The evolution of internal models in non-life insurance

Chris Daykin
Government Actuary of the United Kingdom, 1989-2007
39th ASTIN Colloquium, Helsinki, 2 June 2009
In memory of Professor Dr Teivo Pentikäinen (1917-2006)
Solvency of Insurers and Equalization Reserves, 1982

Solvency of Insurers and Equalization Reserves
Volume I
General Aspects
Edited by Teivo Pentikäinen

Insurance Publishing Company Ltd.
Helsinki

Solvency of Insurers and Equalization Reserves
Volume II
Risk Theoretical Model
Edited by Jukka Rantala

Insurance Publishing Company Ltd.
Helsinki
Developments in the early 1980s

- introduction of cash-flow profit-testing for life insurance
- Maturity Guarantees Working Party, 1980 (asset models)
- development of model office techniques – mostly in life
- 16th ASTIN Colloquium in Liège, September 1982
- UK Solvency Working Party established after GISG 1982
  - specifically charged with reviewing lessons to be learnt from Finnish report
- “The Solvency of General Insurance Companies” JIA 111, 279
Some major themes

- Capital requirements should reflect risk characteristics.
- EU Solvency I requirements not sufficiently risk-based.
- Solvency margins are an early warning mechanism.
- Insufficient attention had been paid to:
  - Asset risk;
  - Potential inadequacy of technical provisions;
  - Business cycles and variability in profitability;
  - Risk of reinsurance failure;
  - Provision for the expenses of running off the business; and
  - Response mechanisms.
Solvency Studies in the 1980s

Contribution of Finnish study
- adaptation of classical risk theory to introduce cycles
- focus on impact of continuing to write new business
- use of stochastic bundles to analyse probability of ruin
- impact of inflation (but limited consideration of assets)
- transition formula for modelling cash flows:
  \[ \Delta U = B + I - X - C - D \]
  - where B is earned premium income (including loadings)
  - I is net investment income
  - X is claims paid and outstanding
  - C is cost of administration, reinsurance, etc
  - D is dividends, bonuses, etc
Solvency Studies in the 1980s

Second GISG Solvency Working Party

- Working Party reconstituted in 1984
- followed lead of Finnish Working Party
  - stochastic bundles
  - both run-off and with 2 years’ new business
  - uncertainty in claim ratio (long and short-tailed business)
  - profitability of new business and growth rate
  - investment policy
  - inflation and asset volatility using autoregressive models

- “The solvency of a general insurance company in terms of emerging costs”  ASTIN Bulletin Vol. 17, No. 1, 85-132
GISG Solvency Working Party 1985
GISG Solvency Working Party 1985

**Figure 12**
Assets remaining at each point during run-off: variant 8(i)

**Variant 8(i)**
Standard basis except for initial asset distribution which is assumed to be 100% in ordinary shares.

With 5000 simulations:
- Number of insolvencies: 349
- Mean assets remaining: 59.0%

<table>
<thead>
<tr>
<th>Remaining assets as % of initial outstanding claims</th>
<th>Number of cases out of 5000 simulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 0</td>
<td>349</td>
</tr>
<tr>
<td>0 - 10</td>
<td>205</td>
</tr>
<tr>
<td>10 - 20</td>
<td>384</td>
</tr>
<tr>
<td>20 - 30</td>
<td>449</td>
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<tr>
<td>30 - 40</td>
<td>498</td>
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<td>40 - 50</td>
<td>476</td>
</tr>
<tr>
<td>50 and over</td>
<td>2639</td>
</tr>
<tr>
<td></td>
<td>5000</td>
</tr>
</tbody>
</table>
Solvency Studies in the 1980s

Philadelphia, June 1986

First International Conference on Insurance Solvency

Al Paulson  Richard Woll  Stuart Coutts
Greg Taylor  Richard Derrig  David Cummins  Teivo Pentikäinen
Solvency Studies in the 1980s

Insurance Solvency Conferences

- First International Conference on Insurance Solvency
  - Philadelphia, USA, June 1986
  - Proceedings published in:
    - Classical Insurance Theory
      - On the solvency of insurers – Teivo Pentikäinen
      - The management of solvency – G Taylor and R Buchanan
    - Financial Models of Insurance Solvency
      - Solvency in terms of emerging costs – GISG Working Party
      - Generalised cash-flow model – S Coutts and R Devitt
      - Cash flow simulation models – A Paulson and R Dixit
      - On the application of finance theory to the insurance firm – J Garven
      - Effects of underwriting risk on insurer’s long-term solvency – J Rantala
      - Solvency levels and risk loadings – a financial view – R Derrig
Solvency Studies in the 1980s

Insurance Solvency Conferences

- Second International Conference on Insurance Solvency
  - Brighton, UK, May 1988
  - Proceedings published in:
    - Managing the Insolvency Risk of Insurance Companies
      - Effects of underwriting cycles on insurance solvency – Greg Taylor
      - A management model of a general insurance company using simulation techniques – C Daykin and G B Hey
      - Synthesis of property-liability pricing techniques – Garven and D’Arcy
      - Capital structure and fair profits in P/C insurance – David Cummins
  - Third and Fourth Conferences
Solvency Studies in the 1980s

**Solvency Working Party of the Groupe Consultatif**

- 1980-85 – Chairman: Sir Brian Corby
- 1985-88 – Chairman: Terry Clarke
- reviewed EU solvency régime
- inadequate attention to run-off risk and investments
- recommended use of internal models instead of formula
- capital requirements should relate to company risks
  - type of business
  - profitability of premium rates
  - investment allocation and strategy
  - reinsurance programme
Solvency Studies in the 1980s

International Congress of Actuaries, Helsinki, 1988

- Special Meeting on the Capital Needs of Insurance Cos.
- ICA sessions on insurer solvency

Emerging conclusions:

- Analysing the balance sheet is not enough
- Strength of technical provisions needs to be considered
- Investment strategy is of key importance
- A stochastic modelling approach is desirable
- New business should be modelled (volume and profitability)
- For solvency control only 2 years’ new business may be needed
- Modelling future cash-flows offers sufficient flexibility
- For management purposes there should be dynamic responses
Solvency Studies in the 1990s

**Practical Risk Theory for Actuaries**

- update of *Risk Theory* by R Beard, T Pentikäinen and E Pesonen
- incorporated more material on simulation approaches
- cash-flow modelling
- investment and inflation models
- solvency control aspects
- published early 1994
Solvency Studies in the 1990s

Greek or Babylonian actuaries?
- article published in The Actuary, May 1996
- Practical Risk Theory criticised by some for lack of rigour
- simulation not regarded as proper mathematics
- problems with classical approach:
  - restrictive assumptions to make mathematics tractable
  - divergence from real world
  - artificial problem settings
- cash-flow modelling offers scope for taking into account:
  - inflation and investment volatility (and correlations)
  - fluctuations and cycles in claims experience
  - reserving uncertainties
Greek or Babylonian?

- Greeks proved Pythagoras theorem by Euclidean geometry
- Babylonians found the same result but from observation
Solvency Studies in the 1990s

Further progress

- computer capacity limited scope for full internal models
- concerns about number of assumptions and realism
- DFA received a high profile in the Casualty Actuarial Soc.
- some consulting firms began to develop models
- awareness of the need to hold appropriate capital for risks
- regulators becoming interested in risk-based approach
- a good internal model is a sign of sound risk management
Canada

- Bill C-28 introduced into Parliament in June 1991
- required Appointed Actuary for both life and non-life cos.
- must report on future financial condition of company
- became known as Dynamic Solvency Testing (DST)
- ...and then as Dynamic Capital Adequacy Testing (DCAT)
- Standard of Practice on DCAT (effective 1 January 1999)
  - standard covers life as well as non-life
  - scenario testing rather than stochastic simulation
- Minimum Capital Test from 2003
- OSFI audits DCAT models used by companies
Developments around the world

USA

- CAS call paper program – focus at meetings from 1990s
- e.g. papers by Feldblum, D’Arcy, etc
- DFA added to CAS exam syllabus
- DFA Handbook produced by CAS in 1995
  - [www.casact.org/pubs/forum/96wforum/96wf001.pdf](http://www.casact.org/pubs/forum/96wforum/96wf001.pdf)
- public access DFA model (1997-98)
- tool for actuarial advice to management
- ...rather than being seen as a regulatory requirement
Australia

- Financial Condition Reporting required since July 2002
- Prudential Standard GPS110 – Capital Adequacy for General Insurers – permits choice between:
  - internal Model Based Method (in-house model)
  - prescribed Method (formulaic)
- APRA Prudential Standard GPS 310 – Audit and Actuarial Reporting and Valuation
- PS305 – Financial Condition Reports for General Insurance
- no explicit requirement for internal model to be used
- trend to introduce models as part of holistic ERM
Developments around the world

UK
- GISG Solvency Working Party 1983-88
- Daykin and Hey paper to Institute, January 1990
- in 1996 GN2 made DST recommended practice for life cos
- Ryan et al paper on financial condition reporting, Mar 2001
- Individual Capital Adequacy Standards from January 2005
- Individual Capital Assessment (ICA) – self-assessed
  - 99.5% Value at Risk measure
  - one year of additional underwriting
  - diversification benefits
- FSA approves ICA but does not endorse model as such
- growth in use of internal models
Developments around the world

International Association of Insurance Supervisors

- Guidance Paper on the Use of Internal Models by Insurers – July 2007 – sets out some key principles about models:
  - should be a key strategic and operational management tool
  - should confirm ability to meet liabilities with high confidence level
  - should be appropriate to nature, scale and complexity of company
  - should be subject to regular feedback monitoring and review
  - should be carefully calibrated
  - should be embedded into risk strategy of insurer
  - should be approved by regulator before being used for solvency
  - information should be supplied for reporting and public disclosure
Definitions of internal model

- International Actuarial Association (IAA):
- An internal model is a mathematical model of an insurer’s operations to analyse its overall risk position, to quantify risks and to determine the capital needed to meet those risks.
Evolution towards Solvency II

Evolution of internal models towards Solvency II

Collective theory of risk

Cash-flow modelling using simulation

Stochastic internal models

Solvency I

Balance sheet approaches to solvency

Dynamic solvency testing

Financial condition reporting

Solvency II Internal models

Comprehensive ERM models

ERM process
Developments around the world

European Union – Solvency II

- under development from around 2000
- companies should have an approved capital model
- 99.5% one year Value at Risk measure
- single additional year of future underwriting
- internal model seen as essential part of risk management
- ...not assigned to actuarial function
- ...but actuary is expected to contribute to it
- actuarial function supported by technical standards
Definitions of internal model

- Solvency II:
- An internal model is a set of processes and procedures that occur within an insurance company. It includes components such as an actuarial model and scenario generators. It cannot be bought ‘off the shelf’ and must be created within the company. It is only when the mathematical part is integrated into the thinking of management and used in running the business that it can be considered an internal model for Solvency II purposes.
Developments around the world

European Union – Solvency II

- Article 43(5)

  For insurance and reinsurance undertakings using a partial or full internal model approved in accordance with Articles 110 and 111 the risk management function shall cover the following additional tasks:

  (a) to design and implement the internal model;

  (b) to test and validate the internal model;

  (c) to document the internal model and any subsequent changes made to it;

  (d) to inform the administrative or management body about the performance of the internal model, suggesting areas needing improvement, and up-dating that body on the status of efforts to improve previously identified weaknesses;

  (e) to analyse the performance of the internal model and to produce summary reports thereof.
Developments around the world

European Union – Solvency II

- Article 47(1)

  Insurance and reinsurance undertakings shall provide for an effective actuarial function to undertake the following:
  a) to coordinate the calculation of technical provisions

  ......

  i) to contribute to the effective implementation of the risk management system referred to in Article 43, in particular with respect to the risk modelling underlying the calculation of the capital requirements...
Developments around the world

**European Union – Solvency II**

- Standards that an internal model must meet (Arts 118-124)
  - use test
  - statistical quality standards
  - calibration standards
  - validation standards
  - adequate system for identifying, measuring, monitoring and reporting risk

- Conditions that need to be satisfied
  - good understanding of the business
  - commitment of senior management
  - knowledge and expertise to create and maintain the model
  - good, deep and rich data sets
Developments around the world

European Union – Solvency II

- due for implementation in 2012
- Groupe Consultatif working parties
- Task Force on Actuarial Standards
- challenge for actuaries to establish role as experts in internal models and, more widely in risk management
- IAIS may follow lead of EU with internal model proposals
Developments around the world

European Union – Solvency II

- a challenge and an opportunity for the actuarial profession to embed itself in the risk management of the insurance industry across the EU
- law-makers and regulators have decided that the time is right to place heavy reliance on internal models
- internal models are not just a mathematical construct
- ...but the contribution of actuaries is essential
- is the actuarial profession ready to respond?
The evolution of internal models in non-life insurance

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