR DIVERSIFIED    (ELOSS = $ 62.0M)
Line       | ELoss %Parent
WC         | 25.0M  40.3%
AL         | 10.0M  16.1%
GL         | 15.0M  24.2%
Property   | 12.0M  19.4%
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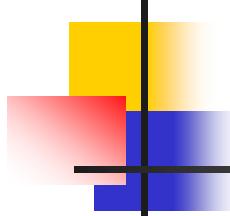
2.1 IR: Multi-Line Aggregate

- **Pricing Summary**
  - Insurer would look for more substantial margin on more leveraged excess deal
  - Transaction cost savings may make cover more economical

	Gross	**Retained**	**Insured**
Expected Loss	$62M	49.6M	12.4M
CV[1] Loss	16.5%	3.0%	77.5%

[1] CV=Coefficient of Variation = (Standard Deviation) / Mean
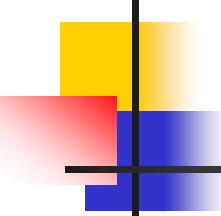
2.2 Financial Risk

- CNA Financial / Global Crossing Investment
- Costless collar to protect sizeable capital gain on on Global Crossing stock holding
- Loews risk averse: "How much can we loose?"

During the first quarter of 2000, the Company entered into option agreements intended to hedge market risk associated with approximately 19.3 million of the 36.1 million shares of Global Crossing owned by the Company. These option agreements were structured as collars in which the Company purchased put options and sold call options on Global Crossing common stock. The average exercise prices were $51.70 and $65.40 on the put options and call options, respectively, subject to adjustments on the call options under certain limited circumstances. The options expire in the first half of 2002 and are only exercisable on their expiration dates. The Company has elected hedge accounting treatment for these transactions. At March 31, 2000 the Company had an unrealized gain of $1.59 billion on its Global Crossing common stock and collars, which was a decrease of $176 million from December 31, 1999. **The net decrease consisted of a $343 million decrease in unrealized gain on the company's Global Crossing common stock partially offset by a $167 million unrealized gain from the collars.** The fair value of the collars is presented in equity securities available-for-sale in the accompanying condensed consolidated balance sheet as of March 31, 2000. CNA Financial 10Q
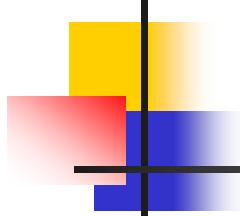
2.3 Finite Risk

- Straddle traditional financing and insurance
- Offer smoothing or spreading of risk over time rather than pure risk transfer
  - Always element of risk transfer for accounting
- Predefined limits
- Substantial premium or additional premium with large return premium if no loss
  - Credit risk component
- Useful for unusual risks with limited diversification opportunity
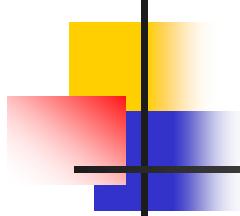
2.3 Finite Risk / Aggregate Stop Loss

- Aggregate Stop Loss is optimal reinsurance
    - Provides frequency and severity protection
- Reinsurers providing finance to insurers
    - Loss discounting allows favorable GAAP reporting
    - Moves liabilities into free surplus
- Design objectives for Agg Stop
    - Earnings stability for cedent
    - Early recognition of investment income for cedent
    - Just-enough risk transfer
- Typical design
    - 40 points of protection attaching at a 60% loss ratio, additional premium (AP) of 45% of ceded losses, $1M margin
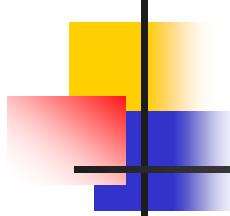
2.3 Finite Risk/Agg Stop

- Funds Withheld Account (FWA)
  - Interest credited annually to FWA
  - Additional premium deemed payable at inception
- Funds Transferred Account (FTA)
  - Assuming company guarantees crediting rate
    - Earns spread: actual earnings over crediting rate
  - LOC issues for non-admitted paper
- Other features to encourage commutation
- Agg stops have undesirable "heroin effect"
 - Decrease earnings in subsequent years
 - Interest credited is ceded premium
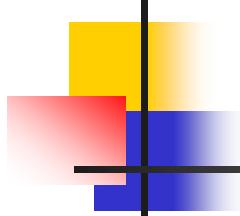
2.3 Finite Risk/Agg Stops

- St. Paul 1999 Annual Statement
  - Ceded $534M of losses for $273M premium
  - Implied discount 51%
    - Agg stop pays based on paid losses
  - Pre-tax benefit of $261M taken in 1999
  - Triggered in part by cat losses
  - Allows discount in longer tailed lines to pay for cat losses
 - Continued benefit in 1Q2000

Smoothed Discounted Factor vs. Nominal Loss

Funds Witheld Final Balance

Smoothed Discounted Factor vs. Nominal Loss
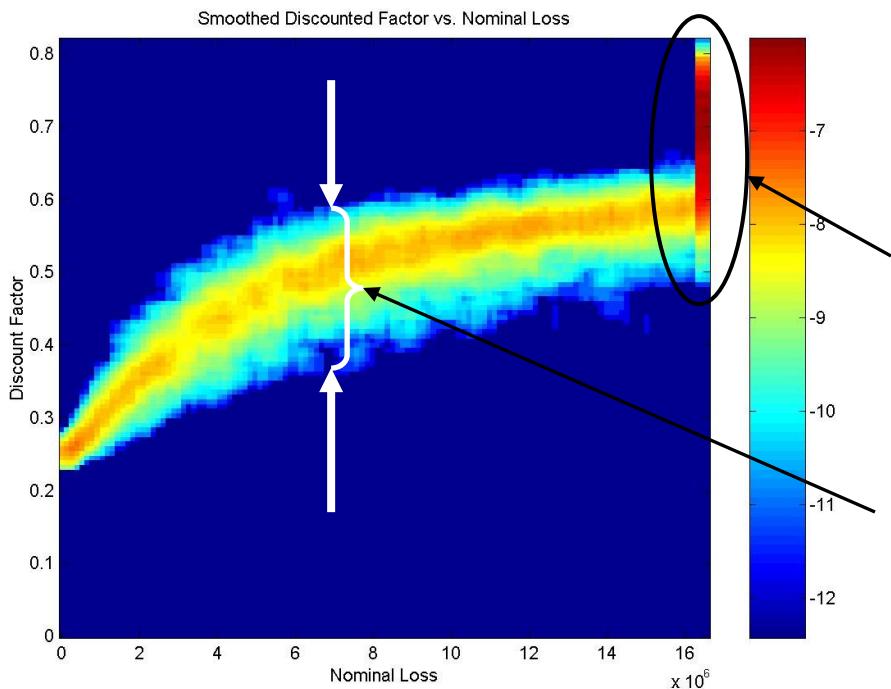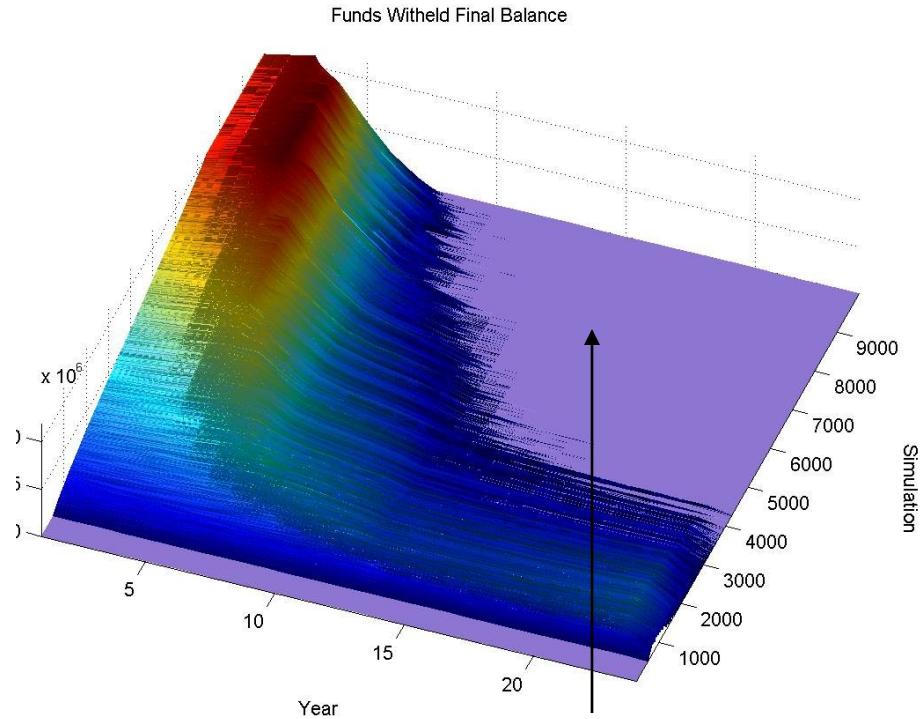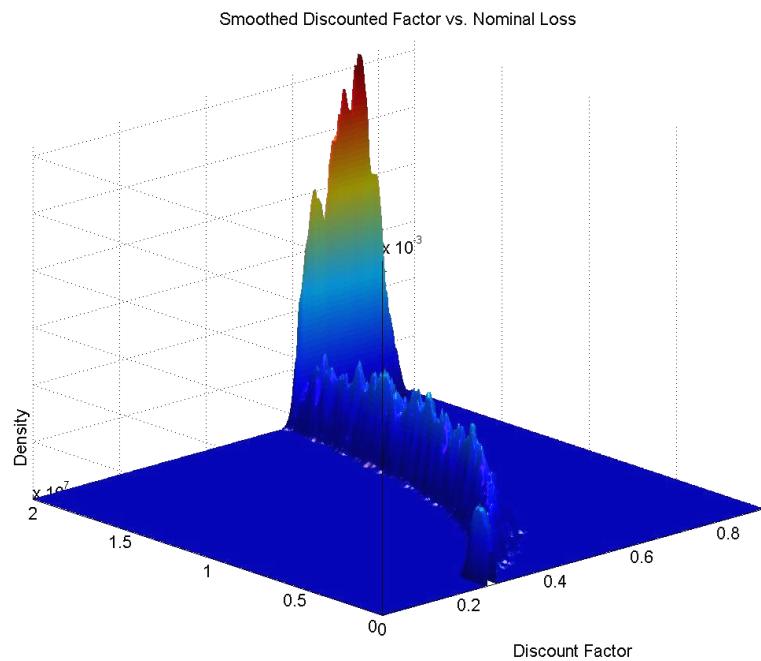
FWA depleted too frequently: restructure/bind!

Discount Factor increases quickly when policy hits limit

Range of discount factors driven by mix of business
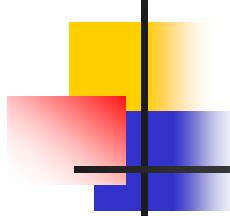
2.4 IR: Double Trigger

- Protect against poor underwriting results and poor investment results
    - "At risk" agg stop: expensive
    - Equity put: expensive
    - Two together provide over-protection
- Double trigger
    - Reinsurance attachment is function of equity performance
    - Equivalently, equity put with strike related to insured losses
    - Only provide protection when needed, results in cost savings
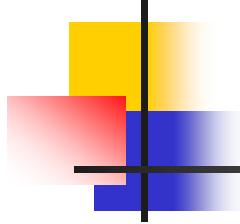
2.4 IR: Double Trigger

- **Double Trigger continued**
  - Very interesting hedging issues
    - How to best hedge stock position?
    - Information impedance mismatch between capital markets and insurance markets
  - FASB 133 and embedded options
  - Quote good for one day
    - New concept for P/C ceded reinsurance departments!
- **Accounting determines exact form of deal**
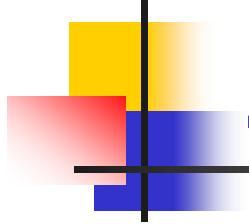
2.4 IR: Double Trigger

- CLM Insurance Fund at Lloyds
  - CLM has long tailed liabilities
  - Invests in FTSE-30 Index fund
  - Covered in event of significant fall in equities and adverse underwriting results
  - Swiss Re
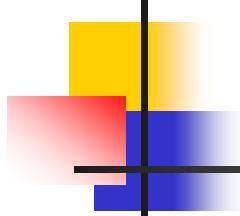
2.5 Contingent Capital

- Put option arranged prior to event
  - Option on debt or (convertible) preferred shares
- Provides immediate extra capitalization after large event
  - Gives greater operational flexibility in challenged market place
  - Allows company to capitalize on opportunities
- Balance sheet protection rather than income statement protection
- Not limited to insurance companies
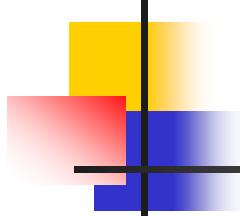
2.5 Contingent Capital

- AON CatEPut®
  - RLI $50M convertible preferred shares through Centre Re
    - Primarily California EQ exposure
  - Horace Mann, $100M multi year deal
    - Countrywide cat
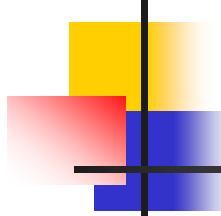
2.6 Finite/ERM

- Business risks unique and difficult to spread
  - Makes sense to spread risk over several years
  - Risk partnership with insurer
    - Offer large no-claims bonus / additional premium (finite)
  - Integrate actuarial and financial pricing methods
  - Risks can often be Securitized (cat, credit, RVI)

"…business risk insurance [can] help companies buy time to confront a problem, smoothing out the impact … over three years"

Wetzel and de Perregaux
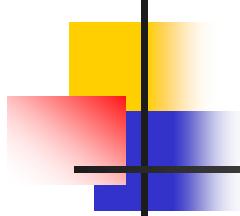
2.6 Finite/ERM: Grain Handling

- **Revenue Guarantee for Grain Handler**
  - Insured has large, fixed capital base / infrastructure supporting grain handling
  - Grain production very variable
    - Weather, seeded acreage, events elsewhere in world
  - Puts on grain handling volumes
    - Objective index
    - More correlated to actual risk than weather derivatives, or agricultural derivatives
  - Integration with existing insurance programs
  - Derivative to insurance policy transformation
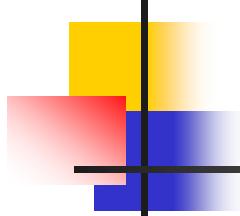
2.7 Finite/ERM: Energy

- Hydroelectric project guaranteed yearly cash flow regardless of rainfall
  - Reduced cost of capital, allowed more capital to be raised
  - Premiums over 10 year period
- Electricity Generation
  - Concerned about too much demand during summer months
  - Dual trigger products: excess demand (temperature) and generator outages
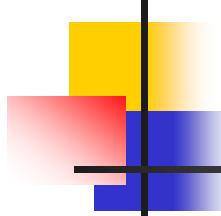
2.8 Finite/ERM: Transportation Revenue

- Revenue Guarantee for New Transportation Infrastructure Project
  - "Big Tent" Actuarial Problem
    - Demographics, Econometrics, Stochastic Simulation
  - Pricing Considerations include:

Demographics: population growth	Operational Efficiency, Pricing, Advertising
Economic development: micro-regional and macro-regional differential growth rates	Reaction of existing modes: bus companies, employer sponsored modes
Consumer take up rates and growth of private transportation	Price Elasticity of Consumers
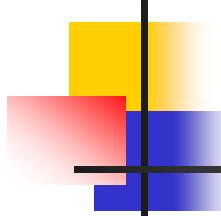
2.8 Finite/ERM: Transportation Revenue

- **Possible insurance structure: passenger guarantee**
  - Multi-year, finite deal
    - Start-up protection, operational flexibility
  - Insured losses = Passenger shortfall x ($/passenger)
    - Objectively determined basis
  - Subject to annual and aggregate limits
  - Experience Account established with AP due if negative
  - Credit issue if future APs become due
  - AP = % of EAB shortfall
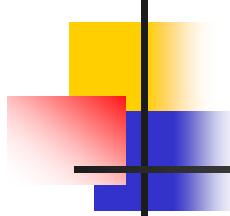
2.9 Finite/ERM: Veal Calf Index

- **Veal Calf Index Option**
  - Veal producers wanted puts on veal calf index option
    - Financial type deal offered to insurers in finite package
  - Asian Option structure, put strike expressed as percentage of 52 week rolling average
  - Option-on-option: multi-year contract with specified rates
    - Weekly premium determined based on proximity to risk
  - Finite structure with Experience Account and commutation features
    - Credit risk concerns
    - Cancellation provisions introduced potential adverse selection
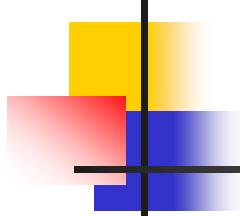
2.10 Lease Residual Value

- Lease residual value
  - Offered through traditional insurance and capital markets securitization
    - Toyota Motor Credit / Gramercy Place
  - Puts on residual values
  - Many drivers of volatility in (auto) residual values
    - New Car prices drive second-hand prices
    - Fashions: sports cars to SUVs
    - Overall Economy: option package depreciation
    - Gas Prices: small or large large vehicles
  - RVI applied to many different assets
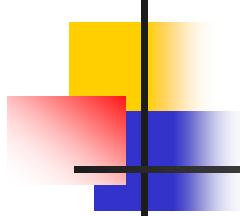
2.11 ERM: Reserve Development

- **EITF D54 Exception**
    - FASB determined treatment of reserve guarantees obtained as part of acquisition should be consistent between insurance and non-insurance entities
    - Allows immediate recognition of benefits to acquiring company
    - Seller may obtain third-party reinsurance to secure guarantee
        - Arrangement contemporaneous and contingent on purchase
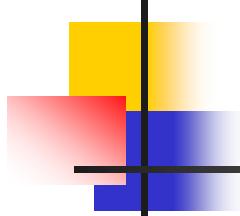
2.11 ERM: Reserve Development

- Fairfax Holdings has arranged similar protection for its acquisitions
- Most recent deal: $1B adverse loss development cover
  - Protects against development and uncollectible reinsurance above 12/31/98 reserves
  - Ceded $251M to treaty at 12/31/99
    - Complex structure
    - Not pure risk transfer
    - AP due in future years if more losses ceded to contract
  - Canadian accounting rules
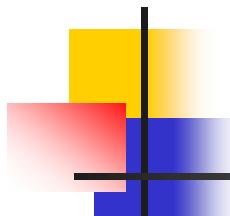
2.11 ERM: Reserve Development

- ACE/CIGNA and Berkshire
  - CIGNA arranged $2.5B aggregate cover for ACE as part of purchase
  - $1.25B assets transferred to National Indemnity (Berkshire Hathaway) to cover liabilities
- CNA / Allstate
  - Reserve Development Bonds
    - $75m Limit
    - Protects Allstate on acquisition Of CNA Personal Lines
    - Redeemed 9/30/2009 for $75M +/-10M depending on UW profitability of CNA PI business
    - Call provision

In addition, the $75 million equity-linked note will be redeemed on September 30, 2009 (subject to earlier redemption on stated contingencies) for an amount equal to the face amount plus or minus an amount not exceeding $10 million, depending on the underwriting profitability of the CNA personal insurance business. CNA Financial 10K, 1999.

2.12 Risk Swaps

I'm not swapping my carefully selected Florida risks with your trash!
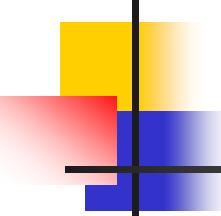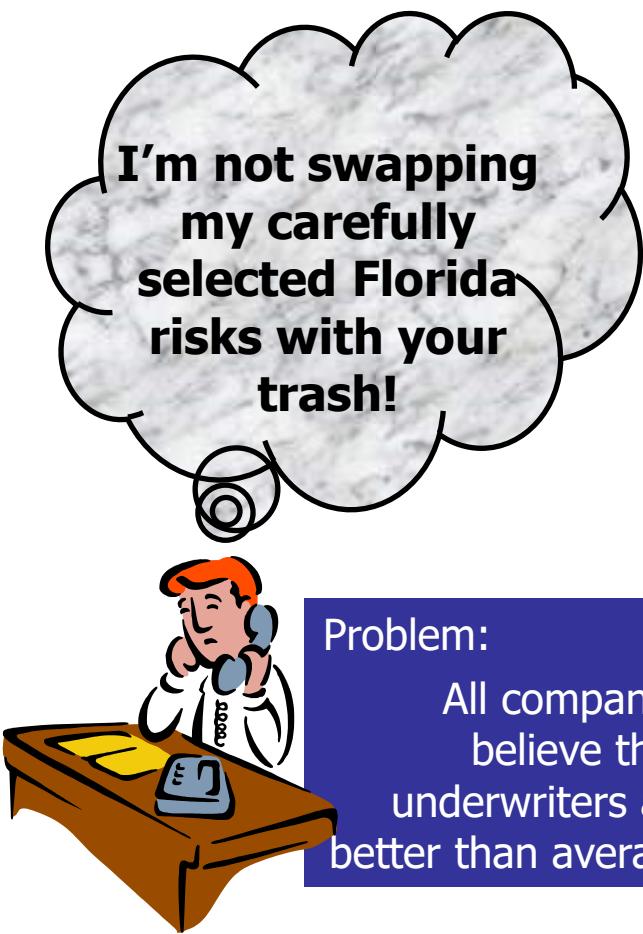
Problem:

All companies believe their underwriters are better than average

- CATEX
  - Internet based market for swapping risks
  - E.g. Florida wind and California quake
  - Reduces risk for minimal cost
    - No ceded premium
    - Expected loss and probability distributions swapped roughly comparable
    - No event, no cash flow
    - Opposite of mean preserving spread
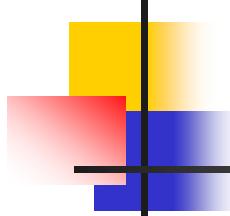
2.12 Risk Swaps

- State Farm / Tokio Marine & Fire
  - $200M Limit
  - Earthquake exposure: Japanese and US New Madrid quake
  - Coverage triggered by magnitude of event, not loss
  - State Farm receives
    - 17.5% of limit for 6.6R quake
    - 100% of limit for 7.1R+ quake
  - Diversifies risk and reduces net exposure
  - No premium outgo, no brokerage
- Many other opportunities exist, even within US
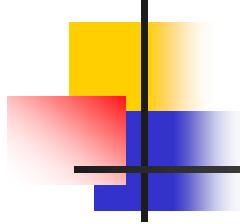
2.13 Commodity Prices

- Many ERM opportunities available on commodity related exposures
- ENRON major market maker
- Products include
  - Caps
  - Floors
  - Guaranteed cost through swaps
  - Swaps on margins between input and output factor price spreads
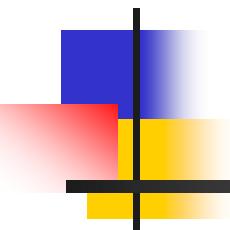
3. Securitized Solutions
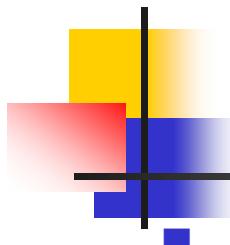
3.1 Overview of Cat Reinsurance

- Common catastrophe reinsurance covers
  - Per occurrence excess of loss
    - $100M xs $150M per occurrence
  - Reinstatements
    - 1 at 100%, 3 "pro rata as to time and amount"
  - Aggregate excess of loss – less common
- Catastrophe Models
  - Per location computation of loss costs and distribution of occurrence and aggregate losses
    - Consider specific location characteristics
      - Soil type, distance to sore
      - Construction type, building characteristics
    - 1000's of simulated events applied to each location
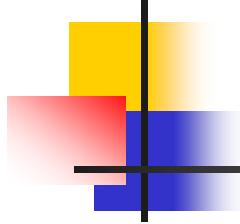
3.1 Overview of Cat Re

- Pricing of Cat Contracts
  - Expected losses typically determined by models
    - Data quality a key concern
  - Premium typically 150% to 500% of expected loss
    - See Froot paper on www.guycarp.com
  - Loss ratio = 1 / Markup
  - Rate on line (ROL) = premium / line extended
  - For a 1:100 year event
    - Loss cost approx. 1% on-line
    - Rate or premium 1.5-5% on line
    - Loss ratio 20% to 66%
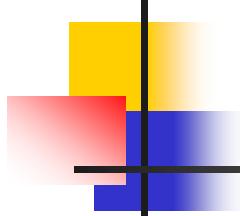
3.1 Overview of Cat Re

- Retro: reinsurance for reinsurers
  - Greater uncertainty about underlying risks
  - Poorer data quality for modeling
  - Do not want to provide capacity to competitors
- Capacity
  - Industry surplus approx. $350B
  - Large event: $100B
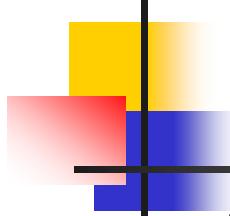
3.1 Overview of Cat Re

US Region	100 Year Return	250 Year Return
Florida Wind	$30B	41
S California EQ	15	27
New Madrid EQ	4.5	14
US Multi-Peril	59	115

-Regional losses on occurrence basis; US total on aggregate basis
-Loss amounts are gross insured loss, net of insured deductibles
-Multi-peril loss includes EQ, fire-following, hurricane, tornado and hail
-AM Best focuses on 250 year returns for EQ and Florida wind, and 100 year returns for non-Florida wind

Source: RMS
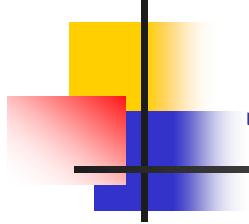
3.2 Securitization

- Bundling or repackaging of rights to future cash flows for sale in the capital markets
  - **Transformation** of uw cash flows into securities
  - **Transfer** of uw risk to the capital markets
- Advantages
  - More capacity
  - No counter-party risk
  - More favorable tax treatment (SPV offshore)
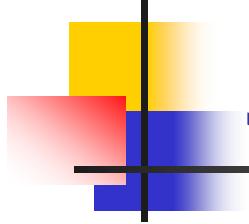
3.2 Securitization

- Characteristics of a successful deal
  - High retention, low probability of loss
    - Capacity rather than frequency risk
  - Underlying risk uncorrelated with financial markets
  - Understandable, quantifiable risk
  - Short exposure period
  - BB or better credit rating from Rating Agencies
  - Liquid market
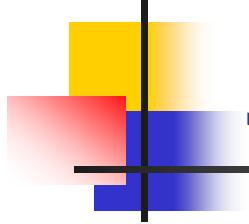
3.2 Securitization

- Characteristics of traded index
    - 10+ years historical data
    - Index independent, verifiable, & auditable
    - Data can be brought on-level
        - Adjusted for current demographics, trend etc.
    - Independent analysis of data available
        - Modeling companies
    - Index correlates well with risk
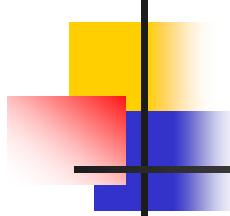
3.3 Exchange Traded Instruments

- CBOT Cat Index
  - Property Claim Services (PCS) loss index
  - 1 point in index corresponds to $100M industry losses
  - European options, settled in cash
  - National and various regional zones
  - Typically sold as spreads
    - Layer of reinsurance
- Bermuda Commodity Exchange (BCE)
  - Similar to CBOT but based on Guy Carpenter loss-to-value index
  - Index available at zip code level
    - Allows more accurate hedging, lower residual basis risk
  - Can cover largest loss, second largest loss, aggregate losses
  - Binary options (pay all or nothing), six month term
- Strangely unsuccessful
  - Accounting
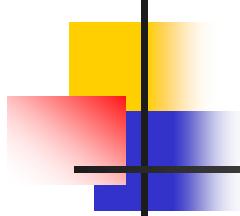
3.4 USAA Cat Bond

- First major securitization (June 1997)
  - Special Purpose Vehicle (SPV) Residential Re
  - Protection: $400M part of $500M xs $1B retention
    - USAA participates in all lower layers
    - Traditional reinsurance $400M part of $550M xs $450M
  - Two Tranches
    - A1 Principal protected $164M @ LIBOR + 273 bps (AAA)
    - A2 Principal at risks $313M @ LIBOR + 576 bps (BB)
    - Provides approx. $400M reinsurance protection
  - USAA writes personal lines for Armed Forces personnel and their families

3.4 USAA Cat Bond

Swap Counter-party — LIBOR - 24 bps → **Reg. 114 Trust**

Reg. 114 Trust → Investment Earnings → **Swap Counter-party**

Reg. 114 Trust ← $313 — **Class A2 Principal Variable**

LIBOR + 576 bps → **Class A2 Principal Variable**

<=$313 @ redemption →

$400 / LIBOR / Rem'g Funds

$400 Reinsurance → **USAA**

USAA → 6% Rate on line

Residential Re Ltd

Residential Re Ltd ← $164 — **Class A1 Extendible Principal Protected**

LIBOR + 273 bps →

$164 @ maturity →

$77 / LIBOR / $77 @ maturity

Collateral Account

$164 @ maturity → **Class A1 Extendible Principal Protected**

$77 contingent on event → **Defeasance Securities Counter-party**

Defeasance Securities Counter-party → $164 @ maturity

········▶ At risk cash flow

All amounts in $M

68

3.4 USAA Cat Bond

- Paying for the spread
  - Income: 6% ROL x $400M = $24M
  - Expense: $23.65M + friction
    - 24 bps on $477M = $1.15M
    - 576 bps on $313M = $18.0M
    - 273 bps on $164M = $4.5M
- Renewed Twice
  - 1998, unprotected tranche LIBOR + 400 bps
  - 1999, unprotected tranche LIBOR + 366 bps
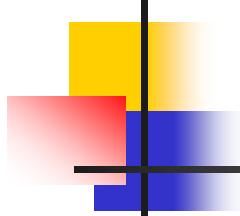
3.5 Cat Bonds

Purchasers:

- Mutual funds
- Hedge funds
- Reinsurers
- Life Insurers
- Banks
- P/C Insurers
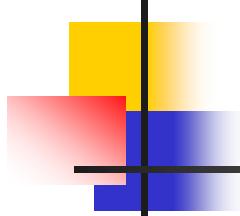
3.5 Cat Bonds

- ## SR Earthquake Fund, Ltd.
    - ### Swiss Re Securitized $112M of California Earthquake for 2 ¼ years
        - #### Related to reinsurance of CEA
        - #### Trigger based on PCS industry losses

Tranche	Rate	ROL	Trigger / Loss of Principal	Rating
A1	L + 255 bps	4.25%	18.5B 20%; 21B 40%; 24B 60%	BBB
A2	L + 280 bps	4.67%	18.5B 20%; 21B 40%; 24B 60%	BBB
B	L + 475 bps	4.75%	18.5B 33%; 21B 67%; 24B 100%	BB
C	L + 625 bps	6.25%	12.0B 100%	NR
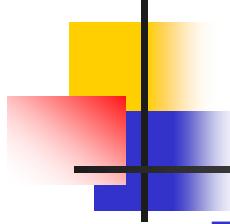
3.5 Cat Bonds

- SCOR / Atlas Re, 3/16/2000
  - $200M cat bond, multi-year, expires 2003
    - $100M xs $200M per event and $200M in aggregate
  - Reference portfolio, ensures data quality
    - Allows better loss modeling
    - Indemnity Payment = Ref. P/f Losses x Adj. Factor
  - Retro protection for SCOR, a reinsurer
    - European wind, US EQ, Japanese EQ perils
  - Atlas Re based in Ireland
  - Class A, $70M BBB+ @ LIBOR + 270 bps
  - Class B, $30M BBB-   @ LIBOR + 370 bps
  - Class C, $100M B   @ LIBOR + 1400 bps
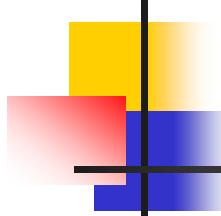
3.5 Cat Bond Summary

Deal	Date	Spread	Trigger	Peril
Res Re I	6/9/1997	576	Indemnity	Various US
SR Earthquake	7/16/1997	475	Index	Ca EQ
Parametric Re	11/19/1997	430	Parametric	J EQ
Trinity Re	2/19/1998	367	Indemnity	FL wind
HF Re	6/4/1998	375		
Res Re II	6/8/1998	400	Indemnity	
Pacific Re	6/15/1998	370		
Mosaic Re A	7/14/1998	440		
XL Mid Ocean A	8/12/1998	412	Retro	Swap/Reins
Trinity Re II	12/31/1998	417	5 month	Fl Wind
Mosaic Re II	2/25/1999	400	Retro	
Domestic Inc	3/25/1999	369		
Concentric Ltd	5/3/1999	310	Parametric	
Res Re III	5/25/1999	366	Indemnity	
Juno Re	6/18/1999	420	Indemnity	
Gold Eagle	11/16/1999	540	Model Based	
Namazu Re	11/23/1999	450	Model Based	
Seismic Ltd	3/1/2000	450	Index	
Atlas Re	3/16/2000	370	Ref. Portfolio	
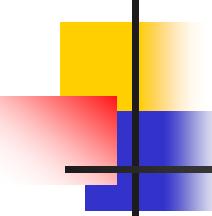
3.6 Trigger Summary

Trigger	+/-'s	Example
Indemnity	No basis risk Need good under-standing of risk	USAA / Res. Re Trinity Re Juno Re
Model	Minimize Basis Risk Data quality risk borne by insured Fast payout after event	Namazu Re Gold Eagle
Index	Simplifies uw'ing Less disclosure Basis Risk Good for retro	ILWs SR Earthquake
Parametric	Very simple uw'ing No disclosure High basis risk	Tokyo Disney Parametric Re

3.6 Triggers

Disclosure v. Risk Continuum

Indemnity Deal

No Basis Risk

Significant Disclosure of Business and Underwriting Processes

Index Deal

Basis Risk Equal to Actual Loss v. Index Result

No Disclosure of Business and Underwriting Processes

Modeled Index Deal

- Cedent describes notional portfolio to modeling firm
- Cedent does not disclose its underwriting practices et cetera
- Cedent may update the notional portfolio every six months, if necessary
- Recovery based upon the notional portfolio using actual event characteristics
- Loss payments are made immediately after the modeled loss is run

Source: AON Capital Markets
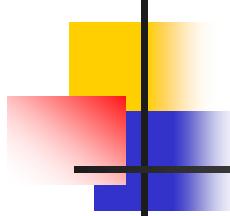
3.6 Model Trigger

- The Notional Portfolio is a hypothetical portfolio of properties and risks
    - Located within territories selected to be covered
    - Designed to correlate closely with reinsured's actual exposures
    - Based upon the reinsured's available exposure data and/or market information relating to the physical distribution of insured risks
    - Constructed in conjunction with selected risk modeling company and by reference to a model held in escrow over the duration of the transaction
    - Ability to update Notional Portfolio to minimize basis risk as underlying book of business changes over time

Setting a Coverage Layer

- Initial attachment point and exhaustion point set by reference to loss exceedance curve. Set to equate to monetary value selected by reinsured

- Expected loss of coverage layer is calculated by reference to loss exceedance curve and fixed for duration of transaction


Source: AON Capital Markets
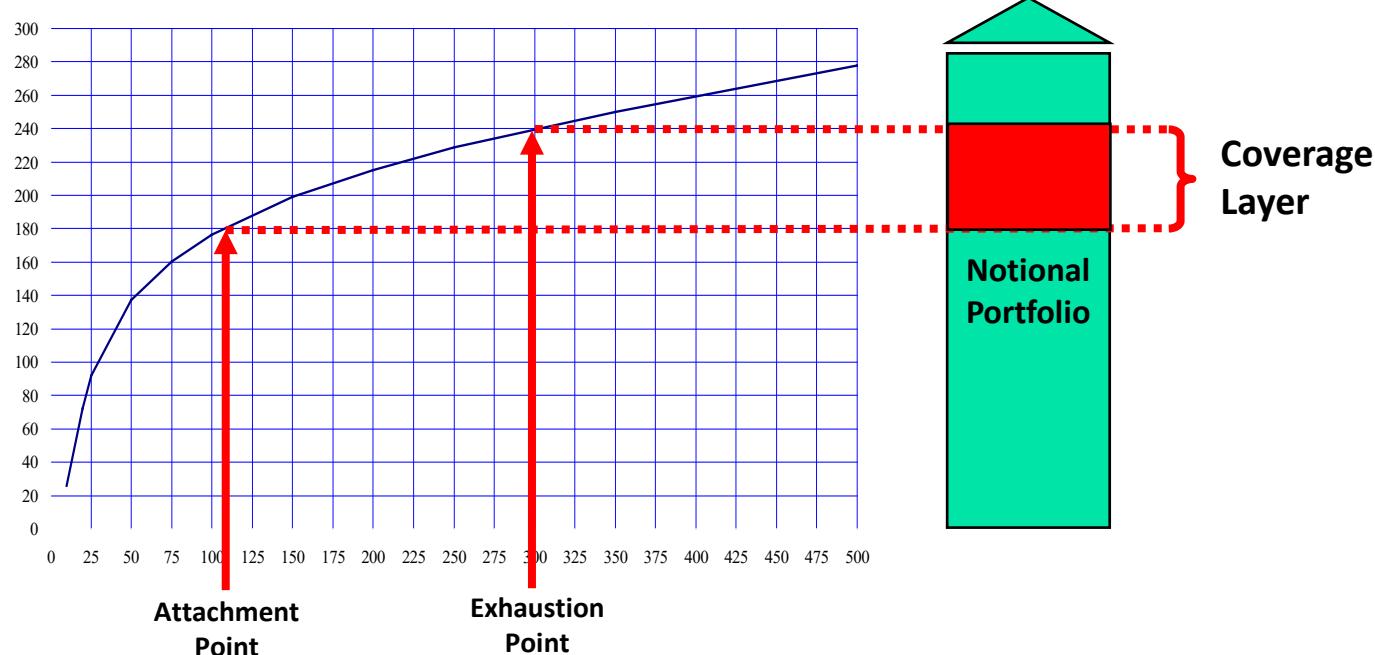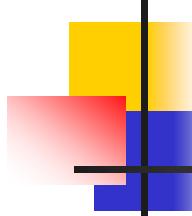
3.6 Model Trigger

- Following the occurrence of a covered event (such as an earthquake or windstorm in one of the covered territories):
  - Reinsured applies to the risk modeling company to calculate a modeled loss
  - The modeling company obtains detailed observed physical event parameters of loss event from pre-agreed monitoring authorities Typically would include:
    - Earthquake
      - Epicenter location and depth
      - Peak ground velocity measurements
      - Soil types
    - Windstorm
   - Barometric pressures, Windspeed, Track,Radius/R-max

3.6 Model Trigger

- Calculating Modeled Loss
  - Risk modelling company uses the Escrow Model with the relevant Notional Portfolio to calculate value of the modeled loss
  - Any excess of the modeled loss over the attachment point (restricted to the value of the coverage layer) is the basis for the reinsured's recovery

Exhaustion Point

Attachment Point

Modeled Loss
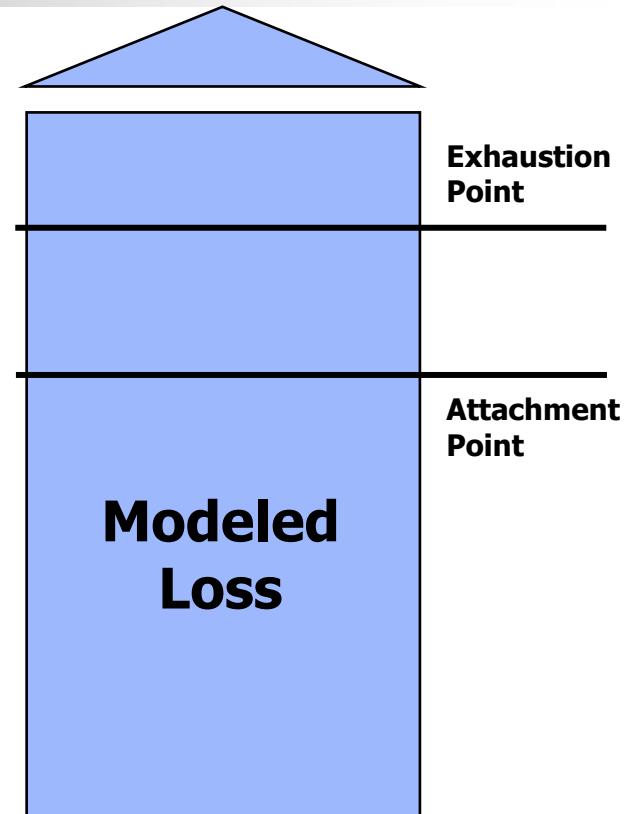
3.6 Model Trigger

- Model Based Reset
- Reinsured's portfolio of exposures will vary over period of transaction
  - Notional Portfolio can be updated as required
  - Risks selected must be within guidelines originally specified
  - By reference to escrow model, modeling company recalculates attachment and exhaustion points based on fixed probability of attachment and expected loss

Exhaustion Point

Coverage layer reset with fixed expected loss

Attachment Point

Updated Notional Portfolio
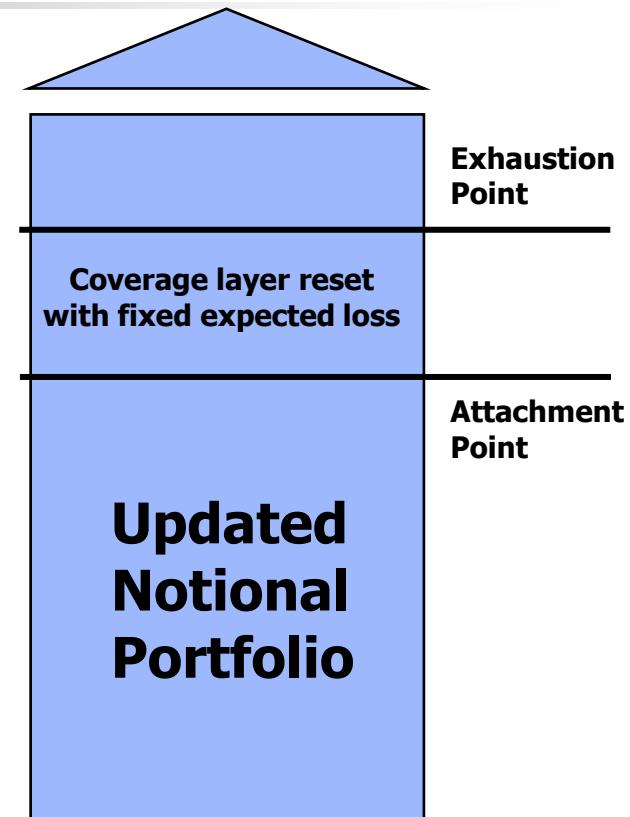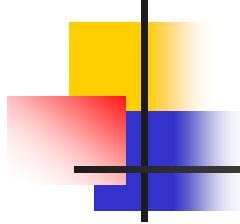
3.6 Model Trigger

- Gerling Global / Namazu Re
  - $100M five year notes rated BB by S&P
  - Used notional portfolio approach
  - LIBOR + 450 bps
  - Allows quick payment following loss
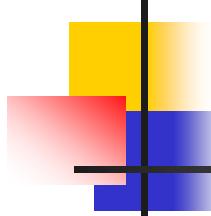
3.7 Market Pricing

	Ba Bonds[1]	Typical Cat Bond
Spread over 1-year Treasuries	1.6%[1]	2.5-5.8%
1 year default prob	1.4%[2]	0.5-2.0%
10 year default prob	20.9%[2]	8.0-20.0%
Expected Recovery Rate	47.5%[2]	32.0%
Risk / Reward Multiple[3]	1.14	2.9-7.2

[1] Bloomberg BB Composite of Moody's Ba2 and S&P BB; one year data
[2] Moody's 1938-1996 default rates
[3] Excess return above risk free rates as multiple of prob of 1 year default
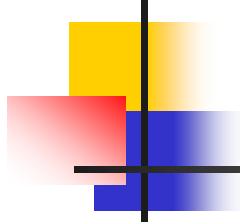
# 3.7 Market Pricing

- Spreads January 1997 To April 2000, compared to BB Securities
  - Expected Profit
    - Spread - Expected Loss
  - Expected Profit v. Expected Loss
    - All Securities
    - Securities With Expected Loss < 1% (Bonds)
  - Expected Profit v. Standard Deviation
    - All Securities
   - Securities With Expected Loss < 1%

3.7 Spreads v. BB Bonds
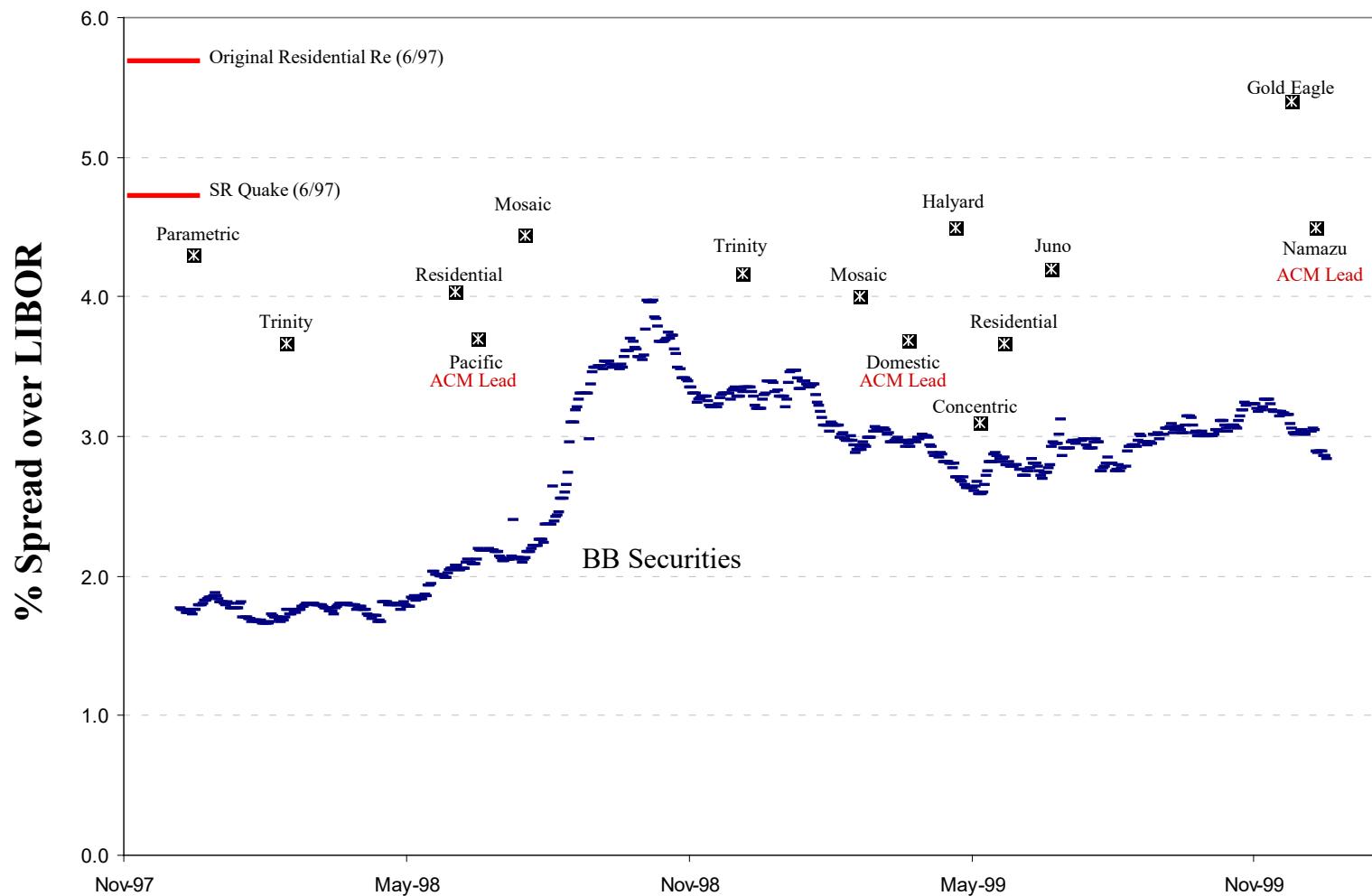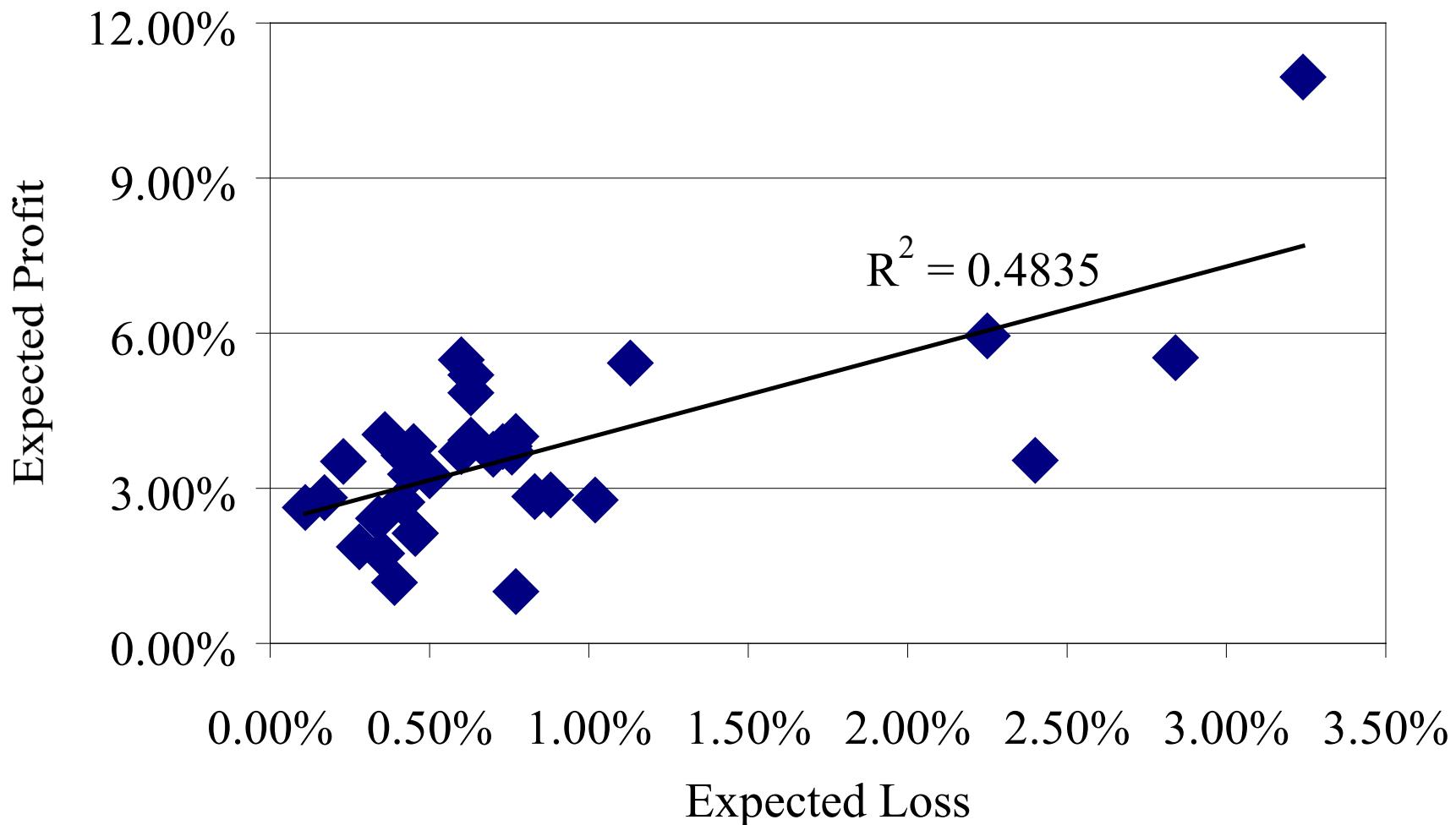
Source: AON Capital Markets

Catastrophe Securities Since 1997
Expected Profit v. Expected Loss

$R^2 = 0.4835$

Expected Profit (y-axis): 0.00%, 3.00%, 6.00%, 9.00%, 12.00%

Expected Loss (x-axis): 0.00%, 0.50%, 1.00%, 1.50%, 2.00%, 2.50%, 3.00%, 3.50%

Catastrophe Securities Since 1997
Expected Profit v. Standard Deviation Loss

$R^2 = 0.4245$

Expected Profit (y-axis): 0.00%, 3.00%, 6.00%, 9.00%, 12.00%

Standard Deviation Loss (x-axis): 0.00%, 4.00%, 8.00%, 12.00%, 16.00%

Catastrophe Bonds Since 1997
Expected Profit v. Expected Loss

$R^2 = 0.0819$

Expected Profit (y-axis): 0.00%, 2.00%, 4.00%, 6.00%

Expected Loss (x-axis): 0.00%, 0.25%, 0.50%, 0.75%, 1.00%

Catastrophe Bonds Since 1997
Expected Profit v. Standard Deviation Loss

$R^2 = 0.1719$

Expected Profit (y-axis): 0.00%, 3.00%, 6.00%

Standard Deviation Loss (x-axis): 2.00%, 4.00%, 6.00%, 8.00%, 10.00%

3.7 Regression Statistics

$$\text{Expected Profit} = a + b \times \text{EL} + c \times \text{SD}$$

All Securities		
Variable	Slope	t
EL	1.3408	1.6800
SD	0.0700	0.3800
Securities With Expected Loss < 1%		
Variable	Slope	t
EL	-2.5775	-1.2137
SD	0.5765	2.2482

Source: AON Capital Markets
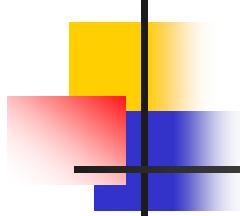
3.8 Weather Derivatives

- Heating / cooling degree days
- ENRON
- Weather
  - Koch Industries/Kelvin Ltd.
  - Portfolio Of 28 Derivative Contracts Covered
  - Temperature Sensitive
  - $50m Two Tranche Transaction
- Some reinsurers trade in market
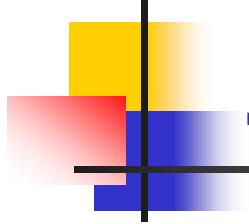
3.9 Cat Bond Swap

- After USAA deal, reinsurer believed Residential Re losses well correlated with their portfolio

- Wanted to short Residential Re cat bonds

- Goldman Sachs executed as a swap
  - USAA bonds had been over-subscribed
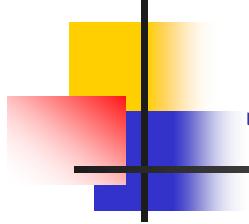
3.10 Recent Developments

a. On-Shore Securitization

c. Retail Securitization

c. Other Securitization Prospects

d. Protected Cell companies
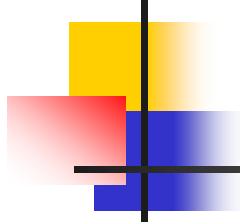
3.10.a On-Shore Securitization

- Advantages
  - Expand investor universe
    - Legal limitations keep some on-shore
    - Investor philosophy keeps others on-shore
  - Minimize income tax effect
    - Use of equity tranche
    - Target corporate sponsors for equity tranche
- Design Hurdles
  - Eliminate regulation threat
    - Investors don't want to be regulated as insurers
    - Reinsured doesn't want note-holder pleading ignorance
  - Isolate SPV from guaranty funds and assessments
  - Collateralize reinsurance agreement

3.10.a On-Shore Securitization

- Benefits
  - Broader investor base
  - Greater regulatory certainty
  - Greater tax certainty

Source: AON Capital Markets
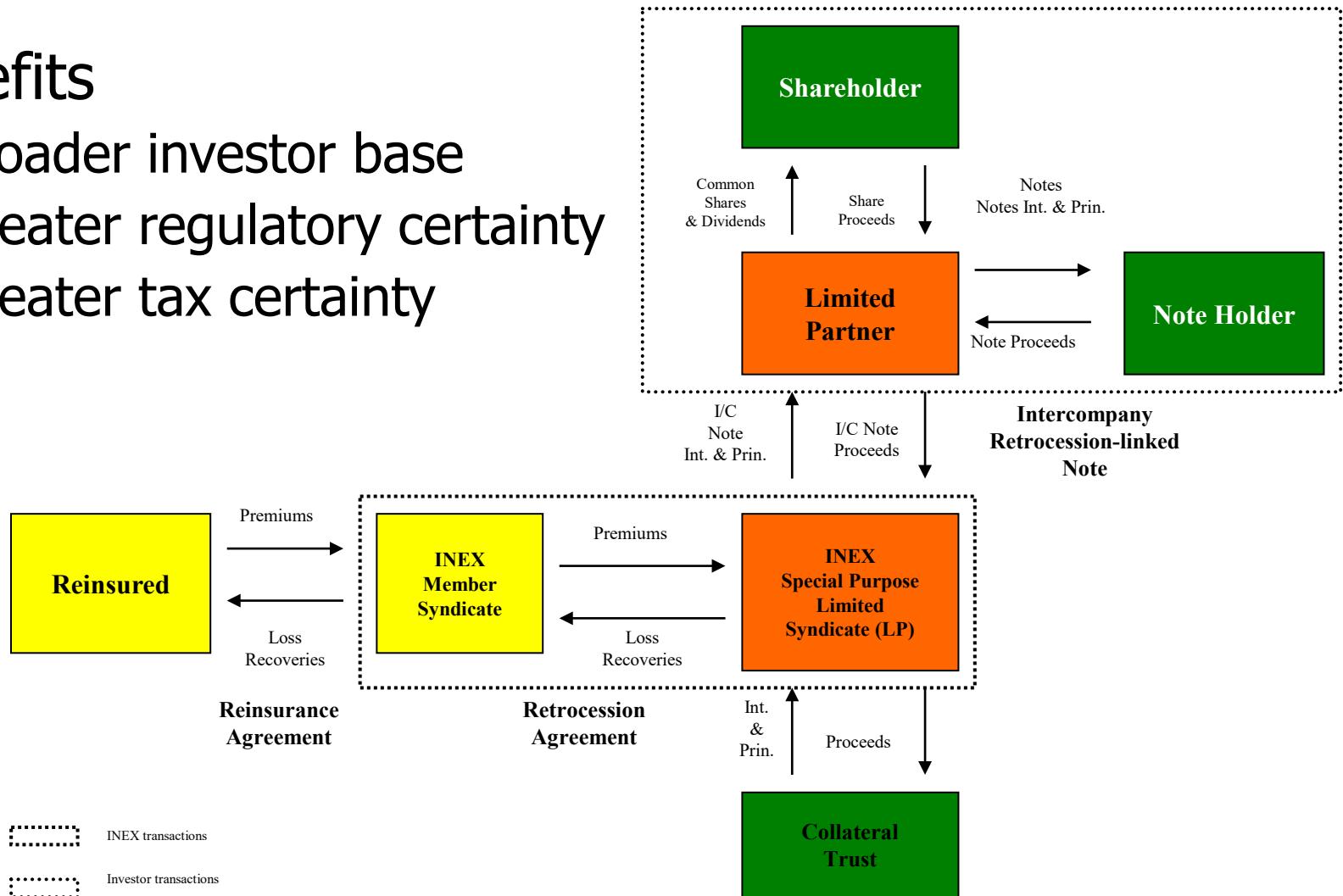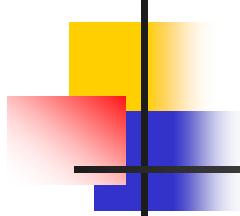
3.10.b Retail Securitization

- Disneyland Tokyo
  - Concentric Ltd.
  - $100m earthquake cover
- Parametric Trigger
  - Three rings around park
  - Trigger points
    - Inner ring, 6.5
    - Middle ring, 7.1
    - Outer ring, greater than 7.6
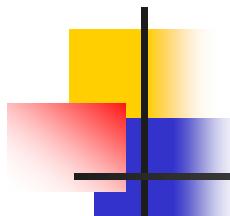
3.10.c Other Securitization Prospects

- Securitization of other lines?
  - Balance desirability to investor with undesirability for insurer
    - Does not make sense for insurer to securitize low volatility, predictable lines
  - Many products (perceived as) too heterogeneous
    - MBS secondary market led to standardization
    - Would standardization be a bad thing for insurance?
  - Credit risk (Gerling/SECTRS) and lease residual value (Toyota/Gramercy Place) have been Securitized
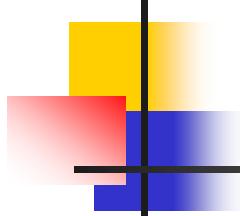
3.10.d Protected Cell Companies

- ACE Ltd. has protected cell company (PCC) in Guernsey
  - Net capacity of $200M
- Segregated assets with full statutory protection
  - Multiple owners
  - Bundle securitizations without expense of multiple SPVs
  - Alternative to captive structure
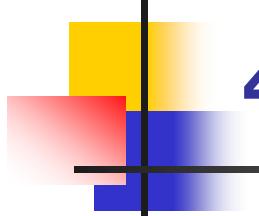
4. References and Links

- "Recent Developments in Risk Transfer" John Aquino and Stephen Mildenhall
  - CAS Spring Meeting
  - Slides 75-80, 83-9 and 93-4 taken from JA's talk
- CAS Website
  - Slides from talks
  - 1999 Discussion papers on Securitization

- CAS Website
  - Discussion of Wacek Proceedings paper by Stephen Mildenhall
  - Compares Black-Scholes and actuarial approaches to pricing
- CNA Re Website
  - Securitization 2000 notes
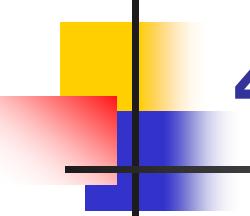
4. References, Links, and Joke

- www.casact.org
- www.soa.org
- www.cnare.com
- www.amre.com
- www.genre.com
- www.rms.com
- www.erisks.com
- www.riskmetrics.com
- www.science-finance.fr
- xxx.lanl.gov

- www.aon.com
- www.guycarp.com
- www.actuary.com
- www.freeedgar.com
- www.actuarialjokes.com

How many actuaries does it take to change a light bulb?

a) How many did it take last year?
b) How many do you want it to take?
c) None, after credibility weighting, we have indications that the bulb is still lit.
d) None, the insurance department is not allowing any modifications to the bulb at this time.
e) Have any of our competitors changed bulbs yet?