The Sting in the tail
A Foreword

• The views represented are my own as are any errors
• I work for Legal and General Investment Management on strategic investment analysis and solutions
• I am not a regulatory actuary focused on Solvency II
• Analysis is approximate and to provide context, rather than to challenge others’ more granular analysis
• Solvency II is not finalised
• New draft text is expected to introduce a matching premium for annuities and reduce capital volatility
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<th>Slide</th>
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Defining tail events

The Players
Swans of every colour

“Contrary to conventional wisdom, crises are not black swans but white swans: the elements of boom and bust are remarkably predictable”

Nouriel Roubini, Crisis Economics, 2011
A simple definition of tail risks

For senior management
An event which defines their lasting legacy

For insurers and pension funds
An event which recasts their future
Franchise value destruction and derisking

- Risk tolerance
- Free capital + embedded value
- Reckless gambling
- Reduced ability to leverage brand
- Full derisking
- Unconstrained strategy
- Institution's risk tolerance
Pension funds have the opposite problem

- Risk tolerance
- Liability driven investment
- Return seeking assets
- Extended derisk path
- Increased employer contributions
- Full derisking/buyout

Time

Risk tolerance
Insurers’ approach

The Set up
Risk management – rapid progress

- GAO hedging c.25 years after Black-Scholes
- Rapid progress since
  - Realistic Balance Sheet
  - Individual Capital Assessment
  - Solvency II
- Stochastic and stresses
- Principles and rules
Draft Solvency II SCR – the year’s must have slide?

- Standard QIS 5 formula
- Equities: 39% for Global, 49% for Other
- Property: 25%
- FX: 25%
- Liabilities discounted based on swaps + illiquidity premium

<table>
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<th>Non-EEA Govs (%)</th>
<th>Corporates (%)</th>
<th>Structure Products (%)</th>
<th>Credit Derivs (%)</th>
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<td>0.9</td>
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<td>1.1</td>
<td>1.1</td>
<td>1.5</td>
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<tr>
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<td>1.1</td>
<td>1.4</td>
<td>1.4</td>
<td>2.6</td>
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<tr>
<td>BBB</td>
<td>1.4</td>
<td>2.5</td>
<td>2.5</td>
<td>4.5</td>
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Draft (QIS 5) SCR correlations

- Solo entity diversification reduces SCR by c.35%
- Owning multiple asset classes reduces benefit of the illiquidity premium

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<th>Up (Down)</th>
<th>MKTint</th>
<th>MKTeq</th>
<th>MKTprop</th>
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<td>0.75</td>
<td>0.5</td>
<td>1</td>
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</tbody>
</table>
Insurers financial strength through recent crisis

Source: Bloomberg LP
European insurers’ sovereign exposures

- Market storms are a long way from being weathered

Source: Societe Generale – Cross Asset Research as at 07/07/2011
The Hook

Enough capital for a 1-in-200 year event?
People judge books by covers

Arbitrary coherence
“1-in-200” encourages risk measurement not management

Very hard to shift mindset once anchored

The impact can be extreme
It can double the price of (Neuhaus) chocolates\(^1\)

So what if the risk calibration and time horizons are wrong?

Time horizons

- Ever dwindling
- Mark to market a guiding Solvency II principle
- Longevity recognised as emerging over the long term
- Credit remains controversial
- Liability illiquidity is the key to the debate

Solvency II isn’t really a one year time horizon
MTM only works if assets and liabilities share similar liquidity levels
Experiments in mark to market liabilities – with profits

Equity backing ratios (2005 – 2010)

- Average EBR around 75% at end of 1991\(^1\)
- Average EBR constant around 70% between 1990 and 2000\(^2\)
- Average EBR rose steadily upwards from c.35% to c.70% between 1970 and 1990\(^2\)

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\(^1\) Source: Asset and Liability Studies on a With Profit Fund, Tim Roff, Presented to the Staple Inn Actuarial Society, October 1992

\(^2\) Source: Smashing With-Profits Business, Howard Froggatt and Icki Iqbal, Staple Inn Actuarial Society, October 2002
Experiments in mark to market liabilities – annuities

Net surplus emerging 2009

- 2009 Institute of Actuaries Working Party¹
- £2bn starting liability portfolio

¹ Source: Unintended consequences and the avoidance of self-fulfilling prophecies, Impacts of regulation and market turbulence on annuity fund investment strategies working party, June 2010
Calibration

By necessity standard formula simplifies
FSA paper

Calibration of the Enhanced Capital Requirement for with-profit life insurers, June 2004

Test the calibration (and that of Solvency II)
Realised historical equity volatility

Great Depression

World War II

Credit Crunch

Oil Crisis

Source: Reuters Ecowin
Credit Stresses

1. Source: Bloomberg for data from 1999 onwards. Based on iBoxx spreads. Prior to Jan 1999 only proxy BBB spreads available - these were dampened to allow for greater volatility of BBB relative to overall portfolio. From October 2007 BarCap data used to infer impact on credit-spreads of re-ratings.

2. Threshold represents 1 in 200 event as implied by table in paragraph 8.8 of the June 2004 FSA paper ‘Calibration of the Enhanced Capital Requirement for with-profit life insurers’ by Watson-Wyatt and fitting a Gaussian distribution to extrapolate the tail.
Correlation between US equities and Treasuries

Source: DataStream
“Tail Events” more common than consensus

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1811</td>
<td>Crimean War, 1853</td>
</tr>
<tr>
<td>1211</td>
<td>American Civil War, 1861</td>
</tr>
<tr>
<td>1411</td>
<td>Global Flu Epidemic, 1890</td>
</tr>
<tr>
<td>1611</td>
<td>Spanish Civil War, 1936</td>
</tr>
<tr>
<td>1811</td>
<td>Formation People’s Republic of China, 1949</td>
</tr>
<tr>
<td>2011</td>
<td>Black Monday, 1987</td>
</tr>
<tr>
<td></td>
<td>Korean War, 1950</td>
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<tr>
<td></td>
<td>World War II, 1939</td>
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<tr>
<td></td>
<td>Vietnam War, 1955</td>
</tr>
<tr>
<td></td>
<td>September 11, 2001</td>
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<td></td>
<td>Lehman fall, 2008</td>
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</tbody>
</table>
The UK annuity and DB pension market

Top ten UK annuity funds

Total UK DB Market

£103bn

£845bn

Standard 65 year old male/female fixed annuity rate\(^2\):
Male: 6.1%, Female: 5.7%

Source: FSA Returns End 2010, From 48, 2: As at 15/1/2011
Source: Calibration of the Enhanced Capital Requirement for with-profit life insurers by Watson Wyatt as at June 2004
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Extreme risk aversion in annuities – QIS 5 vs Gilt only strategies

Longevity 13%, Operational 3%, Credit 11%, Total Expenses 50bps
6% Cost of Capital
1% liquidity premium, additional 0.75% credit return post haircuts
Potential impacts of Gilt only investments

All results vs a QIS 5 capital treatment
Annuity pricing worsens by c.10-15%
Impacts of government substitution

<table>
<thead>
<tr>
<th>Liabilities affected</th>
<th>MTM impact on UK public debt (£bn:%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year of annuities</td>
<td>£1.4bn:0.1%</td>
</tr>
<tr>
<td>All existing annuities</td>
<td>£17bn:1.8%</td>
</tr>
<tr>
<td>All DB pensions</td>
<td>£110bn:11.3%</td>
</tr>
</tbody>
</table>

Insurer shareholders lose c.60%
Corporate funding costs rise, c.£80bn Sterling corporate debt
Increased borrower reliance on short term financing
Risk had been tamed

The Tale
The Great Moderation 1985 - 2007

“potential gains from improved stabilization policies are on the order of hundredths of a percent of consumption”

Robert Lucas, presidential address to the American Economic Association, January 2003

Source: Bloomberg LP
The monetary policy tools
Realised volatility was lower

The Wire
Moderation in action – the Greenspan Put

The fed funds rate and identifiers of Greenspan put

Source: Bloomberg LP
Imported deflation

- Improving Emerging market labour productivity
- Controlled exchange rates
- China lowered U.S. import inflation by c.80bp p.a between 1993 to 2004\(^1\)

\(^1\) Source: Board of governors of the federal reserve discussion paper, Is China “Exporting Deflation”? 2004

\(^2\) Source: Data source Bloomberg L.P., National bureau of statistics of China
Focus on full employment through cycles

- Supercharged economy

U.S. annualised QoQ inflation and unemployment

Source: Data source Bloomberg L.P.
Traders – set up

• Bank bonuses encourage short-term outlook.
• Principal-agent problem: downside consequences not fully passed to traders.
• Example

A – good/usual year, probability 95%
B – very bad year (tail-risk), probability 5%

Payoff for Trader (remuneration) is 10% of profit made by Bank but with a lower limit of zero.
Traders – payoffs

Payoffs for Bank and for Trader (arbitrary units):

<table>
<thead>
<tr>
<th>Case</th>
<th>Probability</th>
<th>Bets on A</th>
<th>Bets on B</th>
<th>Bets on A</th>
<th>Bets on B</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>95%</td>
<td>105</td>
<td>-80</td>
<td>10.5</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>5%</td>
<td>-1,515</td>
<td>2,000</td>
<td>0</td>
<td>200</td>
</tr>
</tbody>
</table>

*Expected payoff:* 24.0   24.0   10.0   10.0
*Volatility of payoff:* 353   453   2.3   44
Traders – behaviour

**Bank best¹ strategy:** c.55% bet on A, 45% bet on B
→ Bank has expected payoff of 24.0 and volatility of 9.8.

**Trader best¹ strategy:** c.95% bet on A and 5% bet on B
→ Trader has expected payoff of 10.0 and volatility of 0.005.

If Trader bets 95% on A and 5% on B the Bank suffers volatility of profit of 313, rather than 9.8.

Severe multi-period repercussions if risk-seeking individuals rewarded/promoted

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¹: Lowest standard deviation combination of bets; in this example split doesn’t impact expected payoff.
The problem of induction

The Shut-out
How recessions compare – cumulative real GDP growth

and an uncertain outlook…

Source: Reuters Ecowin
Source: Monthly and quarterly GDP estimates for interwar Britain by J Mitchell, S Solomou, and M.Wale as at November 2009
Commodity prices booming

Avoiding the pitfalls

The Sting
UK debt outlook

Government net debt to GDP ratio

Source: LGIM Fundamentals Economic and Investment Commentary as at October 2011
Volatilities of asset classes

1. Source: Bloomberg. Volatility of FTSE All Share and UK Govt bonds based on rolling one year of monthly returns.
Developed/developing economies are now more connected.

1. Source: Bloomberg. UK Equity: FTSE All Share. Based on rolling 5 years of monthly data.

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SCR volatility – proxy methodology

- All on standard formula from QIS 5
- Assets = 65% credit, 20% Gilts, 10% property, 5% equity
- Capital = 150% SCR at outset
- Interest rate matching liabilities
- Rebalance assets monthly
- Annual dividend if capital > 150% SCR
Solvency II is a moving feast

- Annuity results presented are based on QIS5
- They do not reflect lower and more stable capital requirements for annuities generated by the Matching Premium included in the latest Level 2 text
- These results do not therefore reflect the expected impact of Solvency II on UK annuity business
Draft Solvency II (QIS 5) applied from 1972

- EIOPA is working to ensure more appropriate SCR volatility
And with stable Gilt yields
How to analyse tail risks

Think macro
Minimal assumptions
Maximise debate
Mitigate behavioural finance issues

Multiple angles of attack are essential – we’re building a safety net, so knit the threads from every direction
Historical scenarios - recalibrated

Data source Bloomberg L.P.
Learning from the past – the Japanese example

Japan and U.S. commercial lending rates

T = 1992 for Japan and 2007 for U.S.

Japan and U.S. YoY lending changes

1 Source: World Bank: World Development Indicators via Thomson Reuters DataStream
2 Source: Data source Bloomberg L.P.
Learning from the past – the Japanese example

Japan and U.S. YoY real estate price change

\[ T = 1992 \text{ for Japan and 2007 for U.S.} \]

Japan and U.S. cumulative non-performing loans

\[ \text{Source: Bank of Japan via Thomson Reuters DataStream, Data source Bloomberg L.P.} \]

\[ \text{Source: FDIC (Federal Deposit Insurance Corporation), Japan Bankers Association via Nomura Bank Research} \]
Separate the white swans from ugly ducklings

- Set risk threshold
- Macro perspective

Scorecard combining scenario impacts and hedge payouts

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Scen 1</th>
<th>Scen 2</th>
<th>Scen 3</th>
<th>Scen 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity weighting of scenario</td>
<td>20%</td>
<td>30%</td>
<td>35%</td>
<td>15%</td>
</tr>
</tbody>
</table>

- Financial crisis
- Oil Crisis
- VaR
- CVar
- Japan crisis
- Worst case
- Oil spike rate rise
Hedge effectiveness differ over time

Equity volatility surface

FTSE 100 volatility over time

Data source: Bloomberg L.P.
Summary

Insurers have advanced risk management approaches
However, 1-in-200 year capital is a mirage

We won’t find all the tail risks, but
• we might identify the white swans and mitigating those…
• …may also indirectly reduce exposure to the black ones
Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged. The views expressed in this presentation are those of the presenter.