



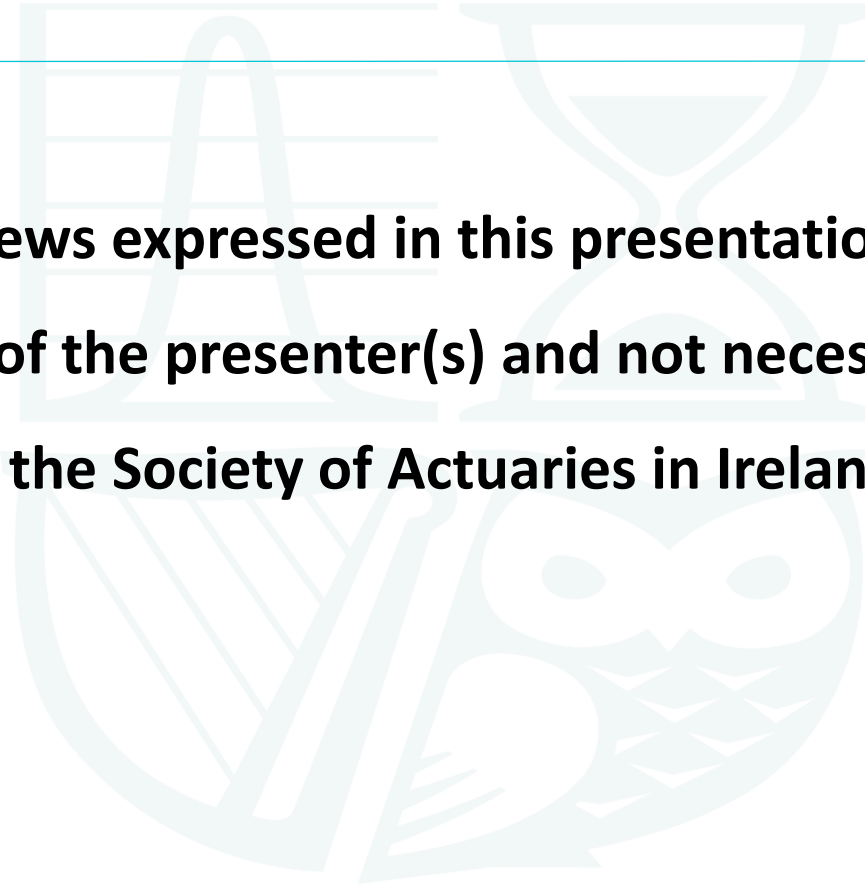
Society of Actuaries in Ireland

Evolution of Economic Scenario Generators

Andrew Smith

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Evolution of Economic Scenario Generators

Extreme Events Working Party

Chair: Parit Jakhria

Presented by: Andrew D Smith

Society of Actuaries in Ireland

24 April 2018

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

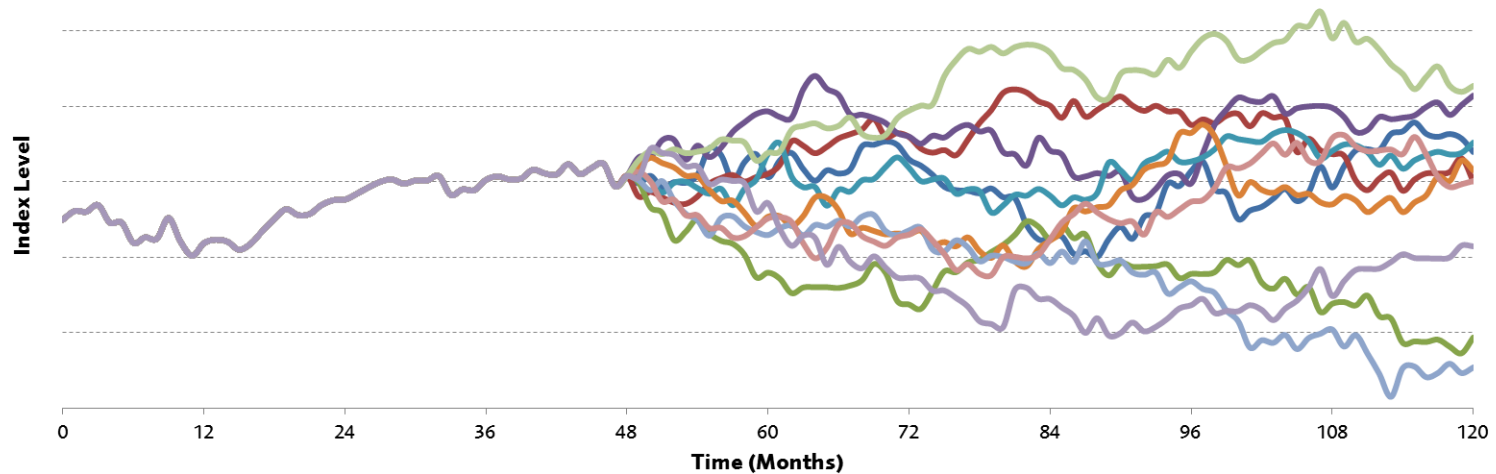


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The need for stochastic models

- *We have only one past, but we 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...





Evolution of Economic Scenario Generators Phases over time

Expertise
Sponsorship
Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals
Supporting

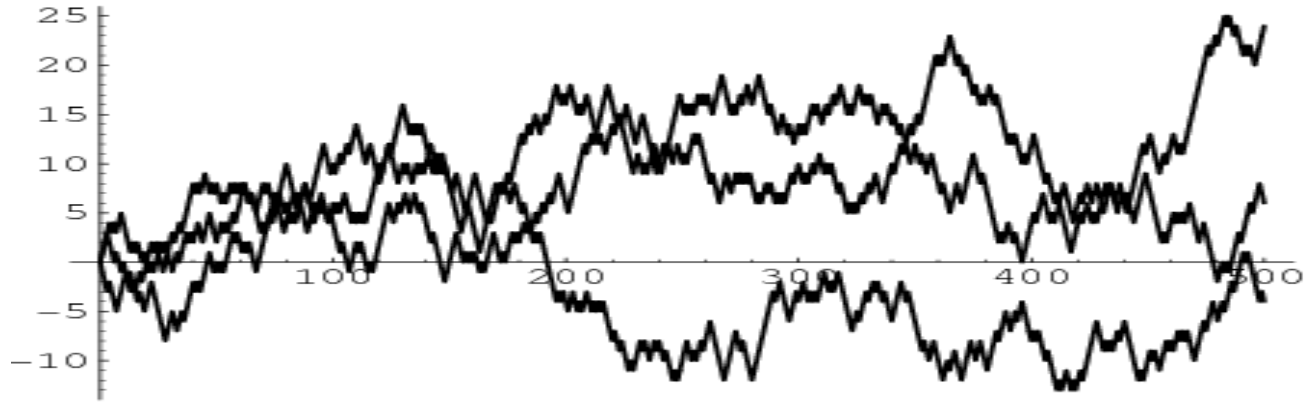
Evolution of Economic Scenario Generators



Evolution Factors	Technical criteria (theory driven or data driven)	
	Social criteria, often comprised of exogenous factors	
	Exogenous / endogenous that drove the modelling jump across phases	
EEWP Activities	Conduct interviews with key ESG players over the past few decades	We explore what lessons and themes we can learn from past developments?
		Postulate what the next phase phase may look like?

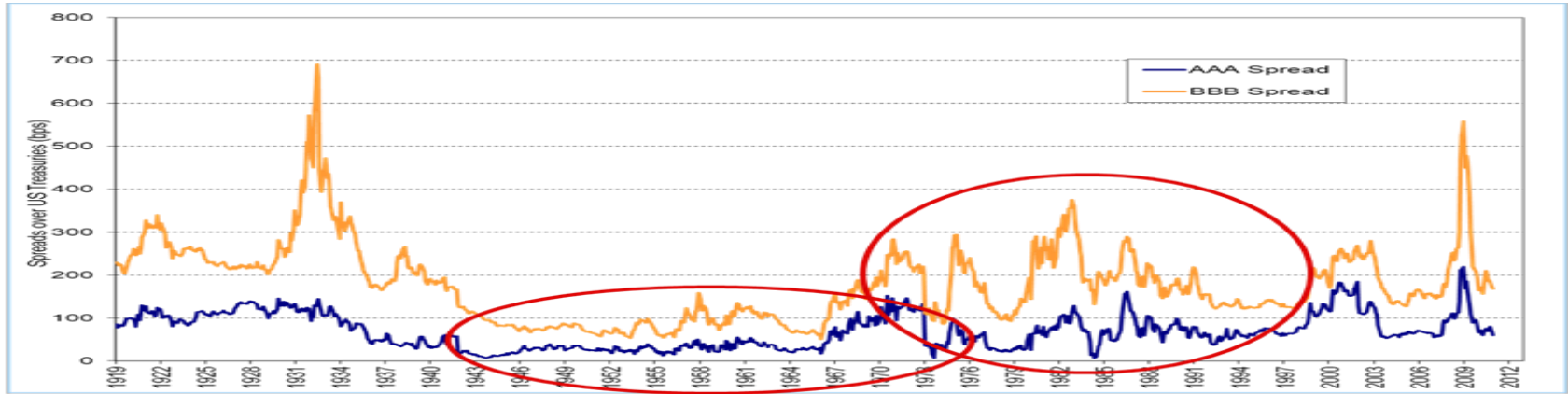


Phase A – Random Walks



- 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 uncorrelated.
- 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***, of Actuaries, published in a peer reviewed journal.
- Extensively used in Investment Modelling

Wilkie Model vs Random Walks

Wilkie Model

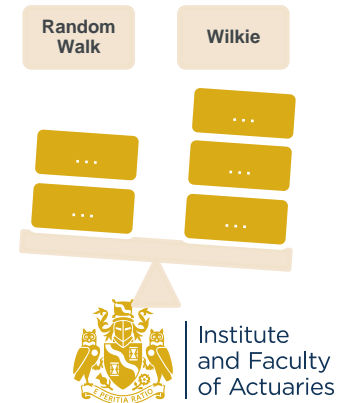
Published model in a peer reviewed journal, discussed by the Faculty of Actuaries, and reviewed in several other published papers.

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).

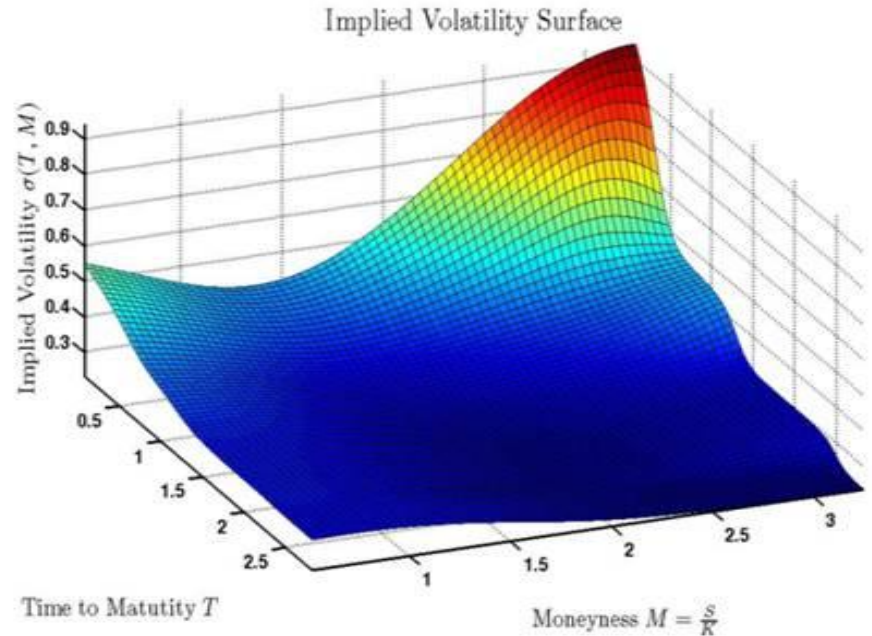
Some Difficult Questions

- *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?***

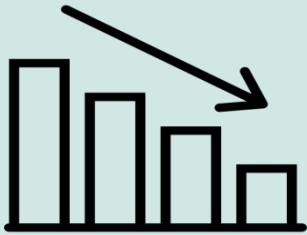


Phase C1 – Option Pricing Models

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

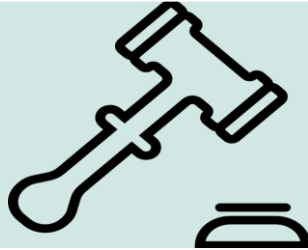


Why did Option Models become Popular?



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.

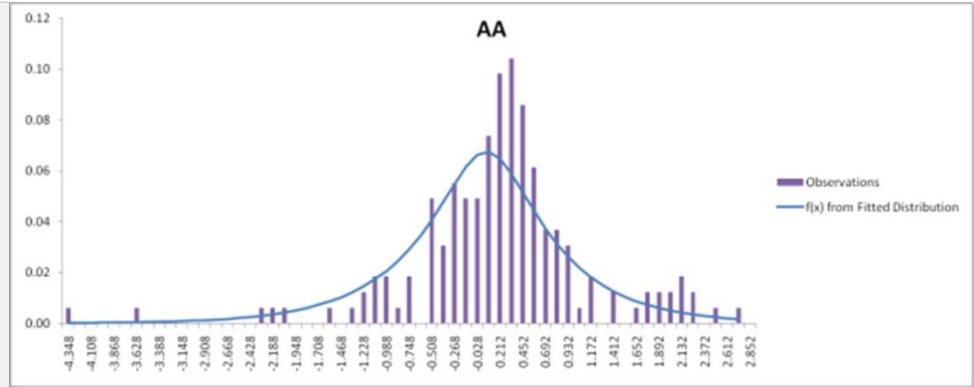


Ideas from Banking

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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Uses, Awareness and Challenges over Time

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Thought leadership
Progress
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Sessional Meetings
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Working parties
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Professional support
Enterprise and risk
Learned society
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Journals
Supporting

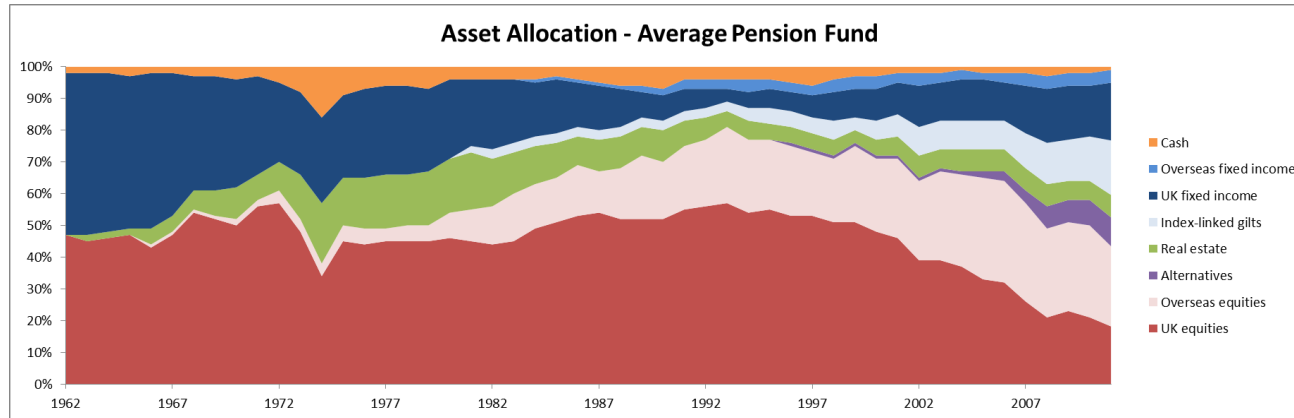
Uses and Awareness

- 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 persistent over time.



The challenge inherent in stochastic asset models

- The increasingly global nature of the assets



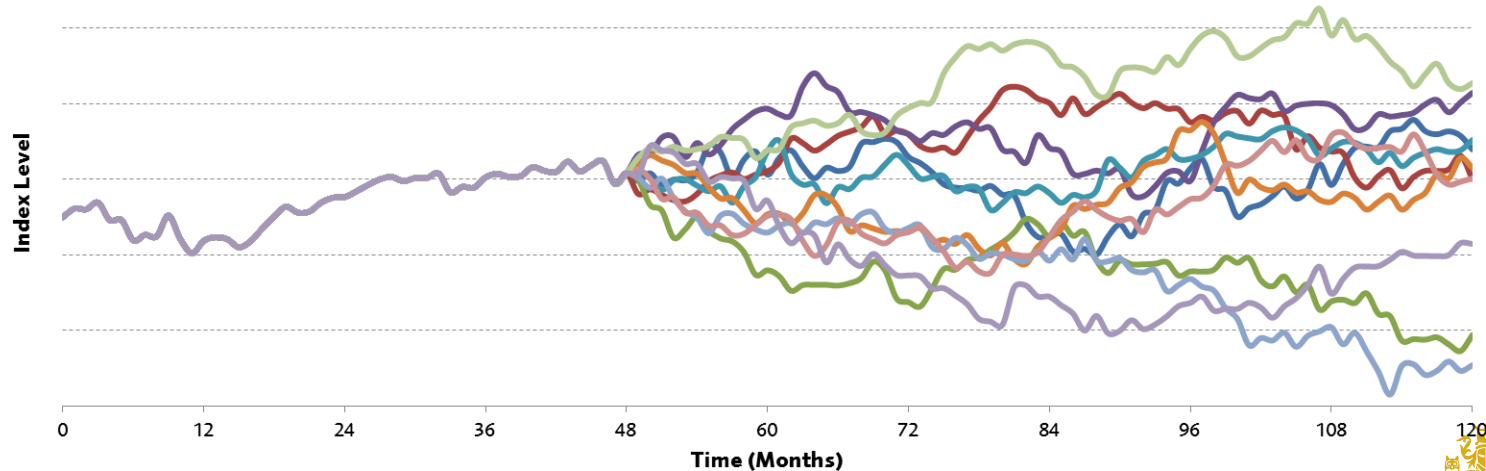
- Long dated liabilities, which require extrapolation in time
- Capital regulations, which require extrapolation in terms of probability



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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Have ESGs captured material risks?

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

Negative Rates

Parameterisation of extreme events

Broadly captured material economic risks over time.

Regime Changes

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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Factors Driving Change Historically & What the Future Holds

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Thought leadership
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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 previous models, and some have been developer-led, *e.g. the Wilkie model introducing stochastic modelling for the reserving of guarantees*



Examples of Technical and Social Criteria

Technical Criteria

Goodness of fit

- Goodness of fit to empirical Data

Accuracy

- Replicating prices of financial instruments

Statistical Properties

- Desirable properties e.g. unbiasedness, robustness and efficiency

Back-testing

- Predicting power outside the sample used for calibration

Mathematical Tractability

- Closed form solutions, tractable computations

Social Criteria

Benchmarking

- e.g. regulatory requirements via comparison of firms

Simplicity

- e.g. ease of design, coding, parameter estimation.

Control

- Ability to influence model output

Compatibility

- Model output and input compatible with requirements, eg all required fields available.

Auditable

- model output can be intuitively explained to layperson

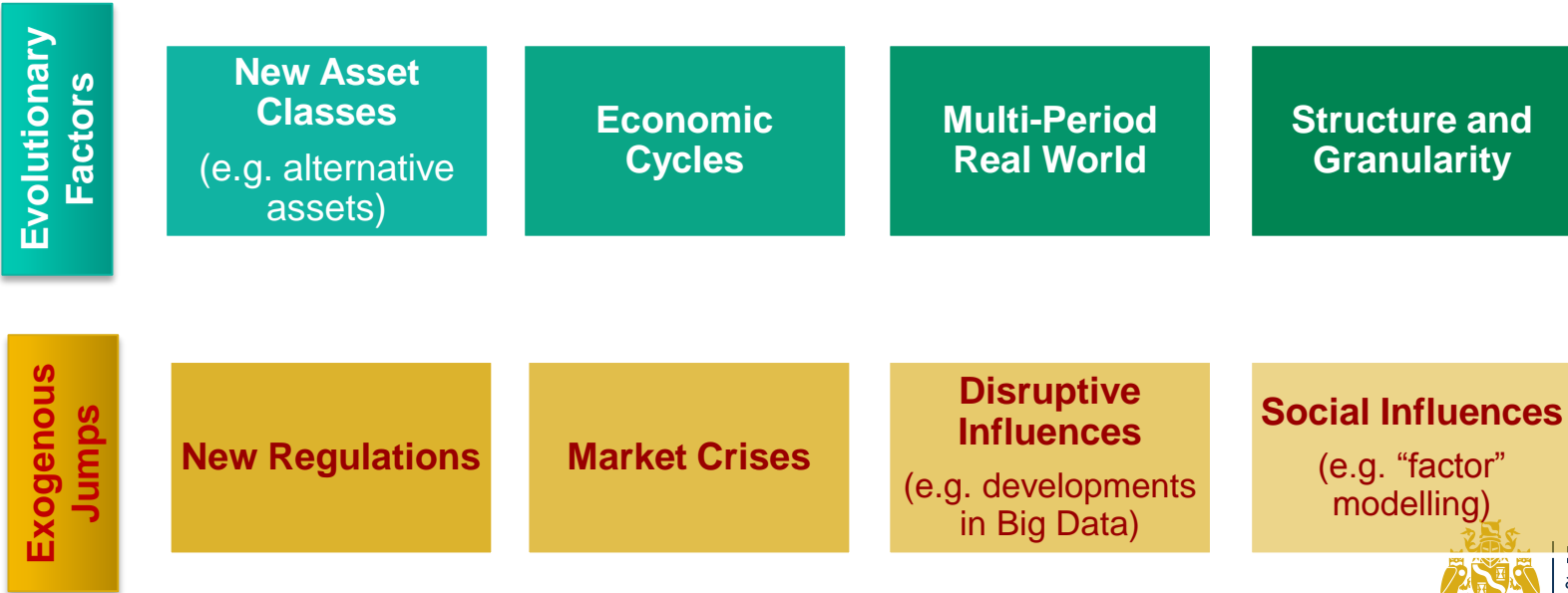
Commercial

- Commercial timescale and budget constraints.

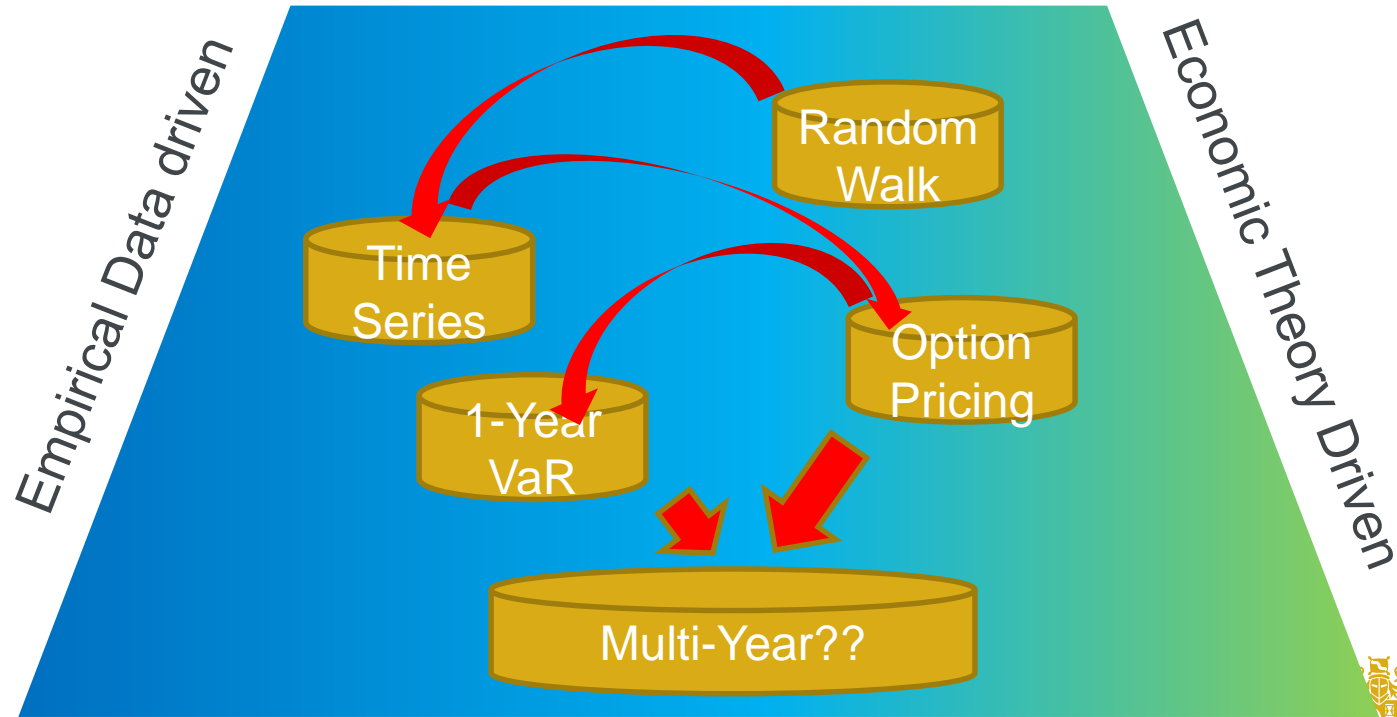


What will determine Future Models?

The history of scenario generators is not one of steadily increasing technical sophistication, but jumps in approaches.



Bridging Data and Economic Theory



Can we Dust off Time Series Models for Multi Year?

Realism

- Leptokurtosis
- Serial correlation
- Volatility clustering
- Parameter / model risk
- Economic cycles

Business needs

- Intuitive Parameters
- Visibility of key judgment
- Business impact
- Validation
- Flexibility



Topics / Discussion points

- Stories of ESG success or failure?
- Any international experience to share?
- How do procurement processes affect the available models?
- What is your view of publication vs proprietary models?
- How do you decide on the complexity for different purposes?
- What is the relative importance of judgement on model design vs parameter choices?



Thanks

A large thanks to the members of the Extreme Events Working Party, in particular Parit Jakhria, Sandy Sharp, Andrew Smith, Andrew Rowe, Ralph Frankland and Tim Wilkins.

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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