The IASB Insurance Project for life insurance contracts: impact on reserving methods and solvency requirements

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Motivation

- Financial stability of insurance industry affected by increasingly difficult economic climate:
  - Equity market crashes in 2001 and 2002
  - Steady fall in bond yields
  - Increased longevity
- Implication: increased focus of regulators on
  - Accounting rules
    - Comprehensive financial reporting framework
    - Standardization of approaches (where sensible)
    - Improved transparency and comparability of accounting information
  ➔ **IASB Insurance project**: IASB & FASB promote a Fair Value based accounting framework
    - Fair Value: amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm’s length transaction
- Solvency
  - Capital requirements
  - Internal models for risk assessment
  ➔ **Solvency II**
Fair value reporting system

Europe:
- IFRS 4 (March 2004), in force since January 2005
  - Increased disclosure accounting information
  - Liabilities to be recorded at FV (embedded derivatives)
- Assets: regulated under IAS 39
  - Available for sale; or Held for trading ➔ M 2 M
  - Held to maturity ➔ amortised cost if able to demonstrate intent to forego future profit opportunities

Other countries:
- UK: Twin Peaks/Individual Capital Adequacy Standards (January 2005)
- Netherlands: Dutch Solvency Review (January 2006)
- Switzerland: Swiss Solvency Test (January 2006)

Common features: full mark-to-market of assets and liabilities + risk capital assessment

Critics of the Fair Value approach
- Inconsistent with managing a long-term business such as those of insurance companies
- High level of subjectivity (measurement of insurance liabilities)
  - Difficult to provide earnings’ forecasts
  - Higher cost of capital
- Increased volatility of reported earnings
Agenda

In the light of these points, we want to analyze the evolution over time of A & L originated by a simple participating contract with minimum guarantee

Focus

- Valuation of liabilities
  - Fair Value
  - “Traditional approach” based on the mathematical reserve
- Shortfall probability at maturity
- Redefinition of the premium
- Model and parameter risk
- Capital requirements and solvency profile of the insurer
Working example

- Participating contract with minimum guarantee \((r_G)\)
- Single premium \((P_0)\); ignore lapses, mortality and death benefits or terminal bonus
- Payoff at maturity

\[
C(T) = P(T) - D(T), \quad D(T) = (P(T) - A(T))^+ 
\]

Cumulated benefit

Default option

Accumulation scheme:
\[
P(t) = P(t-1)(1 + r_p(t)), \quad P(0) = P_0 \\
r_p(t) = \max \left\{ r_G, \beta \left( \frac{A(t) - A(t-1)}{A(t-1)} \right) \right\}
\]

\(\beta = \) participation rate
\(A = \) equity portfolio backing the policy
Valuation

Fair Valuation: 1st order basis

- **Contract fair value** (contingent claim pricing theory)

\[
V_C(t) = E^* \left[ e^{-r(T-t)} \left( P(T) - D(T) \right) \right]_{F_{tt}} = V_P(t) - V_D(t)
\]

- Standard Black-Scholes framework (log-returns normal distributed, constant interest rates, constant volatility)

- **Benefit “price”**

\[
V_P(t) = P(t) \left[ e^{-r(1+r_G)} + \beta N(d_1) - e^{-r(\beta + r_G)} N(d_2) \right]^{T-t}
\]

\[
d_{1,2} = \frac{\ln \frac{\beta}{r_G + \beta} + \left( r \pm \frac{\sigma^2}{2} \right)}{\sigma}
\]

- **Default option price**: via Monte Carlo simulation (due to path dependency)
Market Value Margin (2nd order basis): model risk

- The insurance company uses the Black-Scholes paradigm for pricing (simple to implement)
- The market dynamic of assets though is not log-normal
- What if, for example, the “true” asset in the market is

\[ S_t = S_0 e^{L_t}, \quad L_t = a t + \gamma W_t + \sum_{k=1}^{N_t} X_k \]

\[ V_P(t) = P(t)\left[ e^{-r}(1+r_G) + \beta N(d_1) - e^{-r}(\beta + r_G)N(d_2) \right]^{T-t} \]

- Parameter adjusted to maintain expected rate of growth and total instantaneous volatility constant

Jumps size
Normal distributed
Lévy process
Brownian motion
Compound Poisson process
Scenario generation

Full geometric Brownian motion model: \( \mu = 10\%; \sigma = 15\%; \; r = 4.5\%; \; r_G = 4\%; \; \beta = 80\%; \; P_0 = 100 \)

- \( V_P(0) = 222.73 \)
- \( V_D(0) = 122.73 \)
- \( V_C(0) = V_P(0) - V_D(0) = 100 = P_0 \)

\( \Rightarrow \) no arbitrage

\[ \Pi(P(T) > A(T)) \]
- GBM model: 74.42%
- Mixed model: 81.71%

Based on 100,000 scenarios

Hedging likely to fail
Solvency loading: default option premium

- Probability of default at maturity unacceptably high
- Overall contract sold at fair value
- Benefit sold too cheaply
- Default option premium!
- Solvency loading required to clear arbitrage

\[ P_0 = V_P(0) - V_D(0) \Rightarrow V_P(0) = P_0 + V_D(0) = P_0' \]

Fair value condition for the contract

Fair value condition for the benefit

“Protection” against default

Benefit related premium
Adjusted scenario

Full geometric Brownian motion model: \( \mu = 10\%; \sigma = 15\%; r = 4.5\%; r_G = 4\%; \beta = 80\%; P_0 = 100 \)

\begin{align*}
\Pi(P(T) > A_{\text{tot}}(T)) \\
\text{GBM – model} &= 6.97\% \\
\text{Mixed model} &= 12.74\% \\
\text{based on 100,000 scenarios}
\end{align*}

Any hedging strategy we can think of, has a higher chance of success

Shortfall probability
Shortfall probability

Shortfall distribution

**GBM model**
- No solvency loading
- With solvency loading

**Mixed model**

Significant reduction in the right tail of the distribution
Parameter risk

The higher the expected return on asset, the lower the probability of default (assets grow more than liabilities)

The higher the volatility, the higher the shortfall probability (assets effect only)
Alternative reporting system: mathematical reserve

- Starting point: the contract is issued at a “fair premium”, i.e. there is a solvency loading equal to $V_D(0)$, which is invested in the equity fund.
- Reserve value (equivalence principle)

\[
V_R(t) = P_R(T) e^{-r(T-t)}
\]

Discount rate = risk free rate of interest

Best estimate of the benefit at maturity

- The “fictitious account” $P_R(T)$?
Mathematical reserves

- 6 possible alternatives for the projection method of expected liabilities
  - Static method
  - Dynamic method (4 alternative schemes)
  - Retrospective method

- Comparison with FV technique to assess
  - Adequacy in terms of covering of the liability
  - Cost of implementation
  - Volatility of the balance sheet
  - Cost of capital
  - Solvency profile
**$P_R(T)$**

- **Static:** $P_R(T) = P_0 \left(1 + r_R\right)^T; r_R = 8.5\%$

- **Dynamic:** $P_R(T) = P\left(t_k\right)\left(1 + r_R\left(t_k\right)\right)^{T-t_k}; k = n, 2n, ..., \left\lceil \frac{T}{n} \right\rceil; n = 1, 3, 4, 5$

1. $r_R\left(t_k\right) = \max \left\{ r_R, \beta \bar{\mu}_n\left(t_k\right) \right\}$

2. $r_R\left(t_k\right) = \max \left\{ r_G, \beta \bar{\mu}_n\left(t_k\right) \right\}$

\[
\bar{\mu}_n\left(t_k\right) = \frac{1}{n} \sum_{k=1}^{n} \frac{A_{tot}\left(t_k\right) - A_{tot}\left(t_{k-1}\right)}{A_{tot}\left(t_{k-1}\right)}; \beta = 80\%; r_R = 8.5\%; r_G = 4\%$

3. $r_R\left(t_k\right) = \max \left\{ r_G, \bar{\mu}_n^{(P)}\left(t_k\right) \right\}$

4. $r_R\left(t_k\right) = r_R + \alpha \left( \bar{\mu}_n\left(t_k\right) - \mu \right)$

\[
\bar{\mu}_n^{(P)}\left(t_k\right) = \frac{1}{n} \sum_{k=1}^{n} \frac{P\left(t_k\right) - P\left(t_{k-1}\right)}{P\left(t_{k-1}\right)}
\]

\[
\mu = 10\%
\]

\[
\alpha = \begin{cases}
\beta & \text{if } s_n(t_k) > 0 \\
b < \beta & \text{if } s_n(t_k) < 0
\end{cases}
\]
Scenario generation: static case

- The **static reserves** are always below the fair value.
- At maturity the reserves are clearly insufficient to cover the liability.

**The retrospective reserve** is, as expected, always below the fair value of the liability; however, at maturity it converges to the benefit due.
Scenario generation: dynamic case

- The evolution of reserves is very unstable and volatile.
- As $n$ increases, the smoothing effect becomes stronger and the peaks reduce in terms of frequency and magnitude.
Scenario generation: dynamic case
Adequate reserves? \( \Pi(V_R(t) < V_P(t)) \)

At maturity

**Static method:**
\( \Pi(V_R(T) < P(T)) = 92\% \)

**Dynamic method:**
\( V_R(T) = P(T) \)

During the lifetime of the contract

The dynamic reserves are consistently above the Fair Value \( \rightarrow \) more expensive to implement.
An important aspect of Solvency II project: Target capital

- The target capital is the amount needed to ensure that the probability of ruin of the insurance company, within a given period, is low.
- Likely recommendations:
  - 0.5% ruin probability
  - 1 year time horizon
- We consider the Risk Bearing Capital (SST)

\[
\text{Market value of assets} - \text{Best estimate of liability} = \text{Best estimate of liability}
\]

- The best estimate of liabilities is given by both the FV approach and the mathematical reserves approach.
The Risk Bearing Capital: \( \Pi(RBC > 0) \)

The fair value approach generates the lowest shortfall probability and the more stable RBC.
The mean of RBC is always positive by using the fair value
Irregular pattern of the annual variance of the dynamic reserves
Moments of Risk Bearing Capital for static method of calculating reserves

This result is affected by the low level of static reserves (which are unable to cover the actual amount).

This result is due to the fact that the reserves are completely uncorrelated with the trend of assets.
Conclusions

- The example shows
  - The market-based valuation approach provides awareness of default risk and suggests possible rule for the redefinition of the premia charged
  - Reserving systems need to be consistent with, and appropriate for, the nature of the liabilities

- More specific guidelines needed for fair valuation of insurance liabilities
  - Target accounting model (impact on MVM, shortfall probability, solvency capital requirements) ... → work in progress

- The fair value approach can guarantee
  - Effective and cost efficient ALM policy
  - Stable solvency profile