



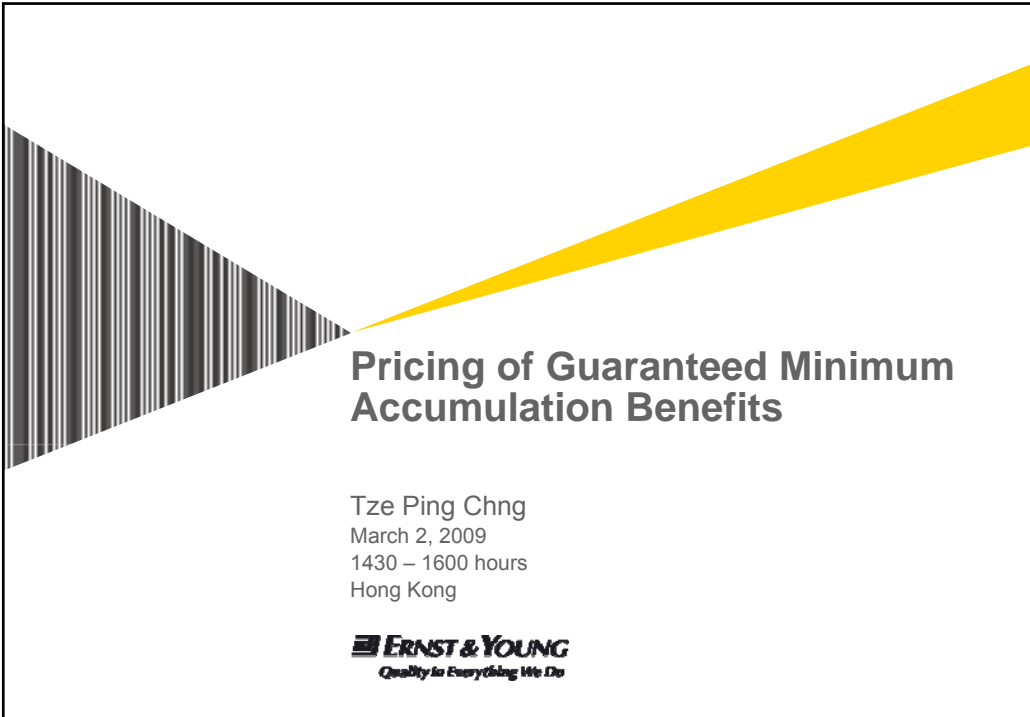
SOCIETY OF ACTUARIES

**Equity-Based Insurance Guarantees Conference  
March 2-3, 2009**

**Hong Kong**

**Pricing Lifetime Income Benefits**

[Tze Ping Chng, David Pan](#)



# Pricing of Guaranteed Minimum Accumulation Benefits

Tze Ping Chng  
March 2, 2009  
1430 – 1600 hours  
Hong Kong

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## Agenda

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1. Pricing approach – overview
2. Guaranteed Minimum Accumulation Benefit (“GMAB”) Pricing considerations
  - ▶ Guarantee design
  - ▶ Base contract
  - ▶ Income and outgo
3. Assumptions
  - ▶ Actuarial
  - ▶ Capital markets
  - ▶ Corporate
4. Practical pricing issues
5. Issues emerging as a result of market turmoil

## Pricing Approach – Overview

- ▶ Two Step Approach
  - ▶ First, price the guarantees on a Risk Neutral (“RN”) basis
    - ▶ Represents the cost of providing the guarantee under the assumptions utilized
    - ▶ The minimum charge for providing the guarantee
    - ▶ Some companies subsidize the cost of the guarantee with fees from the base contract
  - ▶ Then, price the whole contract on a Real World (“RW”) basis
    - ▶ Risk profile
    - ▶ Financial impact under different accounting regimes
    - ▶ Profit measures – Internal Rate of Return, Profit Margin, Embedded Value, Return of Equity, etc.
- ▶ Perform sensitivity runs
- ▶ An iterative process

## GMAB Design Considerations

- ▶ In today’s low interest rate, high volatility environment, the cost of providing the guarantees are very costly
- ▶ Guarantee structure
  - ▶ Level of guarantee – e.g. 80%, 100%, or 120%
  - ▶ Rollup
  - ▶ Ratchet
  - ▶ Combo benefit
- ▶ Illustrative RN cost for a 10-year GMAB, with a 75% equity exposure:

Guarantee Level	RN Cost (bps)
80%	97
100%	177
120%	270

## GMAB Design Considerations (Cont'd)

- ▶ Illustrative RN cost for a 10-year GMAB, with a 75% domestic and foreign equity exposure:

Guarantee Level	RN Cost (bps)
100%	177
3% Annual Rollup	343
Annual Ratchet	299
Combo (3%, Annual Ratchet)	412

- ▶ So, what can we do about it?

## GMAB Design Considerations (Cont'd)

- ▶ Areas for considerations
  - ▶ Revise the guarantee structure
  - ▶ Reduce equity exposure
  - ▶ Use an asset allocation model to control overall risk profile and volatility
  - ▶ Utilize a longer waiting period
  - ▶ Introduce regular premium payment product design
  - ▶ Extend the waiting period upon a ratchet / step-up
  - ▶ Impose caps and limits
  - ▶ Modify the cost structure

## GMAB Design Considerations (Cont'd)

- ▶ Illustrative impact of reducing equity exposure from 75% to either 50% or 25%:

Guarantee Level	RN Cost (bps)		
	75% Equity	50% Equity	25% Equity
100%	177	114	63
3% Annual Rollup	343	274	214
Annual Ratchet	299	189	97
Combo (3%, Annual Ratchet)	412	308	224

## GMAB Design Considerations (Cont'd)

- ▶ Illustrative impact of different waiting period:

Waiting Period	RN Cost (bps)
10-Year	177
5-Year	373

- ▶ Longer waiting period typically reduces the guarantee cost
  - ▶ Impact of discounting
  - ▶ More charges collected
  - ▶ Lower persistency
  - ▶ More time for account value growth, but beware when the total fee drag exceeds the swap rate

## GMAB Design Considerations (Cont'd)

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- ▶ Guarantee charge cost structure
  - ▶ Account value-based
  - ▶ Guarantee value-based
  - ▶ Greater of account value and guarantee value
- ▶ Possibility for the VA writer to increase guarantee charge?
  - ▶ Practice varies by country
  - ▶ Even if adequately priced at issue, re-pricing may be required as capital markets evolve
  - ▶ Utilize the technique used by reinsurers

## Base Contract Considerations

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- ▶ Currency denomination
- ▶ Funds option
  - ▶ Basis risk and FX considerations
  - ▶ Investment management fee and revenue sharing
- ▶ Mortality and Expense (“M&E”) charge
  - ▶ Subsidization of the guarantee charge
- ▶ Commission structure vs. surrender charge
  - ▶ Considerations of distribution channel
  - ▶ Chargeback and trail commission
- ▶ Maintenance expense vs. policy fee
- ▶ Persistency bonus or loyalty bonus
- ▶ Dividends Received Deduction (“DRD”)

## Income and Outgo

- ▶ Illustrative income and outgo for an integrated VA contract:

Component	% of Premium
PV M&E Charge	10.35%
PV Guarantee Charge	7.35%
PV Revenue Sharing	2.73%
PV Surrender Charge	2.19%
PV Policy Fee	0.46%
<b>Total PV Revenue</b>	<b>23.08%</b>
PV Guarantee Claims	10.82%
PV Commission Expense	6.28%
PV Maintenance Expense	2.23%
<b>Total PV Expense</b>	<b>19.34%</b>
<b>Total PV Profit</b>	<b>3.74%</b>

## Considerations when Setting Assumptions

- ▶ Policyholder behavior – base and dynamic
  - ▶ Lapses
  - ▶ Free partial withdrawal
  - ▶ Utilization and annuitization
  - ▶ Mortality and longevity
- ▶ Capital markets
  - ▶ Economic scenario generator model
  - ▶ Swap curve
  - ▶ Volatility
  - ▶ Correlation
  - ▶ Foreign currency

## Considerations when Setting Assumptions (Cont'd)

- ▶ Corporate
  - ▶ Accounting Policy
    - ▶ Reserving under both Statutory and GAAP
    - ▶ Deferred acquisition cost and front-end load
  - ▶ Capital requirements
    - ▶ Principles based capital
    - ▶ Economic capital
    - ▶ Risk-based capital
  - ▶ Tax rate
  - ▶ General account portfolio
  - ▶ Inflation
- ▶ Consideration of provision for adverse deviations (“PADs”) when setting assumptions

## Practical Pricing Issues

- ▶ Double or triple nested stochastic projection required in order to model the different elements of pricing, esp. around risk management and capital calculation
  - ▶ Long run-time and not feasible under existing computing power
- ▶ If hedging, common for companies to:
  - ▶ Assume certain level of ineffectiveness
  - ▶ This is applied to both hedge costs and hedge payoff
- ▶ For capital requirements:
  - ▶ Factor based capital level
  - ▶ May vary by in-the-moneyness of the guarantee
- ▶ Nested stochastic projection may be performed on selected good, bad, and average scenarios

## Issues Emerging as a Result of Market Turmoil

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- ▶ Guarantees underpriced
  - ▶ Companies are re-pricing the guarantees
  - ▶ Some pulled products off market
- ▶ Huge capital constraints
  - ▶ Particularly for VA writers subject to principles-based capital approach
- ▶ Basis risk
  - ▶ Mix of indices chosen to represent the underlying assets do not track accurately
- ▶ Only lower order Greeks hedged
  - ▶ Higher order Greeks (e.g. Gamma) become significant in volatile markets

## Issues Emerging as a Result of Market Turmoil (Cont'd)

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- ▶ Guarantee charges not hedged
  - ▶ Falling income (as % of account value) but higher hedging costs
- ▶ Policyholder behavior
  - ▶ Hedging errors due to inaccurate assumptions about policyholder behavior
- ▶ Hedge strategies not as effective as expected
  - ▶ Market dislocations and non-parallel market shifts
  - ▶ Illiquid market and difficulties in mark-to-market
- ▶ Unaffordability of reinsurance
  - ▶ Some reinsurers have pulled back
  - ▶ Prices have increased significantly



**Thank You**

tze-ping.chng@hk.ey.com





## Equity Based Investment Guarantee Conference (Hong Kong)

### Pricing Withdrawal Benefits

David Pan  
MetLife

March 2, 2009 2:30pm – 4:00pm

### Pricing Withdrawal Benefits

- Topics
  - Customer Value Proposition
  - Actuarial Risk Exposure
  - Market Risk Exposure
  - U.S. GAAP Accounting
  - Challenges in a full pricing model

## Pricing Withdrawal Benefits

- Customer Value Proposition
  - One Product = Base Contract + Guarantee
    - Equity investment with downside protection
    - Good alternative to (near) zero-rate savings
    - Asset allocations
    - Ability to lock in upside gains (reset)
    - Flexibility in taking the withdrawals as needed, up to the contract limit
    - Longevity protection via lifetime guarantees
    - ...
    - Competitive Price

## Pricing Withdrawal Benefits

- Actuarial Risk Exposure
  - Policyholder Behavior
    - Base lapse
    - Dynamic lapse
    - Fund switching
    - Additional deposit
    - Exercise of withdrawal options (timing / amount)
  - Mortality Improvement

## Pricing Withdrawal Benefits

- Actuarial Risk Exposure
  - Policyholder Behavior
    - Base lapse:
      - Based on industry/company experience.
      - Distribution channel
      - Surrender charge schedule
      - Specific product features (ex: reset)
    - Dynamic lapse:
      - Decrease (Increase) the base lapse when the guarantee is ITM (OTM). Impact may vary by policy duration.
      - Capped/Floored
    - Calibration:
      - Difficult! (2+ parameter assumptions, 1 known actual lapse for a given duration)
      - Management consensus based on scenario analysis.

## Pricing Withdrawal Benefits

- Actuarial Risk Exposure
  - Policyholder Behavior
    - Fund Switching
      - Limit equity exposure
      - Passively managed funds
      - Pre-established asset allocations
      - Restrict fund switching by contractual design.
      - Generally not assumed in the product pricing.

## Pricing Withdrawal Benefits

- Actuarial Risk Exposure
  - Policyholder Behavior
    - Additional Deposit
      - Treated as a separate contract / tranche if the original contract is Single Premium.
      - Excluded from the guarantee.
      - Guarantee voided if the scheduled premium is not paid on time, provided the original contract calls for scheduled renewal premiums.
      - Generally not assumed in the product pricing.

## Pricing Withdrawal Benefits

- Actuarial Risk Exposure
  - Policyholder Behavior
    - Exercise of withdrawal options (timing / amount)
      - Cohort approach: different withdrawal assumptions for each cohort.
        - More work to calibrate the assumptions later on with experience.
        - Need to understand what is the rational withdrawal behavior for GMWB, or Lifetime GMWB?
      - Eliminate the risk by product design:
        - Automatic withdrawals upon some attained age or policy duration. Policyholder discretion of “start” and/or “stop” is not allowed.

## Pricing Withdrawal Benefits

- Actuarial Risk Exposure
  - Mortality Improvement
    - Significant in lifetime GMWB product
    - Small offset by GMDB
    - Dynamic mortality improvement factors.  
Improvement factors (like 2.0% per year) = management consensus.

## Pricing Withdrawal Benefits

- Market Risk Exposure
  - Equity Risk
  - FX Risk
  - Interest Rate Risk
  - Volatility Risk
  - Correlation Risk
  - Basis Risk

## Pricing Withdrawal Benefits

- Market Risk Exposure
  - Equity Risk
    - Control the risk by offering funds whose inv. strategy mimics tradable indices.
      - Japan VA: most of the funds' equity investment tracks the basket of TOPIX and MSI Kokusai index
      - Kokusai is not tradable → break it into major tradable components = S&P500, DJStoxx50 and FTSE100.
    - Limit policyholder's equity exposure via asset allocations.
  - FX Risk
    - Present if fund investment includes foreign exposure (ex: Kokusai for Japan VA).
    - Nature is similar to Equity Risk
    - FX pairs must be tradable.

## Pricing Withdrawal Benefits

- Market Risk Exposure
  - Interest Rate Risk
    - Due to path dependency, static interest rate scenario projections underestimate the value of the guarantee
    - Stochastic interest rate models:
      - Captures the volatility of the interest rate
      - Provides a consistent modeling of bond-fund returns
      - Choice of model selections:
        - Simple model: 1-factor short rate models
        - Advanced model: LIBOR model
          - In fact: 1-factor short rate model = special case of LIBOR models
        - Middle ground: 2-factor Gaussian Model.

## Pricing Withdrawal Benefits

- Market Risk Exposure
  - Interest Rate Risk
    - Calibration of pricing models / scenarios
      - Determine interest rate model parameters
        - Set of swaption quotes → Gaussian model parameters
      - Determine the downward adjustments to equity volatilities in order to re-price ATM European put options.
      - Project equity funds with mean return =  $R(s,t)$ 
        - $R(s,t)$  = short rate  $R$  for scenario  $s$  at time  $t$ .
      - Project bond fund based on changes of interest rate and bond fund duration.

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Note: Stochastic interest rate model generates “extra” volatility from interest rate projections. The resulting scenarios will overprice European equity put options if the implied equity vols are applied directly without adjustment.

## Pricing Withdrawal Benefits

- Market Risk Exposure
  - Volatility Risk
    - Limited duration → rollover, or “reinvestment”, risk for long duration guarantees like lifetime GMWB

<u>Index</u>	<u>Longest Duration Available</u>
KOSPI200 ,	~ 5 years
NIKKE225	~ 10 years
S&P500	~ 15 years

- Volatility of Volatility
- Volatility skew
  - Reflected in stochastic volatility model
    - More complex model to work with if stochastic interest rate is also applied.
  - Applying the skew directly
    - Need consistent measure of “money-ness”

## Pricing Withdrawal Benefits

- **Market Risk Exposure**
  - Volatility Risk
    - Applying the skew directly
      - Quoted skews are spot-basis.
      - Due to int. rate and div. yield differentials, forward moneyness is different from the spot moneyness.
      - For quoted (European) options, forward-basis is more accurate measure of moneyness than the spot-basis
      - Thus, liability moneyness should also be measured on forward-basis, not spot-basis.
        - Apply proper vols from the quoted skew table based on liability's forward moneyness.

## Pricing Withdrawal Benefits

- **Market Risk Exposure**
  - Correlation Risk
    - Need to assess the historical observation period to derive the historical correlation matrix.
      - Too short period (3m ~ 3 years): reflective of current market conditions, but is it appropriate for the entire pricing duration?
      - Too long period (10+ years): lack of relevance in the current market, but is consistent with the spirit of long term pricing.
      - Term structure of correlation matrix: middle ground to resolve the above conflicts?
    - Correlation matrix must be positive semi-definite
      - when certain pairs are “implied” from the dealer quotes and others are from the historical data.

## Pricing Withdrawal Benefits

- US GAAP Accounting
  - Relevant if the guarantee is on the books of a public U.S. company.
  - GMWB falls to FAS133/157.
    - Enables matching of hedge G/L against the liability G/L, mitigating both economic and earnings volatility associated with the guarantees
  - Lifetime GMWB poses the accounting issue:
    - Under FAS133, payoff of the guarantee can't be life-contingent
    - However, payoff from the lifetime GMWB is life-contingent...

## Pricing Withdrawal Benefits

- US GAAP Accounting
  - When lifetime GMWB is scoped out of FAS133 (falls to SOP03-1), full hedging introduces earnings volatility while protecting the company's economic interest.
  - Through product designs, a split accounting is possible that makes:
    1. most of the economic risk of the guarantee falls to FAS133, enabling the matching of hedge G/L
    2. the balance of the risk falls to SOP03-1, which can be managed via reinsurance or other means.
    3. the key is to make most of the guarantees effectively non life-contingent through GMDB.

## Pricing Withdrawal Benefits

- Challenges in a full pricing model
  - Initial assumptions (actuarial + capital market) enables us to quantify the value of the guarantee.
  - When pricing the total contract (base + guarantee), significant challenges are ahead:
    - Total contract ROA/IRRs are based on real-world scenarios
    - A set of real world scenario generators is needed in order to examine scenario-based total product profitability. Need generators capable of producing:
      - Real world equity scenarios
      - Real world FX scenarios
      - Real world interest rate scenarios
      - Future implied vols (equity, FX and swaptions)
      - Future calibration of int. rate model parameters
    - Nested stochastic calculations are necessary.