CS D6: Topics in Risk Identification and Risk Measurement for Insurers

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Property/Casualty Underwriting Risk

John Kollar

ERM Symposium

May 3, 2005

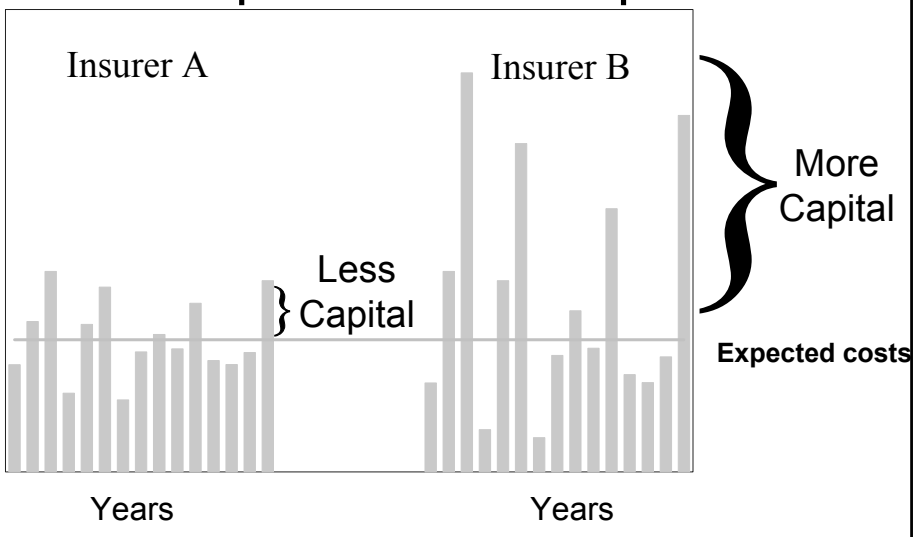
Underlying Themes

- Underwriting is the primary source of risk for a P/C insurer.
- Risk = uncertainty in results
- The insurer's risk is measured by the stochastic distribution of possible outcomes.
- Amount of risk → amount of capital.
- Capital is an expense as it must be paid for.
- Develop strategy to make the most efficient use of capital = maximize return vs. risk.

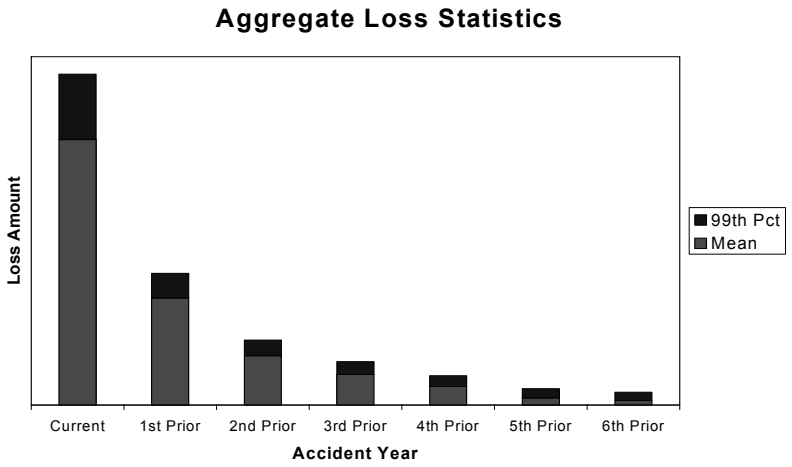
Components of Underwriting Risk

- Loss volatility including
  - Catastrophe and non-catastrophe risk
  - Risk of adverse loss development for long-tailed lines
- How long the capital has to be held to support reserve risk
- Correlation between lines (dependencies)
- Pricing risk (underwriting cycle)

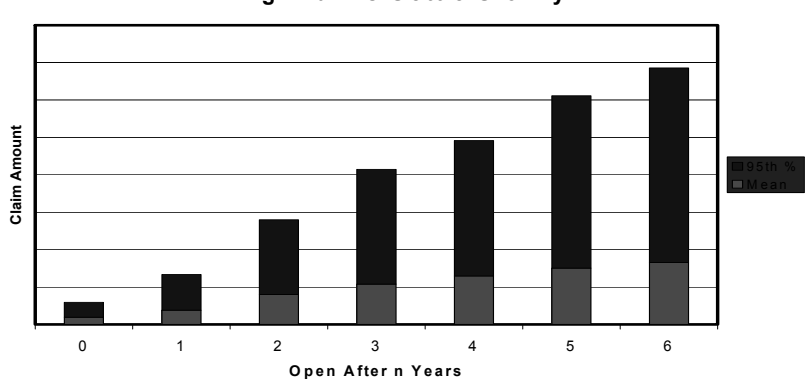
Loss Volatility Requires More Capital



Need to Consider Reserve Risk



Reserve Risk: Average size and volatility of open claims increases over time



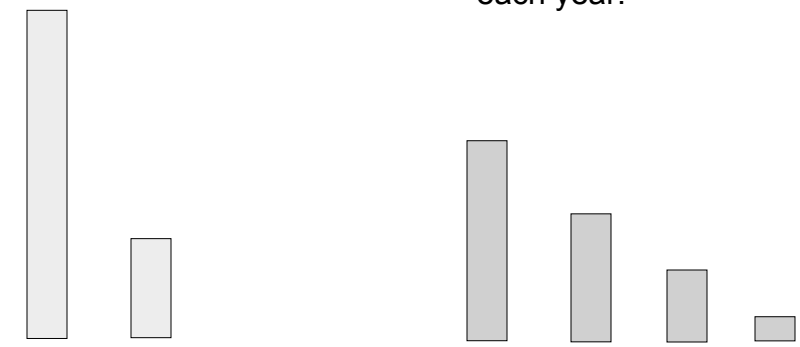
Short vs. Long-Tailed Lines

Short-Tailed Lines

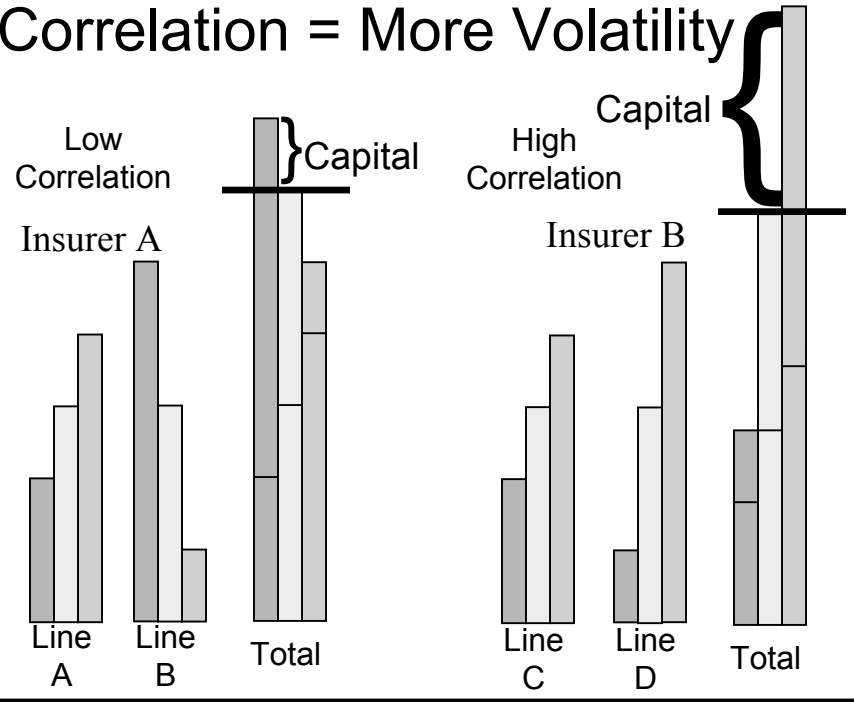
Release most capital at the end of 1st year.

Long-Tailed Lines

Release a portion of capital at the end of each year.



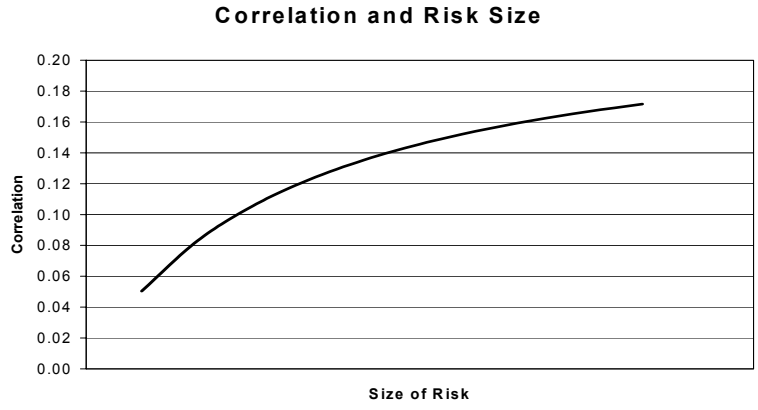
Correlation = More Volatility



Correlation

- Law of Large Numbers: increased volume (larger insurers)
  - Lower process risk
  - Higher correlation
- Greater concentration of exposures = increased catastrophe risk for property insurance, WC, group life
- Diversification
  - Reduced correlation/concentration
  - Higher expenses

Correlation increases with volume



Measuring Underwriting Risk

- Use industry data to develop claim severity distributions:
  - By line (product)
  - By valuation (settlement lag)
- Use data by company (for many companies) to develop claim frequency parameters:
  - By line
  - By valuation
  - Measure correlations by size of insurer using common shock models to develop covariance generators between lines.

Measuring an Insurer's Underwriting Risk

- For each line of insurance:
  - Select a random claim count.
  - Select random claim size for each claim.
  - Adjust claim size for coverage limits and reinsurance.
- The aggregate loss for all lines = sum of all the random claim amounts for all lines.
  - Reflect the correlation between lines (products).
- Use a Catastrophe Model to generate many years of catastrophe losses.

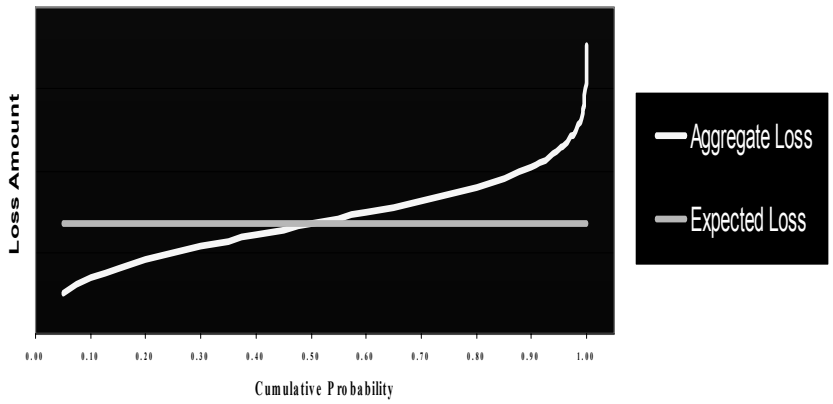
Measuring an Insurer's Underwriting Risk (Cont'd)

- Generate an aggregate loss distribution.
- Or simulate many years of aggregate losses.
- Or simulate many years of individual losses.

Measuring an Insurer's Underwriting Risk (Cont'd)

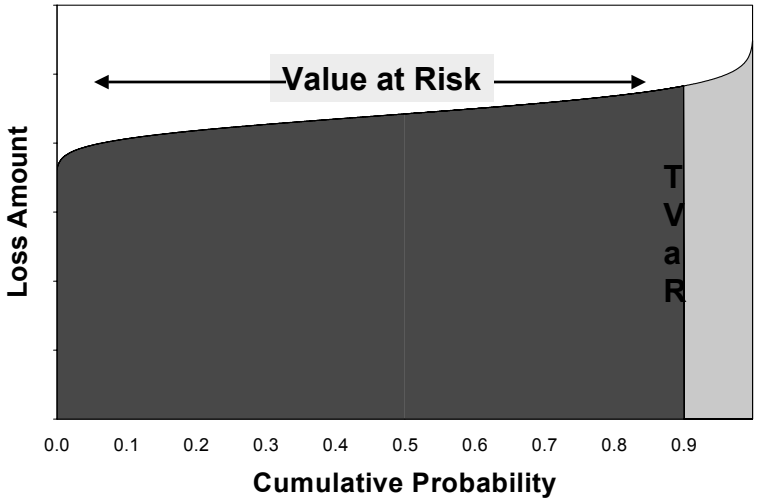
- What is the tolerance for risk?
  - Regulatory requirement (RBC)
  - "A" rating from a rating agency
  - Tradition, etc.
- Select a statistical measure of risk that corresponds to the tolerance for risk.
  - Value at risk (VAR)
  - Tail value at risk (TVAR)
  - Standard deviation, etc.
- Determine total capital for underwriting from the aggregate loss distribution using the selected measure of risk.

Aggregate Loss Distribution (Range of Losses)

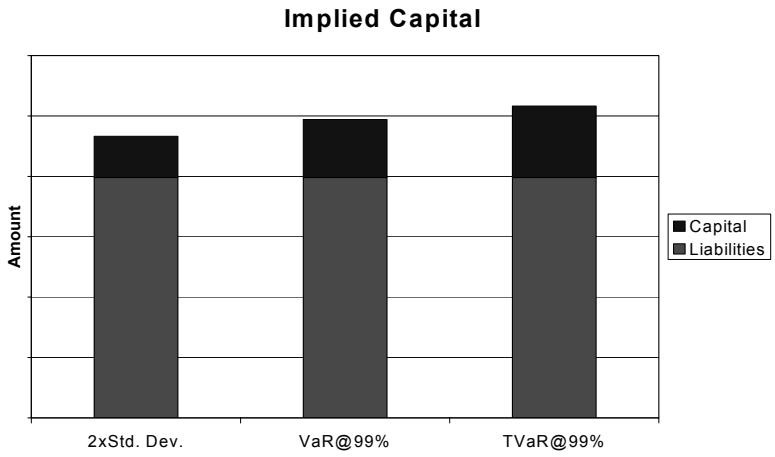


Measures of Risk

Tail Value at Risk = Average of losses over Value at Risk



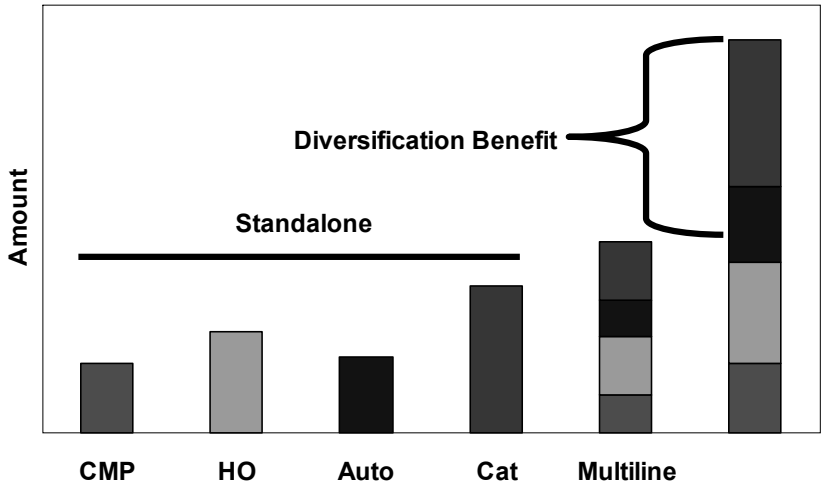
Different measures of risk imply different amounts of capital



Allocating (Cost of) Capital

- Calculate marginal capital for each profit center.
- Calculate the sum of the marginal capitals for all profit centers.
- Diversification multiplier equals the total capital divided by the sum of the marginal capitals.
- Allocated capital for each profit center equals the product of the diversification multiplier and the marginal capital for the profit center.

Capital for Standalone vs. Multi-line Insurers



Optimizing Reinsurance

- Analyze alternative reinsurance programs and implied capital for each alternative.
  - Target return on capital
  - Return on investments
  - Cash flows
    - Investment income
    - Release of capital
  - Corporate income tax rate
  - Net cost of reinsurance (transaction cost)
- Is there adequate risk transfer?

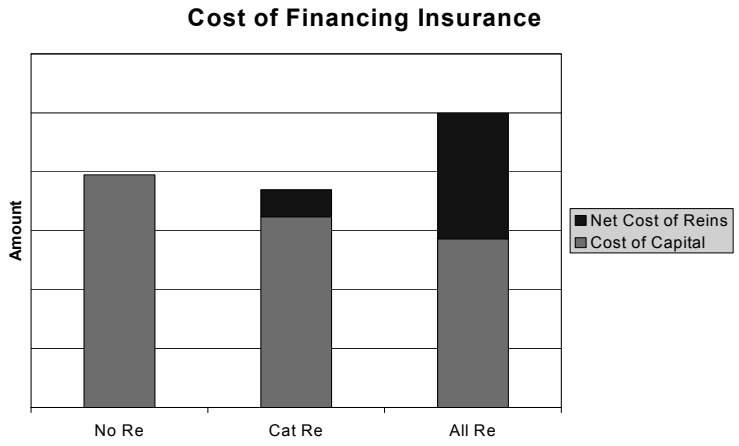
Consider the Time Dimension

- How long must insurer hold capital?
  - The longer capital is held to support a line of insurance, the greater the cost of writing the line of insurance.
  - Capital can be released over time as risk is reduced.
- Investment income generated by the insurance operation
  - Investment income on loss reserves
  - Investment income on capital

Cost of Financing Risk = Cost of Capital + Net Cost of Reinsurance

- Cost of capital = target return x capital
  - Comparable basis to reinsurance
  - Discounted
- Net cost of reinsurance
  = Premium – Expected Recovery
- Minimize the cost of financing risk.

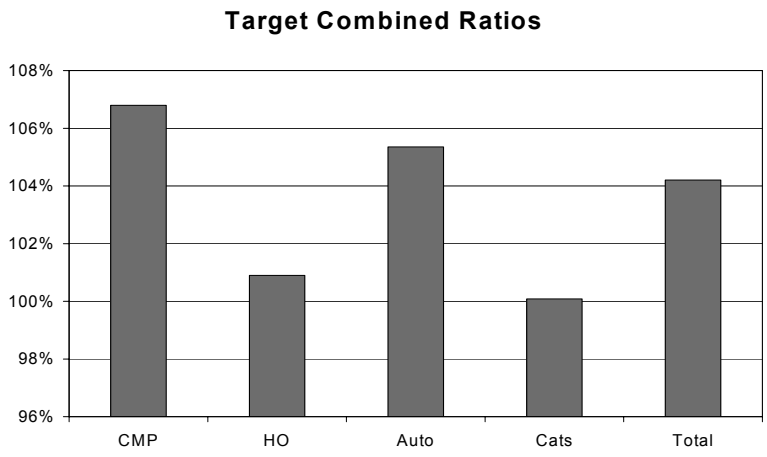
Optimize reinsurance by minimizing the cost of financing



Setting Combined Ratio Targets by Line (Product)

- Expected losses
- Expected expenses
- Investment income
- Cost of financing risk
  - Cost of capital
  - Net cost of reinsurance

Set combined ratio targets by line and overall



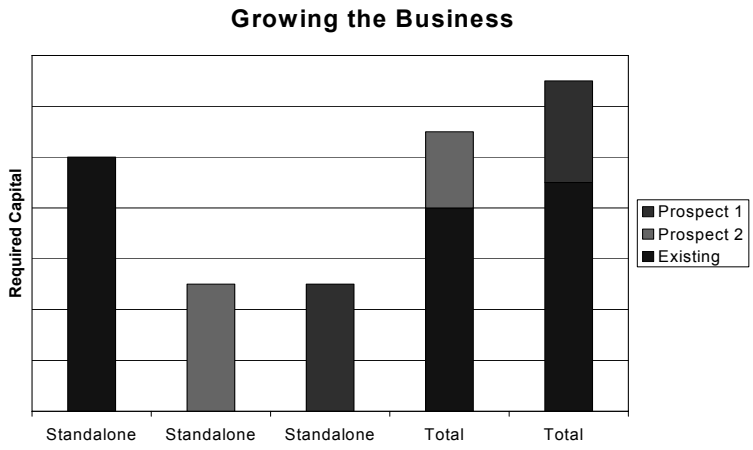
Pricing Risk

- Adjust indicated rates for marketplace conditions.
- Calculate (projected) combined ratio.
- Calculate (projected) return on capital.

Planning Underwriting Strategy

- Add policies/portfolios that increase the return on capital.
- Drop policies that diminish return on capital.
- Optimize underwriting portfolio.

Reflect risk in planning growth



Robust Analysis of Underwriting Risk

- Board of Directors
  - Benchmarking
- Rating Agencies
  - Financial strength ratings
- Regulators
  - Capital requirements
- Stock Analysts
  - Stock recommendations

Commonalities & Differences

Property Casualty (P/C)

Life

Health

Catastrophe Losses (Benefits) (Exposure Concentration)

- Property/Casualty
  - Property lines are generally subject to hurricanes, earthquakes (some policies), terrorism.
  - Workers Compensation is subject to earthquakes, terrorism.
- Life
  - Group Life is subject to earthquakes, terrorism, fatal contagious diseases.
- Health
  - Group Health is subject to serious contagious diseases.
  - Transplants, multiple chronic conditions

Loss (Benefit) Volatility (Non-catastrophic)

- Property/Casualty (primary source of risk)
  - Commercial liability products can have very volatile losses, particularly for claims that may arise many years later, e.g., asbestosis.
  - Correlations can increase volatility.
- Life
  - Low volatility of benefits over longer time periods
- Health
  - Group health is not particularly volatile.
  - Seasonality (flu, elective surgery, etc.)

Capital

- Property/Casualty
  - Premium/capital is less than 1.1 today.
  - Capital may not be released for many years for “long tail” product lines.
- Life
  - Few Companies holding capital for C2 risk due to covariance adjustment
- Health
  - Typically pay as you go
  - Reinsurance for self-insured employers and regional plans

Investments

- Life
  - Investment returns are an integral part of benefits
  - Companies shy away from creating capital gains & losses due to treatment by rating agencies and stock market analysts
- Property/Casualty
  - Investment income is important for liability lines and Workers Compensation.
  - Capital gains/losses can play a role.
- Health
  - Not a significant factor; pay as you go.

Customer Retention

- Life
  - Efficiency of customer in taking advantage of "In the market" benefits is key concern.
- Property Casualty
  - Mature portfolio of risks is more profitable than new business.
- Health
  - Client acquisition costs are high.
  - Annual renewal cycles allow for (some) repricing.

Mortality Risk Measurement

David Ingram, FSA, FRM, PRM

Agenda

1. Characteristics of Mortality Risk
2. RBC for Mortality
3. Factors that Influence Mortality Risk
4. Small Group Risk
5. Concentrated Group Risk
6. Counterparty Risk

Characteristics of Mortality Risk

- Individual Mortality generally Independent
  - The more you write the lower the standard deviation
  - For homogenous groups
    of size >= 1/qx, Volatility is < qx

  Mortality for most groups is low
- Mortality Improvement trend

RBC for Mortality

- 0.0023 for first $50M of NAR,
- 0.0015 for $50M to $500M
- 0.0012 for $500M to $2.5B
- 0.0009 for excess over $2.5B

NAR is Net Amount at Risk

How Were these Factors Created?

- Monte Carlo model of groups of insured lives
  - 10,000 100,000 and 1 million
- Looked at:
  - random variations in mortality
  - variations due to errant predictions of future claim costs
- 95th Percentile
- Applies to NAR
  - Expected Claims would have been preferable

RBC Assumptions

- Margin – 5%
- Modeling Period
  - Ordinary Life – 5 years
  - Group Life - 3 years
- Retention – Assumed to be proportionate to number of lives

RBC Scenario Tests

- AIDS Scenarios
  - Variations in company AIDS exposures
- Catastrophic
- Anti-Selection Lapse Spiral
- Misestimation of Trend
  - Competitive Risk

How accurate is RBC?

- Inaccurate for companies:
  - Higher or lower Average Size
  - Higher or lower expected claims as pct NAR
  - Different Spread of policy sizes
  - Different Retention Limit per policy
  - Different confidence interval on expected claims

Expected Claims

Group of 100,000 lives

Expected Claims Rate	95th Percentile* Excess Claims Per k NAR	95th Percentile* Excess Claims Pct EC
.25%	.26	10.4%
.50%	.37	7.4%
1.00%	.51	5.1%

* Reflecting random fluctuations only

Factors that Influence Mortality Risk

Random Fluctuations	Missestimation of Claims Levels
Missestimation of Trend	Catastrophe

Missestimation of Mean

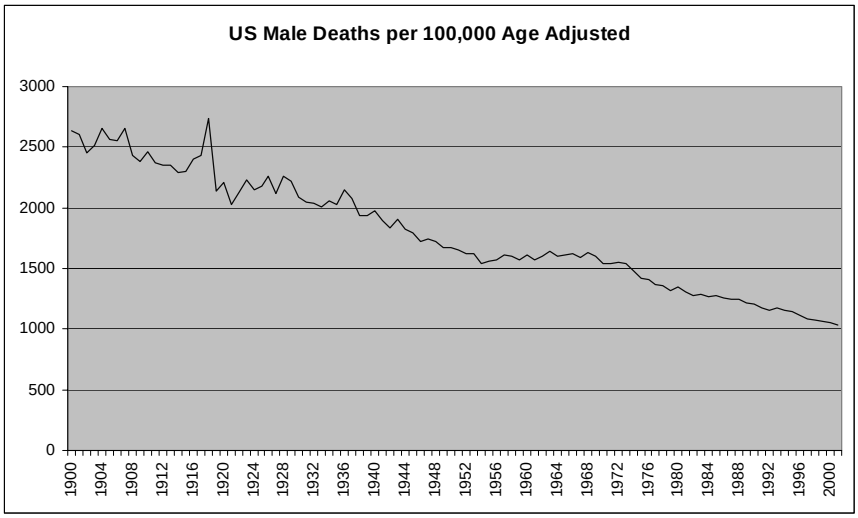
- Underwriting Class Assignment
  - Distribution within classes
  - Error Rate Measurement
- Experience and Testing
  - Use of Chi squared Test
  - Higher confidence in expected mortality with more measurement periods

Missestimation of Trend

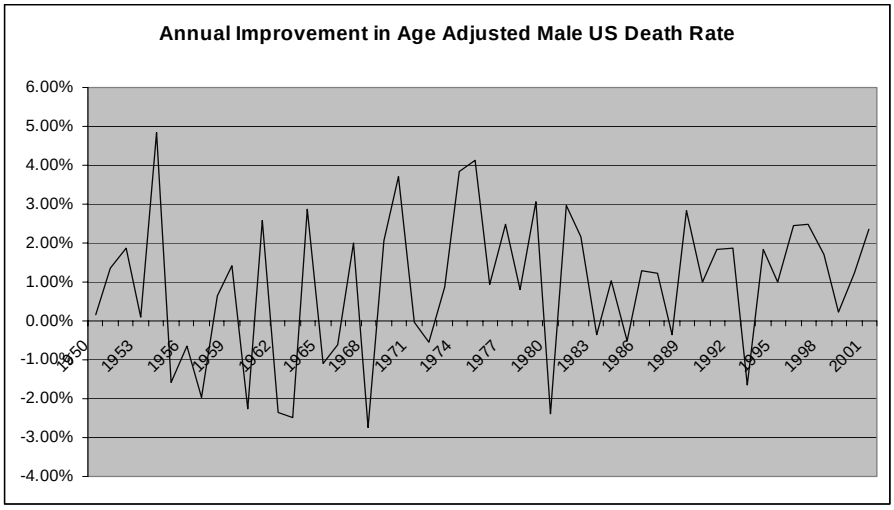
Mortality Improvement Trends in US

Cohort Effect in UK

US Mortality Improvement



US Mortality Improvement



UK Cohort Effect

Longevity in the 21st Century

Table 2.15a. Average annual rate of mortality improvement, England and Wales population, by age group and decade, males

Age group	1960s	1970s	1980s	1990s
25-29	**1.30%**	0.10%	0.40%	-1.00%
30-34	**1.50%**	1.50%	-0.60%	-0.90%
35-39	**1.50%**	**1.00%**	0.20%	1.00%
40-44	-0.20%	**2.20%**	2.20%	0.60%
45-49	-0.10%	**1.80%**	**2.40%**	1.10%
50-54	0.00%	0.60%	**3.20%**	2.50%
55-59	0.90%	1.10%	**3.10%**	**2.40%**
60-64	0.60%	0.90%	1.70%	**3.20%**
65-69	0.00%	1.40%	1.80%	**3.10%**
70-74	0.00%	1.10%	1.50%	1.90%
75-79	0.50%	0.40%	1.50%	2.00%
80-84	1.50%	-0.10%	1.40%	1.40%
85 and over	-0.20%	0.70%	1.20%	0.50%

Own figures - data source: O.N.S. (2003)

Authors: Willets, Gallop, Leandro, Lu, Macdonald, Miller, Richards, Robjohns, Ryan Waters

Catastrophe

- Flu Pandemic History
- Current Concerns
- Terrorism
- Other Catastrophic Risks

Random Fluctuations

- Impact of Size of Block of Lives
- Impact of Variety of Block of lives

Mortality Risk Transfer Securities

- Swiss Re Cat Bonds
- Securitizations of XXX reserves
- BNP Paribas Longevity Bond

Risk Transfer Securitization

- Swiss Re – mortality risk transfer – Vita I
  - raised $400 million in principal from investors to hedge against catastrophic mortality exposure
  - If population mortality deteriorates to certain trigger levels (which was determined to be highly unlikely), Swiss Re will not have to pay back some or all of the principal.
  - The mortality index based on general population mortality in the U.S. and four European countries.
  - Not guaranteed by monoline insurer.
  - Vita I uses a one year period.

Swiss Re plans second mortality bond

- Transfer catastrophic mortality risk to capital market investors.
  - $200m deal, with comprise four tranches, each transferring a different layer of risk.
  - only plans to sell bonds from two of the tranches for now.
- The deal uses a combined mortality index, which measures mortality rates across five different countries.
- Each of the bond's tranches pay out if mortality rates are a pre-set percentage higher than they were in a chosen reference period.
- Vita Capital II uses a two-year period
  - reference period is 2002 and 2003.

Vita Capital II

- The bond's tranches are triggered if mortality rates exceed the average during this period by certain percentages.
- For example, the bond's class A notes, rated A+ by Standard & Poor's (S&P), pay out when mortality rates during a two- year period are 125% of the average during 2002 and 2003. The notes pay out on a sliding scale until mortality rates reach 145%
- The class B notes, rated A-, are triggered when mortality rates hit 120% and they pay out up to 125%. The class C notes, rated BBB+, pay out between 115% and 120%. And the class D notes, rated BBB-, pay out between 110% and 115%.
- It would take a very serious pandemic or man-made disaster to trigger the tranches. S&P estimates that 1,077,000 more people would have to die during a two-year period than in 2002 and 2003 to trigger the class A notes. Some 860,000 more people would have to die to trigger the class B notes. It would take 646,000 more deaths to trigger the class C notes, and 430,000 more to trigger the class D notes.

Standard & Poor's Comments

- Events such as the peak of Aids deaths in 1995, September 11 or the recent tsunami catastrophe in south-east Asia would not have triggered the bond.
- Even the 1918 influenza pandemic, which caused a 33% increase in mortality rates over a single calendar year, would not have triggered the bond.
- The rating agency believes the biggest risks are another pandemic, a full-scale ground war or several nuclear explosions. Only these types of events are likely to cause a loss for bondholders.

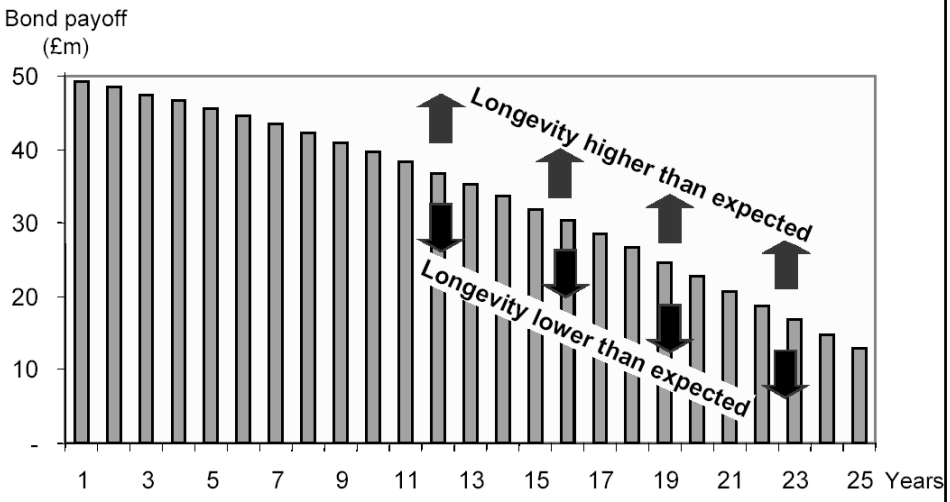
Vita II Structure

- Swiss Re is only selling notes from class C and D for now. It will issue $100m of bonds from each. The notes will mature in January 2010.
  - Swiss Re Capital Markets is the deal's lead manager and arranger.
  - Consultant Milliman calculated the deal's mortality risks.
- The index underpinning Vita Capital II comprises five countries.
  - weighted to reflect Swiss Re's exposure to these markets.
  - US (62.5%), the UK (17.5%), Germany (7.5%), Japan (7.5%) and Canada (5%).
  - also weighted to reflect the sex and age of the policyholders in Swiss Re's portfolio. A wide range of age groups is included in the index.
- The deal's structure is the same as most catastrophe bonds.
  - Investors' money is held in a trust and invested in very secure short-term investments.
  - If the bond is triggered, the proceeds go to Swiss Re.
  - If it is not, the proceeds go back to investors.
  - The interest is paid from a combination of the return the trust makes on its safe investments and the premium Swiss Re pays for the coverage.

Risk Transfer Securitization

- BNP Paribas – Longevity Bond
  - Hedges Mortality Trend Risk in UK
  - Partnership with EIB, BNP Paribas and Partner Re
  - Bond Payoff based on ONS reported longevity for UK 65 year old Male Cohort

Longevity Bond



Key Advantages of the Longevity Bond

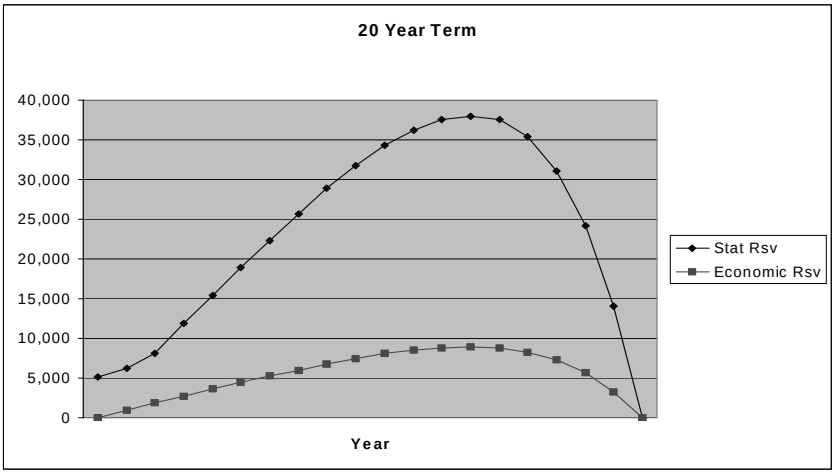
- The Longevity Bond embeds a hedge against longevity risk
  - covers virtually all of the longevity risk but is much cheaper than bulk buyouts
  - is much easier to implement and administer than bulk buyouts
  - carries the highest possible issuer credit level (AAA)
  - The payoff is similar to a pension in payment
  - The longevity index is completely transparent and independent - data are published by the UK Government

  - Source: BNP Paribas Presentation to First International Conference on Longevity Risk and Capital Markets Solutions 18th February 2005

Reserve Funding Securitizations

- First Colony Life Insurance Company, a GE Financial subsidiary
  - In July 2003, First Colony concluded a securitization transaction through a special purpose vehicle, to obtain reserve relief under Regulation Triple X.
  - Initial capital raised through the transaction was $300 million.
  - As reserve strain grows, more principal can be raised – up to $1.15 billion.
  - MBIA guaranteed interest and principal.
- Many others in progress.

Rationale for Triple X Securitization



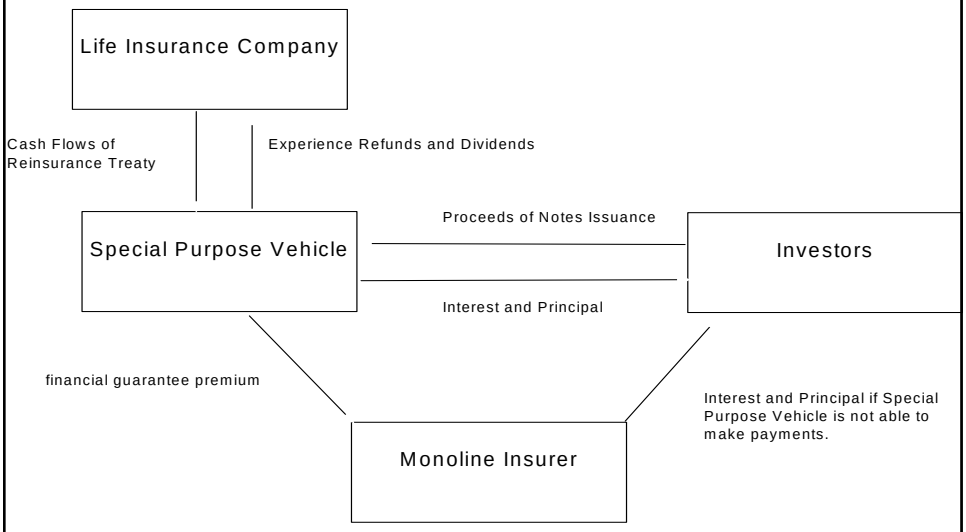
Basics

- Assets backing redundant Triple X reserves are funded by the capital markets
- Surplus Notes issuance / redemption linked to build up / runoff of redundant reserves
- Assets backing redundant reserves invested in similar instruments used to purchase Notes

Basics

- Notes are wrapped by a monoline, with monoline agreeing to back future issuance of Notes up to specific limit as hump grows
- Includes in force business and limited amount of new business

Securitization Structure



Key Mortality Risk Issues

1. Economic reserve assumptions
2. Amount of collateral
3. Experience refund and dividend rules
4. Post-level term profits

Promoting Fair and Efficient Health Care

Predictive Modeling in Group Health and Workers Compensation

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Marilyn Schlein Kramer

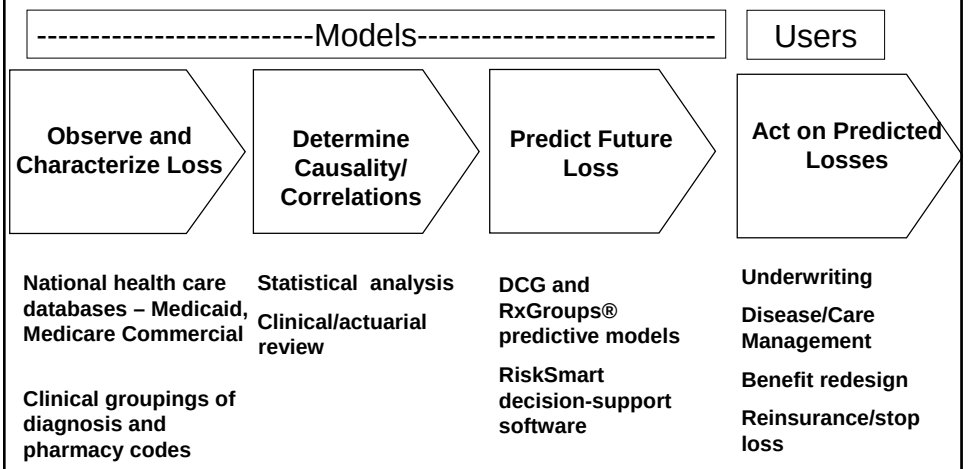
ERM Symposium 2005

May 3, 2995

Outline

- Compare and contrast healthcare modeling with P&C modeling
- Overview of health care model actuarial applications in group health
- Applications to Workers Comp

Predictive Models Enable Better Understanding and Management of Risk

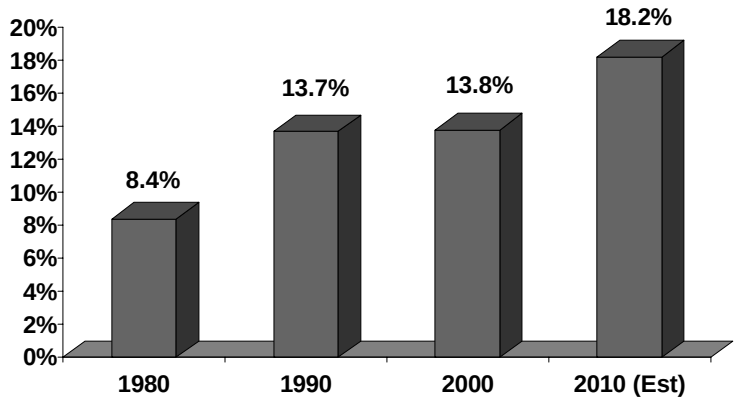


Health Care Insurance

- Not volatile; seasonal
- Limited use of financial instruments; pay as you go
- Catastrophic cases/chronic cases
- Reinsurance
- Trend!!!!

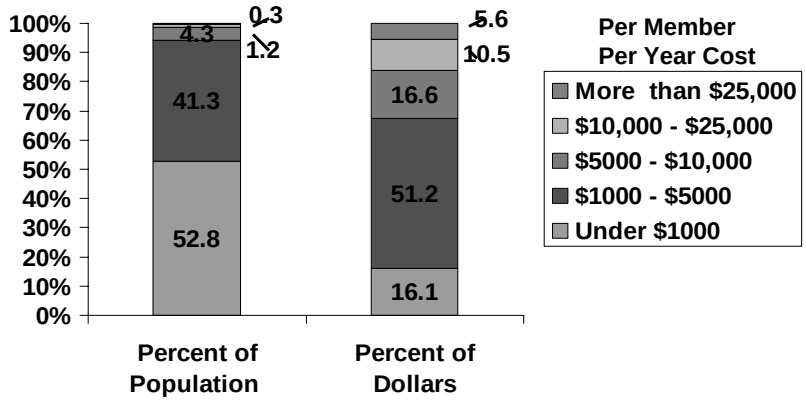
Trend!!!

Proportion of National Income Spent on Health Care



Catastrophic Cases

The top 2% is almost 20% of the cost



Chronic vs Acute Conditions

	Acute	Chronic
Recurring	**Typically no**	**Yes**
Impacts Costs <u>This</u> Year	**Yes**	**Yes**
Impacts Costs <u>Next</u> Year	**No**	**Yes**
Examples	**Flu, Broken Leg, etc.**	**Congestive Heart Failure, Diabetes, etc**

Clinicians and Consumers Are Good At Predicting

- Sicker people cost more than healthy people (even with management)
- The cost of chronic disease is predictable
- Physicians know this
  "But my patients are sicker"
- Consumers use this in decision making
  "Adverse selection"

Predictive Modeling

Starts with Comprehensive Understanding of Current State

Member ID: 00001
Name: John Smith
Age: 50
Sex: M

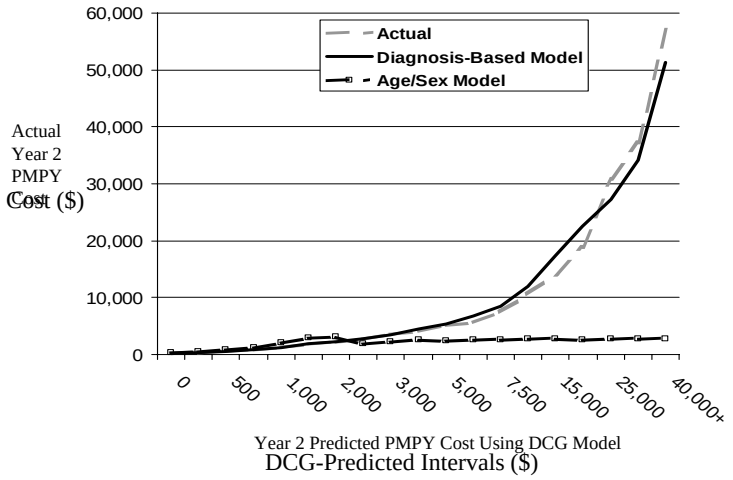
- **x Hypertension**
  - **x essential hypertension**
- **x Type I Diabetes Mellitus**
  - **x type I diabetes w/ renal manifestation**
- **x Congestive Heart Failure**
  - **x hypertension heart disease, w/ heart failure**
- **x Drug/Alcohol Dependence**
  - **x alcohol dependence**

Relative Risk Score: 9.41

John Smith is 9.41 x Sicker than Average

Current State and Historic Patterns Used to Predict Future State

Age/Sex Predicted, Diagnosis-Predicted, Actual Costs by Prediction Intervals



Predictive Modeling : From Medicare-funded Research ….

1982	**Congress enables Medicare beneficiaries to enroll in HMOs**
	Medicare observes younger healthier beneficiaries enrolling in Medicare HMOs, resulting in higher costs **Medicare funds several teams to develop alternative models to quantify impact of illness burden on expected costs**
1997	**Balance Budget Amendment (BBA) mandates risk adjustment for Medicare Part C (Medicare+Choice later renamed Medicare Advantage)**
2004	**Medicare Modernization Act extends use of risk adjustment to Medicare Part D (Drug Benefit) as well as in Chronic Care Improvement Programs in Part B (traditional Medicare)**

…to Commercial Uses in Group Health

- Risk adjustment → predictive modeling
- Risk transfer payments→
  - Underwriting renewals High cost case identification
  - Prioritization for disease/care management
  - Outcomes (ROI) analysis of cost containment programs
  - Physician incentive programs

Which Provider Group Cares for a "Sicker" Population?

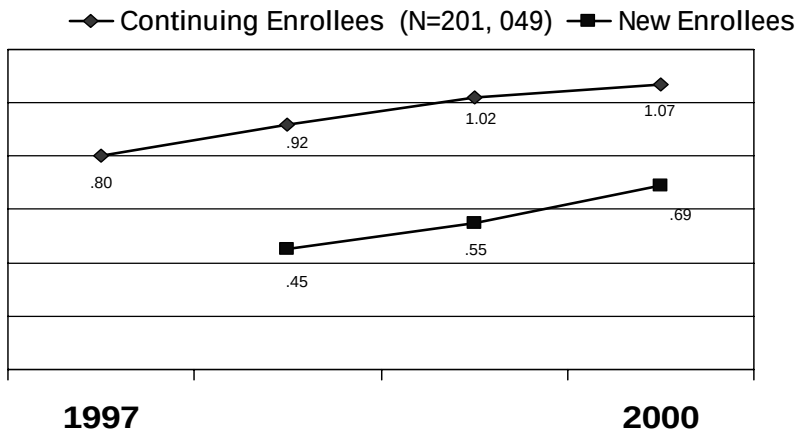
	Total	Risk Unit A	Risk Unit D	Risk Unit E
PMPM Expenditures	**$105**	**$114**	**$88**	**$181**
Age/Sex Relative Risk Score	**1.00**	**1.15**	**0.64**	**1.22**
Diagnosis-Based Relative Risk Score (DCG)	**1.00**	**1.16**	**0.61**	**1.52**

What Accounts for Differences in Health Status?

Rate Per 10,000 Selected Condition Categories

Diabetes With...	Nation	System-wide	Risk Unit Group A	Risk Unit Group D	Risk Unit Group E
Neurologic or Peripheral Circulatory Manifestations	**16**	**24**	**16**	**8**	**169**
Ophthalmologic Complications	**22**	**22**	**21**	**12**	**141**
No or Unspecified Complications	**168**	**170**	**166**	**68**	**410**

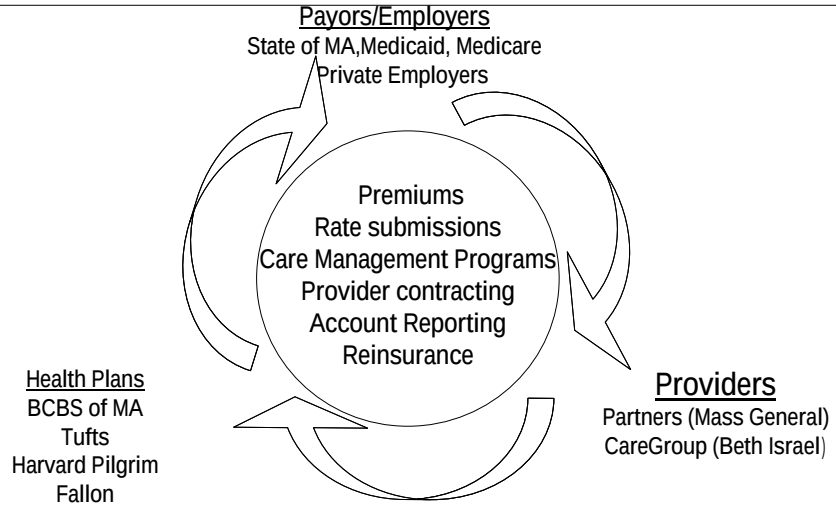
Is Membership Growing "Sicker" Over Time ?
(1.00 is mean risk using pharmacy-based models)



Using Predictive Modeling for Reinsurance: Client Finding

- For small and mid-sized groups (up to 249 members), diagnosis-based models outperformed prior year costs at all retention levels
- For high retentions ($100K+), diagnosis-based models generally outperformed prior year costs

Many “Actors” Use Predictive Models
Market Example: Massachusetts



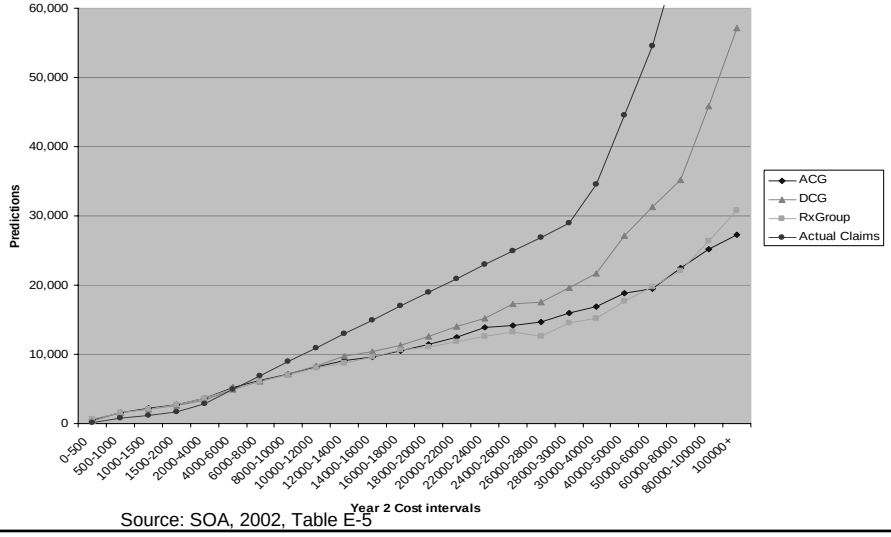
Health Care Model Progression

- Age/sex/experience
- Diagnosis based models
- Pharmacy based models
- Combination models

Benefits of Pharmacy Models

- "Skinnier" dataset
- Shorter lag time (between service and adjudication of claim)
- Able to "see" chronic illness more quickly
- More real time predictions for renewals

Society of Actuaries Study Comparison of Models Using Administrative Data



Source: SOA, 2002, Table E-5

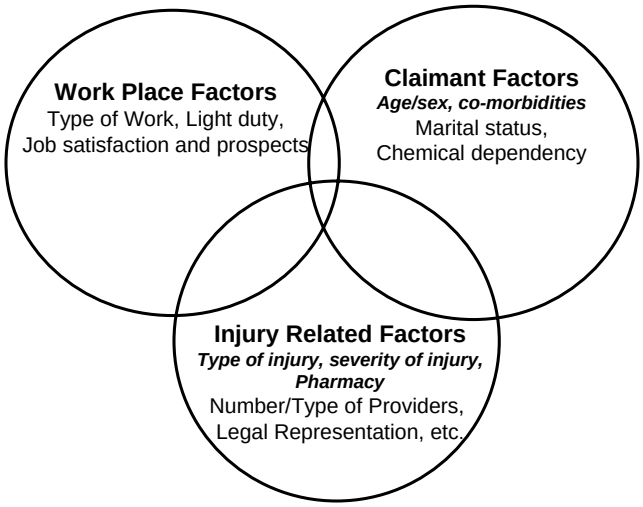
Beyond Administrative Data

- Health risk assessments/surveys
- Lifestyle issues
- Lab values
- Biometric findings
- Genetic markers

Why Group Health Models May Be Helpful in Workers Comp

- Small percentage of cases account for large % of claim costs
- Comordibities appear to influence costs
- Proactive case management approach has positive outcomes
- Data classification and management needed to build successful models

Finding High Cost Claimants



Workers' Comp Predictive Models: Key Success Factors

- Predicts high percentage of high exposure claim
- Applicable early enough (60/90/120 days) to allow impact on future costs
- Minimizes false positives and "loss"
- Easy to implement
- Low-cost to maintain/update