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## Economic Scenario Generators

Evolution & Lessons Learned from History

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*on behalf of the*  
Extreme Events Working Party

November 2016



### 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 Event Working Party



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## Thanks

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

We also have a 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.

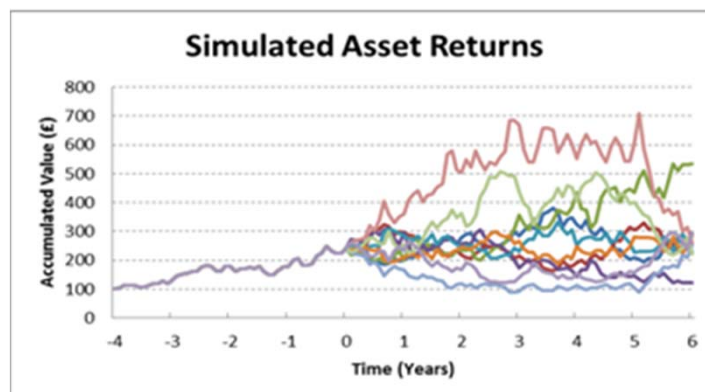


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## The Challenge

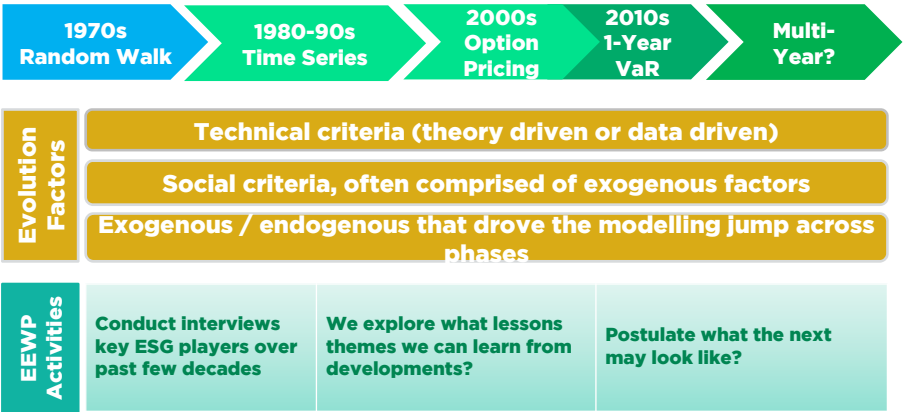
- *A truly accurate model of the (asset) world would potentially be as large as the asset world itself!*



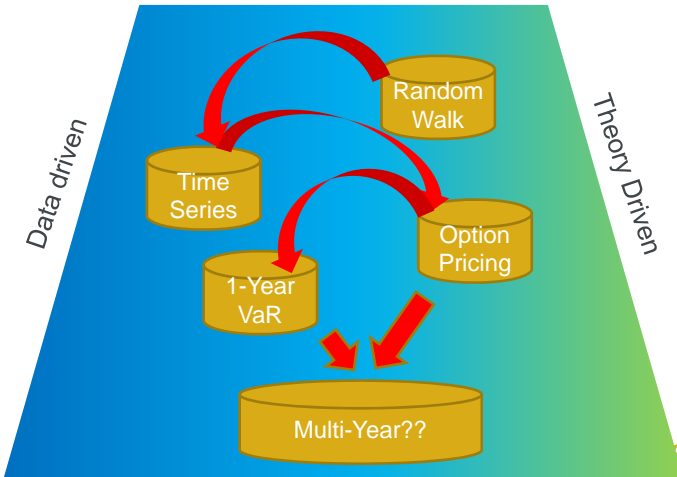
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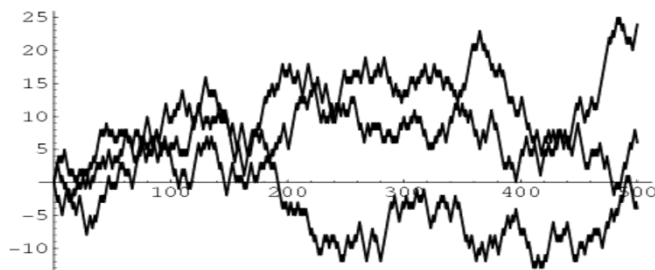
## Evolution of Economic Scenario Generators



## Bridging Data and Economic Theory



## Phase A – Random Walks



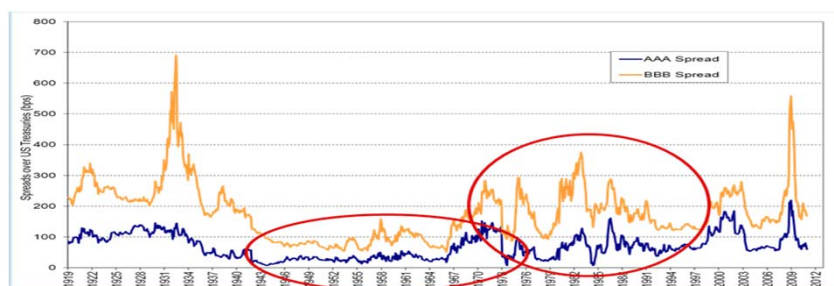
- A significant step up from deterministic models
- Leveraged the rise of computing power since the 1950s, together with the Monte Carlo processes in physics
- Captures one general factoid, that asset returns in different periods are independent and identically distributed
- Small number of intuitive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

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## 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

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## Wilkie Model vs Random Walks

### Wilkie Model

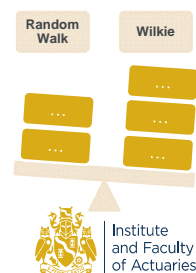
Published model in a peer reviewed journal, discussed by the Faculty of Actuaries, and reviewed in several other published papers.

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?**

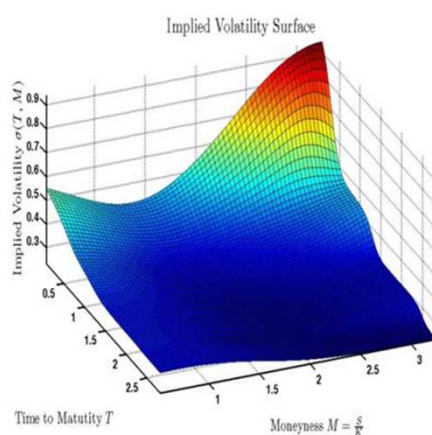


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## Phase C1 – Option Pricing Models

- 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

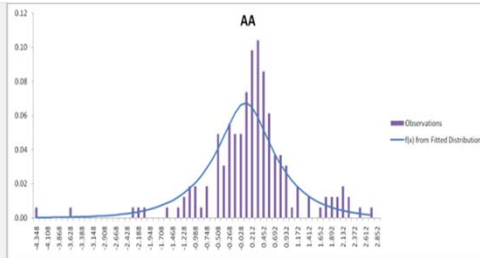


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## Phase C2 – One Year VaR

- 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.



## Surveys and Interviews (in progress)

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  
 Support

## The Interviews

- Put the same questions to Developers and Users (apart from one specific question to each)
  - Users were influential players at a time of change in model design

- Have 14 interviews so far:

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

- Some others in progress.



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## Interviewees & Questions

- Interviewees
- Background questions
  - Tasks / decisions ESGs are used for
  - Knowledge, general awareness , peer review / publication
- Factors influencing change in the past
  - User led, designer led, regulation, exogenous factors, etc...
- Factors may influence the future path of ESG
  - Examples where models did not capture emerging risks
  - New components / features to be added
  - How ESG will evolve in the future



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## Background Questions

- Interviewees
- Tasks / decisions ESGs are used for
- Knowledge / reliance of model and calibration
- General awareness trend
- Peer review / publication



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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*

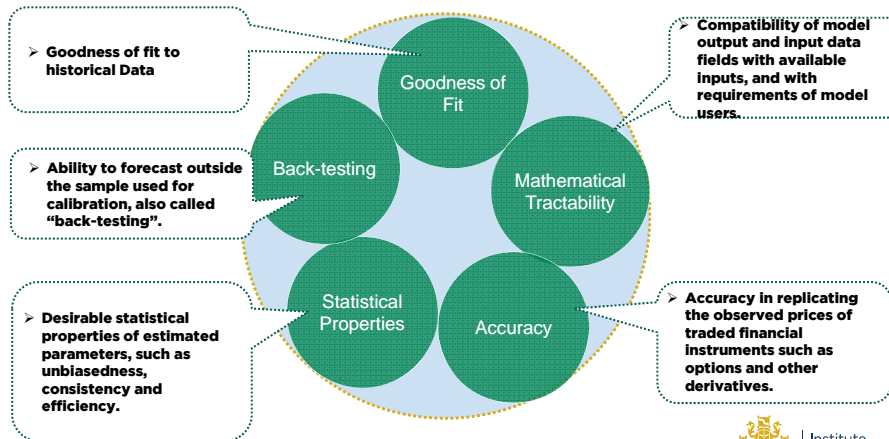


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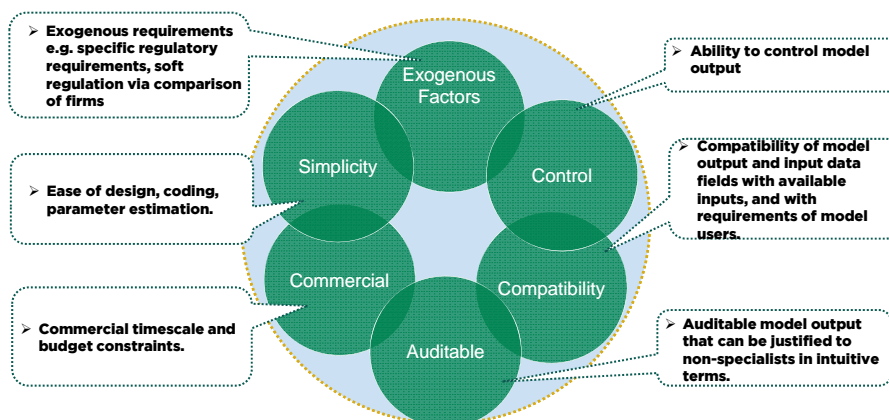
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## Examples of Technical Criteria



## Examples of Social Criteria



## Have ESGs captured material risks?

- General agreement that ESG's have broadly captured material economic risks over time
- although regime changes have been missed and very difficult to predict.
- Arguably large falls in long term interest rates have not been adequately captured.
- View expressed that there is a continual learning process to develop models against the backdrop of real world experience.



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## The Uses of ESG

- Agreement that ESG's now used much more widely than was the case in the past, although not using an ESG is using an ESG with zero variability!
- Wide variety of thoughts about future evolution
  - continuing regulatory lead with better regulatory understanding of models
  - better identification of non-market risks
  - more focus on multi-time period modelling.
- Sentiment of difficulty in monitoring model development



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## Why did Option Models become Popular?

- Influence of solutions and idea from the banking sector – more advanced at individual asset class level (and traded on the markets)
- Post Equitable Life crisis, general realisation that there was embedded “Cost of Guarantees” was an important factor for insurance company balance sheets
- Regulations: 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?
- Market consistency was difficult to achieve from a Wilkie Model – additionally adding constant risk premiums to option pricing models gives stability to dynamic utility-maximising portfolios, (unlike for Wilkie-style models)
- Theoretically appealing concept of no-arbitrage?



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## Next Big Evolution?

- regulatory changes
- unforeseen economic changes
- modelling management actions
- modelling of illiquid / alternative asset classes
- modelling new applications, such as multi-period real-world modelling for asset allocation decisions.
- Computing advance, dynamically perform market consistent calibrations.



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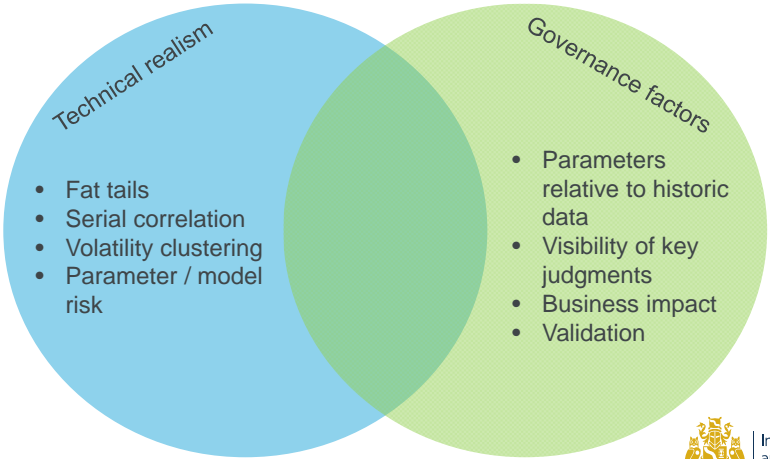
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# What the Future Holds

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Expertise  
Mentorship  
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  
Support

# Can we Dust off the Time Series 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.
- Developments in big data?
- Exogenous shocks – New impending regulations?
- Fundamental changes in capital markets and / or future crises?



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## Questions

## Comments

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