Risk Management in Variable Annuities in Japan

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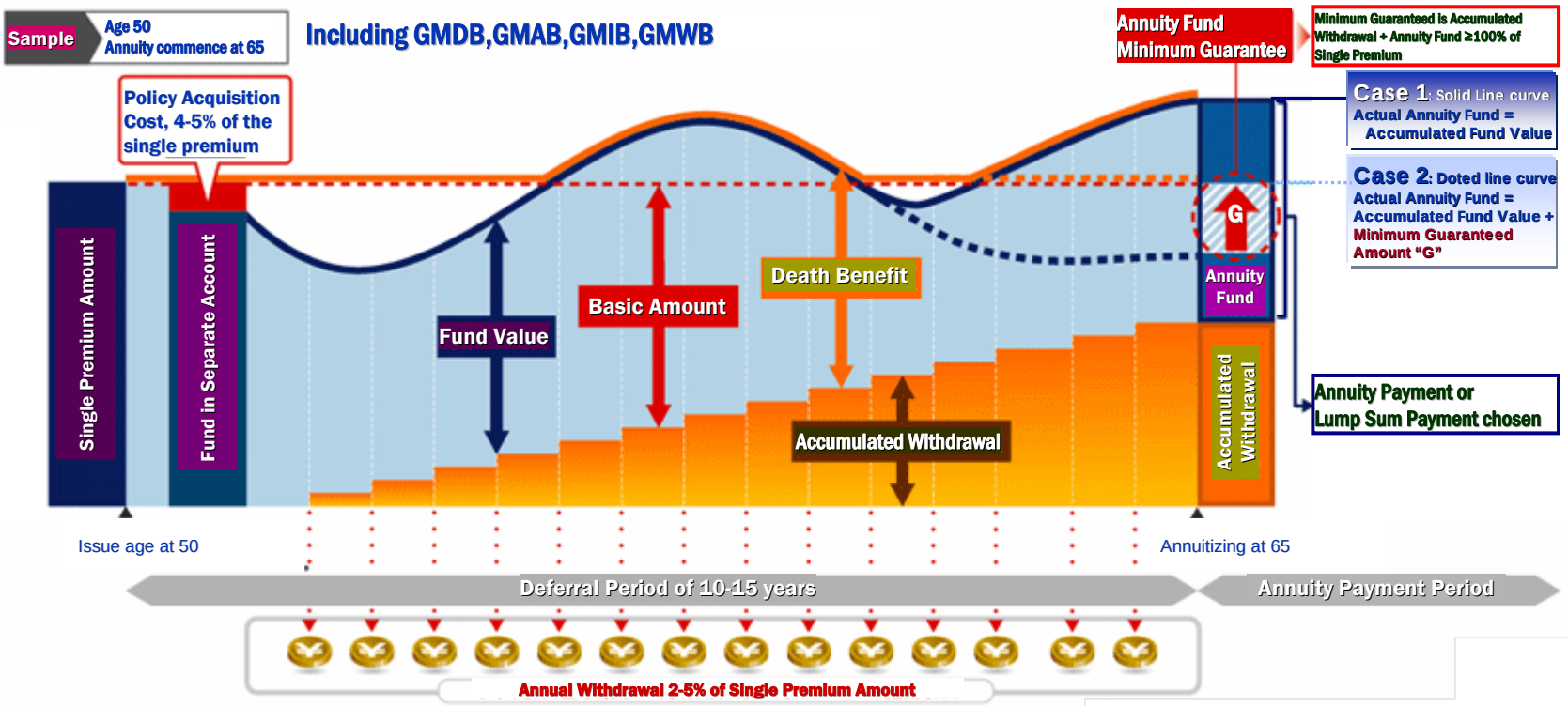
Overview

- Products and Market
- Capital Market Pricing Model
- Risk Management Issues

Variable Annuity Product Features



GMDB = Guaranteed Minimum Death Benefit = Death benefit guaranteed during the deferral period
= **Single Premium Amount – Accumulated Withdrawal**

GMAB = Guaranteed Minimum Accumulation Benefit = Lump Sum guaranteed at the Annuity Payment commencement date
= **Single Premium Amount – Accumulated Withdrawal**

GMIB = Guaranteed Minimum Income Benefit = Total Annuity Payment guaranteed
= **Single Premium Amount – Accumulated Withdrawal**

GMWB = Guaranteed Minimum Withdrawal Benefit = **Annual Withdrawal x 9-14 times (depending on deferral period)**

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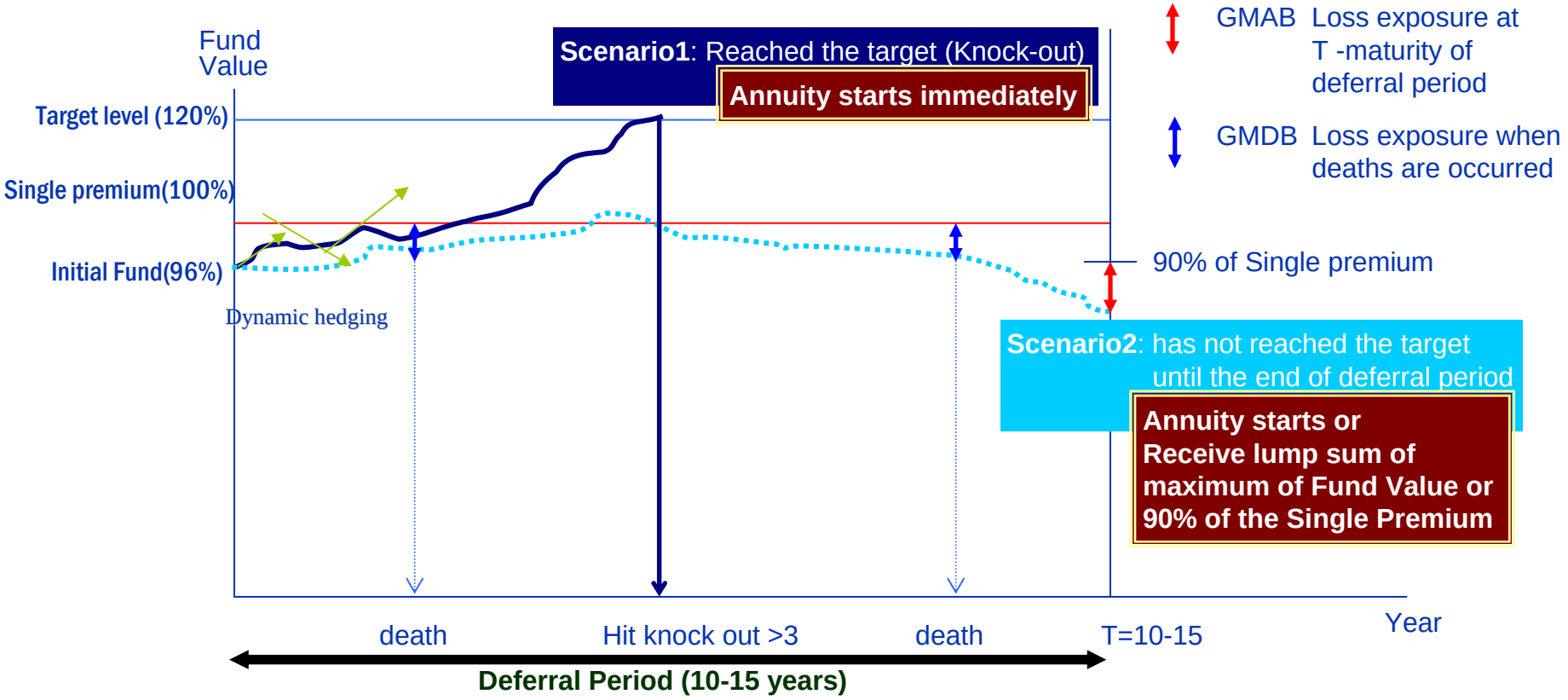
New Product Features

Products have evolved from the simple GMDB & GMAB features to include more complex options.

Example: Target Option rider



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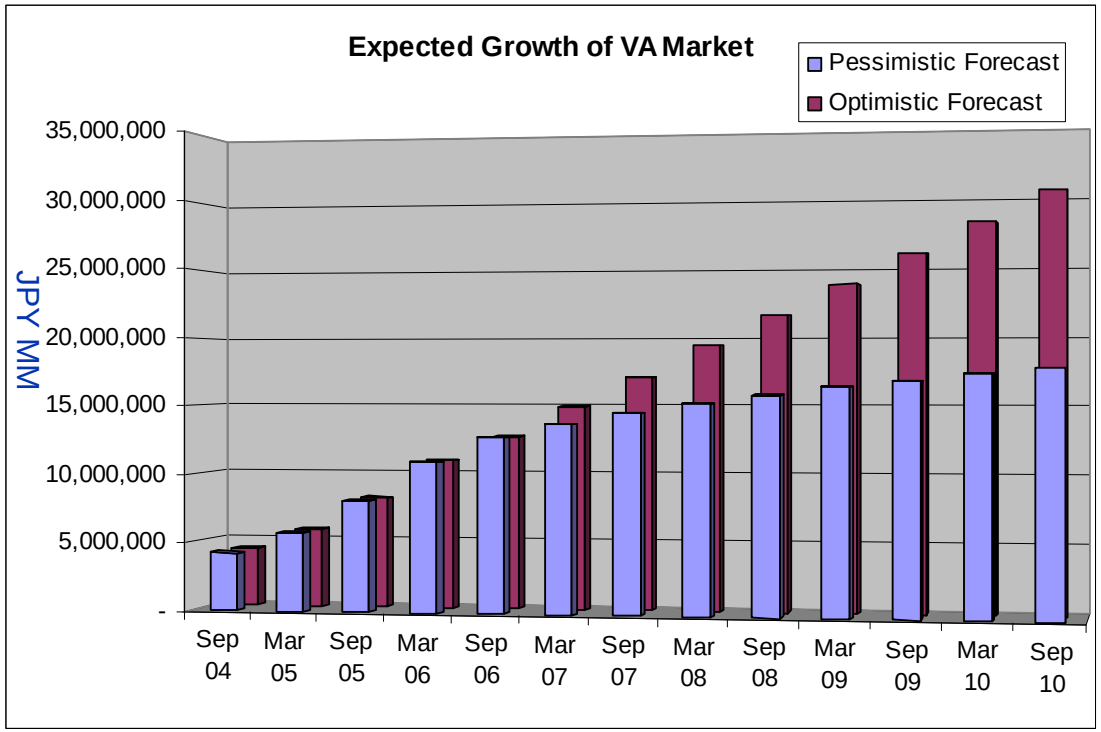
Japanese VA Market Potential

Since Oct 2002, the opening of the bank channel to Variable Annuity, the VA market has been growing at a rapid pace. By March 2007 the inforce volume reached to ¥14.5t (USD128b). This is not expected to slow, due to:

- Retirement of large numbers of baby boomers
- Full liberalization of Bancassurance or life insurance sales through bank channel
- Potential additional players in VA Market (ie, Kampo)



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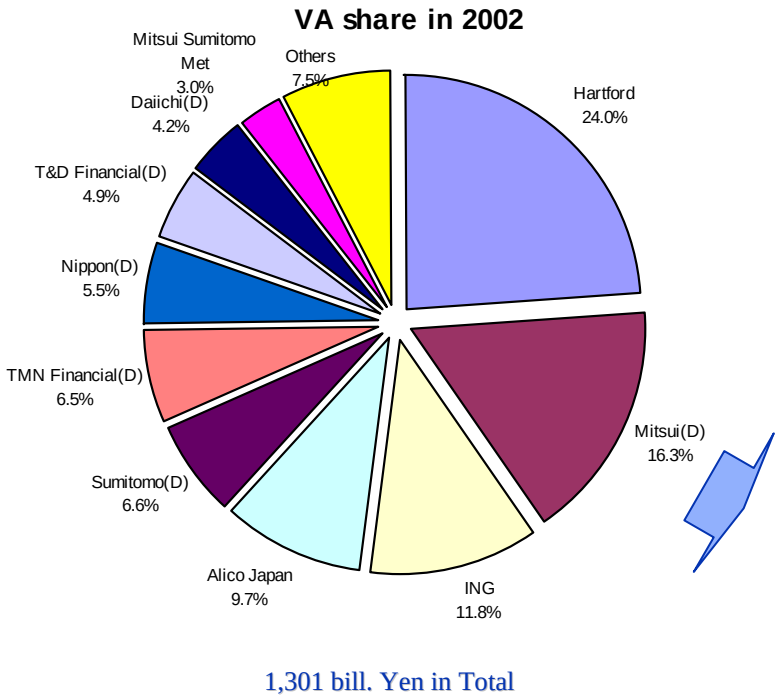
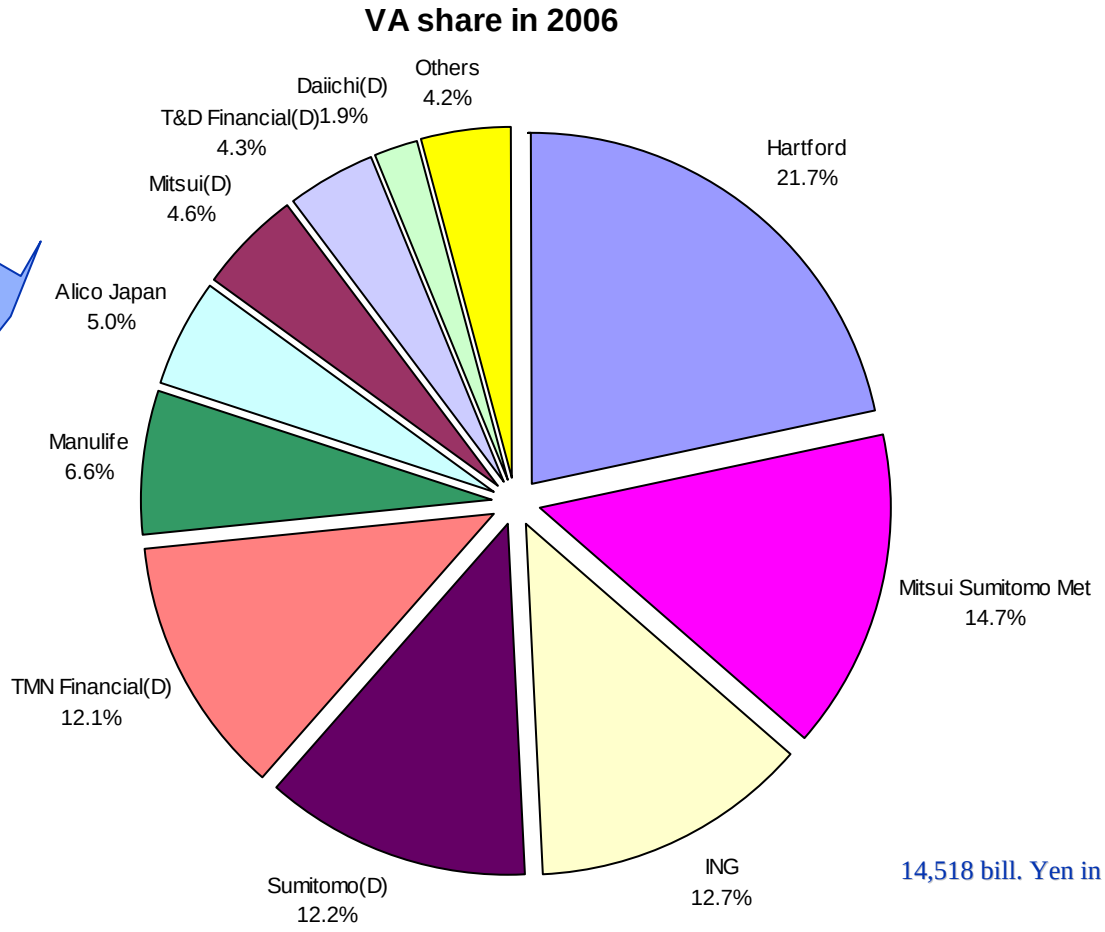
VA players in Japan



1,301 bill. Yen in Total



14,518 bill. Yen in Total

Hartford, Mitsui Sumitomo Met, and ING are top 3 players. Sumitomo, TMN (Tokyo Marine Nichido) Finance follow them in hot pursuit recently.

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Product Structure: Capital Market Model

$$\text{GMAB Loss} = E^{Q}[\exp(-\int_{0}^{T}\{r(s)+h^{1}(s)\}ds)\cdot {}_{T}P_{x}\cdot \max(1.0\text{-}NAV(T),0)]$$

Expectation on risk neutral measure

Interest rate Discount

Survival rate to laps

Survival rate to mortality

Compensation Cash Flow at T as GMAB

$$\text{GMDB Loss} = E^{Q}[\int_{0}^{T}\mu_{x+s}\exp(-\int_{0}^{s}\{r(u)+h^{1}(u)+\mu_{x+u}\}du\cdot \max(1.0\text{-}NAV(s),0)ds]$$

Instantaneous death rate at s

Compensation Cash Flow at s as GMDB

$$\text{Receive Unit} = E^{Q}[\int_{0}^{T}\exp(-\int_{0}^{s}\{r(u)+h^{1}(u)+\mu_{x+u}\}du\cdot 1\cdot ds]$$

Survival rate to laps and mortality

: Integral is for aggregation of Cash Flow at each time s.

$r(s)$: spot rate

$h^{1}(s)$: hazard rate for laps Fixed value or scenarios according with ITM/OTM of NAV

μ : power of death

$NAV(s)$: Net Asset Value at s

$$\text{NAV}(s) = \sum_{i=1}^{4} S_{s}^{i} \qquad dS_{t}^{i} = S_{t}^{i}[(r_{t}+\lambda_{i})dt + \sum_{j=1}^{n}\sigma_{i,j}dB_{j}]$$

Japanese Stock, Japanese Bond, Foreign Stock, Foreign Bond considered their correlation.

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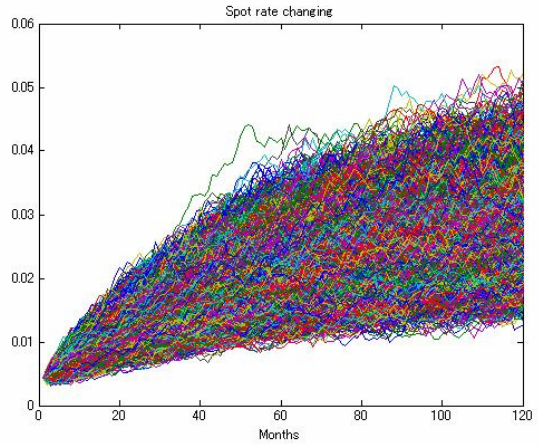
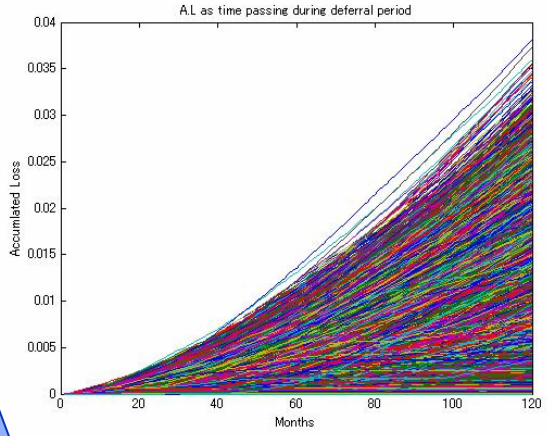
Premium setting through Monte-Carlo simulations

Stochastic modelling is employer to derive the hedging cost and manage risk exposure.



Spot rate dynamics by CIR model

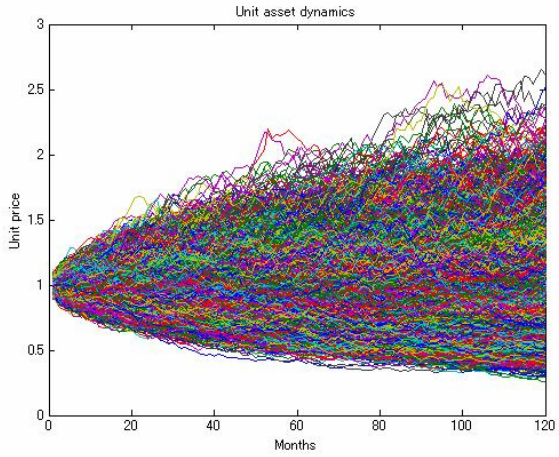


Accumulated Loss for GMDB

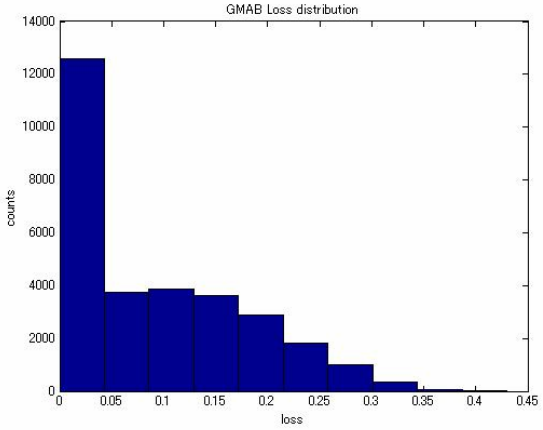
Premium calculation

Expected return	-1.23%	0.02%	1.26%	2.50%	3.74%
Premium for GMDB	23.6	16.4	10.5	6.0	3.5
Premium for GMAB	135.6	86.6	49.4	23.0	9.8
Annual Premium	159.2	103.0	59.9	29.0	13.3
CTE50	288.8	200.9	119.0	57.7	26.5

Unit: bp

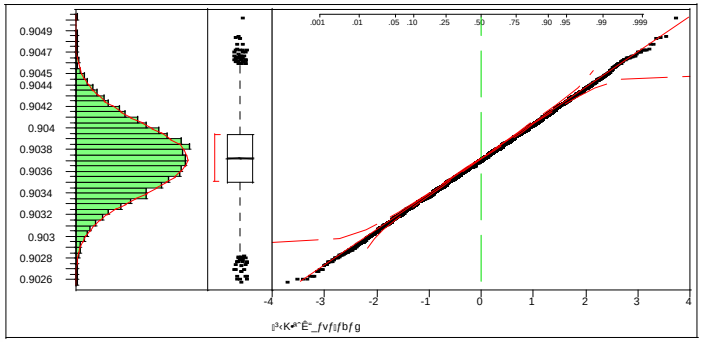


Asset Value Dynamics



Histogram for GMAB Loss

Risk control



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VA Risk Management Complexities

- Multiple and complex risks exist and are compounded.

- Typical Actuarial methods cannot control GMxB risks because,
  1.Market fluctuation risk is not stabilized by following “Big numbers’ rule” even if a lot of contracts will be gathered (risks are not independent).
  2.Actuarial mathematics based on a deterministic or a static approach to risks are hardly applied to uncertain feature in time series.
  3.The volatility level is relatively higher than traditional insurance risks (market risk).

- Furthermore, hedging instruments such as capital markets derivatives cannot be applied as there is no consideration of insurance risk nor customers’ behaviours.
  (Instruments in capital market are based on ideals such as a complete market, no arbitrage, abundant capability, but insurance risks are entirely different from this basis)

- The interface community between Actuaries and “Quants” has not been developed before appearances of new product like VA which is in the middle of these 2 markets

Risks contained in VA

- Market Risks
  - *Stock volatility
  - *Bond volatility
  - *Interest rate fluctuation
  - *Credit risks (MBS, corporate bond, etc)
- Insurance Risks
  - *Mortality
  - *Longevity
- Integrated Risks (Customers' behavior risk)
  - *Surrender risk (Lapse)
  - *Switching risk

Large impact

Small impact

Middle impact

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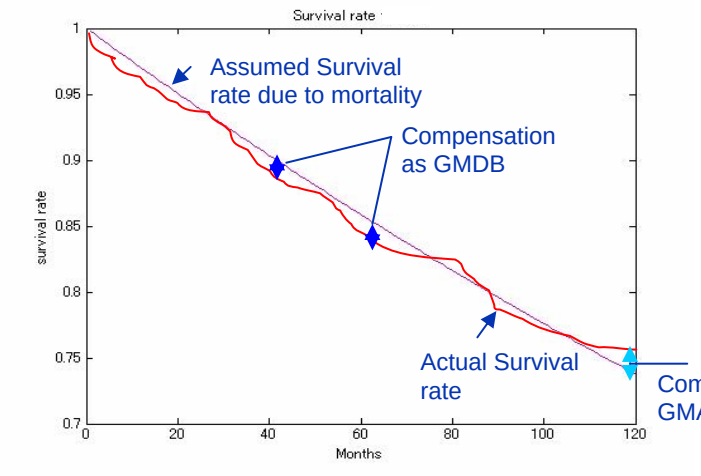
How do these risks manifest ?

- **Market risk**

  ⇒ **Asset Value may not reach guaranteed level (See p2)**

- **Insurance risk & Surrender risk**

  Risk is the difference between assumed rate and actual rate.



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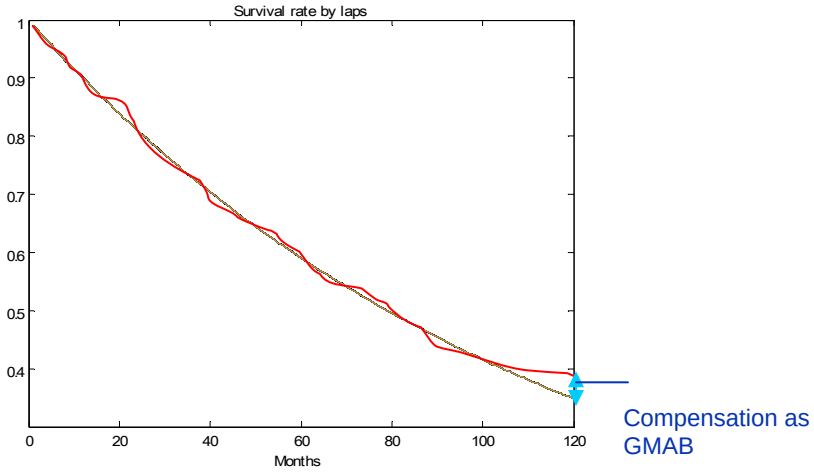

Mortality

The mortality difference in deferral period is compensated as GMDB and at maturity is paid as GMAB. The volatility for it can be minimized by grace of “Big numbers’ rule”.

Surrender (Lapse)

The GMAB benefit at maturity is sensitive to differences in surrender behaviour, which is believed to have strong correlation to change of asset value.

The industry doesn’t have sufficient data to analyze yet.

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Difficulties for managing Surrender risk

- **What makes it hard to make a model for Japanese customers' Surrender activity.**

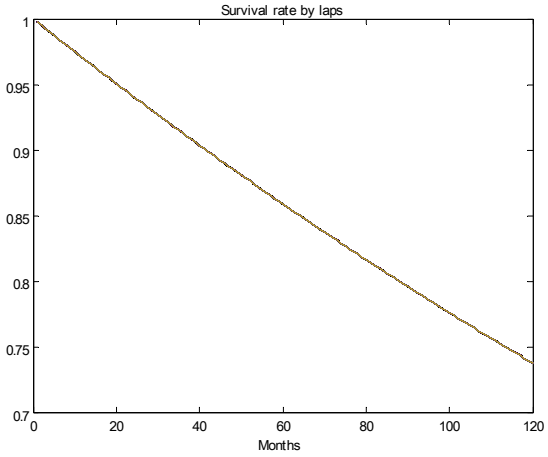
  1. Insufficient data has accumulated in Japan – Only 5 years' experience (Investment market has been flat for last 5 years)
  2. Japanese consumer behavior with financial products is different from that of US or Europe. Hence, transferring the model from there may not be appropriate.
  3. The typical VA customer is from the 'silver generation' which is different from the customer buying investment products.
  4. The existence of surrender charge (penalty) makes sensitivity to potential factors, interest rate, stock price ,etc. lower than would otherwise be the case.
  5. VA is not a pure capital market product with no arbitrage, complete market, etc therefore regarding it simply as a derivative is inadequate.

- **However, ignoring this risk is dangerous as:**

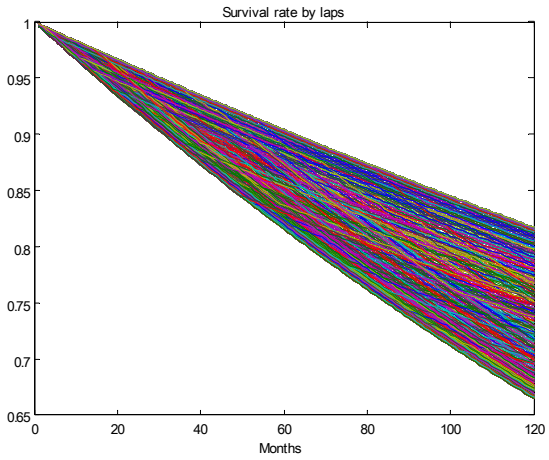
  1. Large deviations from the assumed survival rate at maturity could cause severe GMAB lossed to the insurance company.
  2. Using a fixed surrender rate might result in "over-hedging" or "under-hedging"

Trial to manage surrender risk – Dynamic lapse approach

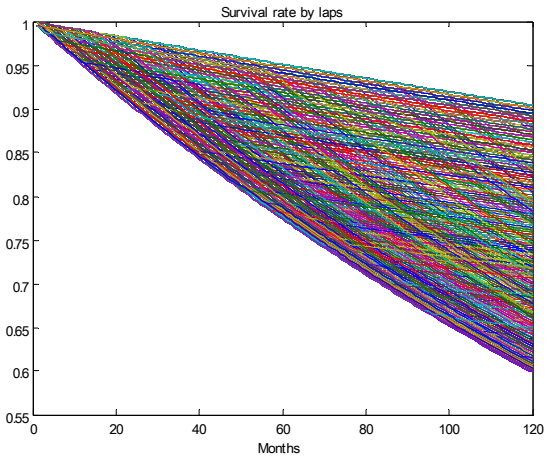
- Persistency is thought to be negatively correlated to asset values.



Fixed Laps rate – 3%



ITM 2.0% OTM 4.0%

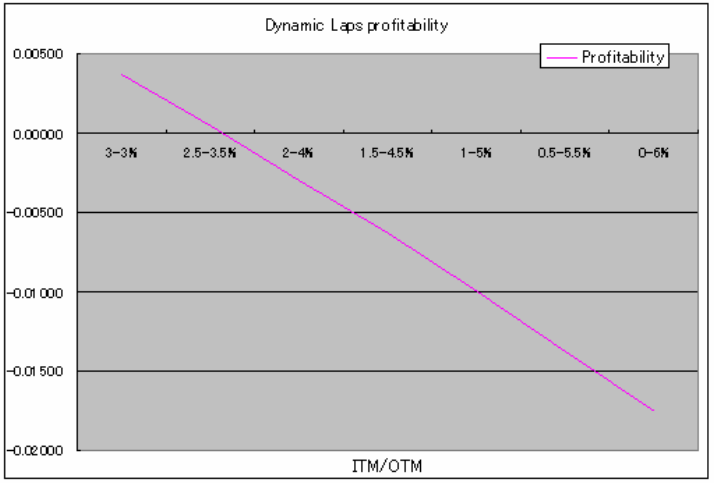


ITM 1.0% OTM 5.0%

Assumption: The contracts will lapse at higher rates when asset value is larger than initial value. (OTM)

The contracts will lapse at lower rates when asset value is smaller than initial value. (ITM)

Through the simulation, profitability change can be predicted for managing risk

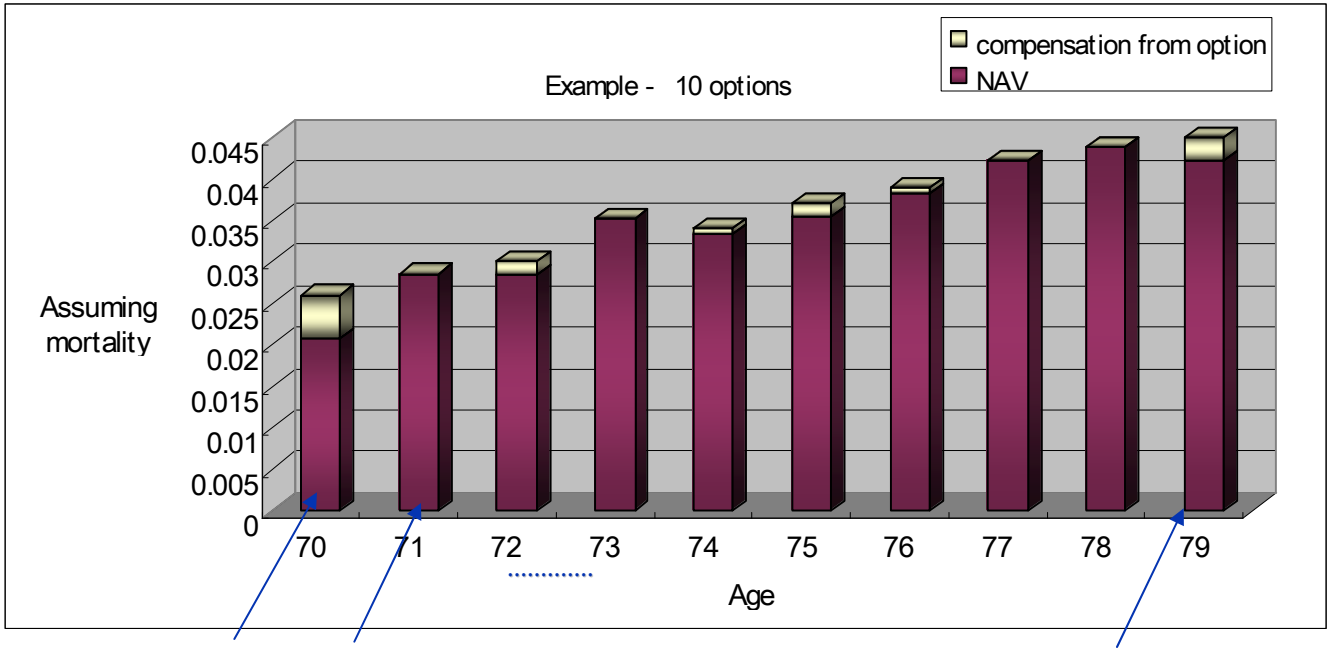


Hedging of market risk in Japan

- Market risk hedge solutions are not common because of difficulty of control, lack of providers, restricted regulation.
- Major foreign insurance companies cede out to their parent companies.
- Domestic insurance companies have retained with high reserving imposed by FSA
- Investment Banks are eager to sell their financial products but the cost level seems to be higher than expected cost level of insurance company.
- Recently, Millea holdings announced to establish VA reinsurance company with JP Morgan. This kind of movement will be followed in several years.

Market risk hedging - Static Hedging

- To prepare the basket of put options. Each option could correspond to assumed cash flow in liability applying fixed mortality table and fixed lapse rate. If these assumptions are as predicted, a complete market hedge could be attained. However the cost to rearrange will be expensive if experience deviates from the assumptions.



10 options corresponding to each year's cash flow which should be same as mortality rate

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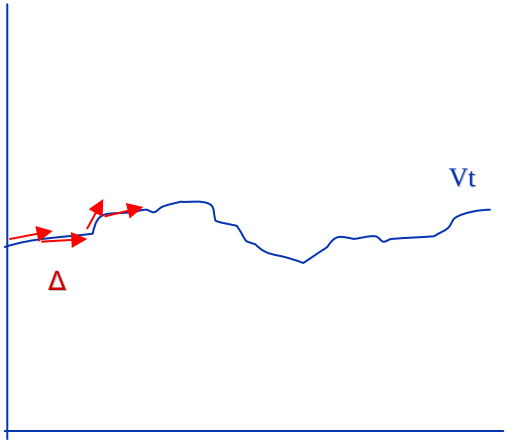
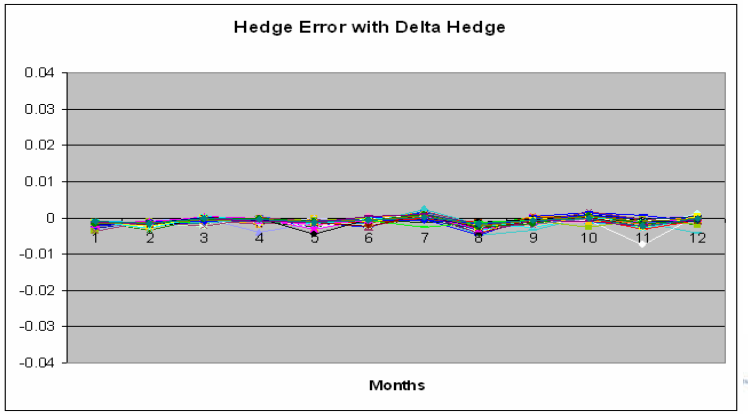
Market risk hedging - Dynamic Hedging

- To have an opposite position to immunize a change of present value of GMxB. Rebalancing is performed periodically. The frequency of rebalancing and depth of immunization are determined considering the trade-off relation of accuracy and cost.



"Greeks"

Applying "Greeks" for market risk hedge



$\Delta = \frac{\partial Vt}{\partial At}$: first derivative by underlying asset

$\Gamma = \frac{\partial^2 Vt}{\partial At^2}$: second derivative by underlying asset

$\upsilon = \frac{\partial Vt}{\partial \sigma_t}$: first derivative by volatility

$\rho = \frac{\partial Vt}{\partial rt}$: first derivative by interest rate

Potential Future Developments

- Trial approach for modeling customers' behaviors (Lapse)

To adapt survival analysis to each customer segment.

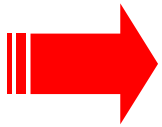
1. **When customers' behavior depends only on passed time "t"**

=>Kaplan-Meier estimation

2. **When customers' behavior depends on several dynamic factors.**

=>Proportional hazard rate model

$$L = \prod_{i=1}^{T} \frac{\exp(\beta x_i)}{\sum_{j=1}^{N} \exp(\beta x_j)}$$



$$P_t^s = \exp(-\int_0^t h_0(t)\exp(\beta x_u)du)$$

Parameters are calibrated through maximizing log likelihood or AIC

Continuous survival rate on lapse

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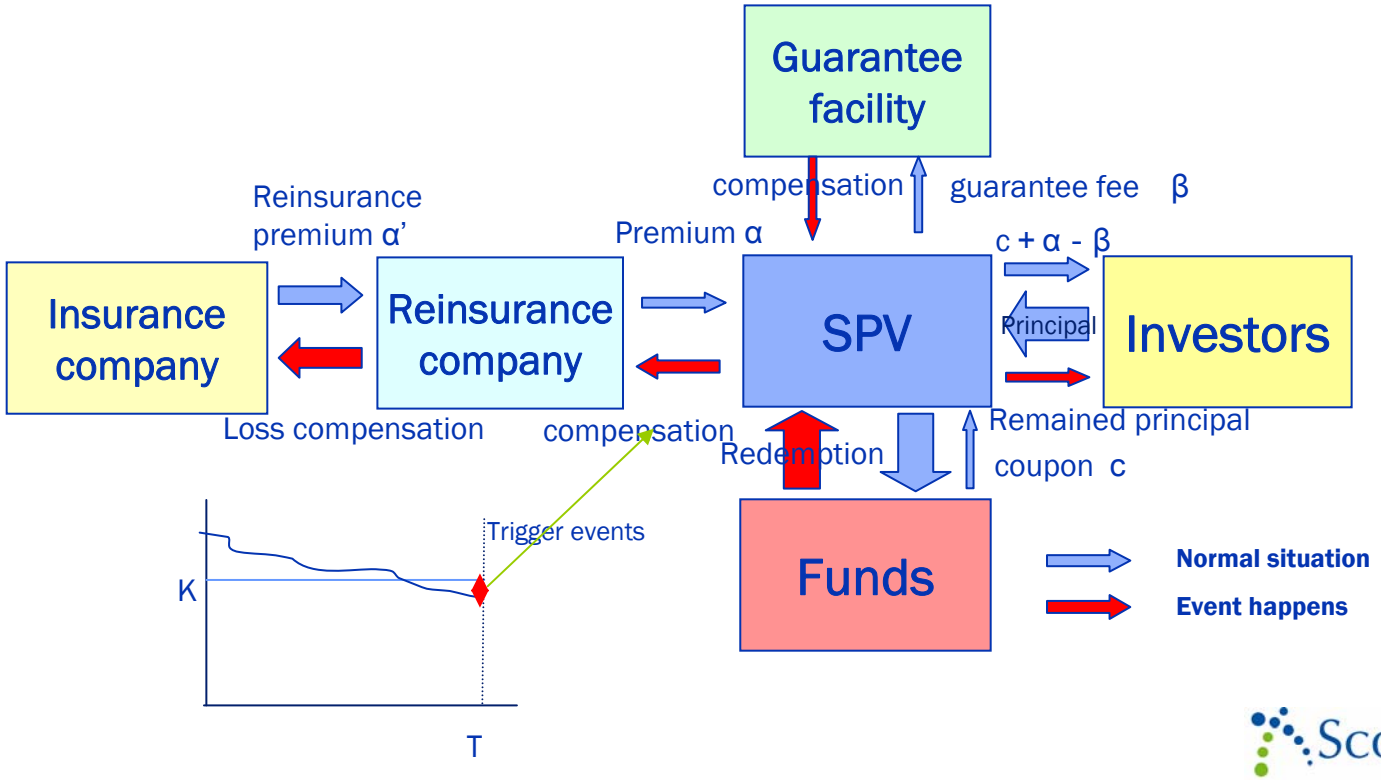
Potential Future Developments

- Feasibility of securitization as a funding vehicle

To transfer market risk and combined risk (surrender risk) to the capital market is a potential key response to the change of insurance industry in Japan, considering its huge capacity and efficiency of capital market.



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The End

Thanks for your attention

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About the Authors :

Andrew Linfoot
Andrew Linfoot is the Regional Director, Asia Pacific of Scottish Re, and the Principal Officer of the Singapore Branch. Having worked with other life reinsurers in Asia since 1996, Andrew joined Scottish Re in 2005 to establish its operations in the region. Prior to his life reinsurance career, Andrew spent several years in pensions consulting with a large life office in Australia.

A Fellow of the Institute of Actuaries of Australia since 1995, Andrew is actively involved in industry activities, and is the longest serving President of the Singapore Actuarial Society. Andrew currently sits on the Executive Board of the East Asian Actuarial Congress and the Board of Examiners of the Singapore College of Insurers.

Andrew is a frequent speaker at conferences in the region on topics of capital and risk management, and is a keen reader, golfer and musician. Andrew has a Bachelor of Economics, Masters of Business Administration, and three children (not in order of importance).

Kunihiko IInuma
Kunihiko joined Scottish Re as senior actuarial consultant in October 2006 with bringing variety of local actuarial knowledge extended to the financial engineering and responsible for all actuarial and planning task for Japan Representative Office. He is the fellow of IAJ (Institute of Actuary of Japan) and an examination committee member since 2002 and also completing his PhD of Applied Statistics. Prior to Scottish Re Kunihiko was the ALM department head for MassMutual Japan. He also have a non-life experience and served in Ace Insurance and Zurich Insurance Company. He has a BS in Mathematics from Keio university and MBA in Financial Engineering from Hitotsubashi university.