MOODY'S
ANALYTICS

Life Insurance Conference 2016

Modelling Low and Negative Rates

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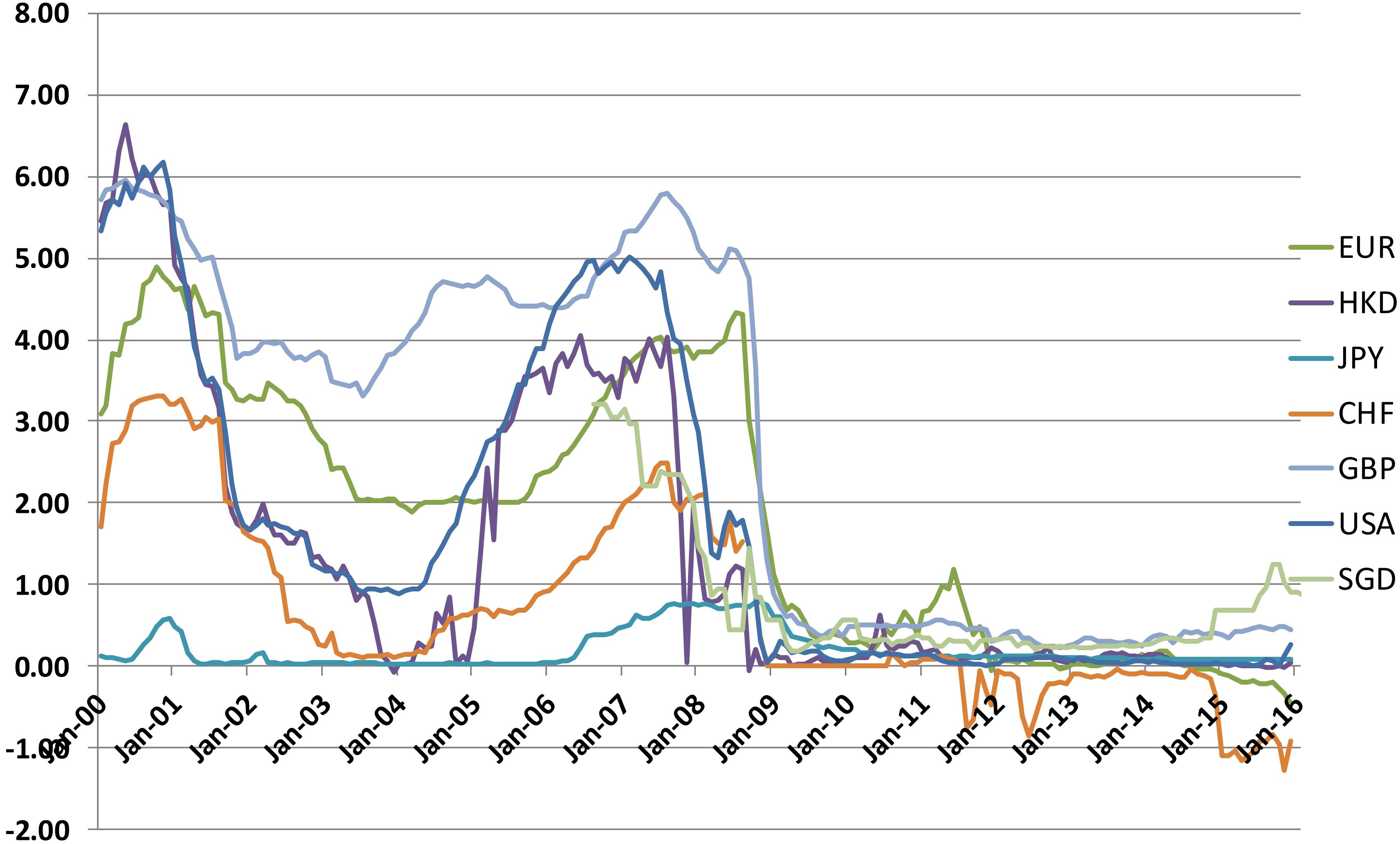
Agenda

- A bit of background/observation on low/negative rates.
- Implications for market consistent valuation & models.
- Real world stochastic projection to consider low/negative rates.

Global Rates Fell and Haven't Recovered Following The Financial Crisis



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Declines in investment returns create a risk of losses

Rates are low and will remain low by historical standards (lower than in the past)

Insurers' investment return will continue to decline

For life insurers that have offered long-term guaranteed rates, investment returns may fall below the guaranteed rate

Risk of losses

Low interest rate risk is a key (solvency) risk for life insurers

Level of risk that major life insurance markets face

VERY HIGH RISK TO PROFITABILITY

Markets in which investment returns are already below or close to the guaranteed rate and where duration gap is high.

The **profits of many insurers' will deteriorate and the capital of some will deteriorate** if interest rates stay low for the next five years.

HIGH RISK TO PROFITABILITY

Markets in which investment returns are already below or close to the guaranteed rate but the duration gap is low.

The **profits of many insurers will deteriorate and the capital of some could progressively deteriorate** if interest rates stay low for the next five years.

MODERATE RISK TO PROFITABILITY

Markets in which insurers are well matched or are readily able to lower credited rates.

The **profits of many insurers will progressively deteriorate** if interest rates stay low for the next five years, but **risk of losses is limited.**

LOW RISK TO PROFITABILITY

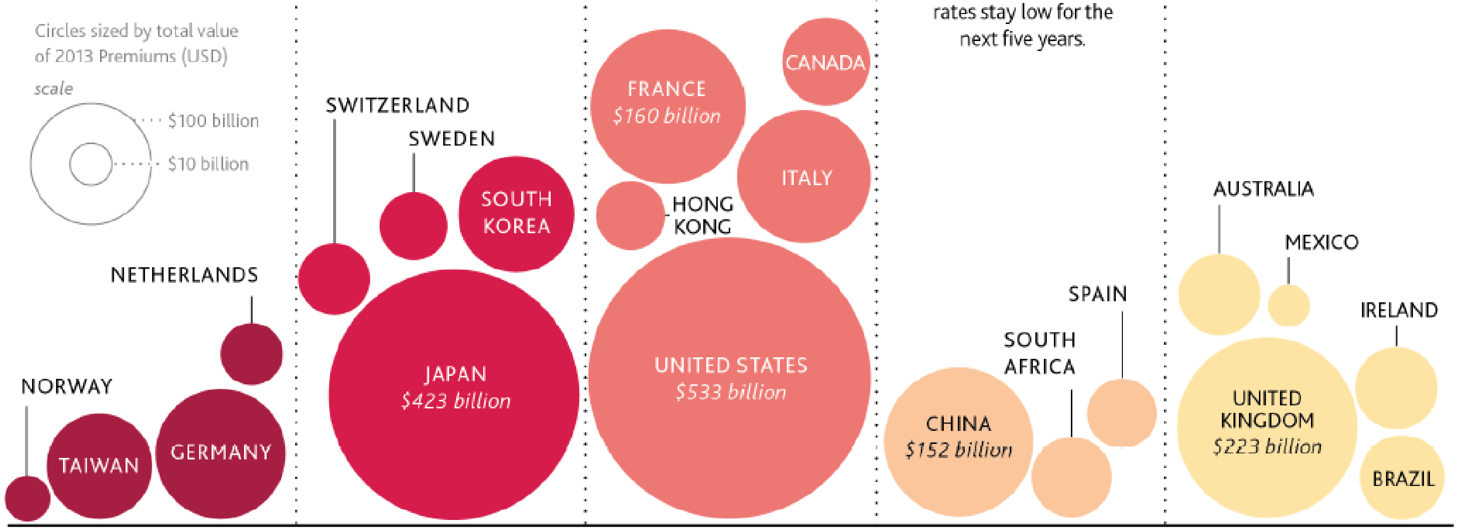
Markets in which guaranteed products have specific features *(e.g., ability to claw back bonuses, guaranteed rate linked to performance of assets)* or in which growth is such that new business rapidly dilutes insurers' legacy books.

The **profits of insurers will deteriorate slightly** if interest rates stay low for the next five years.

VERY LOW RISK TO PROFITABILITY

Markets in which the weight of guaranteed products is low and guarantees are very low.

The **profits of insurers will hardly deteriorate** if interest rates stay low for the next five years.



This assessment is made at the country level and mostly focuses on the direct impact of low interest rates on profitability generated by in-force policies. However, not all insurers in each country face the same level of risk. Moody's insurance financial strength ratings reflect the specificities of each individual insurer. Please refer to moodys.com for research on Moody's-rated insurers.

Source: Moody's Investors Service

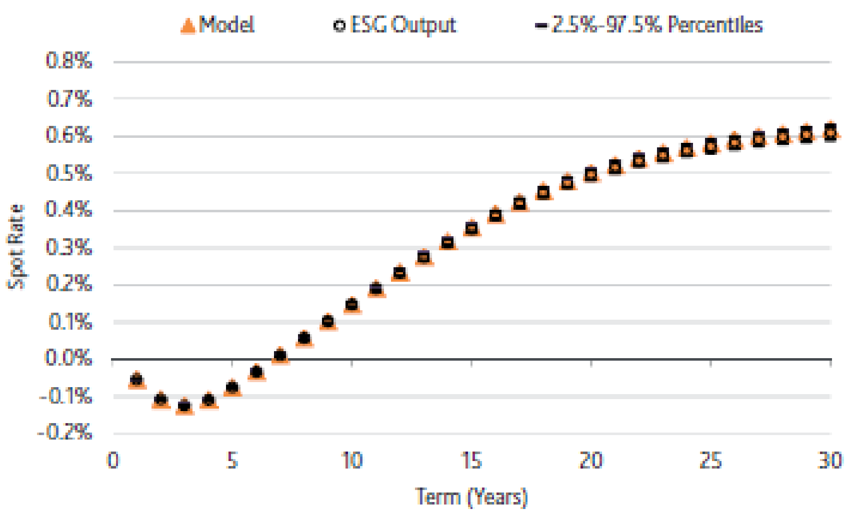
Why is accurate modelling of low rates important within MC & RW scenarios?

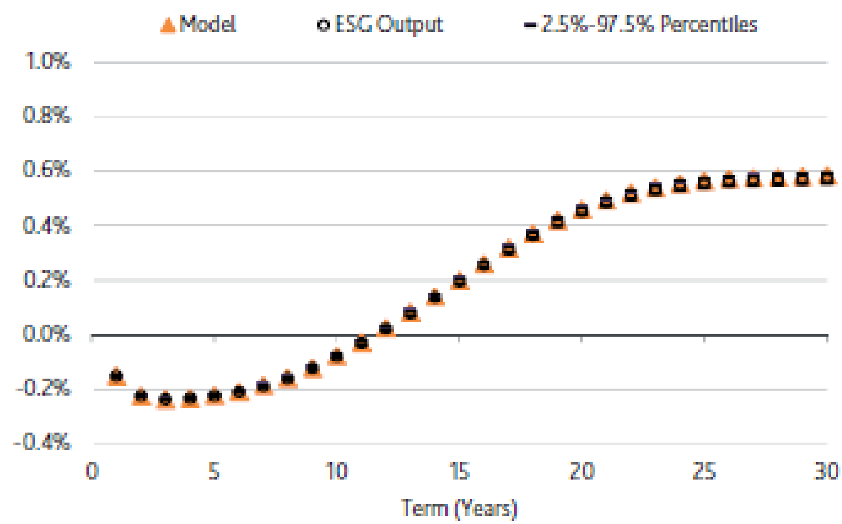
- Market consistent (MC) and real world (RW) scenarios are widely used in insurance valuation, risk management and investment applications
- The global regulatory (and firm internal) trend is to move to market basis valuation, which typically requires stochastic scenarios to value complex life insurance liabilities
- Low rates may lead insurers investing in alternative asset classes, offering higher yields, but with different risk sensitivities, which need to be accurately modelled and managed
- Government bond yields are low (or negative) and using current valuation methods display increased volatility, which significantly effect shareholder value
- When rates are close to the 'strike' on products with guarantees, pricing is at its most sensitive. In this situation accurate rate modelling is important for product pricing – insurers may wish stop issuing these products, as they become unprofitable or present an excessive an capital requirement

Implications of Low Rates for MC Valuations

Negative nominal interest rates at 2016:

» The impact of a negative policy rate in Japan has had a clear and profound impact on both swap and government yield curves



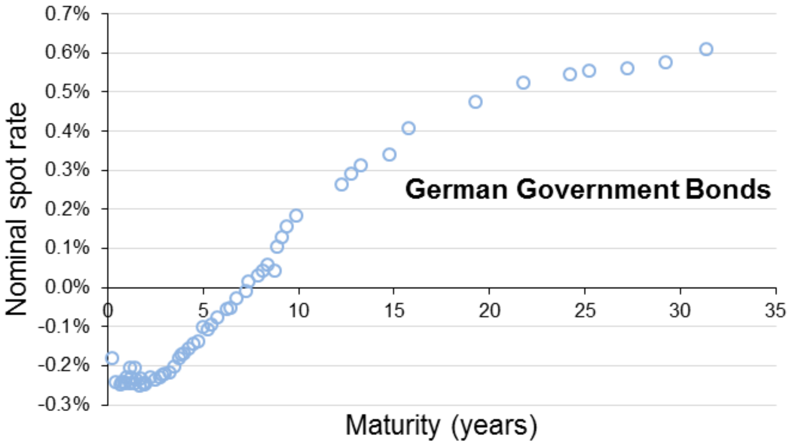


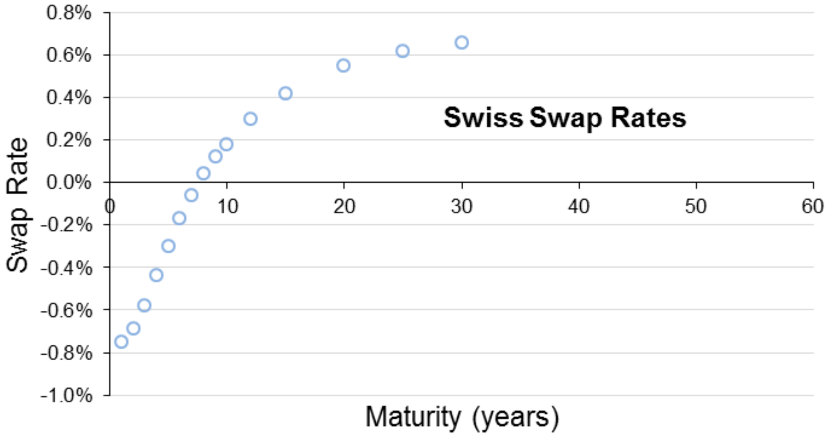
Negative nominal interest rates in other economies:

» Government bond prices implied negative yields for several economies: EUR, CHF, DKK, CZK, SEK and HKD (in 2014) and JPY.

– Observed since early 2013 for CHF.

» Negative swap rates for 4 economies: CHF, SEK, EUR and JPY





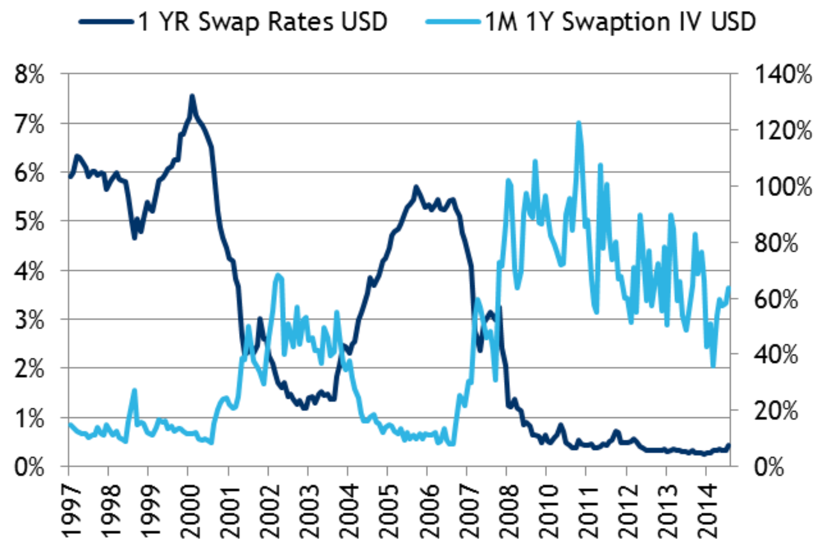
Market conventions and implications for standard practice

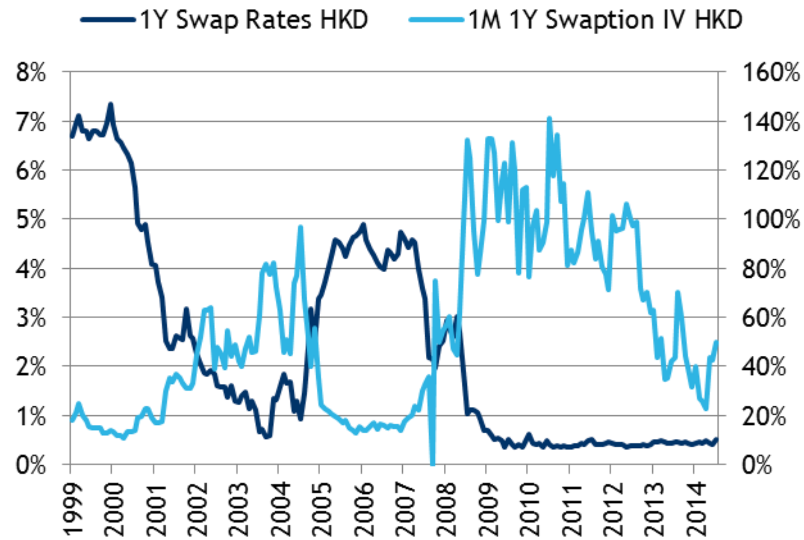
- » Lognormal assumption for interest rates is breaking down in a number of different ways
  - – Negative strikes and forward rates cannot be supported
  - – Market-implied swaption volatilities become infinitely sensitive to IR levels as rates tend to zero
  - – Skew in market-implied swaption volatilities becomes steeper and steeper the lower rates become
- » Markets responding by using alternatives to Black's swaption formula
  - – Displaced lognormal swaption formula
  - – Normal swaption formula

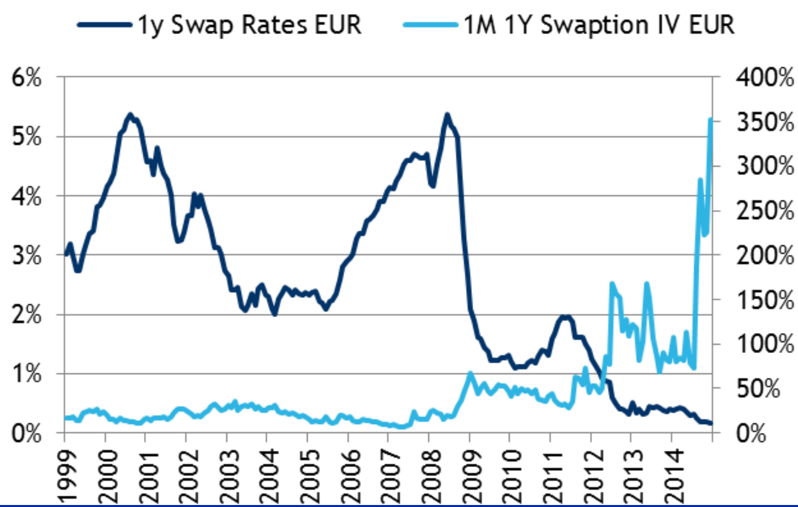
Implied Volatility	Stable?	Objective?
Black	✗	✓
Absolute/Normal	✓	✓
Displaced Lognormal	✓	✗

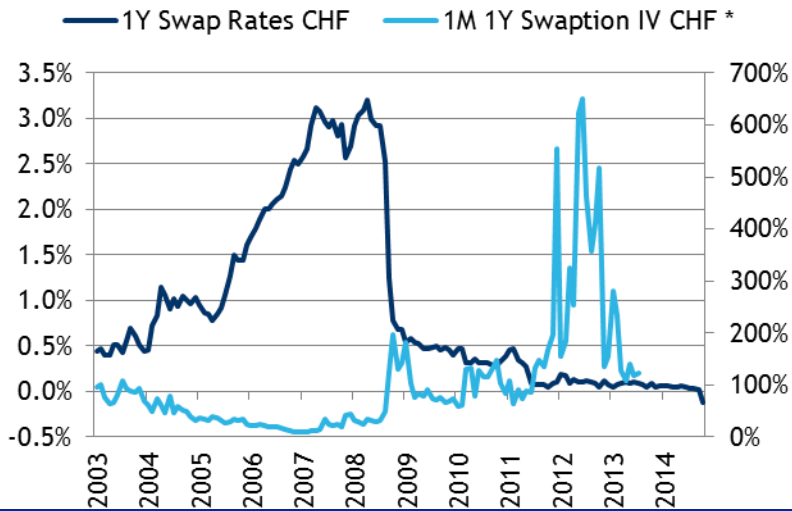
- » Choice of stochastic model for IR very important. In many market lognormal approach is increasingly unpopular – 'displaced' models can capture negative rates *and* market skew

Historical Black's Implied Volatility and Swap Rates

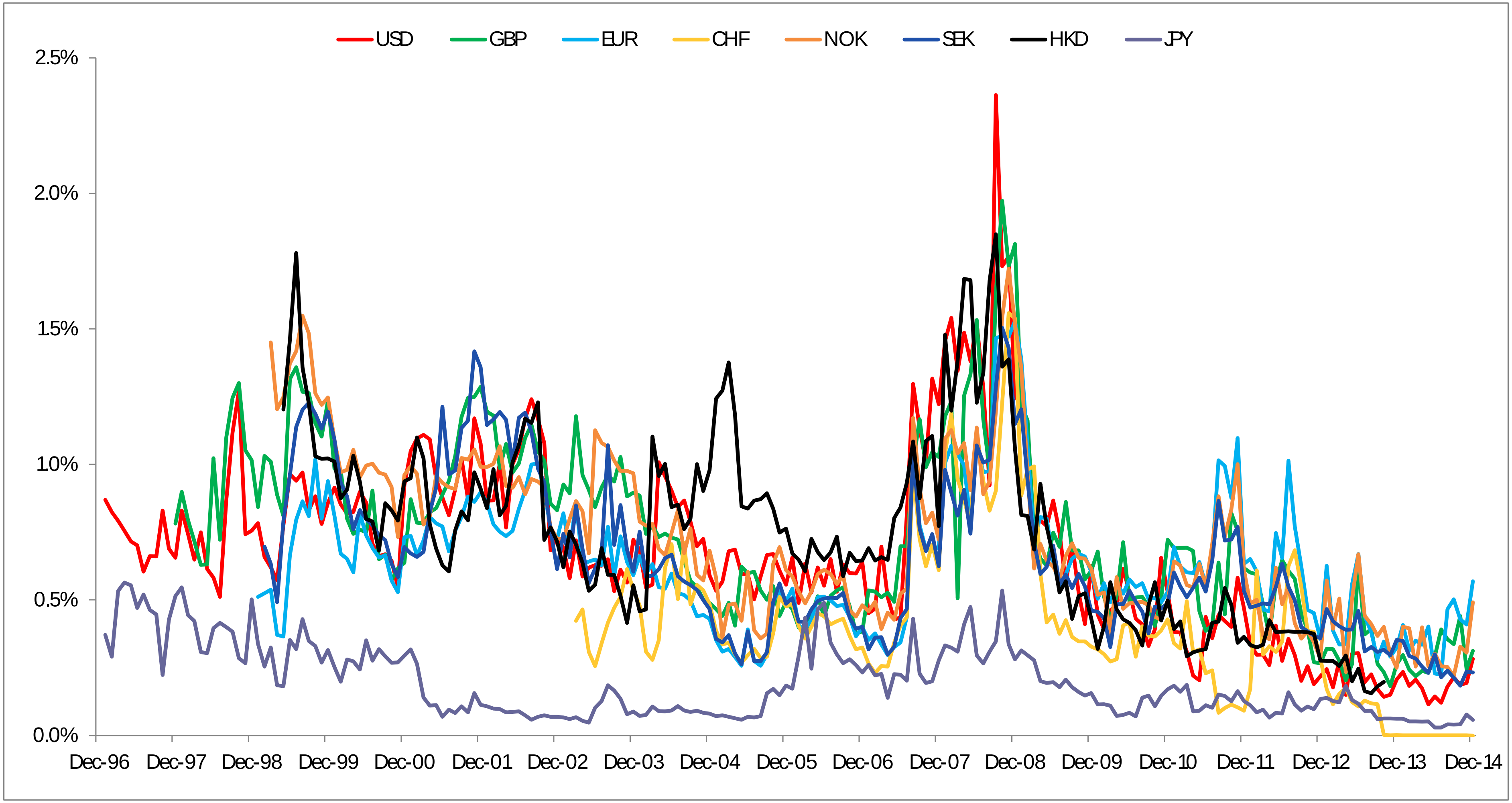








Historical Absolute Implied Volatility



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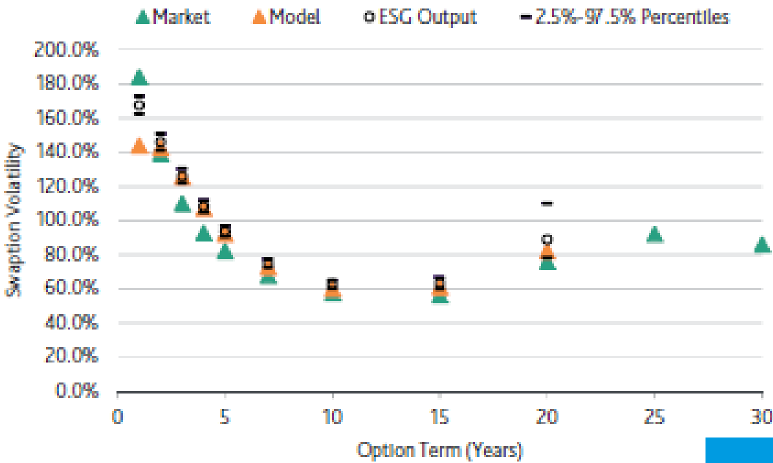
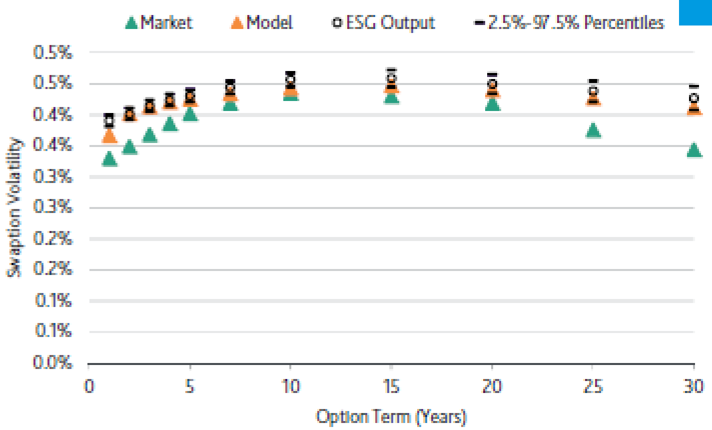
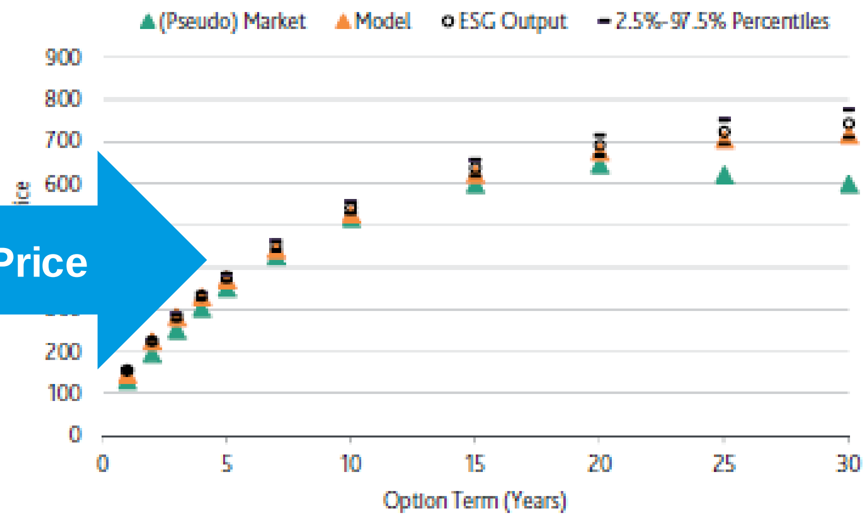
Validating ATM Fits



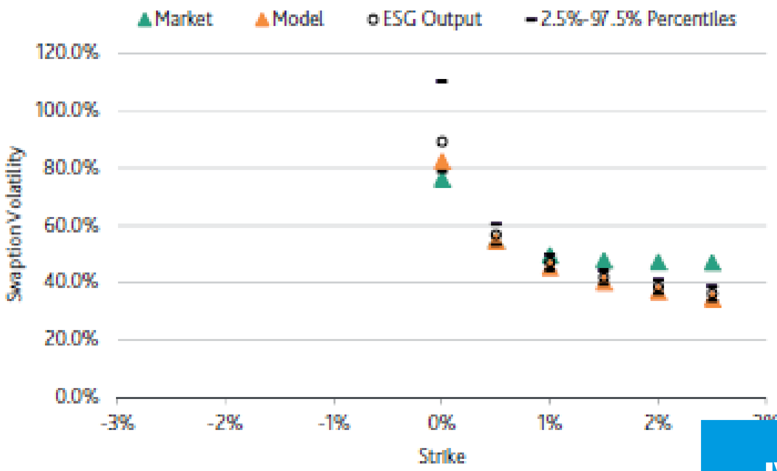


IV to Price

Fit to 10Y Swaption Prices

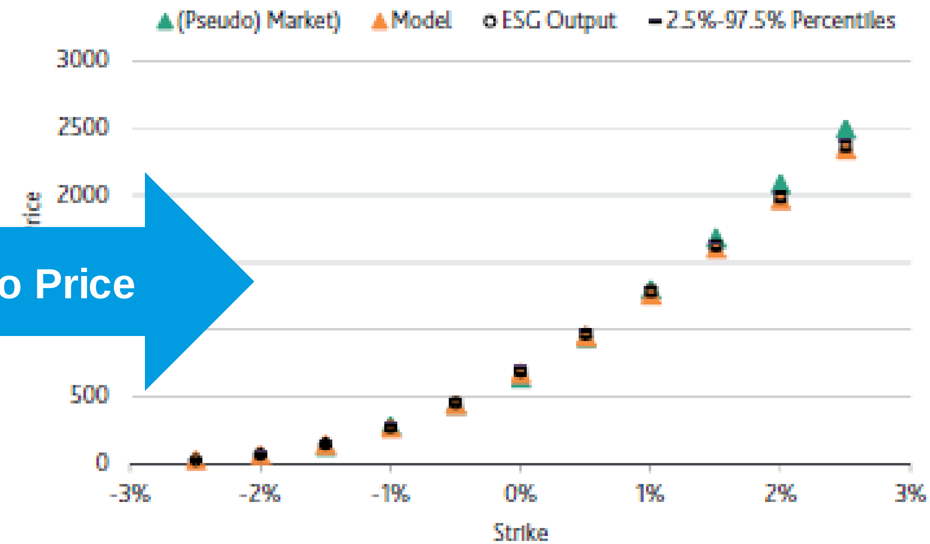


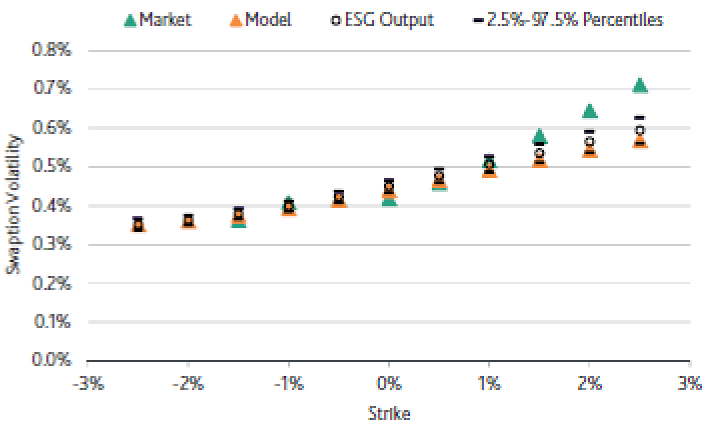
Validating Away From the Money



IV to Price

Fit to 20Y Maturity, 10Y Tenor Swaption Prices





Implications for Insurers when changing IV convention

- Evaluating fit to market, volatility extrapolation and volatility anchoring
  - Evaluating fit to market is easier with absolute/normal volatility
- Moneyness of guarantees
  - Most insurers' liabilities are deeply in the money – modelling smile important
  - Extrapolating lognormal or normal models away from the money may produce biased calculation
- Which convention to use when calculating financial exposures like effective duration and convexity?
  - Holding normal volatility constant will produce different values than holding Black volatility
- Correlation between implied volatilities and yield curve moves
  - With normal volatilities this is typically slightly positive!
- Which convention to use if base curve is changed (eg from offshore to onshore or by adding liquidity adjustment)
- Hedging interest rate risk and volatility
  - Using absolute volatility/normal volatility makes it easier to focus on hedging underlying yield curve moves

Model Key Features: Summary MC

LMM
- Log Normal
- Positive
- ATM Only

Hull White
- Normal
- Many Negative Rates
- ATM Only

(d) e2FBK
- Displaced Log Normal
- Some Negative Rates
- ATM Only

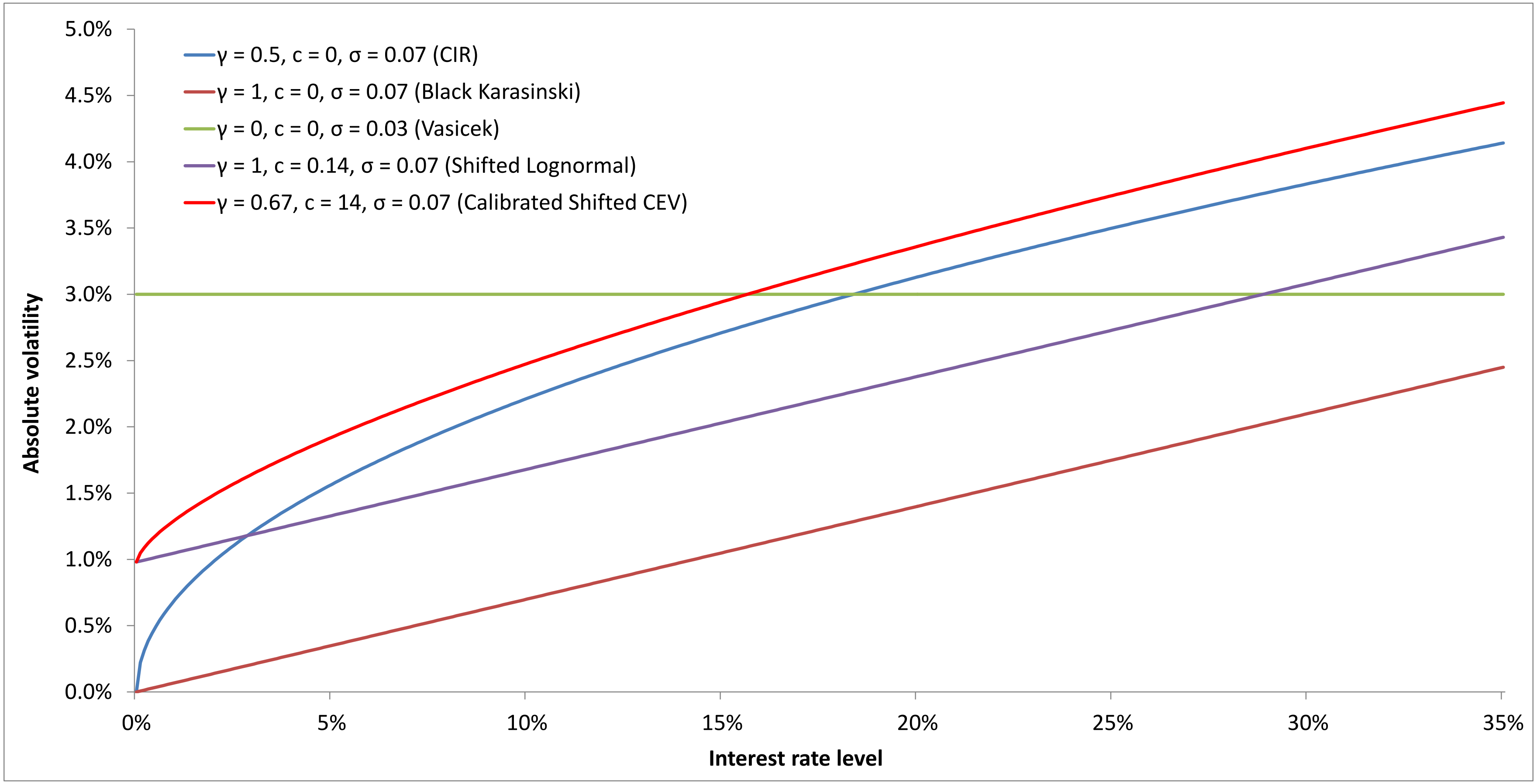
LMM+
- Displaced Log Normal
- Some Negative Rates
- ATM and AFM

	LMM	Hull-White	(d)E2FBK	LMM+
Factors	2	2(1)	2	2(3)
Negative Rates	No	Yes	Yes	Yes
Control TS Correlations	Yes	Some	Some	Yes
RMSE ATM	4.56	4.82 (6.23)	4.53	4.14
RMSE All	19.59	8.28 (9.89)	9.17	5.72

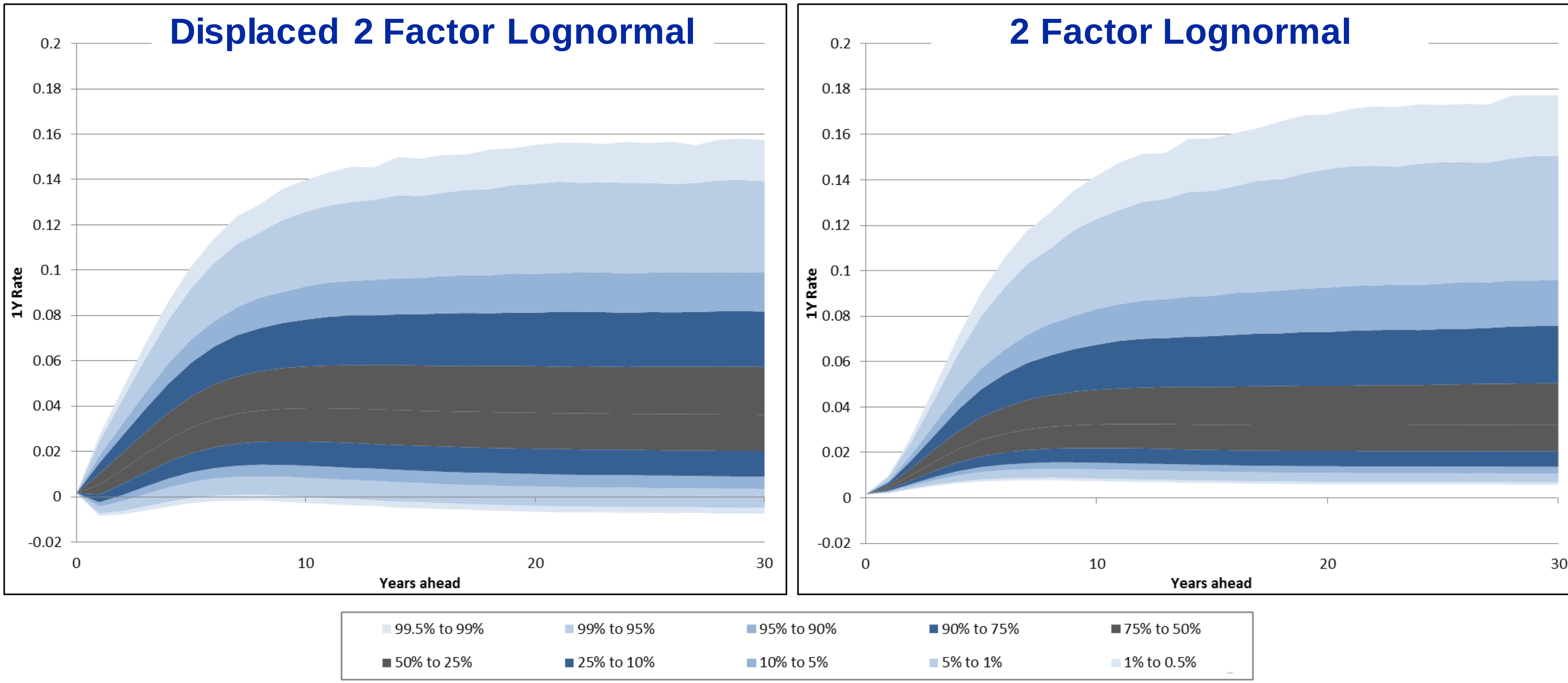
Implications for RW Projections

Interest rate models; a number of approaches to proportional volatility

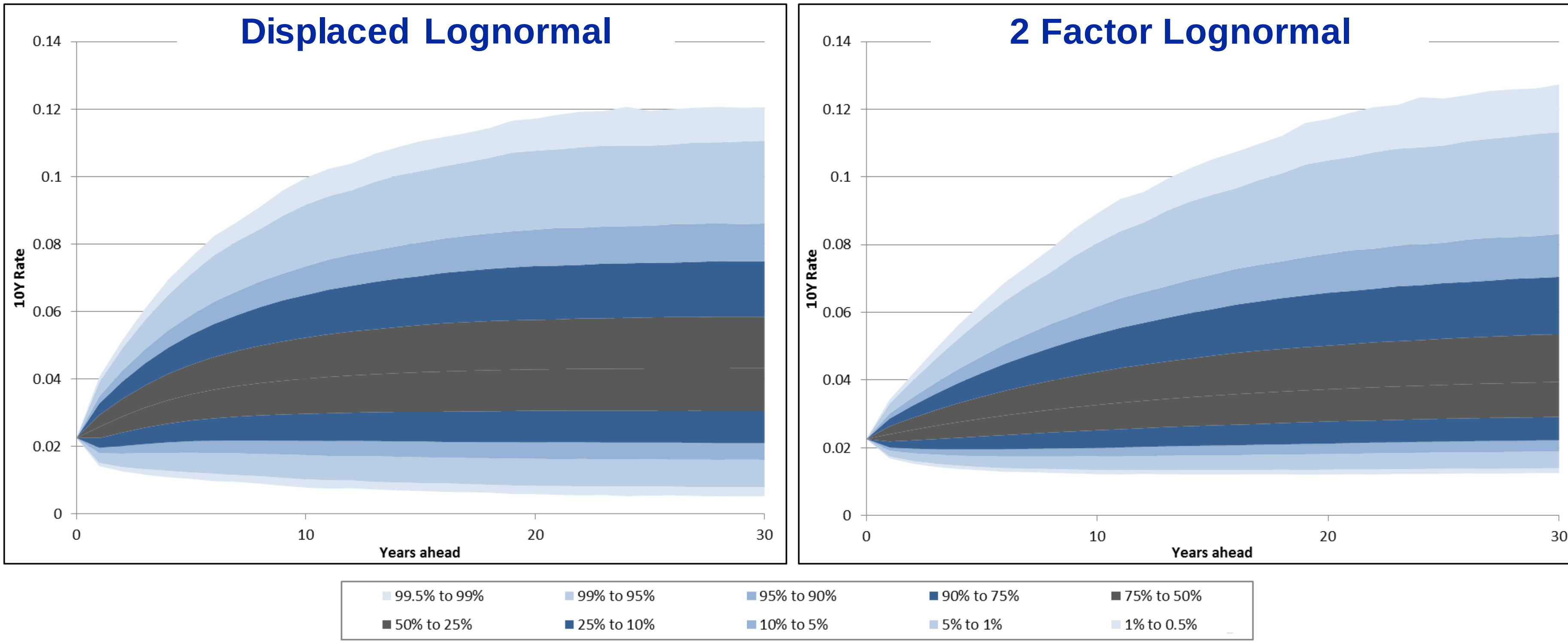
$$dr = (a + br)dt + \sigma(r^{\gamma} + c)dZ$$



Real world model comparison lognormal and displaced, 1Y rates



Real world model comparison lognormal and displaced, 10Y rates



Model Key Features: Summary RW

LMM
- Log Normal
- Positive
- No path control

Hull White
- Normal
- Many negative rates
- Unrealistic downside

LMM+
- Displaced Log Normal
- Some negative rates
- No Path Control

(d) e2FBK
- Displaced Log Normal
- Some negative rates
- Control 2 rate paths

	LMM	Hull-White	LMM+	(d)E2FBK
Factors	2	2(1)	2(3)	2
Negative Rates	No	Yes	Yes	Yes
Control TS Correlations	Yes	Some	Yes	Some
CTP	No	Yes	No	Yes
TVTP	No	Yes	No	Yes

Why is accurate modelling of low rates important within MC & RW scenarios?

» Very low, persistent and even negative rates a reality.
  – Even just few years ago not uncommon to assume that it couldn't happened full stop!

» As discussed low rates pose challenges from a modelling perspective:
  – From both a valuation of liability perspective
  – And how you project real world outcomes

» More importantly poses a (potentially significant) risk for insurance companies
  – Particularly for life businesses with guarantee products

» Important to be aware and prepared to incorporate suitable models
  – Accurate pricing/valuation of liabilities becomes very relevant.
  – Do certain products remain viable?
  – If you're projecting interest rates a key (obvious?) risk to capture.