Derivatives and Regulatory Capital

Derivatives Working Party

11 November 2003

Martin Muir, Tim Wilkins, Gary Finkelstein

2003 Life Convention
Birmingham, 9-11 November

Derivatives Working Party

- Terms of reference
  - "To consider examples where life insurance companies are currently utilising derivatives, or might like to use derivatives, and if their use of derivatives is constrained."
- Membership
  - Martin Muir, Andrew Chase, Paul Coleman, Paul Cooper, Paul Fulcher, Gary Finkelstein, Tim Wilkins

Agenda

- Impact of various asset allocation strategies on regulatory capital for a simplified "with-profits" bond
- Use of options in setting bonuses and asset allocation
- Dynamic bonuses and asset allocation
- Possible further areas of work.

Derivatives and Regulatory Capital

Simplified WP Bond examples

Simplified Bond – "unhedged"

- 13,000 Sum Assured + Vested Bonus
- 12,000 Asset Share
- 10 year outstanding term
- Future reversionary bonuses ignored initially
- Terminal bonus based on 100% of unsmoothed asset share
- Passive asset allocation

Assumptions

- Equity yield 3%, bond yield 5%
- Equity volatility 20%
- No decrements
- Statutory valuation
  - discount guaranteed benefits only
  - pro rata hypothecation for valuation interest rate

Assumptions

- Realistic peak
  - market-consistent valuation of liability
  - replicating portfolio or stochastic valuation
- Resilience reserve / Risk capital margin
  - 25% equity fall
  - 20% movement in yields
  - volatility remains 20% (no ‘smile’)

Asset allocation

- 75% equities, 25% ten year ZCB
- Put (external)
- Put (internal)
- Long term collar
- Short term collar
- Reduced EBR

Simplified Bond
Statutory valuation - unhedged

Valuation yield:	3.41%
Base reserve:	9,294
Resilience reserve:	1,292
Total reserve:	10,586

Simplified Bond
Put held outside asset share (external)

- Fund purchases a put option to hedge guarantee

  Bond payoff at maturity = 3,000 x 1.05^{10} = 4,887

  Equity payoff required = 13,000 – 4,887 = 8,113

  Put option must cover initial value 9,000 of equity with a strike level of 8,113 in 10 years

- Price of put is 386

Simplified Bond
External put – statutory valuation

Asset	Amount	
Bond	3,000	} Asset share
Equity	9,000	
Put	386	

- Valuation interest rate
  - Put held “in connection with” equities
  - Calculate IRR on combined equity and put

Simplified Bond
External put – statutory valuation

	Hedged	Unhedged
Valuation yield	3.08%	3.41%
Base reserve	9,600	9,294
Resilience reserve	1,321	1,292
Total reserve	10,921	10,586

NO BENEFIT FROM HEDGING
LOSS OF TIME VALUE

Simplified Bond
Realistic liability - unhedged

Replicating portfolio:		Assets held:	
Asset	Amount	Asset	Amount
Bond	3,000	Bond	3,097
Equity	9,000	Equity	9,290
Put	386	Total	12,386
Realistic liability	12,386	Assets mismatched	

Simplified Bond
RCM & total capital - unhedged

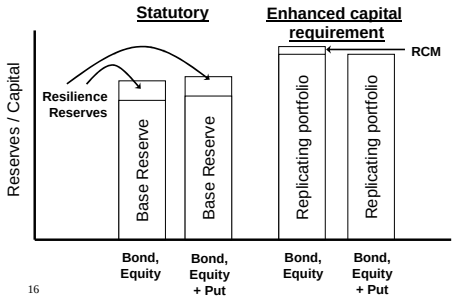
- Revalued replicating portfolio 11,013
- Revalued assets 10,375
- Shortfall 638
- Grossed up (=RCM) 762
  - backed 75% equity, 25% bonds
- Total capital 13,148
  (= 12,386 + 762)

Simplified Bond
Realistic liability – external put

Replicating portfolio:		Assets held:	
Asset	Amount	Asset	Amount
Bond	3,000	Bond	3,000
Equity	9,000	Equity	9,000
Put	386	Put	386
Realistic liability	12,386	Assets matched – RCM is zero	

BENEFIT FROM HEDGING
NO IMPACT ON BASE LIABILITY
REDUCED RISK CAPITAL MARGIN

Simplified Bond
Summary of unhedged vs external put



Simplified Bond
Other strategies

- Put funded by asset share
  - ie guarantee recharged to asset share
- Put funded by selling call option (collar)
- Short term collar
- Switch to bonds

Simplified Bond
Put held within asset share (internal)

- Put option purchased to hedge guarantee, funded by asset share
- Policyholder has same guarantee but lower equity exposure

  Bond payoff at maturity = 3,000 x 1.05^{10} = 4,887
  Equity payoff required = 13,000 – 4,887 = 8,113

  Sell equity, buy put to cover remaining equity (8,535) with strike 8,113 in 10 years
- Equity sold = put price = 435

Simplified Bond
Internal put – statutory valuation

Asset	Amount	
Bond	3,000	Asset share
Equity	8,535	
Put	435	
Total	12,000	

Simplified Bond
Collar hedge

- Put option purchased to hedge guarantee, funded by sale of call option
- Policyholder has same guarantee but equity upside is capped

Put value 386 (strike 8,113 in 10 years)

Call value 386 (strike 33,099 in 10 years)

Simplified Bond
Collar hedge

Asset	Amount	
Bond	3,000	Asset share
Equity	9,000	
Put	386	
Call	-386	
Total	12,000	

Simplified Bond
Collar hedge – statutory valuation

- Valuation interest rate – 2 approaches
  - put held in connection with equity, call treated as separate liability
  - collar treated as single asset held in connection with equity
- Calculate IRR on combined asset

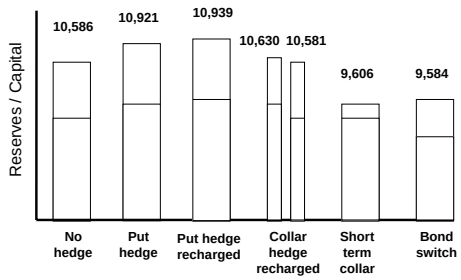
Simplified Bond
Short term collar

- 1 year put option purchased to hedge guarantee, funded by sale of call option
- Aim to get protection in resilience scenario
- For convenience same protection level as long term collar

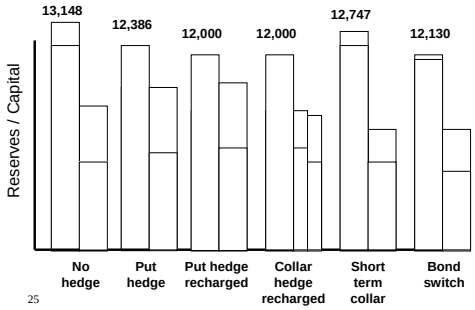
Put price 213 (strike 8,113 in 1 year)

Call price 213 (strike 11,210 in 1 year)

Simplified Bond
Statutory reserves – Summary



Simplified Bond
ECR – Summary



25

Derivatives and Regulatory Capital

Use of options in setting bonuses and asset allocation

Recap – The With Profit Contract
Assumptions

- 13000 = sum assured + reversionary bonuses
- 12000 = asset share
- 10 years = outstanding term
- 5% per annum = risk-free interest rate
- 20% per annum = equity volatility
- 25% risk-free bonds & 75% equity – FTSE 100
- No rebalancing
- No decrements

27

Cash Flow Matching – Time = 10
Bonus = 0% – Strike = 1803

Scenario	$Index_{10}$	ASH_{10}	VB_{10}	GC_{10}	$Payoff_{10}$
1	5482	29556	13000	–	–
2	4469	24997	13000	–	–
3	2761	17310	13000	–	–
4	1168	10143	13000	2857	2857
5	298	6226	13000	6774	6774

28

Valuation
Example – Bonus Rates = 0%

Initial FTSE 100 Total Return Index = **2000**

Guaranteed benefits at maturity = **13000**

Guarantee cost equal to the value of a European put option with maturity = 10 years and strike = **1803**

Guarantee cost = put option value = **386**

29

Valuation
Example – Bonus Rates = 1%

Initial FTSE 100 Total Return Index = **2000**

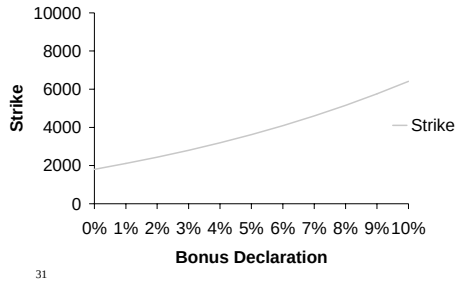
Guaranteed benefits at maturity = **14360**

Guarantee cost equal to the value of a European put option with maturity = 10 years and strike = **2105**

Guarantee cost = put option value = **646**

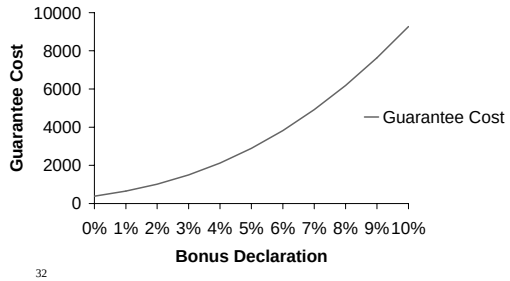
30

Bonus Declaration Impact
Option Strikes



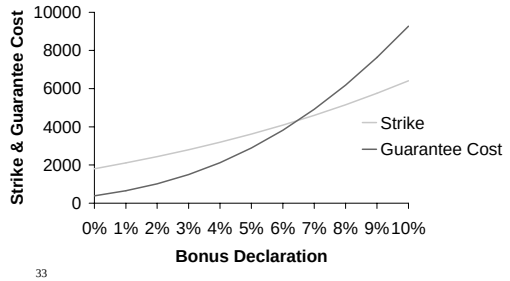
31

Bonus Declaration Impact
Guarantee Cost



32

Bonus Declaration Impact



33

Bonus Rate Changes

- b_p% = previously assumed future uniform compound bonus rate
- b_n% = new future uniform compound bonus rate

Cost at time t of increasing bonus rates to b_n% uniform compound can be quantified as the difference in value between European put options

Bonus change cost = $VPO_t(b_n\%) - VPO_t(b_p\%)$

Bonus Rate Changes
Example – Bonus Increase from 0% to 1%

- b_p% = 0% per annum over contract term
- b_n% = 1% per annum over contract term

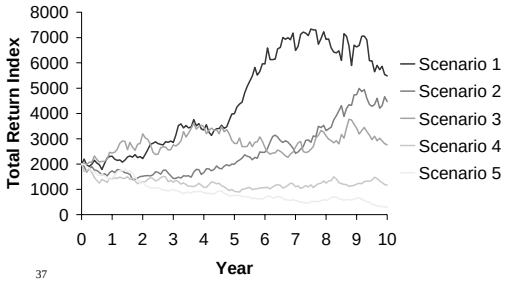
Initial cost of 1% increase to future uniform compound bonus rates is quantified as

$VPO_0(1\%) - VPO_0(0\%) = \mathbf{646} - \mathbf{386} = \mathbf{260}$

Cost Depends on the Bonus Level
1% Initial Bonus Increase Cost

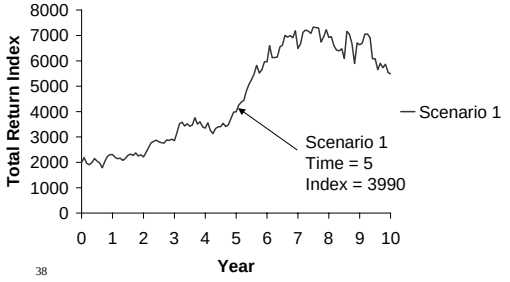
Initial Uniform Bonus Declaration	1% Increase Cost
0%	260
1%	364
2%	486
3%	622
4%	771
5%	929

FTSE 100 – Total Return Index
Scenarios – Initial Index = 2000



37

FTSE 100 – Total Return Index
Scenario 1



38

Scenario 1 – Time = 5
Bonus Increase

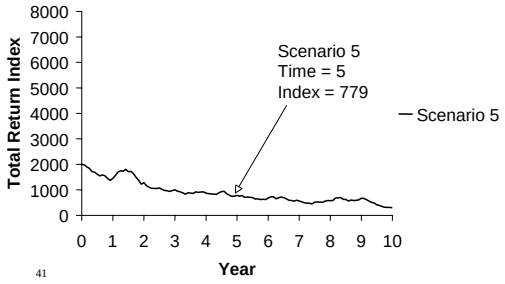
- FTSE 100 total return index rises from initial value of **2000** to value at time 5 of **3990**
- Competitive pressures demand a **1%** increase in bonus rates from time 5 to **2%** compound per annum for the remainder of the term

39

Scenario 1 – Time = 5
1% Bonus Increase (b_p = 1% & b_n = 2%)

Index	3990
Asset share	21786
Vested benefits	13663
Terminal bonus buffer	59%
1% Bonus Cost = $VPO_5(1\%)$	46
2% Bonus Cost = $VPO_5(2\%)$	73
1% Increase Cost	**27**

FTSE 100 – Total Return Index
Scenario 5



Scenario 5 – Time = 5
Bonus Rates Suspended

- FTSE 100 total return index falls from initial value of **2000** to value at time 5 of **779**
- Financial pressures force a **suspension** of bonus payments

Scenario 5 – Time = 5
1% Bonus Reduction (b_p = 1% & b_n = 0%)

Index	779
Asset share	7335
Vested benefits	13663
Terminal bonus buffer	–46%
1% Bonus Cost = $VPO_5(1\%)$	3960
0% Bonus Cost = $VPO_5(0\%)$	3433
1% Reduction Cost	**–527**

Time = 5 – Summary Scenarios
1% Bonus Increase (b_p = 1% & b_n = 2%)

Scenario	$Index_5$	ASH_5	VB_5	TBB_5	Uniform Cost	One-off Cost
1	3990	21786	13663	59%	**27**	**5**
2	1987	12771	13663	–7%	**259**	**48**
3	2820	16519	13663	21%	**106**	**19**
4	917	7957	13663	–42%	**538**	**105**
5	779	7335	13663	–46%	**555**	**108**

Summary

- Cost of bonus replicated/estimated by put
- Non linear relationship with bonus level
- Cost influenced by
  - Existing bonus level
  - Asset share buffer
  - Market conditions

Applications

- Asset allocation
  - Static, dynamic strategies
  - Hedge on price / total returns
- Determination of bonus policy
  - Supportable bonus after allowing for targeted level of terminal bonus, natural link with bonus increase costs
  - Extend to allow for time value of options, assessed using prices of put
- Dynamic Control System

Derivatives and Regulatory Capital

Dynamic bonuses and asset allocation

Dynamic bonuses

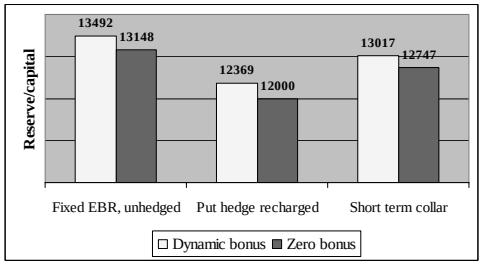
- Dynamic reversionary bonus rule, calculate supportable RB assuming
  - Asset share earns bond yield
  - Target terminal bonus cushion of 30%
  - Maximum annual change in bonus of 1%

Modelling approach

- Stochastic simulations
- Lognormal equity returns
- Risk neutral, 20% volatility, 5% risk free
- 100,000 scenarios
- Recalculate under stress test

With Profit Bond – dynamic bonus

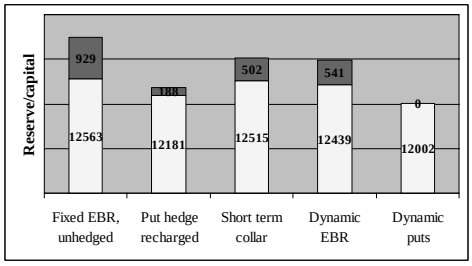
Enhanced capital – Summary



Dynamic asset allocation

- Dynamic EBR rule (annual), constant proportion portfolio insurance
  - Risk tolerance 25%
  - Maximum rebalancing 10%
- Dynamic put protection
  - Puts held to match current level of guaranteed benefits
  - Further puts purchased each year to cover increased guarantees as bonuses declared
  - Cost charged to asset share

With Profit Bond – dynamic bonus
Enhanced capital – Summary



Conclusions

- In general, derivative hedges are more effective in the realistic balance sheet than the statutory balance sheet
- Greater incentive for *economic* hedges
- But also greater benefit from a dynamic asset allocation, with and without the use of options
- Option pricing potentially useful in determining policyholder benefits

Further work (SIAS Paper and beyond)

- Extension of examples
  - Bonus policy
  - Charging for guarantees
  - Asset allocation, including more complex options
  - Policyholder perspective
- Other product examples, eg GAOs
- Volatility of future capital position and how this could be managed
- Credit derivatives
- Derivative backed retail products (IL, synthetic WP)

Derivatives and Regulatory Capital

Derivatives Working Party

11 November 2003

martin.muir@eu.watsonwyatt.com

2003 Life Convention
Birmingham, 9-11 November