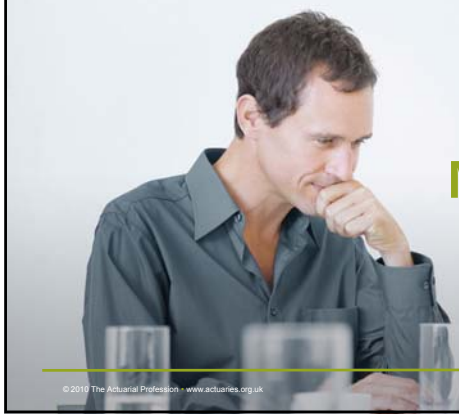
The Actuarial Profession
making financial sense of the future

Life conference and exhibition 2010
John Hibbert and James Maher



Making sure actuaries don't choke on their free lunch

7-9 November 2010

Agenda

- Introduction
- Earning Liquidity Premiums
  - limitation, risks and pitfalls
- Paying liquidity premiums
  - Option Price replication, Charging Policyholders, Future Risks
- The solvency II dimension – Reasonable Understanding or Political Compromise ?
- Conclusion.

Introduction: What's contained in a market price?

Some factors generally assumed to drive price & value changes:

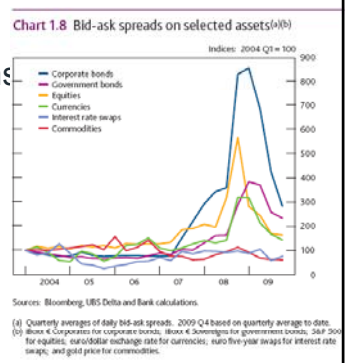
- Changes to underlying asset cash flow expectations
  - Changing expectations for future dividends and rental income
  - Changing expected default experience
- Changes in discount rates
  - Changes risk-free interest rates
  - Variation in the price of risk

Introduction: What's contained in a market price?

- Variation in the level of risk
  - Volatility changes, Convexity effects
- Variation in the price of risk
  - Time variation in risk premia ('fear & greed', 'animal spirits', 'disaster myopia')
- Changes in the level & price of liquidity
- Other asset premia
  - Volatility, currency risk

So, what happened in 2008?

- A deflationary shock to the global economy
  - Reduced growth and income expectations
- Increasing uncertainty
  - Authorities' policy response (short rates)
  - Elevated volatility of asset prices
  - Increasing dealing costs
- A collapse in confidence
  - Flight to quality / increasing risk aversion and risk premia
  - Flight to liquidity / increasing price of liquidity
  - Increasing volatility premia



*Source: *Bank of England Financial Stability Report December 2009*

What is the liquidity premium?

The basic idea

- The basic idea is that financial instruments which offer identical cash flows can sell at different prices as a result of their trading liquidity.
- Hard-to-trade instruments will sell at a price discount (or yield premium) compared to otherwise equivalent assets as a result of demand from 'mark-to-market' investors.

What is the liquidity premium?

Liquidity premia have implications for the fair valuation of illiquid liability cash flows

- If markets price liquidity then market-consistent valuation techniques would be expected to value illiquid (i.e. predictable) insurance cash flows in a consistent way.
- The illiquid replicating asset portfolio reveals the economic, market-consistent liability value.

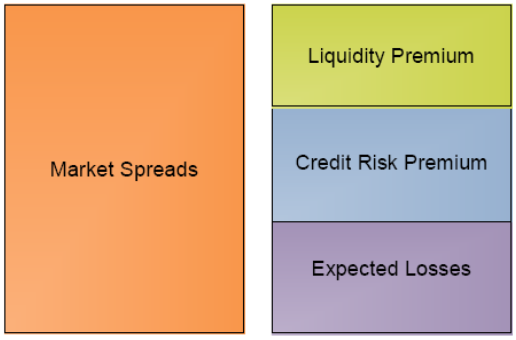
Evidence

- Both the industry and regulators' views and position have evolved following the 2008 market crisis
- There are strong theoretical arguments and a large body of empirical evidence to support the existence of liquidity premia
- Nevertheless, estimation of asset liquidity premia is challenging
- Insurers have focussed on the corporate bond markets.

A reminder: Decomposition of market credit spreads

The corporate bond spread can be decomposed as:

- the expected default loss on bonds
- plus the risk premium that investors demand for the possibility that corporate defaults will be higher than expected
- plus a *liquidity premium* to compensate for the expected costs (and uncertainty of those costs) of trading bonds.



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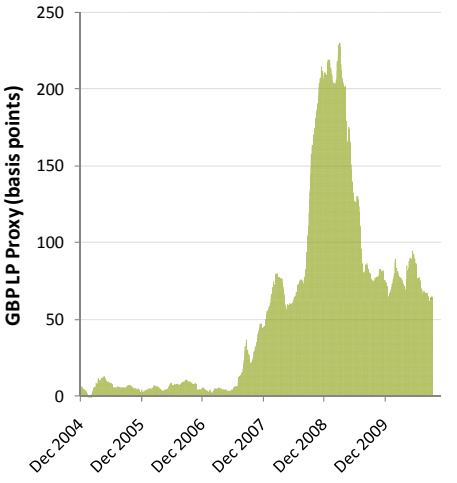
A proxy for the liquidity premium contained in Sterling corporate bond spread

- Various methods have been proposed to estimate the liquidity premia in corporate bond spreads
- A simple proxy provides a good match for the combined output of these methods

*LP = 50% * (Spread – 40 bps)*



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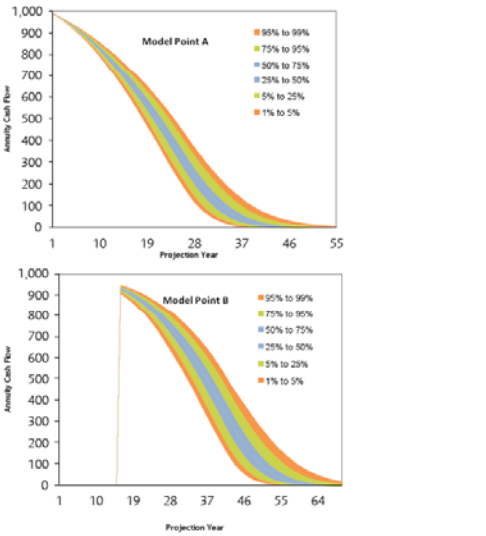
Application & predictability of liability cash flows

- How predictable are annuity cash flows?

	Predictability Ratio, PR, for:	
Statistic	***Model point A***	***Model point B***
Mean	97.6%	98.2%
Std Dev	2.9%	2.5%
50th percentile	99.0%	99.6%
25th percentile	95.5%	97.0%
10th percentile	93.2%	94.4%
5th percentile	92.1%	92.8%
1st percentile	90.0%	89.8%
0.5th percentile	89.0%	89.1%

Impact of stochastic mortality on annuity cash flows for the two annuity model points A and B



Some pitfalls?

- For less than perfectly-predictable cash flows, what is the potential for forced selling and disruption of the portfolio?
- What sort of market liquidity might be available if the portfolio is required to sell?
- If these costs/benefits are driven by market-wide (i.e. non-diversifiable) risk, how much should the shareholder give away to policyholders?

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Part 2 – Paying Illiquidity Premiums for Options

Introduction

- Long history of
  - Guarantee Provision
  - Mixed track record
- Liquidity and Option Prices
  - Pricing disconnect between Investment Banks and Insurers
  - Mixed messages from CEIOPS
- Reducing the Actuarial “Anti Library”

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Investment Banks & Option Costs

Black Scholes in the Ideal World

BS Formula for European Put (no dividend stock) :

$Exp(-T*R_f)*\{Strike*N(-d2)-Spot*\ Exp(-T*R_f)*(N(d1)\}$

For $d1 = \{ln(Spot/Strike)+ (R_f + .5\sigma^2)*T\}/\{\sigma\sqrt{T}$), $d2=d1- \sigma\sqrt{T}$

Pricing – Lay man explanation

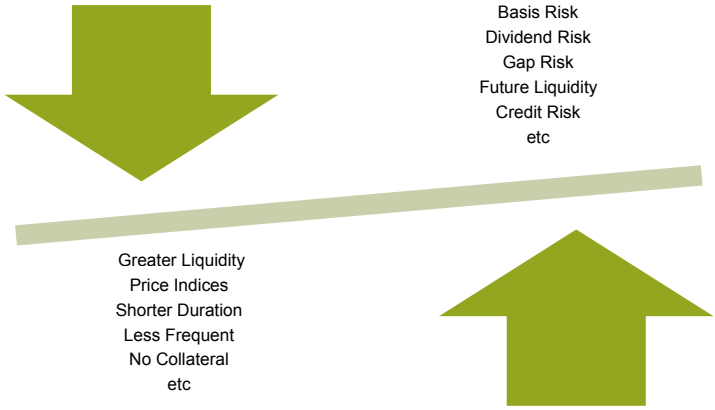
- Accumulation = Expected Forward State = Spot* $Exp(T*R_f)$
- Expected claim/Uncertainty based on time and variance $(T*\sigma^2)$
- Discounting = $Exp(-T*R_f)$

However,

BS not used for (insurance) pricing

Used for replication => different explanation of formula

Traders Tradeoffs



Black Scholes in the real world

BS Formula for European Put (no dividend stock) :

$Exp(-T*R_f)*\{Strike*N(-d2)-Spot*\ Exp(T*R_f)*(N(d1)\}$

For $d1 = \{ln(Spot/Strike)+ (R_f + .5\sigma^2)*T\}/\{\sigma\sqrt{T}$), $d2=d1- \sigma\sqrt{T}$

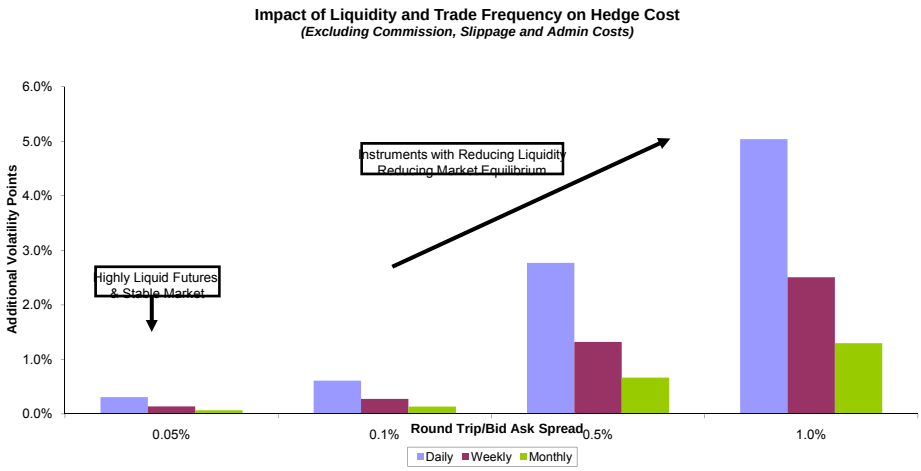
Replicating Differences – Lay man explanation

- Forward replicated through "short" => includes borrow cost =>**Repo Rate**
- Statistical Volatility replaced with IVOL which adjusts for stock process and **rebalance costs and gap risks**
- Discounting is replaced with **rate for accumulating cash** under condition of derivative
- **Dynamic replication => exposure to future variation in these rates**
- **Margin for an "offer" price**

Implied Volatility

- Inferred parameter given known option price
- Related to expected stock price process
- **But** Includes adjustments
- Transaction costs
  - Round Trip Cost of Rebalance
  - Impact of “slippage”
- Discrete time hedge error
  - Function of time step, volatility and “gamma”
  - “Expected” ultimate cost is nil – but not deterministic
  - “utility” cost for interim noise and ultimate outturn
- Market Equilibrium

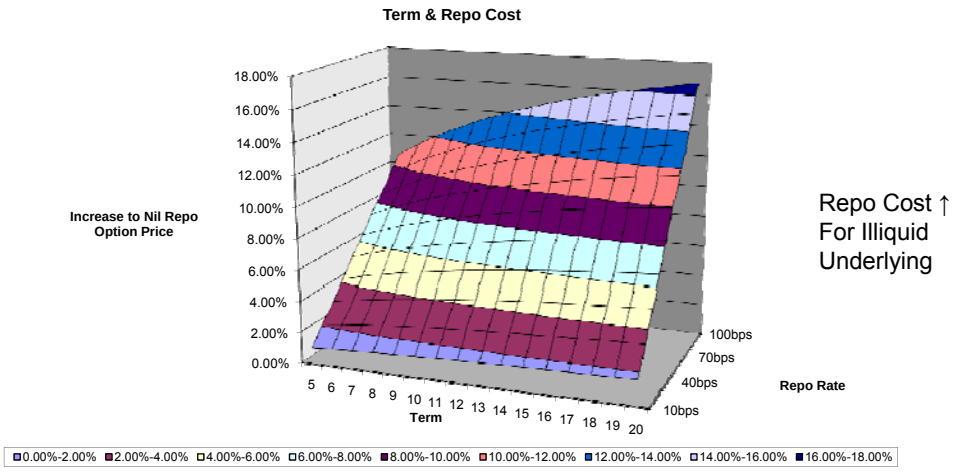
Bid/Ask Transaction Costs



What is Repo ?

- Repo = Repurchase Agreement
  - Term to reference a collateralised lending agreement where an asset is temporarily sold with requirement to repurchase at a later date
- Repo Rate
  - Refers to the rate of interest on the loan agreement
- Application
  - Liquidity
  - Balance sheet management (Repo 105)
- Stock Lending
  - Covered “Short” Sales
- Related Concepts
  - Futures “Implied Repo Rate”
  - Total Return Swap

Repo Cost & Option Price



Repo Cost ↑
For Illiquid Underlying

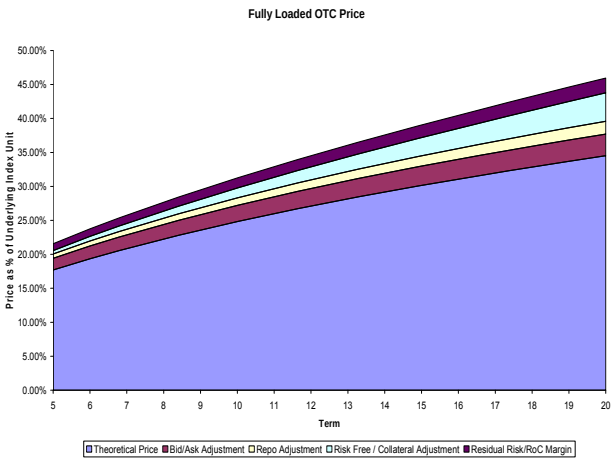
Discount Rates ?

- Discount Future Claims = Exp(-r*t)
  - Risk Free = Overnight Interest, N month Libor, Treasury, Other ?
- (Pre Crisis) Industry Standards
  - Exchange Trades = Overnight Interest Swaps
  - OTC = LIBOR Swap
  - LIBOR Swap ≈ OIS Swap (circa 10bps)
- Crisis
  - Bank Credit Risk/Liquidity Crisis
  - Libor >> OIS
- Post Crisis
  - New equilibrium - LIBOR > OIS
- Situational Discount Rate ?
  - Collateral and Collateral Structure Count
  - Discount rate follows own investing freedom adjusted for risk

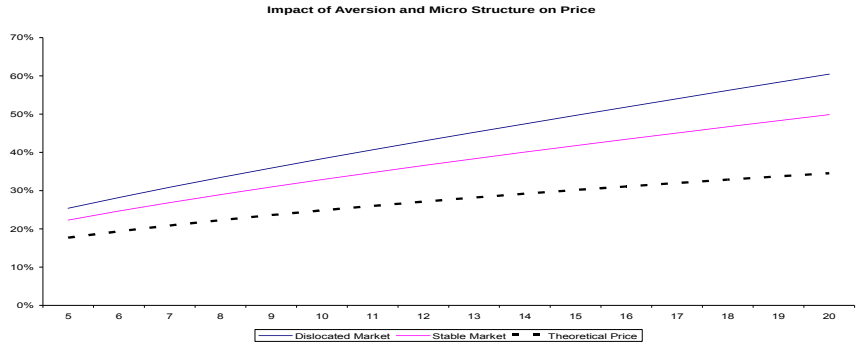
Illustrative Price

Element of the Basis	Stable Market
Statistical Volatility	20%
Risk Free Rate*	5%

Element of the Basis	Stable Market
Transaction Costs (Volatility)	+ 2% (20%+2% = 22%)
Uncollateralised Borrowing	5%
Repo Rate	30bps
Overnight Investment	20bps
Risk Margin/Profit Loading	+5% (Price*105%)

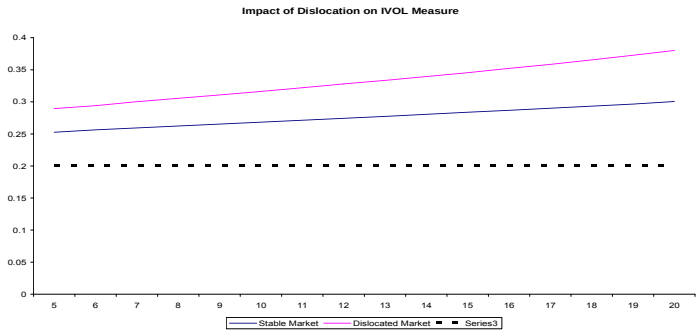


Increased Transaction Costs



- Not stable over time
- Correlated (Level of Rates, Markets, Each Other)
- Adjusted Vol & Repo a proxy for basis risk
- Implicit price adjustment for hedging “illiquid” funds

Calibrating ESG’s to IVOL only ?



- All cost information is transferred to Volatility parameter
- Material, upward sloping,volatile
- Shifts “at the money” forward => possible misattribution between Time Value and Intrinsic Value ?
- Implications for inference and extrapolation ?

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Solvency II/QIS 5 & Option Costs

QIS 5 Technical Specification

Reconciling the Specification

Market Consistent Pricing
V
Liquidity Premiums

Implied Volatility
V
Historic Volatility

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Quantitative Impact Study 5

Questions & Answers

QIS5 - List of Methodological Issues Raised by participants and supervisors – 218 items included

General Disclaimer

The answers given below are not official CEIOPS positions but tentative Working Group answers referring to QIS5 only.

A good question

Question:
The answer to question 21 in the Q&A asks us to include the appropriate liquidity premium for both projecting and discounting. In this way, assets roll up and get discounted at the same rate. The answer does not give any indication of whether or not we accept that option prices will change. Specifically, if we simply generate scenarios using an altered starting yield curve that includes the liquidity premium, without re-calibrating to option prices, then we will alter the price of options. Put and floor type options which are prevalent in the industry will become cheaper. For example, consider the value of a 5 year, at the money European put option. Using the Black Scholes formula with an interest rate of 4% and a volatility of 30%, a dividend of 0%, we get a price of 15.84%. Increasing the risk free rate by 41bps, for example (50% of GBP liquidity premium at 12/31/2009) decreases the value of this put option to 14.99%. This is the result of the higher accumulation rate, leading to fewer and less severe payouts, and a higher discount rate. However, if we only discount the put cash flows, in this example, this would decrease the value of the put option to roughly 15.4%, which reflects only the impact of discounting at a higher rate, effectively assuming that we could replicate this option with (partially) illiquid assets.

- Implication
  - Option prices are lower with illiquidity premiums (2.5% / 5%)
  - The more illiquid the replication instrument the cheaper the option premium ?????

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First half answer :

Answer:
Your understanding of the answer to question 21 is correct: the appropriate illiquidity premium for the valuation of the liabilities has to be included both for projecting and for discounting the assets, thus assuring that the assets are rolled up and discounted with the same rates.
According to TP2.97.b, asset models should be calibrated to a risk-free interest rate curve that includes an illiquidity premium - and thus differs from the risk-free term structure implicit in the market price of some options.
The convention in the over-the-counter option market is to use swaps as risk-free rates. As QIS5 is based on a different relevant risk-free rate, market option prices and market implied volatilities can no longer be replicated simultaneously.
The asset models should nevertheless be market-consistent and comply with TP2.97 c.

- Interpretation ?
  - ESG should be calibrated using reference rate
- Implication ?
  - Increase “at the money” forward => reduce claims
  - Increased “discount rate” => reduce NPV
  - Increase “Time Value” of guarantees to compensate

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2nd Half of Answer

The market-consistency of the asset models that no longer reproduce observable market prices can be demonstrated in a two stage approach. In the first stage relatively simple closed form solutions can be parameterized to match the market value of observable options using the swap rate, i.e. the market implied discount rate. These closed form solutions and the same parameters should then be reused with the relevant QIS 5 risk-free rate to establish theoretical market values consistent with the definition of risk-free used in the valuation of the liabilities in QIS5. These theoretical market values can then be used to validate the market consistency of the liability valuation approach by confirming that the liability approach adequately reproduces those theoretical market values.

- Interpretation ?
  - Calibrate ESG as Normal
  - Replace the Risk Free Curve with Reference Rate
- Implication
  - New concept “Theoretical Market Values”
  - Theoretical Market Value < Market Value

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Summary

- Understanding Liquidity is Critical to understanding Market Prices
- Unexplained amounts should not be capitalised unless understood
- Liquidity premiums
  - can be “earned” from long positions
  - But are “paid” for short positions
- The dynamics of market liquidity and its correlation to market levels is critical to understanding how it can be used
- Pragmatic arguments or compromises should not be dressed in science

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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.