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# Economic Scenario Generators

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# Economic Scenario Generators

Evolution & Lessons Learnt from History

# 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.”*

*- Extreme Events Working Party*

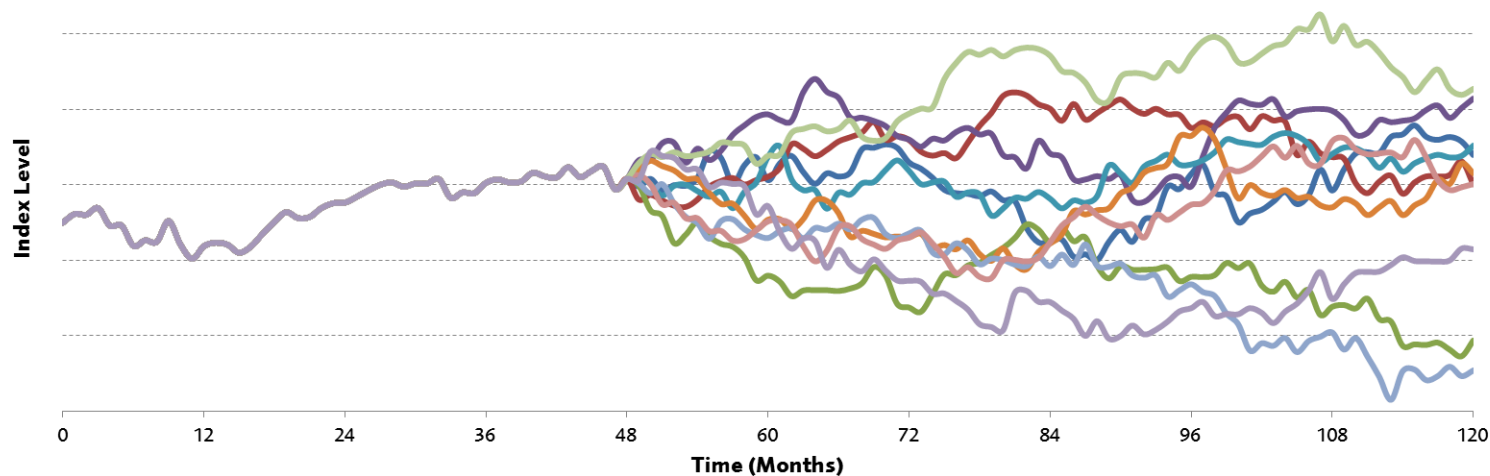


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# The need for stochastic models

- *We have only one past, but unfortunately face many possible futures...*

## One Past, Many Futures...



# Interviews & Research

- Selected key individuals over an extended historical period (1970s to 2010s)

Gabriela Baumgartner	John Hibbert
Andrew Candland	Adam Koursaris
Stephen Carlin	Patrick Lee
Andrew Chamberlain	John Mulvey
David Dullaway	Craig Turnbull
Adrian Eastwood	Ziwei Wang
David Hare	David Wilkie

- Have 14 interviews so far, with others in progress...





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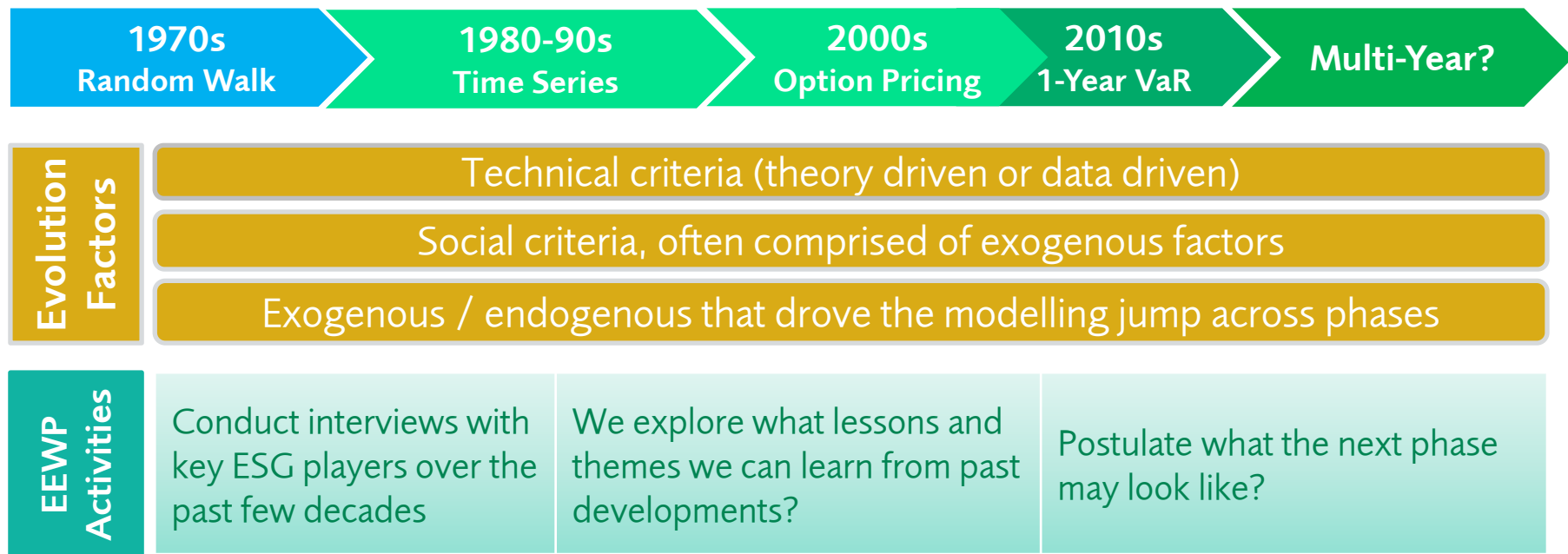
# Evolution of Economic Scenario Generators

14 June 2017

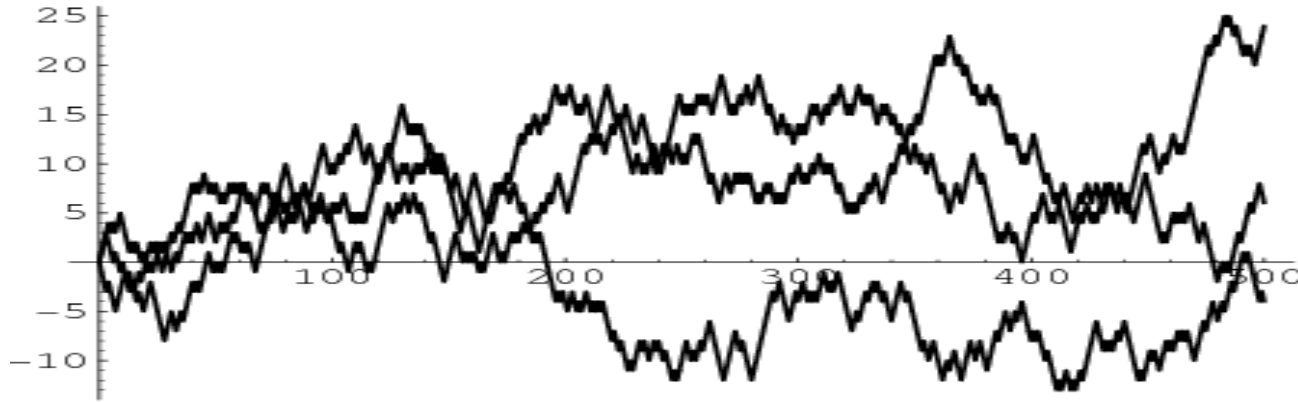
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# Evolution of Economic Scenario Generators



## Phase A – Random Walks



- A significant step up from deterministic models
- Leveraged the rise of computing power since the 1950s, together with the Monte Carlo processes in physics
- Captures one general factoid, that asset returns in different periods are independent and identically distributed
- Small number of intuitive parameters



## Phase B – Time Series Models



- Captured developments in statistics e.g. **Box and Jenkins (1969) Time Series Analysis – Forecasting and Control**
- **A. D. Wilkie (1984) – A stochastic Investment Model for Actuarial Use**; Presented to Faculty of Actuaries, published in a peer reviewed journal.
- Extensively used in Investment Modelling

# Wilkie Model vs Random Walks

## Wilkie Model

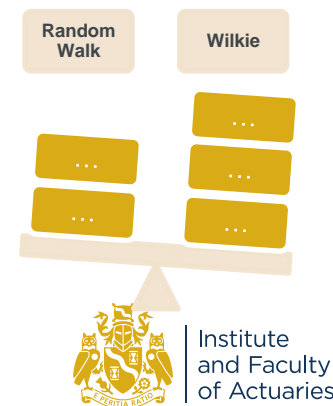
Published model in a peer reviewed journal, discussed by the Faculty of Actuaries, and reviewed in several other published papers.

Recommended parameters included, and 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).

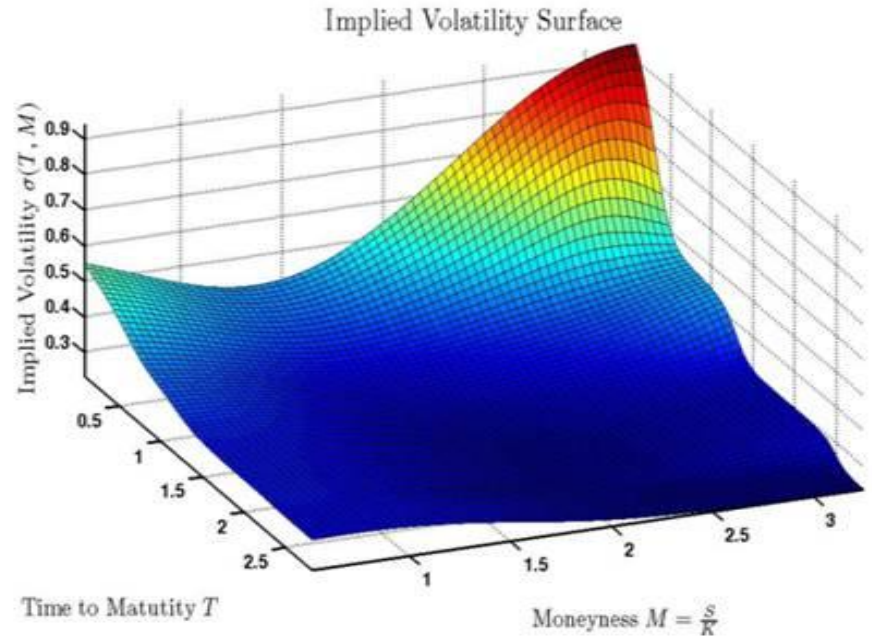
### Some Difficult Questions

- *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 1980-1995;*
- ***But was the increase because of the Wilkie model?***

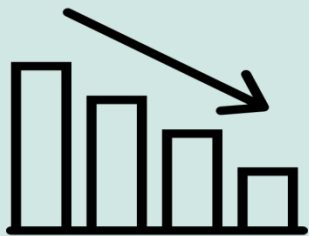


# Phase C1 – Option Pricing Models

- Very much theory driven
- Pricing of options and other derivatives, under idealised (frictionless market conditions)
- **Fisher Black, Myron Scholes (1973) *The Pricing of Options and Corporate Liabilities***
- **J. Hull, A White (1990). *Model of future interest rates***
- Often different bottom-up models for different asset classes, challenging to consider from a holistic perspective

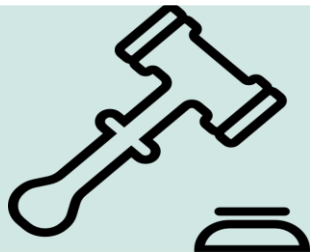


# Why did Option Models become Popular?



## Crisis

Post Equitable Life, a general realisation that embedded “**Cost of Guarantees**” was a critical factor for insurance company balance sheets



## Regulations

In 2003 the FSA introduced realistic reporting (for UK with-profits funds), which required ‘**market consistent**’ arbitrage free models



## Arbitrage Free

This condition was difficult to achieve from a Wilkie Model; led to new avenues. Adding risk premia also retained some *Real World* benefits.

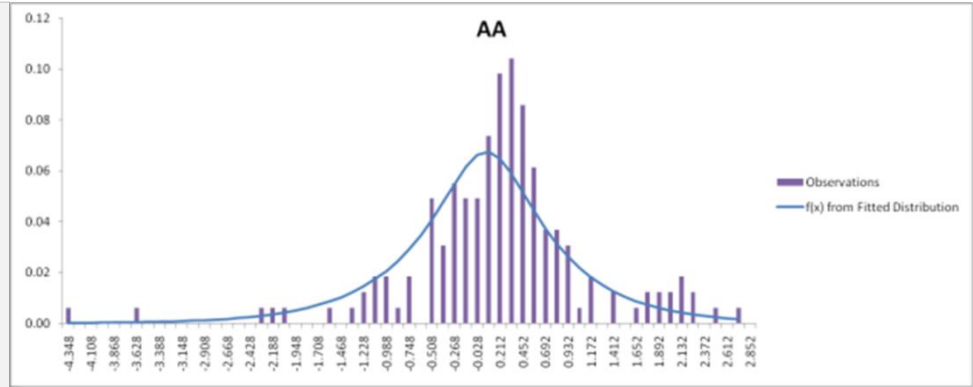


## Ideas from Banking

Influence of ideas from banking option pricing models. These were more advanced at asset class level (and linked to markets).

# Phase C2 – One Year VaR

- Data driven
- Use of distributions imposed by regulations requiring 1 in 200 event. ICAS, Solvency II
- Focus on tails of distribution, kurtosis
- Self-assessment introduced by the FSA with effect from 31.12.2004 (GENPRU 2.1.6)
- Extreme Events Working Party created and published work on different asset classes.



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# Factors Influencing Change in the Past

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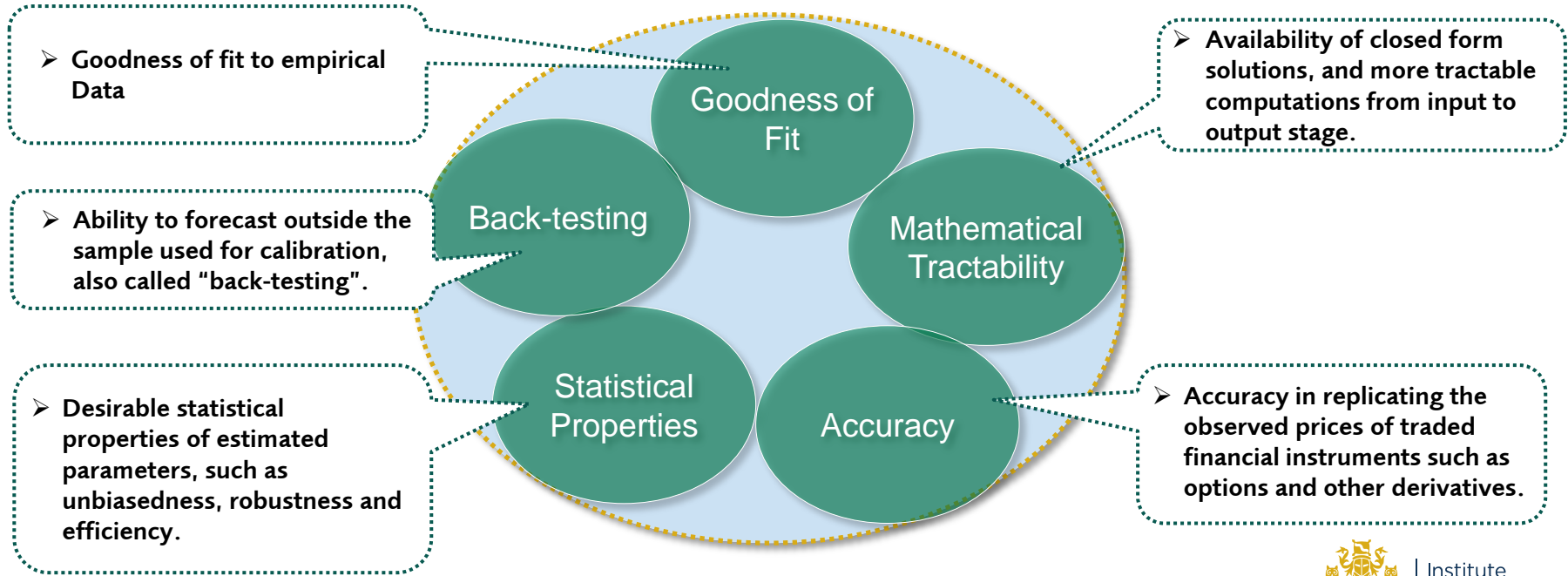
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# Factors Influencing Change in the Past

- Most interviewees have suggested changes regulatory led, *e.g. move to market consistent valuations led by the FSA*
- Some changes have been driven by unforeseen changes in the economic environment, *e.g. negative interest rates currently*
- Some user led by shortcomings in ESG's and some have been developer led, *e.g. the Wilkie model introducing stochastic modelling for the reserving of guarantees*

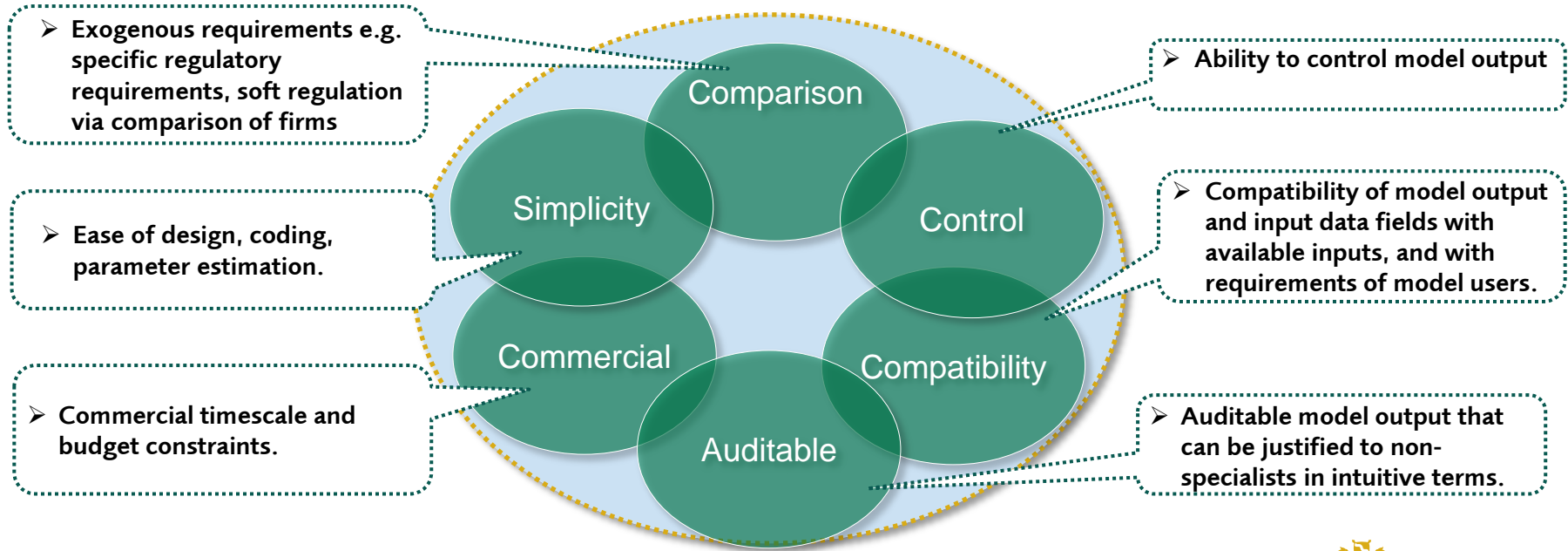


# Examples of Technical Criteria





# Examples of Social Criteria





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# Current & What the Future Holds

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# Uses and Awareness

- ESG's now used much more widely than was the case in the past in particular for valuation and reporting, although some core uses have persisted over time.



# Have ESGs captured material risks?

!! Negative rates + have been completely missed by some models, and large fall in rates significantly underestimated



Parameterisation of extreme events



These are difficult to predict, and often results in over or underestimation of risks

“A continual learning process to develop models against the backdrop of real world experience”.



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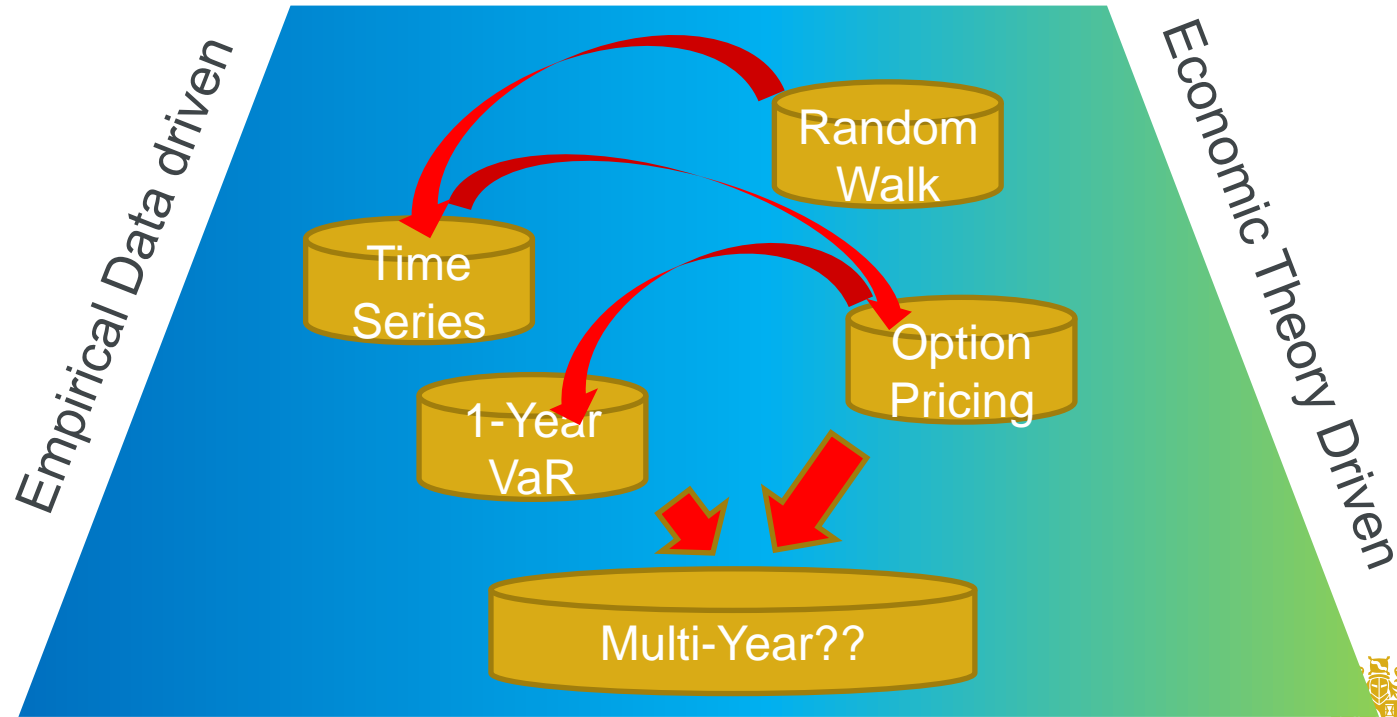
# What will determine Future Models?

The history of scenario generators is not one of steadily increasing technical sophistication, but is impacted by occasional jump processes

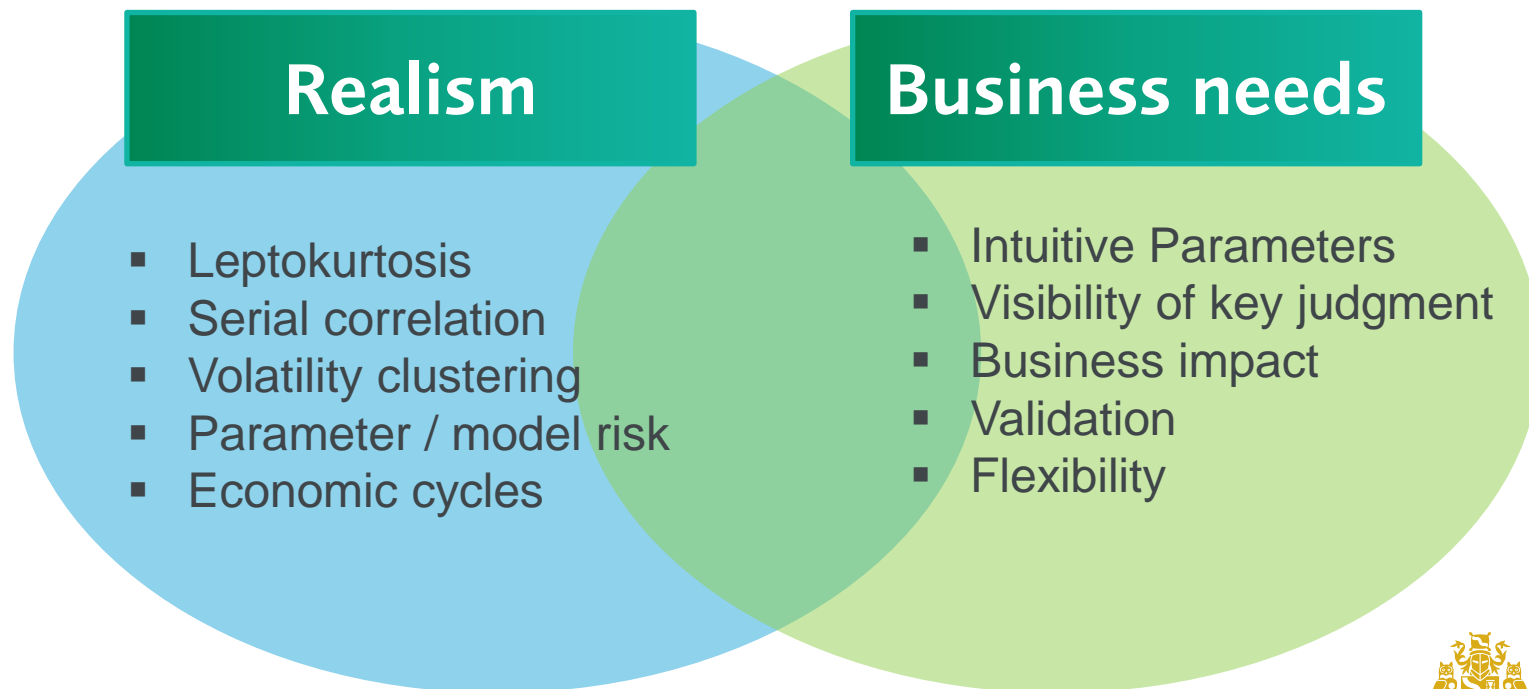
Evolutionary Factors	New Asset Classes (e.g. alternative assets)	Economic Cycles	Multi-Period Real World	Identifying Key Judgements
Exogenous Jumps	New Regulations	Market Crises	Disruptive Influences (e.g. developments in Big Data)	Social Influences (e.g. “factor” modelling)



# Bridging Data and Economic Theory



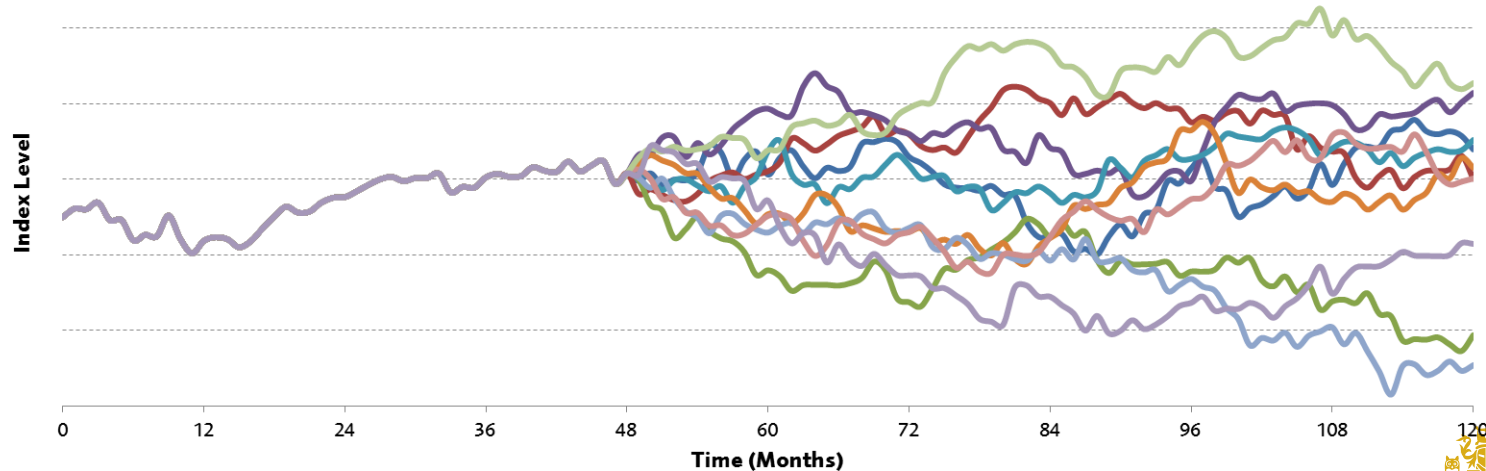
# Can we Dust off the Time Series Model for Multi Year?



# The Challenge

*A truly accurate model of the (asset) world would potentially be as large as the asset world itself! The problem is compounded by the need to extrapolate in time and probability. Beware of complexity, challenge to summarise the universe efficiently*

**One Past, Many Futures...**



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# Thanks

A large thanks to the members of the Extreme Events Working Party, in particular Sandy Sharp, Andrew Smith and Andrew Rowe.

We also owe large debt of gratitude to a number of key players in the stochastic modelling space who have been generous with their time and thoughts as we seek to uncover some of the historic drivers of change.



# Questions

# Comments

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