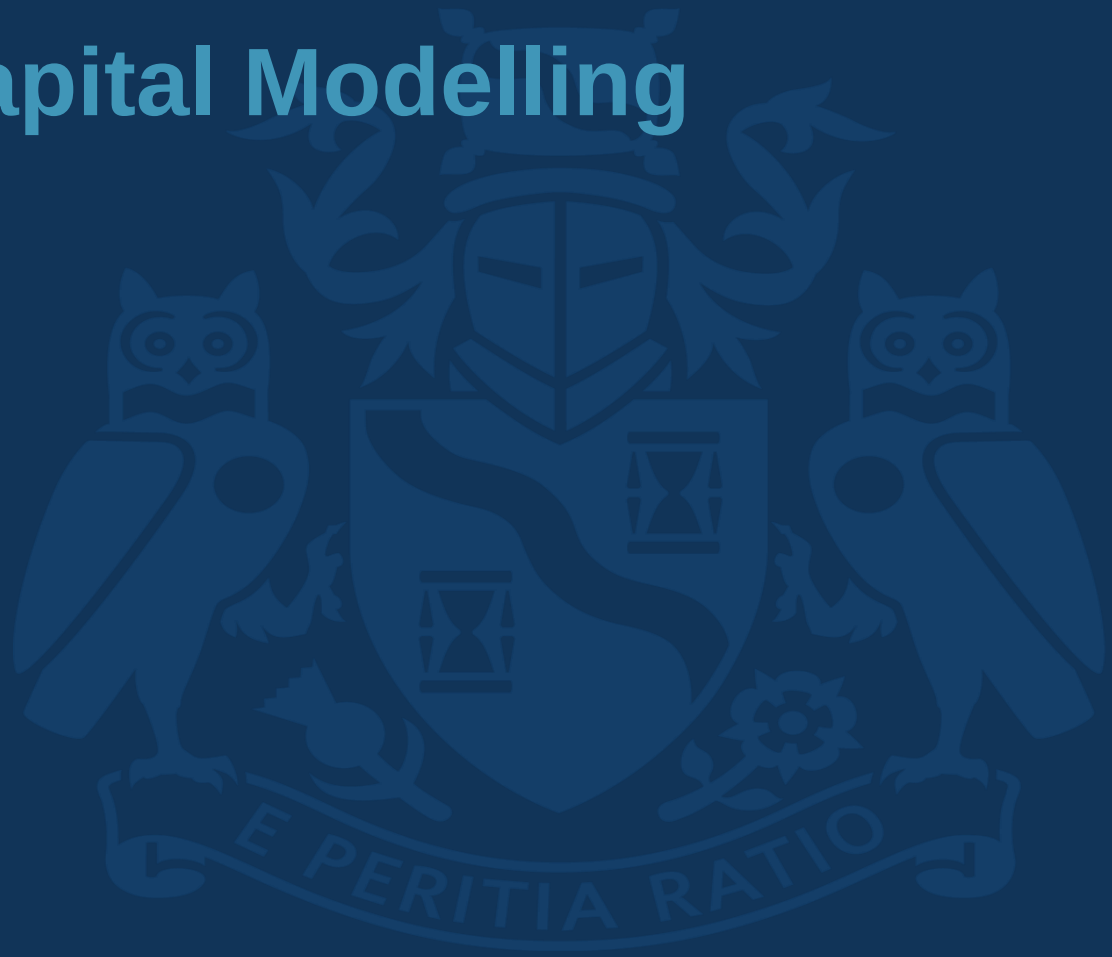
Institute and Faculty of Actuaries

LCP INSIGHT CLARITY ADVICE

Parameter Uncertainty in Capital Modelling

Neil Gedalla



18 October 2017

Motivation

- Parameter uncertainty – one of the key remaining challenges in capital modelling?
- Three modelling “camps”:
  - Parameter uncertainty well implemented and communicated
  - Little attempt at parameter uncertainty
  - Parameter uncertainty mostly dealt with outside the models
- Objectives:
  - Parameter uncertainty matters
  - As an industry, we are doing more than we think to take account of it…
  - … but further work (and research) is necessary

Agenda

Overview of parameter uncertainty

- Terminology and definitions
- An example

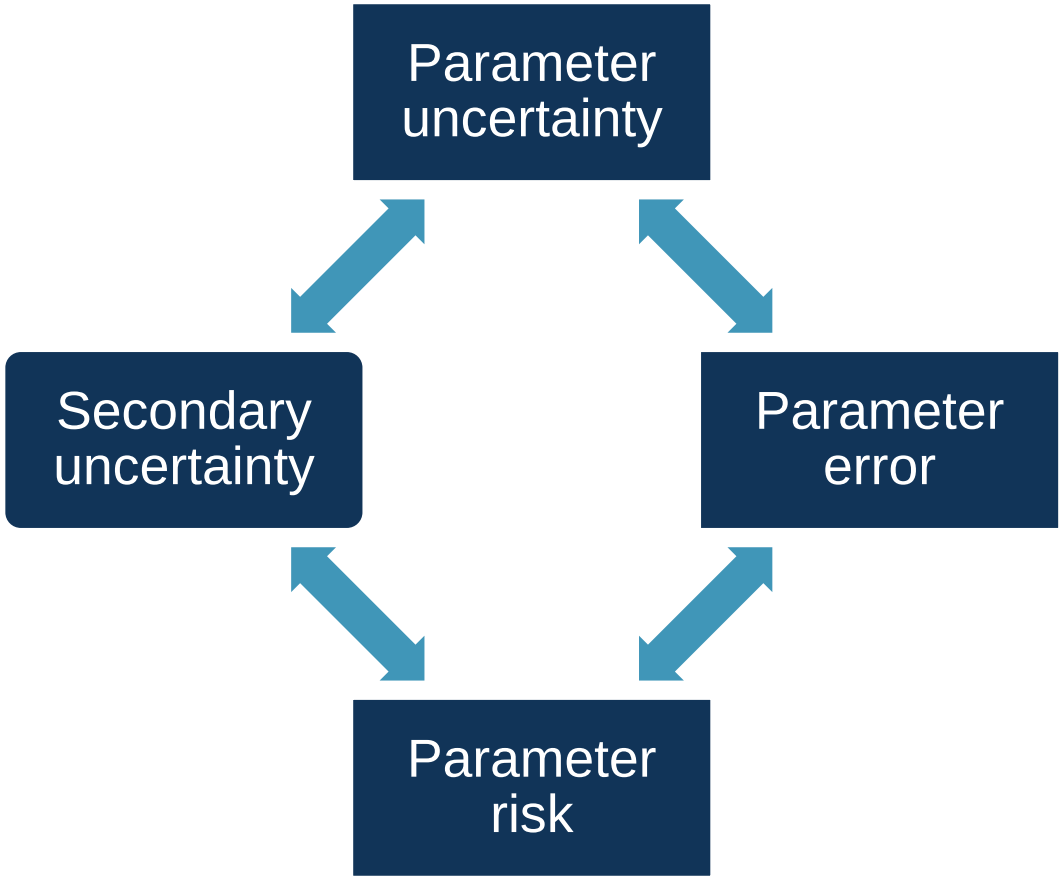
Parameter uncertainty within capital modelling

- Current state
- Future state?

Underwriting risk – some ideas

Overview of parameter uncertainty

A brief note on terminology



These terms (and possibly others) are used interchangeably

Definitions

- Process variance:
  - Caused by the real world nature of the risk, ie natural variability in the claims process
- Parameter uncertainty:
  - Caused by uncertainty of the values of the parameters chosen
- Model error:
  - Caused by having chosen the wrong model

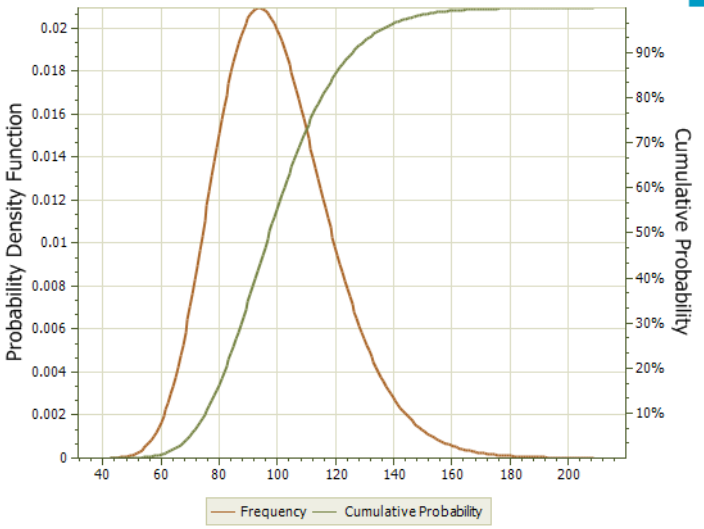
An example

- A simple game:
  - Entry fee £6
  - Player tosses 11 coins
  - Receives £1 for each coins that lands heads
  - Operating costs £20
- Base case assumptions:
  - All coins used are fair, ie P(Head) = P(Tail) = 0.5
  - Independence of tosses by the same player
  - Independence of tosses by different players
  - 100 players

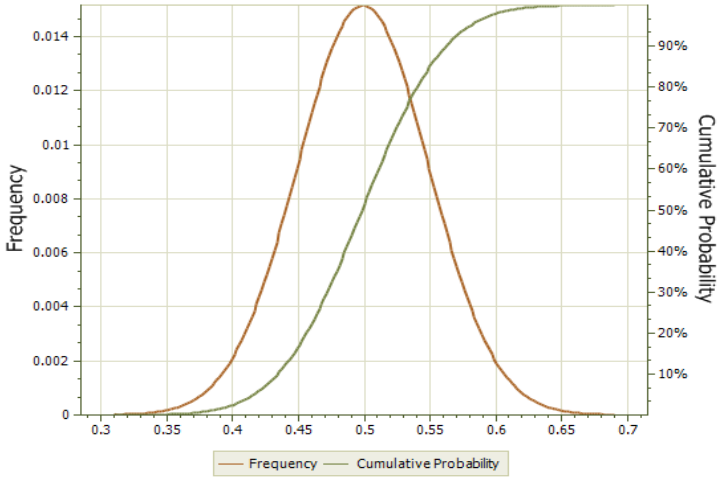
An example

- Introduce parameter uncertainty:
  - Number of participants ~ LogN(100, 20^2)
  - Coins fall heads with probability ~ N(0.5, 0.05^2)
- Introduce model error:
  - Assume coin tosses are not independent
  - Coin 1 = heads => Coin 2 is more likely to be heads
- Analogy to capital model:
  - Number of participants = Premium volume
  - Number of heads = Risk volatility
  - Dependency = Dependency
  - Profit = Profit

Participants



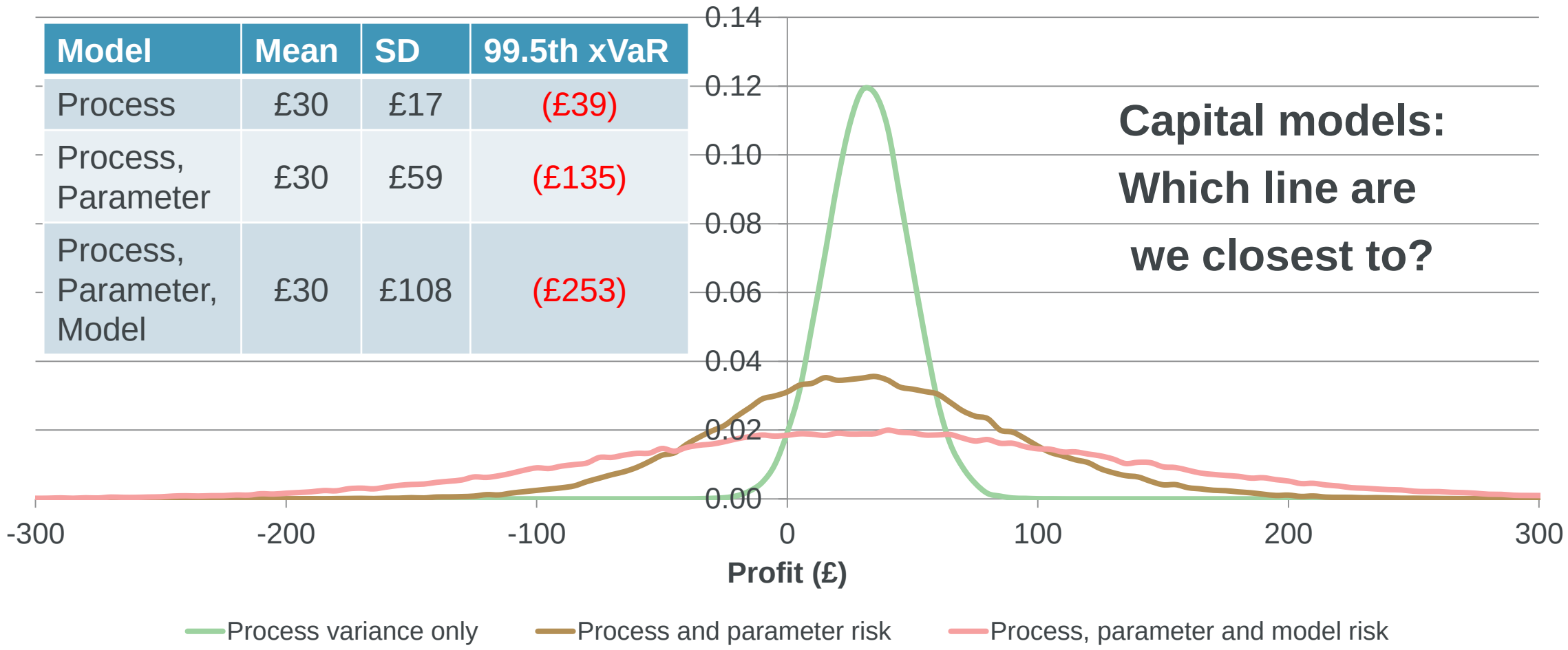
P(Heads)



An example

Results

Model	Mean	SD	99.5th xVaR
Process	£30	£17	(£39)
Process, Parameter	£30	£59	(£135)
Process, Parameter, Model	£30	£108	(£253)



Capital models: Which line are we closest to?

An example

Summary

Process variance

In general, we think we understand this and are dealing with it well

Parameter uncertainty

This is interesting!

Model error

Beyond the scope of our standard approaches

Parameter uncertainty within capital modelling

Capital models

Current state of parameter uncertainty within capital modelling

Risk Type	Usually	Sometimes / other approaches	Rarely
Underwriting risk		**Budget gross loss ratio** **Volatility parameters** Premium rate	Claim payment patterns Budget volume Written/earned patterns
Catastrophe risk	Secondary uncertainty (vulnerability)		**Event frequency**
Reserve risk	Volatility parameters via bootstrapping		**Mean opening reserve**
Application of RI			Budget ceded loss ratio Future RI premiums
Market risk			**ESG?**
Credit risk		**Transition & default parameters**	LGD
Operational risk			Volatility parameters
Dependencies		**Trigger based dependencies**	**Correlation parameters**
Other		One-year recognition parameters	EOY Unincepted (Volumes, LR) Risk margin parameters

Capital models

Future state

- Options:
  - Continue as we are
  - Make everything stochastic
  - Middle ground?

- Some areas seem better candidates than others:
  - Insurance risk – business plan
  - Market risk/ESG
  - Dependencies – can of worms?

Capital models

Insurance risk – current state

Risk area	Model		Sensitivity tests	
	Mean	Variance	Mean	Variance
Underwriting	Rarely	Sometimes	Usually	Usually
Reserving	Rarely	Usually	Sometimes	Usually
Catastrophe	Rarely	Usually	Rarely	Sometimes

Capital models

Market risk

- Unclear to what extent ESGs have parameter uncertainty built in
- Possible to argue that economic variables have lower levels of uncertainty
- Currently, the evidence indicates that this is not the case
- Some variables are easier than others, eg exchange rate volatility
- Volatility may be easier to agree on than the mean
- Possible to estimate levels of uncertainty empirically by comparing range of ESGs…
- … but unclear how best to implement this within capital model

Capital models

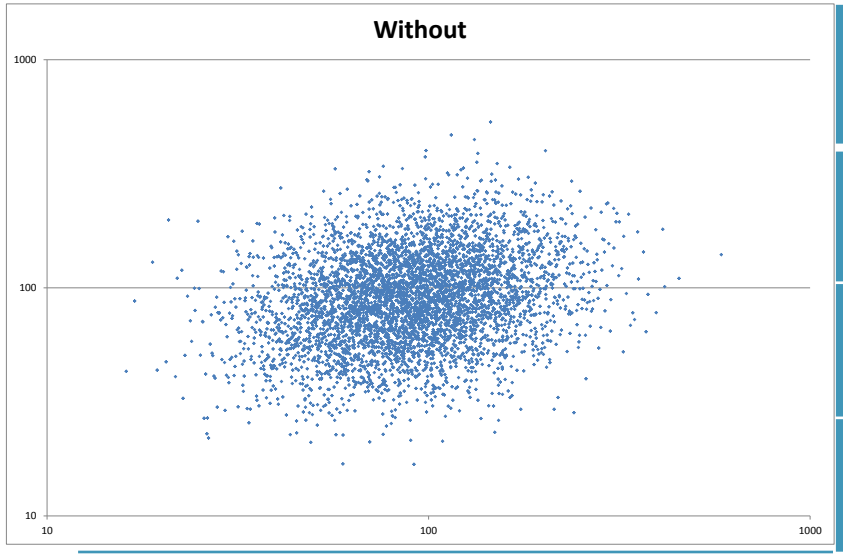
Dependencies

- May be difficult to implement in current framework
- Implications for run time, model parsimony, model complexity, …
- Gaussian copula – undercorrelated in the tail?
- Difficult to parameterise, and …
- … again, unclear how best to implement this within capital model

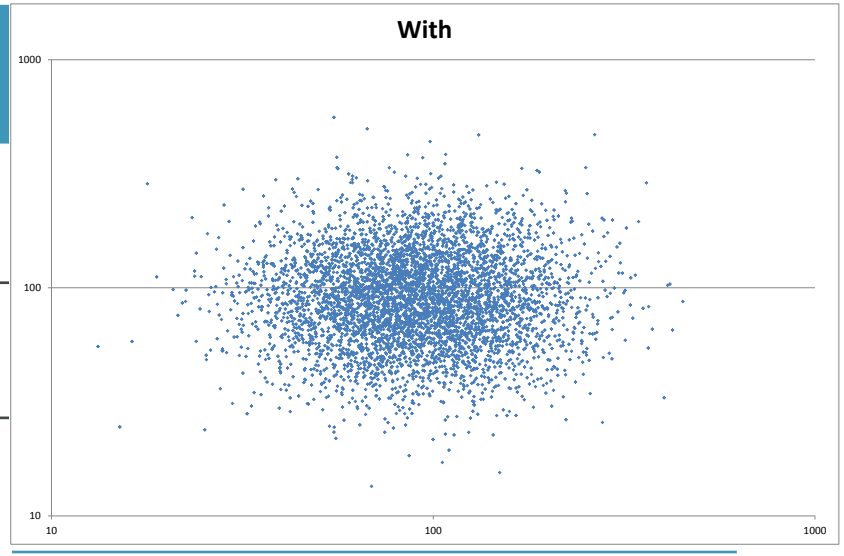
Capital models

Dependencies

- Example:
  - Two lines of business, LogN(100, 50^2)
  - Base run has 500k trials @ ~25% correlation
  - Instead, run 10x 50k trials with different levels of correlation
  - Idea is to impose parameter uncertainty distribution ~ Normal(0.25, 0.15^2)



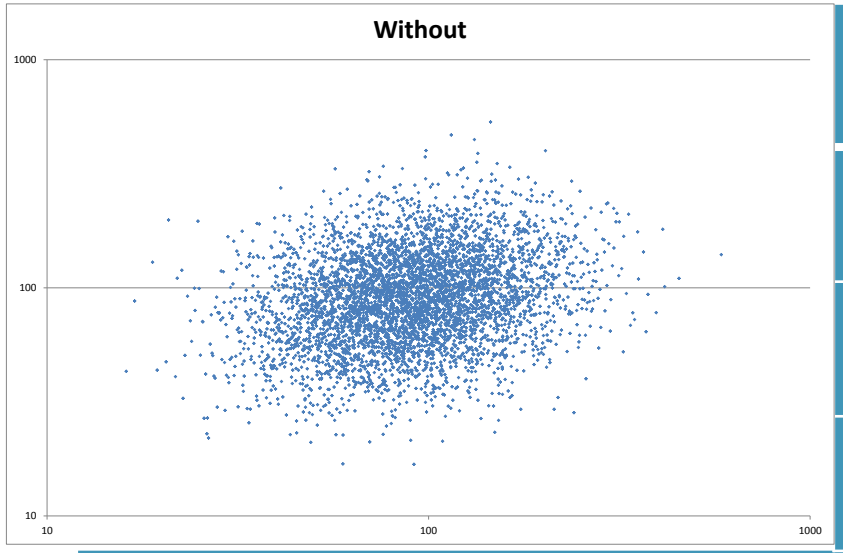
Tertiles – expected	1st	2nd	3rd
1st	↑	↑	↓
2nd	↑	↓	↑
3rd	↓	↑	↑



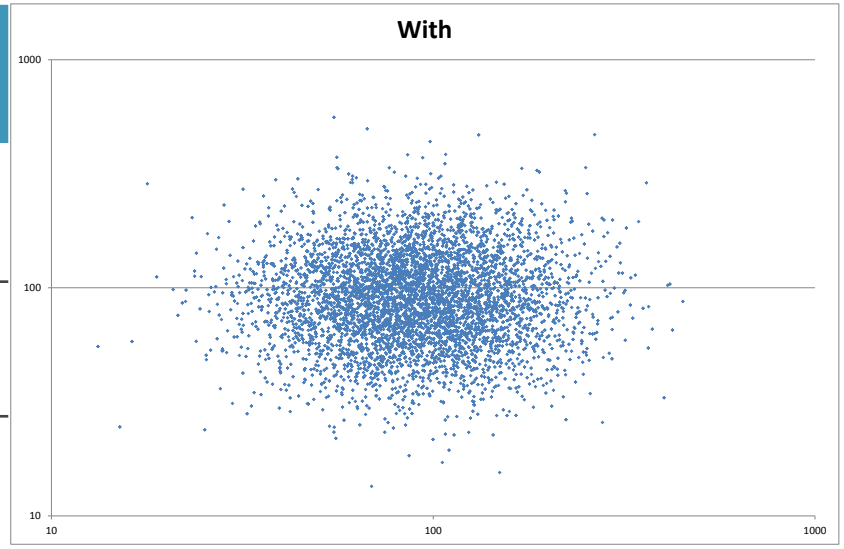
Capital models

Dependencies

- Example:
  - Two lines of business, LogN(100, 50^2)
  - Base run has 500k trials @ ~25% correlation
  - Instead, run 10x 50k trials with different levels of correlation
  - Idea is to impose parameter uncertainty distribution ~ Normal(0.25, 0.15^2)



Tertiles – actual	1st	2nd	3rd
1st	→	↓	→
2nd	↓	↑	↓
3rd	→	↓	→

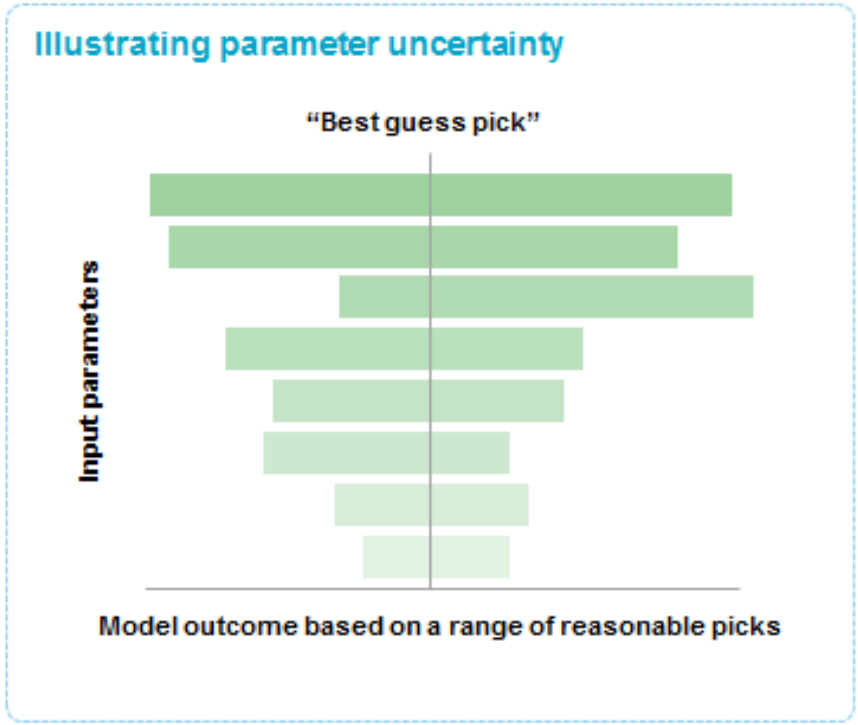


Underwriting risk – some ideas

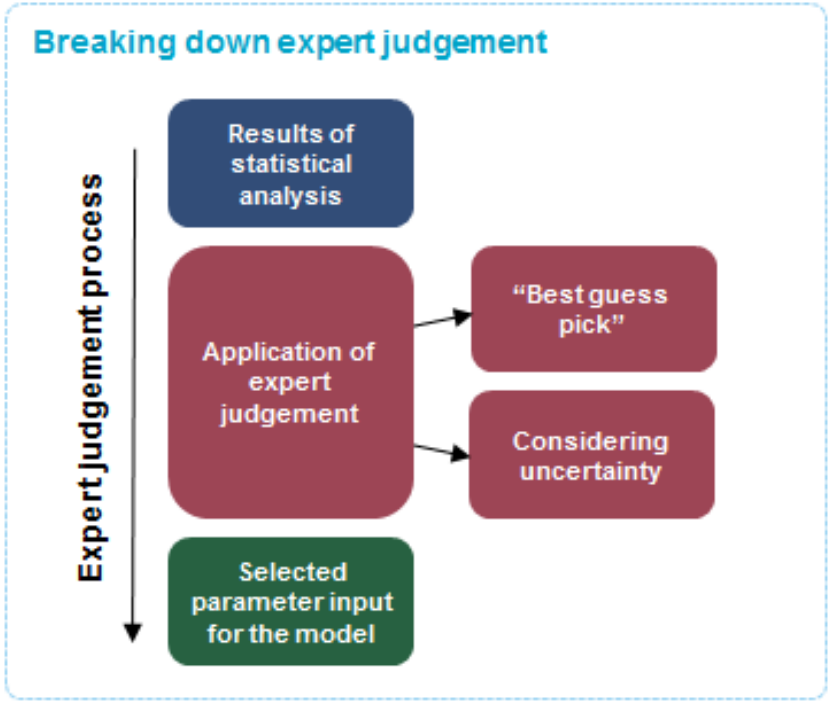
Underwriting risk

Easy options

Type II sensitivity testing



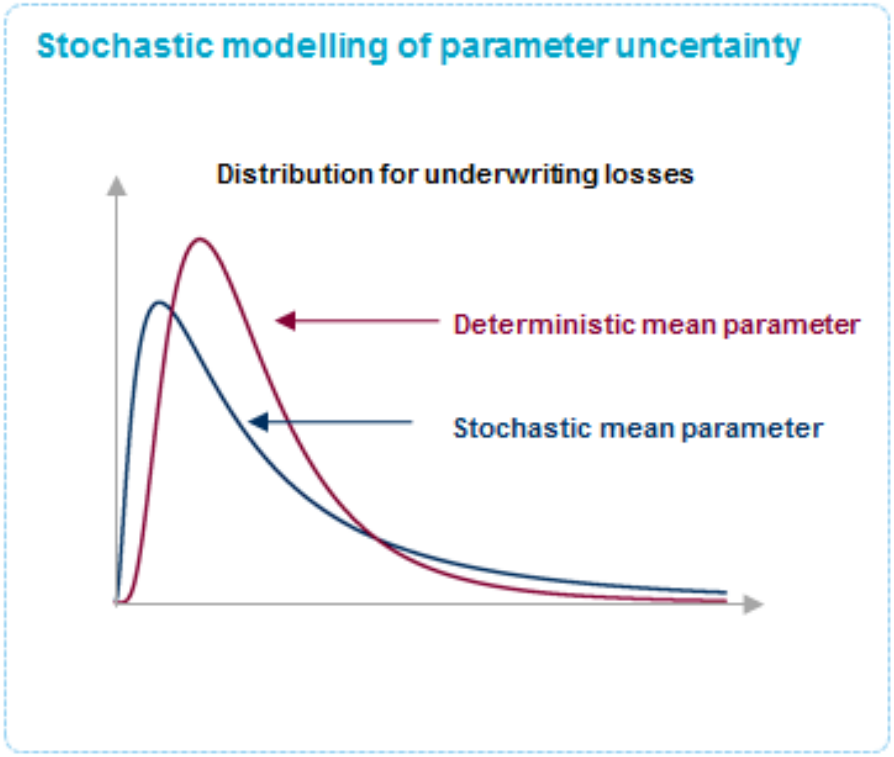
Split existing parameters



Underwriting risk

Slightly harder options

Stochastic mixing distributions



Bootstrap

Summary

- Be clear what sources of risk are and are not included in models, and why
- Both means and variances can have parameter uncertainty
- Some possible areas for further research:
  - Underwriting risk
  - Market risk and ESGs
  - Correlations
  - Are trigger based dependencies an example of secondary uncertainty?
- Better methods to articulate impact of parameter uncertainty, using underwriting risk volatility as a test case
- Introducing explicit margins may be easier than mixing distributions, but communication is key!

Motivation

- Parameter uncertainty – one of the key remaining challenges in capital modelling?
- Three modelling “camps”:
  - Parameter uncertainty well implemented and communicated
  - Little attempt at parameter uncertainty
  - Parameter uncertainty mostly dealt with outside the models
- Objectives:
  - Parameter uncertainty matters
  - As an industry, we are doing more than we think to take account of it…
  - … but further work (and research) is necessary

Questions

Comments

LCP INSIGHT CLARITY ADVICE