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# Economic Scenario Generators

Lessons Learned from History

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*on behalf of the*  
Extreme Events Working Party



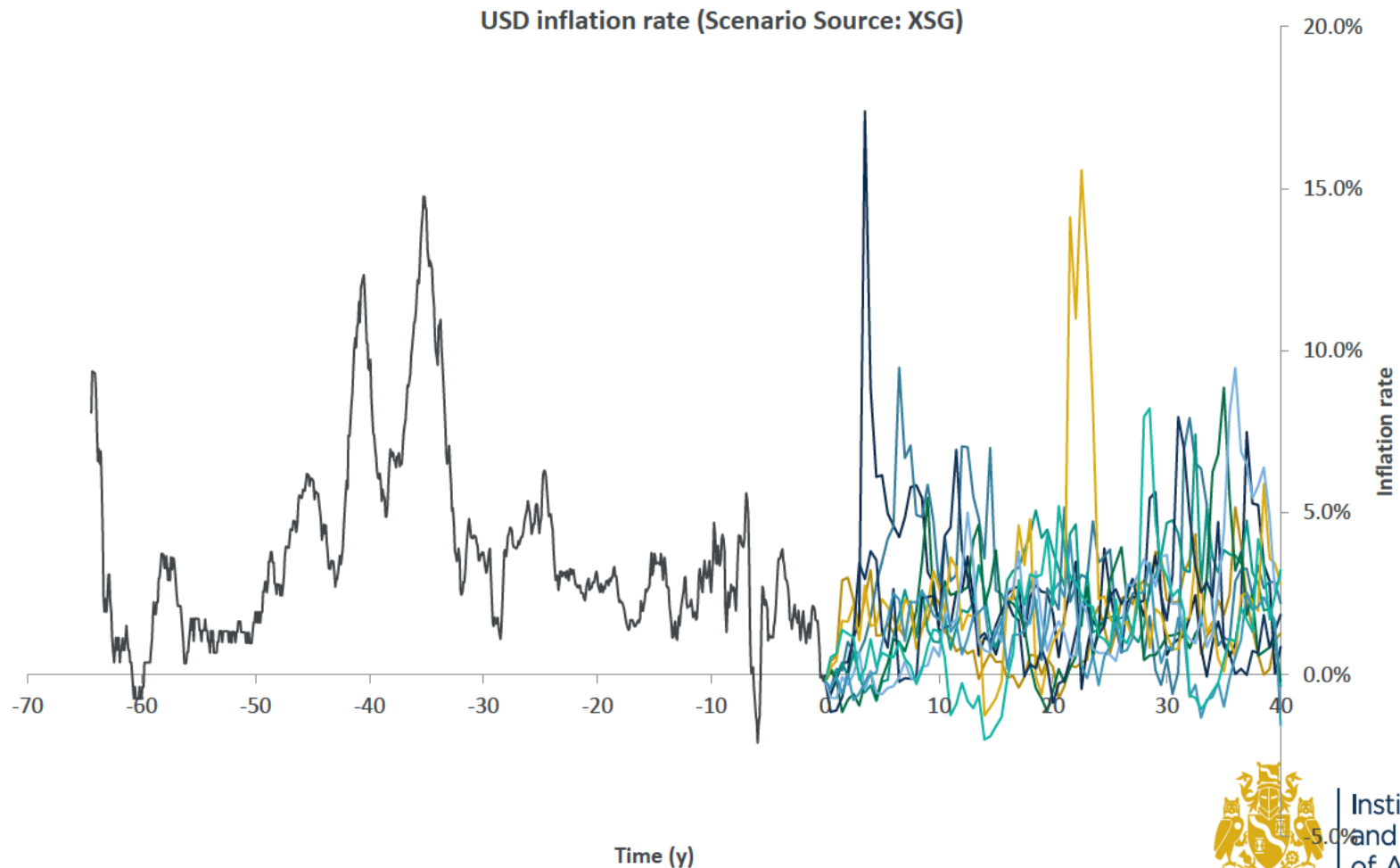
# Abstract

Some UK insurers have been using real-world economic scenarios for more than thirty years. Popular approaches have included random walks, time-series models, arbitrage-free models with added risk premiums or one-year distribution fits. Based on interviews with experienced practitioners, this workshop traces historical model evolution in the UK and abroad. We examine the possible catalysts for changes in modelling practice with a particular emphasis on regulatory and socio-cultural influences. We apply past lessons to provide a non-technical perspective on the direction in which firms may develop real world multi-period economic scenario generators in future.



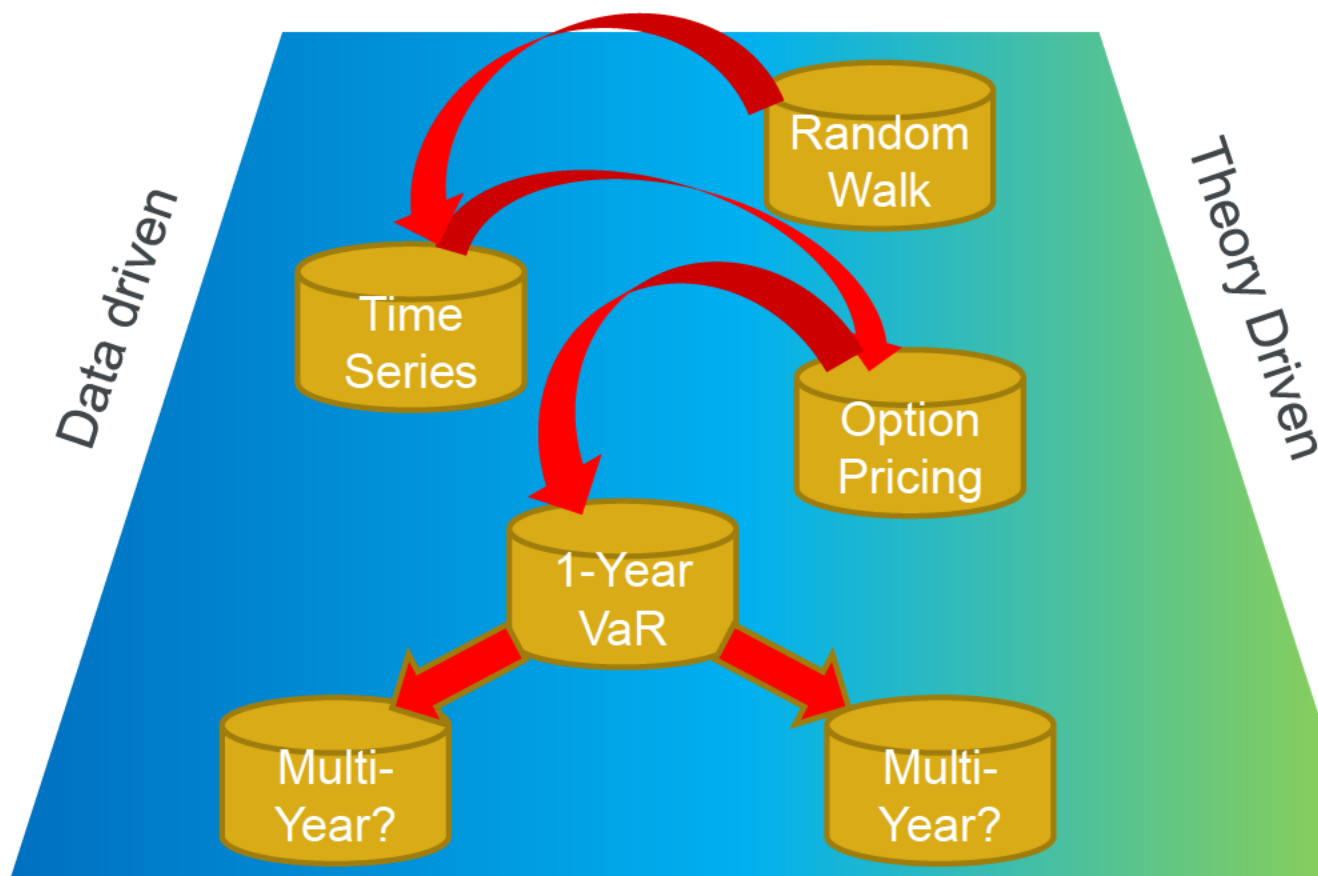
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# Example ESG Output: Funnels of Doubt



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# Bridging Data and Economic Theory



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# Our Survey (in progress)

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# Example Background Questions

- What do you feel are the most important / material components of an ESG?
- What is the range of tasks / decisions that you use/produce Economic Scenario Generators for?
- Do you think some model users place too much reliance on calibrations they don't understand?
- Do you feel that the general awareness has improved over time?
- How important do you think it is that models are published in (peer-reviewed) journals?



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# Factors Influencing Change in the Past

- What are the key factors that affect change within the ESG industry historically? Would you classify them as user led, designer led, or led by exogenous factors.
- With hindsight were there any features that you wanted from an ESG that weren't available when you needed them?
- Why do you think time series models (such as Wilkie) supplanted random walk models in the 1980's?



# Past Changes: Continued

- In 2003 the FSA introduced realistic reporting requirements (for UK with-profits funds), and about the same time, market-consistent economic scenario generators became available. Cause or effect?
- In the run-up to the ICAS regime and more recently the Solvency II regime, many insurance firms had access to multi-period, realistic (at least in spirit) scenario generators. Yet few of these insurers now use those models to calculate capital requirements. Instead, one-period models with explicit marginal distributions are prevalent. Why do you think this is?







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# Technical and Social Model Criteria

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# Examples of Technical Criteria

- Goodness of fit to historical data.
- Ability to forecast outside the sample used for calibration, also called “back-testing”.
- Desirable statistical properties of estimated parameters, such as unbiasedness, consistency and efficiency.
- Accuracy in replicating the observed prices of traded financial instruments such as options and other derivatives.



# Examples of Social Criteria

- Ease of design, coding, parameter estimation.
- Commercial timescale and budget constraints.
- Auditable model output that can be justified to non-specialists in intuitive terms.
- Compatibility of model output and input fields with data sources and other software systems.
- Ability to control model output.
- Re-use models developed for other purposes (few economic scenario generators developed specifically for GI).



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# Random Walk Model

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# UK Returns in the 20<sup>th</sup> Century

Return	Asset	Geometric	Arithmetic	Stdev
Nominal returns	Equities	10.1%	11.9%	21.8%
	Bonds	5.4%	6.1%	12.5%
	Bills	5.1%	5.1%	3.9%
	Inflation	4.1%	4.3%	6.9%
Real returns	Equities	5.8%	7.6%	20.0%
	Bonds	1.3%	2.3%	14.5%
	Bills	1.0%	1.2%	6.6%
Risk premiums	Equities vs bills	4.8%	6.5%	19.9%
	Equities vs bonds	4.4%	5.6%	16.7%
	Bonds vs bills	0.3%	0.9%	11.3%

Source: Dimson, Staunton & Marsh.



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# Random Walk Properties

- Captures one general factoid, that asset returns in different periods have low correlation, but cannot capture bond pull-to-parity.
- Small number of intuitive parameters (expected return, volatility, correlations).
- Connection with efficient market hypothesis (which is simple even if not correct).
- Historic statistics have been collated in a way that makes calibration easy.

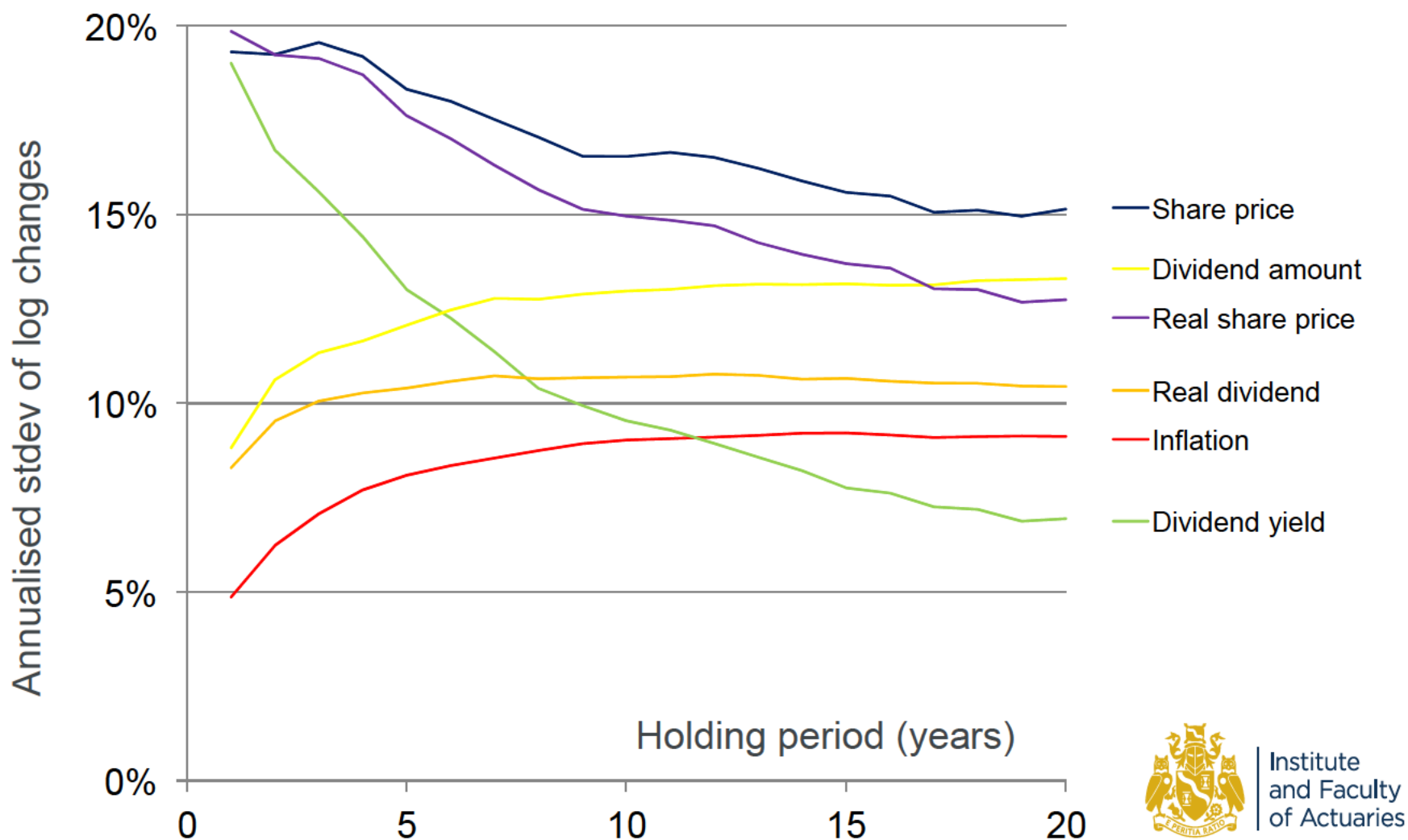




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# Time Series Analysis

# Volatility Term Structure (Wilkie Model)



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# Wilkie Model vs Random Walks

- Published model in a peer reviewed journal, with recommended parameters, discussed by the Faculty of Actuaries, and reviewed in several other published papers
- Easy to code in a spreadsheet
- Use of static “strategic” asset allocation modestly improves expected return for an acceptable level of risk, by increasing equity allocation or making portfolios more efficient (according to the model).
- Dynamic optimisation results are unbelievably good.



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# Some Difficult Pensions Questions

- Compared to a random walk, Wilkie's equity volatility term structure implies shares are a better long term match for long term inflation linked liabilities.
- Widespread use of Wilkie and similar models accompanied a general increase in pension scheme equity allocations in the period 1980-1995
  - Was the increase *because of* the Wilkie model?
  - Did it lend support for risky strategies that trustees or sponsors wanted to adopt anyway?
- How would we describe the key judgements?





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# Option Pricing Models

# What are Option Pricing Models?

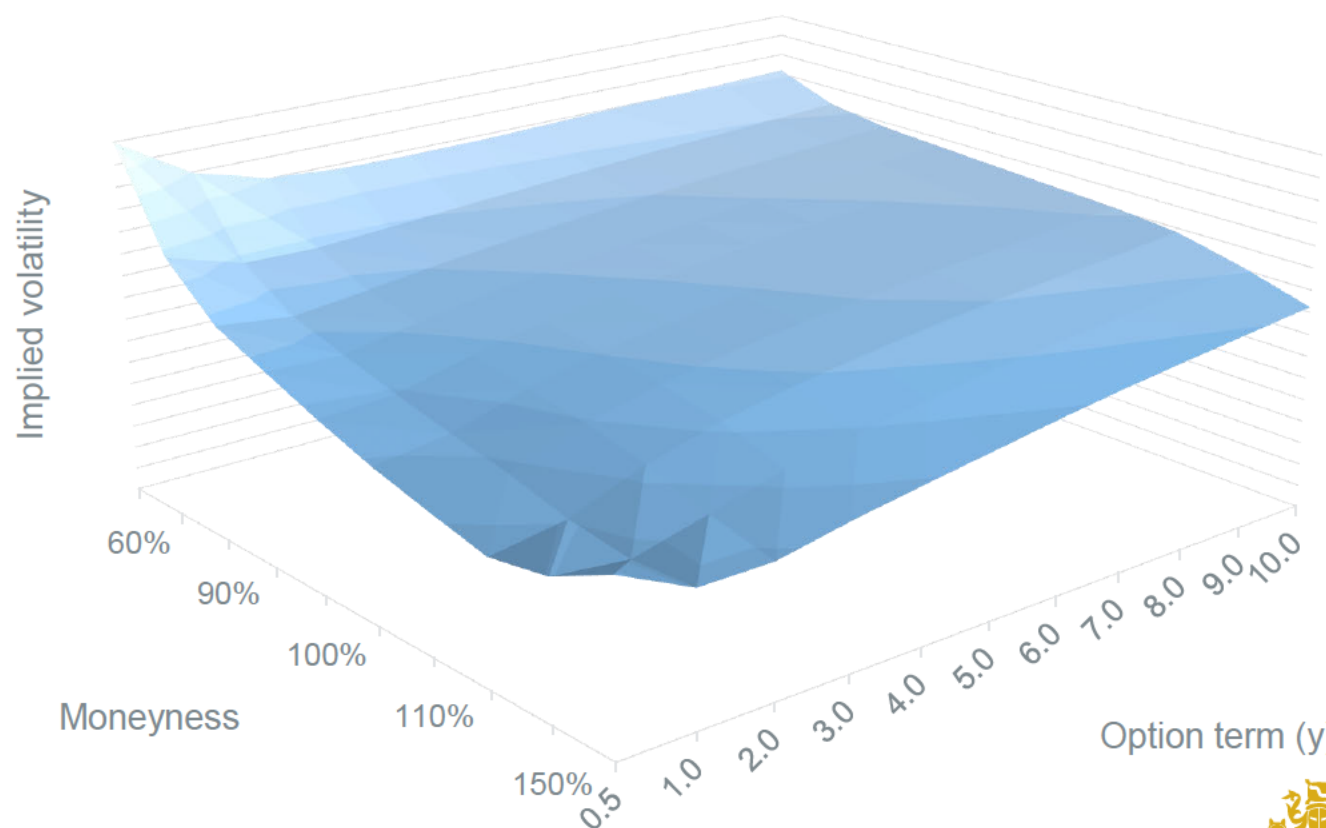
- Theories for pricing options and other derivatives, under idealised (frictionless) market assumptions.
- Little consensus of how to adapt the framework for risk premiums associated with market imperfections such as illiquidity premiums, funding or capital cost.
  - These are relevant for GI investors seeking illiquidity premiums for example in asset-backed securities
- Some (but not all) general insurers have used these models, even though they don't need to price options. What were the reasons for this?



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# Deriving Parameters from Option Prices

FTSE 100 implied volatility (Q2 2015)



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# Why did Option Models become Popular?

- Straightforward solutions for pricing options and guarantees, and easy to hire people able to implement them.
- If you assume a diffusion model, then subsequent calibration to option prices appears “objective”.
  - Given the derivatives whose prices happen to be observed.
  - Difficult for traders to game the calibration process.
- Adding constant risk premiums to option pricing models gives stability to dynamic utility-maximising portfolios, (unlike for Wilkie-style models)

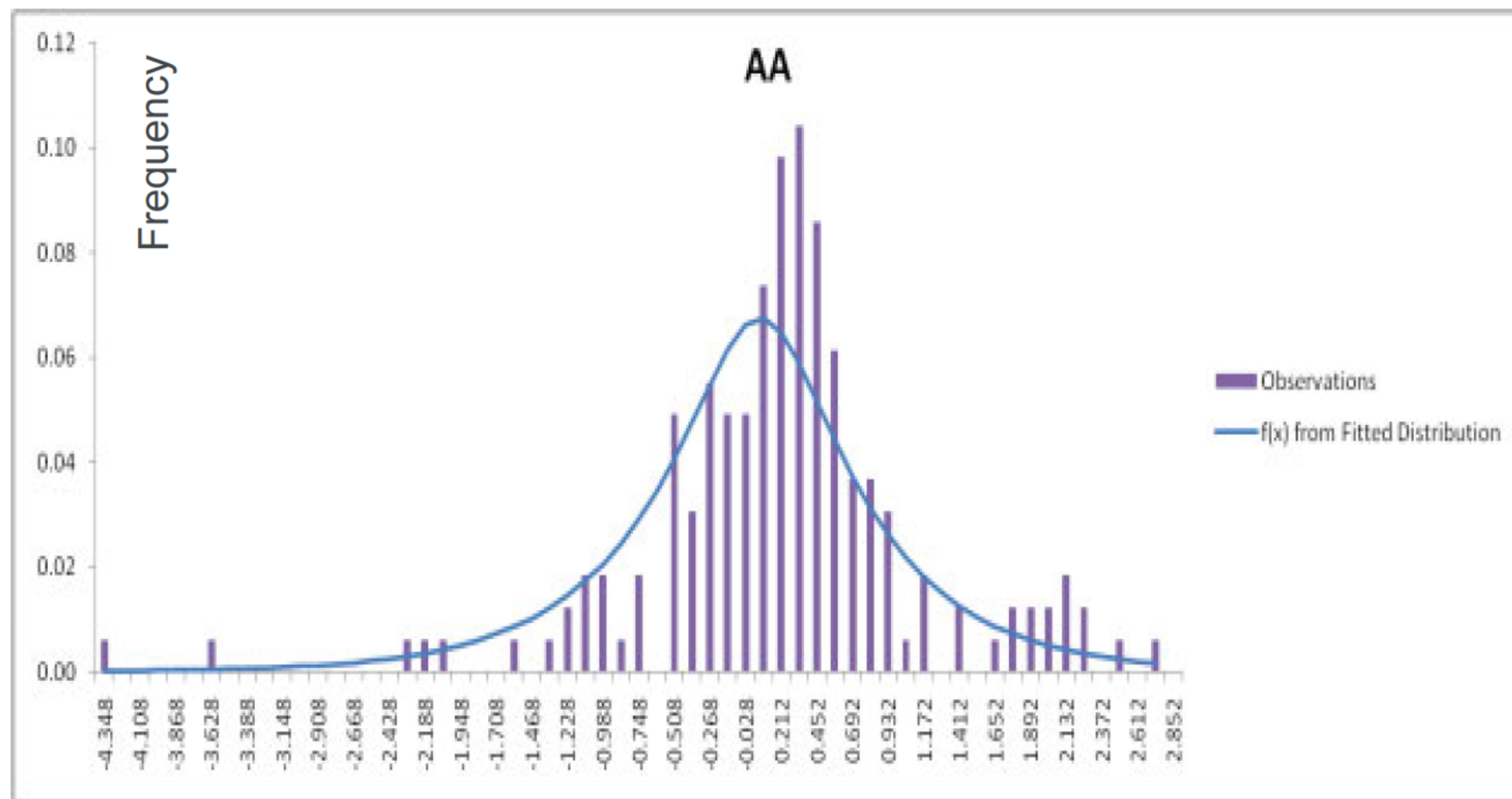




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# One Year Value-at-Risk

# Fitting Changes in AA Bond Spreads



Stationarity adjusted change in AA spreads



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# One Year Var Models

- Sample moments of historic distributions (mean, standard deviation, skewness, kurtosis) translate directly into a fitted distribution
- Graphical governance: histograms, PP plots, percentile of historic events
- Industry standard approach has now been explained to regulators, rating agencies etc.



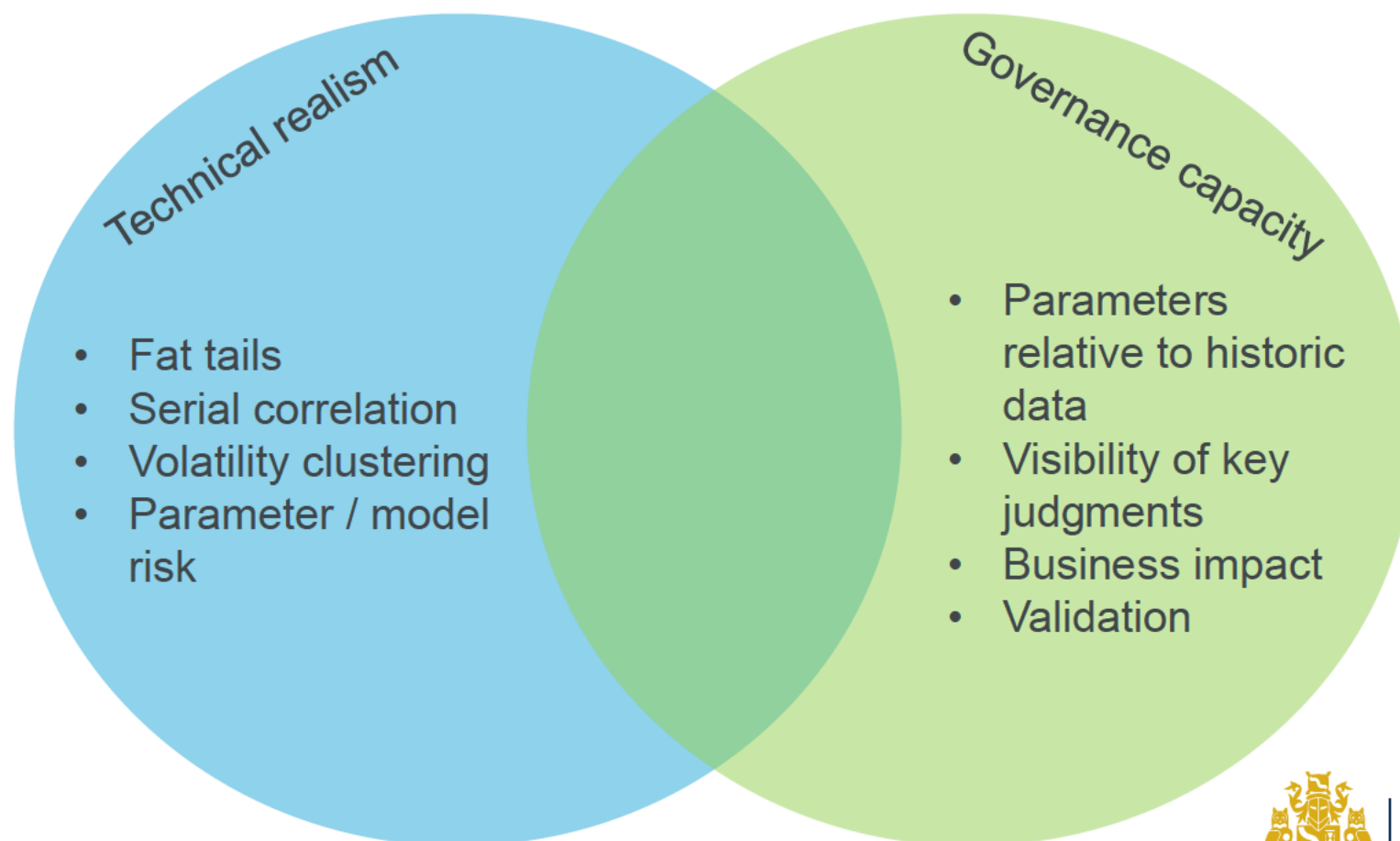


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# What the Future Holds

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# Can we Dust off the Wilkie Model?



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# What will determine Future Models?

- The history of scenario generators is not one of steadily increasing technical sophistication.
- Governance processes for multi-period models, as for 1-year VaR, now requiring term structures of return, volatility, skew, kurtosis.
- Importance of identifying “key” judgments.
- Permission is needed to discuss social constraints. Flexible software can help but does not make the judgements for you.



# Questions

# Comments

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