Non-Life Insurance: Catastrophes, Risk-Based Capital, Claims Reserves, and Finite Reinsurance

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1. Finite Reinsurance (Alternative Risk Transfer)

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Alternative Risk Transfer

Reinsurance in which losses are limited or in which the present value of future profits is significant versus the reinsurer's liability

Life & Health side includes surplus relief

P&C side includes surplus relief or improvement in surplus / premium ratios

Life & Health - Example

Life Block based on current environment (8% interest, 1995-00 mortality) has profits equal to 40% of reserves

Reinsurer provides ceding commission equal to 25% of reserves

P&C Examples - Prospective Covers

1 Financial Quota Share – sliding scale commission

2 Prospective XOL – spread loss cover. Reinsurer receives big upfront deposit to cover claims. If fund goes negative cedent pays in more premium.

P&C Examples – Retroactive Covers

3. Loss Portfolio Transfer – used for discontinued operations. Covers claims that have occurred but are not yet paid.

4. Retrospective XOL – covers adverse development on policies already written.

5. Time and distance. Treaty specifies specific date ("time") before a payment will be made ("distance")

Source Monti & Barile, Practical Guide to Finite Risk Insurance. & Reinsurance.(1995)

P&C Examples

Existing block of WC reserves

Reserve with no discount equals $40 million.

Reserve with 8% discount = $25 million

Reinsurer gives ceding commission of $10 million; plus can recapture when $10 million is recovered.

P & C Example

Fire occurred at MGM grand hotel

The loss portfolio was covered

The claims settled much faster than originally estimated and the reinsurers lost money

Regulators

- NAIC = Natl. Assoc. Insurance Commissioners (issued Ch.22)
- SEC = Securities and Exchange Commission
- AICPA = American Institute of Certified Public Accountants
  - issue SOP = statements of positions
- FASB = Financial Accounting Standards Board (Issued FAS 113 and Emerging Issue Task Force 93-6)
- IRS = Internal Revenue Service, section 845

FAS 113

Financial Accounting Standards Board

FAS 113 distinguishes “reinsurance accounting” versus “deposit accounting”. Deposit accounting – all cash flows regarded as deposits, with no surplus effect. Reinsurance accounting recognize gain in surplus.

FAS 113 requires “significant probability) (viz 5%) or a “significant loss” (viz 5%) premium. (Some use 10% & 10%.)

FAS 113, the 5-5 Rule Revised

The probability of death of a young female is about 1/2000. Prob. 9.0 earthquake (moment scale) also low. Instead of 5-5:

- 5% prob. of 5% loss OR
- 1/200 prob. of 50% loss OR
- 1/2000 prob. of 500% loss OR
- 1/20,000 prob. of 50 times loss

FAS 113

Retroactive insurance often treated as deposit accounting

Some of the other reinsurance agreements treated as a deposit

NAIC since 1976 has suggested the cedent should set up a liability if sliding scale commissions are used

Life Side

Most treaties are straightforward quota share, that are “over collateralized”

Statutory Surplus credit is allowed, subject to certain requirements:

- reinsurer can’t cancel
- reinsurer covers expenses
- “interest rate” subject to certain limits

NAIC Rules

National Assoc. Insurance Commissioners

In U.S. statutory accounting gain from ceding an inforce block is shown in the “surplus account” rather than in “gain from operations”

Other NAIC Rules
Mirror Surplus (Mirror Reserving)

New York and other countries concerned that a tiny reinsurer could reinsurer the U.S. industry, providing almost unlimited amounts of surplus relief.

NY 5th amendment to regulation 20 required "mirror reserving." The reinsurer is suppose to reduce its surplus by the amount of surplus credit taken by the cedent.

Other NAIC Rules - Security

NY 114 trust - if liability of reinsurer is secured by a trust, then should be few restrictions

NY LOC rules - if liability of reinsurer is secured by a letter of credit, then

clean irrevocable, evergreen letter of credit

should not be secured by the cedent

2. Fair Value Accounting

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It is an idea promulgated by the IASC.org.uk. The idea is that all assets and liabilities are to be valued at "market."

Banks said some of the their liabilities have no "market value." For P&C companies there is even a narrower market.

Life companies noted that some products had guaranteed cash values and amortized cost and asset liability matching is more appropriate.

Fair Value Accounting Today

P&C: Claim reserves are to be reduced – by discounting.

L&H: Reserves are to be determined by a prospective reserve. DAC (deferred acquisition costs) are eliminated.

Fair Value for Certain P&C Reserves

Some P&C liabilities are also “long term” (> 13 months) and are non cancelable (can’t be cancelled by the cedent, nor the premiums raised)

Examples are: Malpractice tail coverage, auto warranty insurance

Presumably “life insurance rules” would apply

Uncertain Areas
Non-Can. Long Term

Is the reserve a “gross” or net premium reserve?

Net Versus Gross Prem. Res.

Prospective reserve formula:

$$V[t] = PVFBE[t] - P * PVone[t]$$

PVFBE = present value future benefits & expenses

PVone = present value of one unit

t= duration

For Net premium reserves $P = PVFBE[0] / PVone[0]$

For gross premium reserves P=G = gross premium.

Problems with gross method: (1) can be manipulated, (2) anticipates profit; (3) small changes in assumptions produce large changes in reserves; (4) ugly.

NAIC Model for Long Term Non-Can P&C Products

Reserve is greater of:

(1) Amount of return of premiums on cancellation by policyholder

(2) Net Single Premium

(3) Prospective gross premium reserve.

3. Risk Based Capital (RBC)

3. Risk Based Capital Formulas

Attempt to relate “riskiness” of a company to its surplus.

Problems:

(1) Political

(2) Doesn’t forecast insolvencies

(3) Inconsistencies between L&H vs. P&C.

Originally Three Contingencies

C1. Asset Default (% assets)

C2. General Pricing (% premium, reserves)

C3 Interest Mismatch

Overall: square root formula

Sources: NAIC formulas; Trowbridge committee 1979 (www.soa.org).

Now P&C: R0, R1, R2, R3, R4, R5.

Now L&H: C0, C1, C2, C3a, C3b, C4a, C4b

Political

RBC was developed with “industry help”

Companies who wrote annuities got low percentage for annuity reserves, but there were spectacular insolvencies involving annuity cos. Charter Natl; Baldwin United

Companies wrote health insurance hit hard. (bigger cos. withdrew before the formulas were finalized)

Inconsistencies with RBC

Life companies with common stock hit with 30% factor

P&C companies with common stock used 15% factor

P&C companies generally have more common stock – because “proration rules” for U.S. federal income tax are more favorable for P&C companies

RBC - Not Particularly Good Predictor of Insolvencies

Mortgages have very low factor, even though highly illiquid

Common stock very high factor, even though liquid

Good Things with RBC

Establishes certain rules. Does penalize junk bonds (involved in Executive Life insolvency).

P&C RBC - Factors

R0= asset risk on affiliated investments.

R1 = asset risk on fixed income assets

R2 = asset risk on equities

All based on varying percentage of the asset values.

R3 = underwriting risk on reserves

R4 = underwriting risk on premiums

P&C Square Root Formula for RBC

P&C RBC = R0 +

+ sqrt ($R1^2 + R2^2 + R3^2 + R4^2$)

L&H RBC = C0 + C4a +

+ sqrt (sqrt $(C1+C3a)^2 + C2^2 + C3a^2 + C4b^{2)}$

Sources P&C page PR027

Sources L&H LR025

P&C Adjusted Capital

1. Statutory capital & surplus

less 2. non tabular statutory discounting

plus 3. certain amount of “capital notes”

Notes:

- Statutory surplus includes “surplus notes”
- Interest owned on assets backing surplus & capital notes might be less than the interest paid

Comparison

Compare Risk Based Capital with “adjusted surplus”

To make the percentage look larger the RBC is multiplied by 50%

L&H Formula

C0 = affiliated assets

C1 = non affiliated assets

C2 = insurance risk (L & H)

C3a = interest rate risk

C3b = health credit risk

C4a = business risk (prem. & liab)

C4b = Health business risk

L& H Square Root Formula

$$\text{L\&H RBC} = C0 + C4a +$$

$$+ \text{sqrt}\left(\text{sqrt}\left(C1+C3a\right)^2 + C2^2 + C3a^2 + C4b^{2)}\right)$$

C0, C1 asset risks; C2 insurance risk; C3a interest rate risk; C4a business risk; C3b, C4b health risks.

Sources P&C page PR027

Sources L&H LR025

L&H Adjusted Surplus

Capital and surplus

+ AVR (asset valuation reserve)

+ portion of “capital notes”

Notes:

– Capital & surplus includes “surplus notes”

– IMR is NOT added back – even for companies which have no annuity bus.

Risk Based Liquidity

Kischuk found that “risk based liquidity” a better measure than “risk based capital”

Common stock are more liquid than mortgages.

Annuities are very susceptible to a lapse risk

4. Catastrophes

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In some countries catastrophes reserves are deductible (Finland)

In U.S. catastrophe reserves are not deductible, but NAIC is trying to make them deductible for tax purposes

Natural Disasters

Natural disasters in last 100 yrs have killed up to 3.7 million people

Include earthquake, tsunami, windstorm, volcano, fires, explosions

NYT 1999 article: within the 21st century a natural disaster could kill 1 million people

Coast lines are more susceptible to disasters and more people are moving to coastal areas.

Diseases & Injuries

U.S. 1% people die each year. (about 2 million)

Injury deaths are about 5% of all deaths
(about 100,000)

Car deaths are about 40% of injury deaths
(about 40,000)

Source: Injury Facts. U.S. Statistical abstract

Man Made Disasters

Wars & related acts have killed millions

Weapons mass destruction could kill billions

Cherynobyl (1986) may cause tens of thousands of cancer deaths

Bhopal India chemical plant caused 3849 deaths

source World Almanac 2004, pp 182-192

Terrorism

9/11/2001 about 3000 people died

2600 towers, 125 Pentagon, 265 on 4 planes (not counting 19 hijackers)

Property damage about $100 billion

Effect on the economy unknown

Note “911” is the emergency call number in the United States

How Do We Price for Catastrophes
Natural Disasters

Past is some guide on property side

Models look at exposure by zip code

But hard to factor in building codes

How Do We Limit Exposure

Cap: One U.S. Company provided 100K / person “accidental death” but there was a $50 million cap for any one occurrence

Carve out or cap NRBC (nuclear, radiological, biological, chemical) terror incidents and non-terror incidents

How Do We Charge for NRBC and Terror?

Past is no guide. Models help some

Need to know maximum possible loss (not just maximum probable loss)

Need to charge for total exposure

Accidental death rates in U.S. were 20 cents / thousand

Perhaps terror costs $2 cents / thousand with a cap.

Examples of Floods, Tsunami

1931 Aug	Huange He, China	3.7 million
1939	North China	200,000
1979, Aug	Morvi, India	15,000
1999, Dec	Venezuela	9,000
2000	Bangladesh	1,000 +
2002	India, Bangladesh	1,100

Examples Hurricanes, Typhoons

1937	Hong Kong	10,000+
1942	N. Bengal, India	40,000
1965	Bangladesh	30,000
1970	Bangladesh	300,000
1991	Bangladesh	139,000
1998	Honduras, Nicaragua	9,888
1999	East India	9,392

Railroad Disasters

1944, Jan	Spain, Leon Prov.	500
1944, Mar	Italy, Salerno	521
1970, Feb.	Buenos Aires	236
1981, June	Bihar, India	800+
1994, Sept	Tolunda Angola	300
1995, Aug	Firozabad, India	358
2002, June	Igandu, Tanzania	281+

Airline Disasters

1977,1996 Mar	Tenerife	583
1979, May	American	275
1985, Aug	JAL	520
1988, Jan	Pan Am Lockerbie	270
1996, Nov	Saudi AL, in Delhi	349
9/11/2001	4 planes	265

Explosions Incidents

1956, Aug	Colombia	1,100
1982	Afghanistan	1,000
1984, Dec	Bhopal, India	3,849
9/11/2001	NYC	3000

Earthquakes – Using Richter Scale

1939, Jan	Chile	28,000	8.3
1970, May	N. Peru	66,000	7.8
1976, July	Tangshan, China	255,000	8.0
1988, Dec	Armenia	40,000+	7.7
1999	W Turkey	17,200	7.4
2001	Gujarat, India	20,000+	7.9
2004	Iran	40,000	

5. IBNR or Claim Reserves

Computing Claim Reserves

- Short Tail, 1880s?
- Tarbell's Method, 1934
- Method for A&H – loss ratio, 1990s
- Chain Ladder – triangular, 1950-60s
- Bornhuetter Ferguson, 1972; Cape Cod
- Ruth Salzmann Method 4 – claims count
- Standard Deviation of Chain Ladder, 1993
- Zenhwirth Curve Fitting, risk theory techniques

Sources of Data

Casualty Actuarial Society

Papers by Mack (1994), Salzmann, Bornhuetter, Stanard, Tarbell (1934), Zehnwirth (1998), etc.

Society of Actuaries [RSA 1990]

Cape Cod method

Brown, Gottlieb; Ratemaking & Loss Reserving, 2001

Salzmann, Loss Reserves, 1984

Definitions

Claim = demand for payment

Loss = amount of claim ($, Rp or some currency)

Claim Reserves = liability for claim amounts which will be paid in future periods.

- Case reserves (estimate of individual claims)
- IBNR (incurred but not reported)

IBNR also includes claims where “not enough has been reported” (IBNER)

Definitions

Case incurred = case reserve + Paid claims

Unearned Premium Reserves = liability for amounts of premium allocated to future periods; usually on a “pro rata” basis

Underwriting year = policy year = year policy written or renewed

“Accident Year” = “year accident occurs” (could be calendar year, or “underwriting year”)

Policy Year vs. Accident Year

Policy written in 7/1/2003

If Claim occurs on 10/1/2003, then the policy year and the accident year are 2003

If claim occurs on 4/1/2004, then the policy year is still 2003, and the accident year is 2004

IBNR – Short Tail Line

"Life Insurance" is a long term contract, and a whole life contract may last over 100 years

The "claims tail", however, is very short

Usually claims are reported within one week. There are no recoveries and the face is fixed

Animal mortality (written by P&C) also short tail business

IBNR for 12/31 = claim observed in January

A&H Method

using cumulative losses by underwriting year

Policy quarter	Underw Year 1999	Underw Year 2000
1	8	10
2	14	18
3	16	? (16) (18/14)
4	17	? (17)(18/14)

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Example of Tarbell

see Bornhuetter Ferguson, 1972

1930 IBNR as of 12/31/30 = $1.3 million

1930 IBNR as of 12/31/31 = $1.5 million

Note 0.2 million adverse development

1930 premium inforce = 13 million

1931 premium inforce = 16.9 million

Thus

1931 IBNR = $1.5 (16.9/13) = 1.95 million.

Tarbell's IBNR Method, 1934

Tarbell's method applies to short tail property business

The 12/31/1930 IBNR is "observed" as of 12/31/1931. Then the estimated 12/31/1931 IBNR is:

- 1931 IBNR est. = 1930 IBNR observed * Ratio
- Ratio could be 1931 premium / 1930 premium or 1931 case incurred / 1930 case incurred claims.

A&H Method

Usually based on loss ratios or combined ratios (loss + expense / premium)

Usually supplemented by case reserves on large claims

Losses, Paid premiums, commissions, Loss Adjustment Expense may also be shown in the columnar data

“Accident date” often not defined for chronic illness; so policy year is used

A&H Method

Using Cumulative Losses by Underwriting Year

Policy quarter	Underw Year 1999	Underw Year 2000
1	8	10
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Chain Ladder

Usually rows represent

- "policy year"
- or "accident years"

The columns represent reporting dates

The data is typically cumulative losses

Losses could be paid losses or "case incurred" (paid plus case reserve)

Bornheutter Ferguson Data- 1972

We want to estimate the 12/31/72 & later data

Acc yr	12/31/66	12/31/67	12/31/68	12/31/69	12/31/70	12/31/71
1966	2500	3650	4200	4325	4330	**4330**
1967		2150	3225	3725	3965	**3960**
1968			3200	4500	5050	**5150**
1969				3700	5200	**5775**
1970					3300	**4800**
1971						**4250**

Chain Ladder Computation

Computation uses link ratios:

f[k] = link ratio (col k/k+1)

Cum[i] = cumulative link ratio (diagonal to last col)

Last Report[i] = Diagonal entry (row i)

Ultimate[i] = Last Report[i] * Cum[i]

IBNR[i] = Ultimate[i] – Last Report[i]

Chain Ladder Computation

Computation uses link ratios:

$f[k] = \sum_i C[j,k] \;/\; \sum_i C[j,k+1] \quad k=1,\ldots,n-1$

$i = 1,\ldots,m-k$

$Cum[k] = f[n-1]\, f[n-2] \ldots f[k]$

Variations. Use average of $F[i,k] = C[i,k]/C[i,k+1]$
or use last three entries in each column

Standard Deviations of Chain Ladder

Thomas Mack in PCAS 1994, gave formulas for the standard deviations of the chain ladder reserves (See also 1993, 1999 papers)

It is worthwhile to compute the reserves, as a matter of course, and we have enclosed some spread sheets and APL programs to compute the results

Bornhuetter Ferguson
Using Expected Claims

If the claims are usually reasonable, then one can estimate the “ultimate expected” claims as a percent of premium

Using the “expected claims” one can compute an estimate of the IBNR

Bornhuetter Ferguson

Recall

(1) IBNR[i] = Ultimate[i] - Last Rpt[i]

(2) Ultimate[i] = Last Rpt[i] * Cum[i]

(3) IBNR = LastRpt[i] * (1-Cum[i]) use (1),(2)

(4) IBNR = Ultimate[i] * (1 – Cum[i]) / Cum[i]

- use (2) and (3)

Bornhuetter Ferguson replaced Ultimate in (4) by an “expected ultimate”

Cape Cod

Recall for accident year "i"

(1) IBNR[i] = Ultimate[i] - Last Rpt[i]

(2) Ultimate[i] = Last Rpt[i] Cum[i]

(3) IBNR = LastRpt[i] (1-Cum[i]) use (1),(2)

(4) IBNR = Ultimate[i] (1 – Cum[i]) / Cum[i] use (2),(3)

Replace Ultimate[i] in (4) by a variation of (2)

Sum-i LastRpt[i] / Sum-i 1/Cum[i]

See Stanard (Simulation Test); RSA 1990

Examples of Reserving Techniques

On aviation claims we use “case reserves” for the large crashes (TWA 800; PanAm Lockerbie; Swiss Air; 9/11 crashes)

The case reserves may also inflate.

The smaller claims are reserved using Bornhuetter Ferguson

Other Reserve Methods

Ms. Ruth Salzmann gives a variety of reserve techniques. These include the chain ladder (methods 1-3); reserves based on “expected claims” (method 6-7) and reserves based on expected claim counts (methods 4-5).

Ruth Salzmann – Method 4 Given (1), (b), (5), (6)

(1) = 1980 reported # claims as of 12/31/81	17,727
(b) = fraction 1980 $ reported as of 12/31/81	97.4%
(c) = (1)(b) = estimate ultimate #	18200.2
(i) = (1)(c) = ultimate $ claims	52,325,378
(5) = paid claims ($)	22,805,000
(6) = case incurred ($)	21,812,000
IBNR = (i) – (5) – (6)	6,598,378

Policy Year vs. Accident Year

Old Schedule P was on a policy year basis.

Ms. Ruth Salzmann (PCAS 1967) suggested an accident year approach

Ms. Salzmann recognized that policy year approach gave more accurate loss ratios, but accident years were consistent with accounting year data

Example of Ruth Salzmann 1967 PCAS p.128

Pol Yr	Acc Yr	12/31/63 Claims	12/31/64 Claims	12/31/65 Claims	12/31/66 Claims
1963	63	10	13	14	**14**
1963	64		10	13	**14**
1964	64		11	14	**15**
1964	65			11	**14**
1965	65			12	**15**
1965	66				**12**
1966	66				**13**

Example of Ruth Salzmann

1967 PCAS

"accident year" with projected values of claims

Acc Yr	1st Rpt	2nd Rpt	3rd Rpt	4th Rpt
63	10	13	14	**14**
64	21	27	**29**	? 29
65	23	**29**	? 31.2.	? 31.2
66	**25**	? 31.9	? 34.3	? 34.3
Link	69/54	43/40	14/14	

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Zehnwirth Models – Curve Fitting

Barnett and Ben Zehnwirth, 1998, “Best Estimates of Reserves”

Discusses a 3 parameter model (p.10)

Includes Chain Ladder, Cape Cod, trend models.