The Actuarial Profession
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Parameter and Model Risk – Implications for Value-at-Risk

Andrew D Smith

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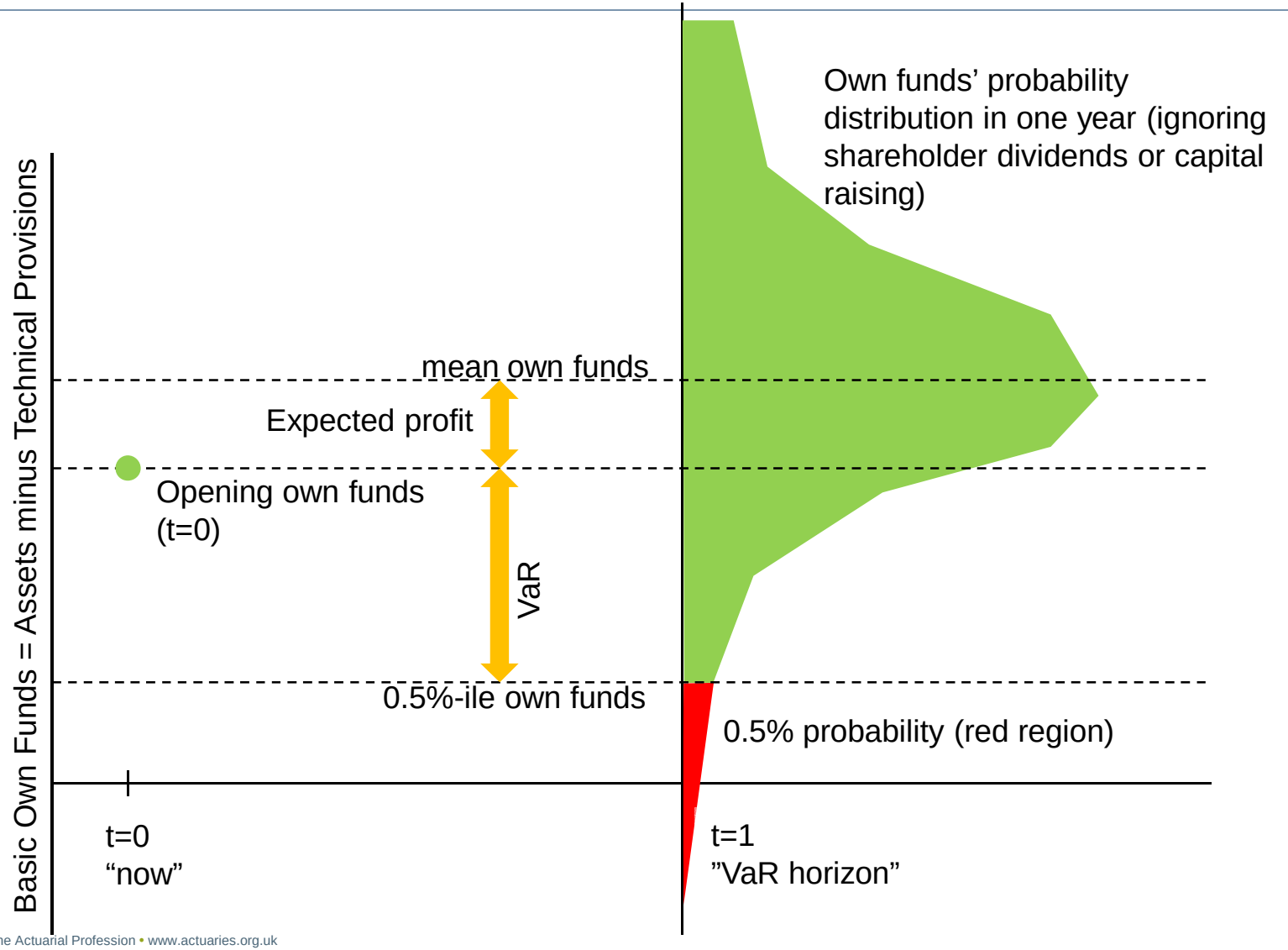
What is Value-at-Risk?

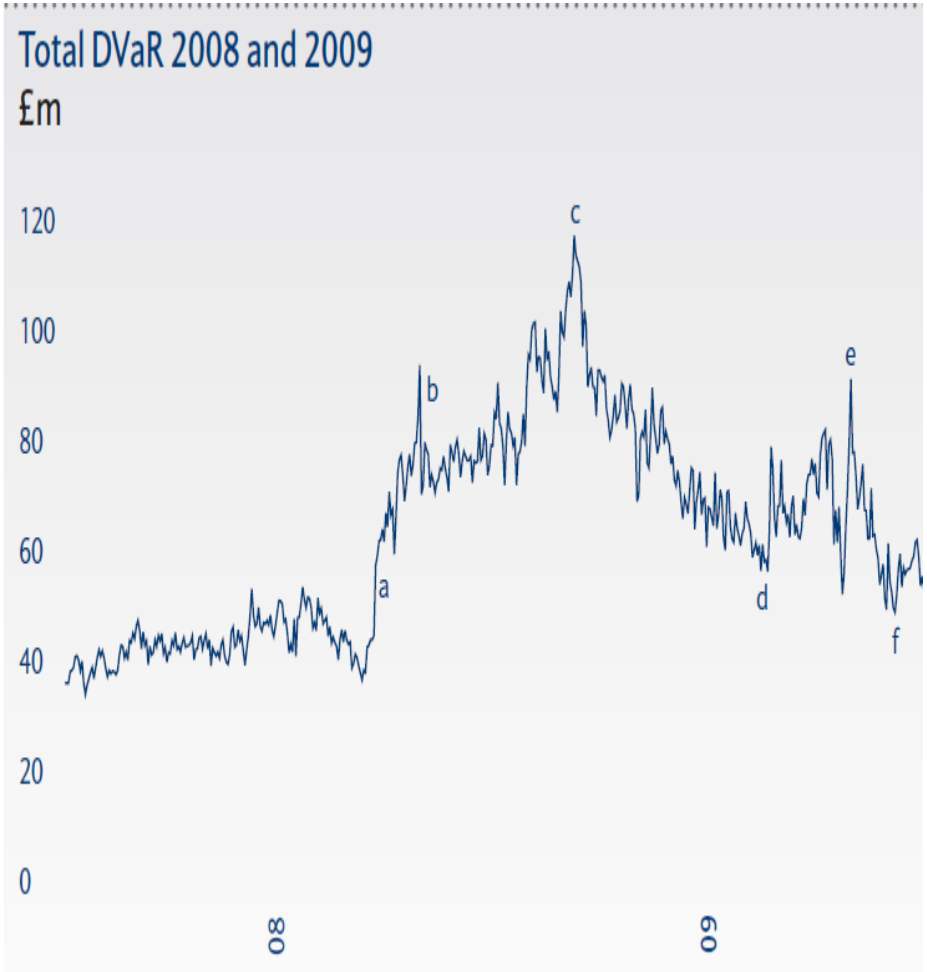
- Jorion (2007): “The worst loss over a target horizon
- Such that there is a low, pre-specified probability that the actual loss will be larger”
- Legislative references: Insurance Solvency II Directive:

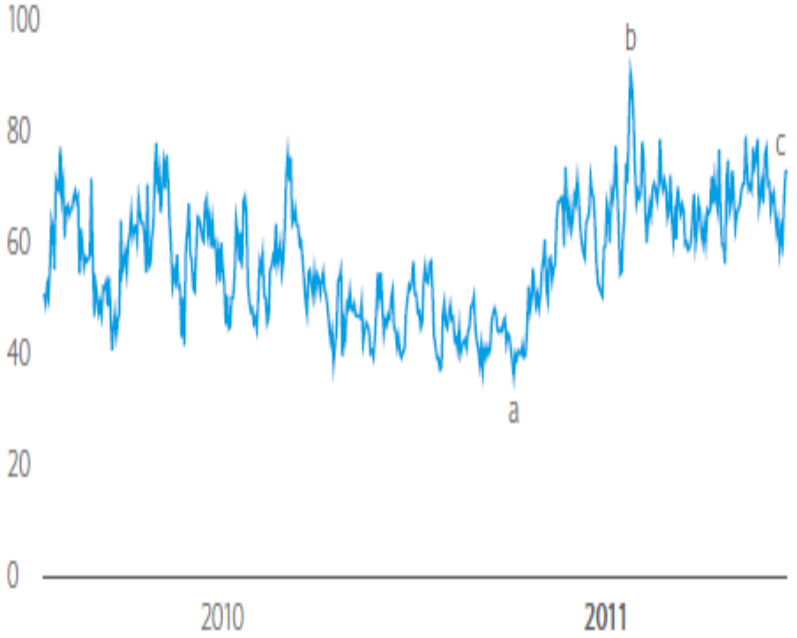
The Solvency Capital Requirement ... shall correspond to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5 % over a one-year period.

Calculating VaR Using Percentiles



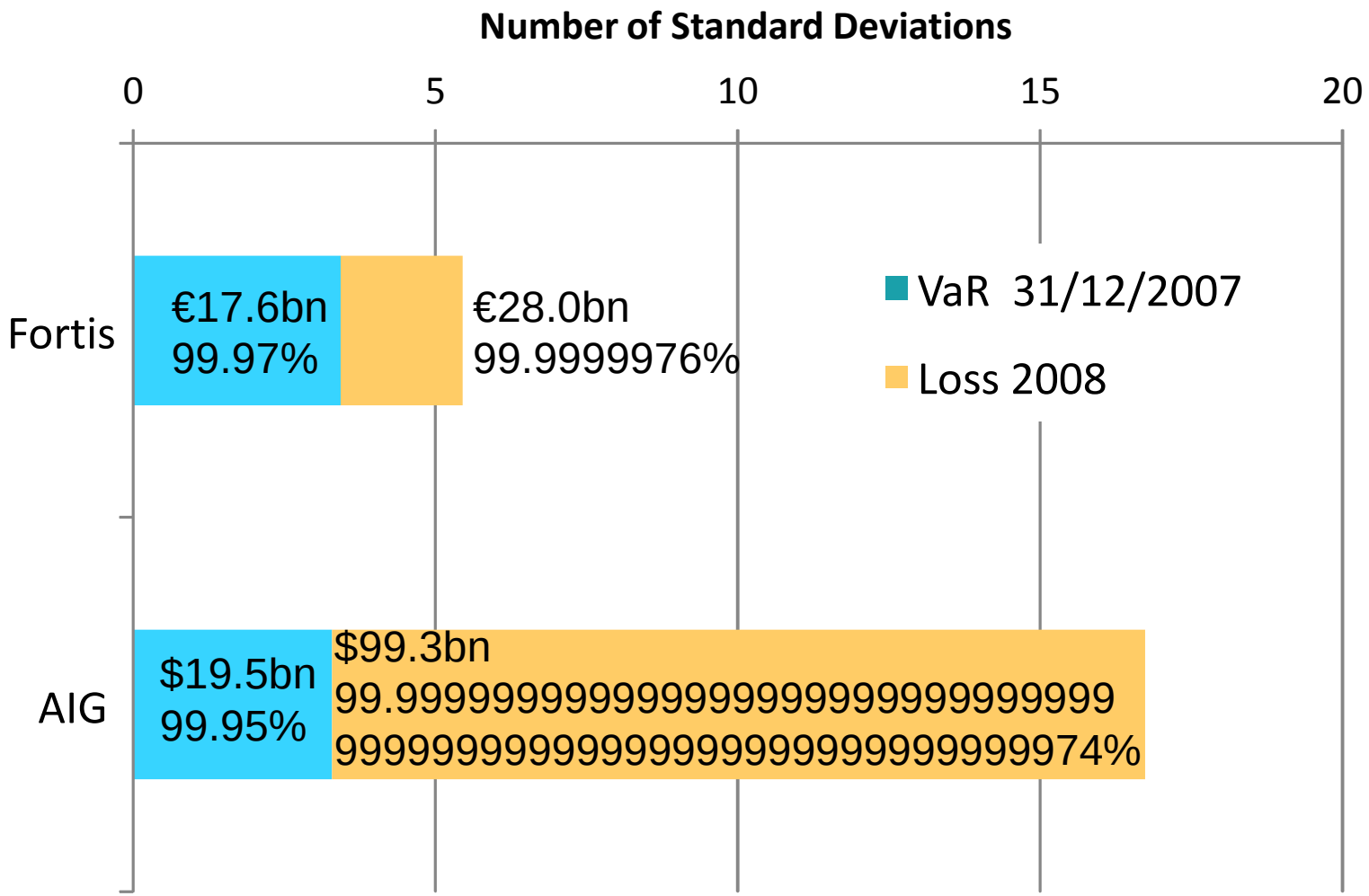
Daily Value at Risk example: Barclays





Source: http://www.barclaysannualreports.com/

Examples of Extreme Losses & Percentiles (calculations based on Normal distributions)



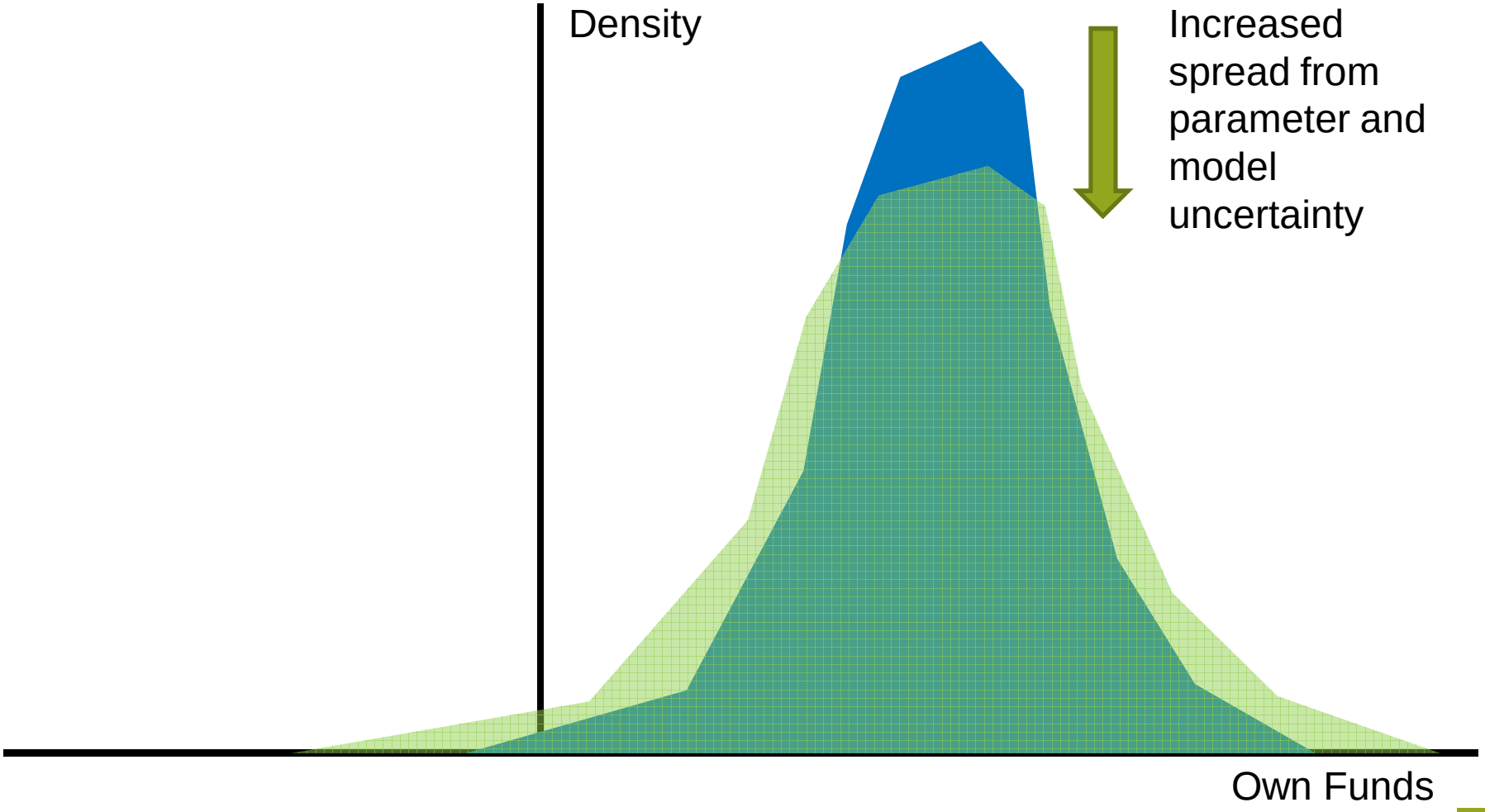
Potential sources of error in VaR Calculations (the well-known examples)

Category	Example	
Random	Draw from an experiment whose distribution is not in dispute. Textbook examples: coin toss, drawing coloured balls from an urn.	
Parameter error	Estimation of parameters from finite samples	
Model error	Chosen mathematical model family does not contain the process that generated the data	

Less-discussed sources of error
Did these contribute to AIG/Fortis Exceptions?

Category	Example	
Cyclical (point in time estimates)	Mis-identification of hidden state variables, excluding “irrelevant” historic periods	
Data	Incomplete or inaccurate	
Exposure (proxy model)	Mis-statement of asset and liability sensitivity to combined moves in risk drivers	
Computation	Roundoff in floating point calculations; differential equation discretisation, simulation sampling error	

What is the Effect of Allowing for Uncertainty?



Sources of Error Come with Biases

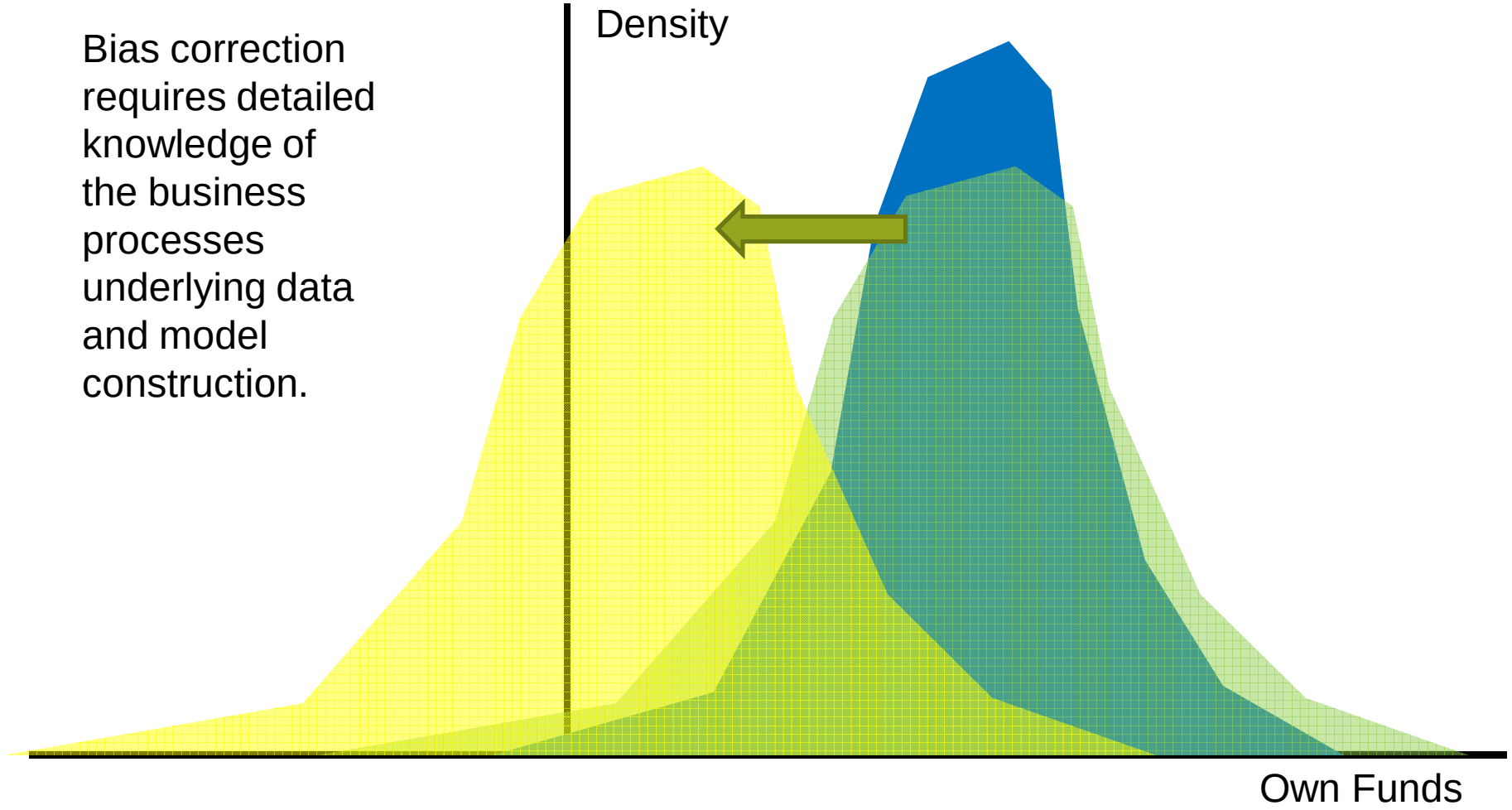
Category	Example	Bias
Random	Draw from an experiment whose distribution is not in dispute. Textbook examples: coin toss, drawing coloured balls from an urn.	
Parameter error	Estimation of parameters from finite samples	Portfolio optimisation finds strategies where returns are over-stated or risks under-stated
Model error	Chosen mathematical model family does not contain the process that generated the data	Complexity bias (eg use normal distribution instead of fat tails, linear AR1 instead of non-linear heterosecastic, dimension reduction, commercial pressure)

Biases for Complex Errors

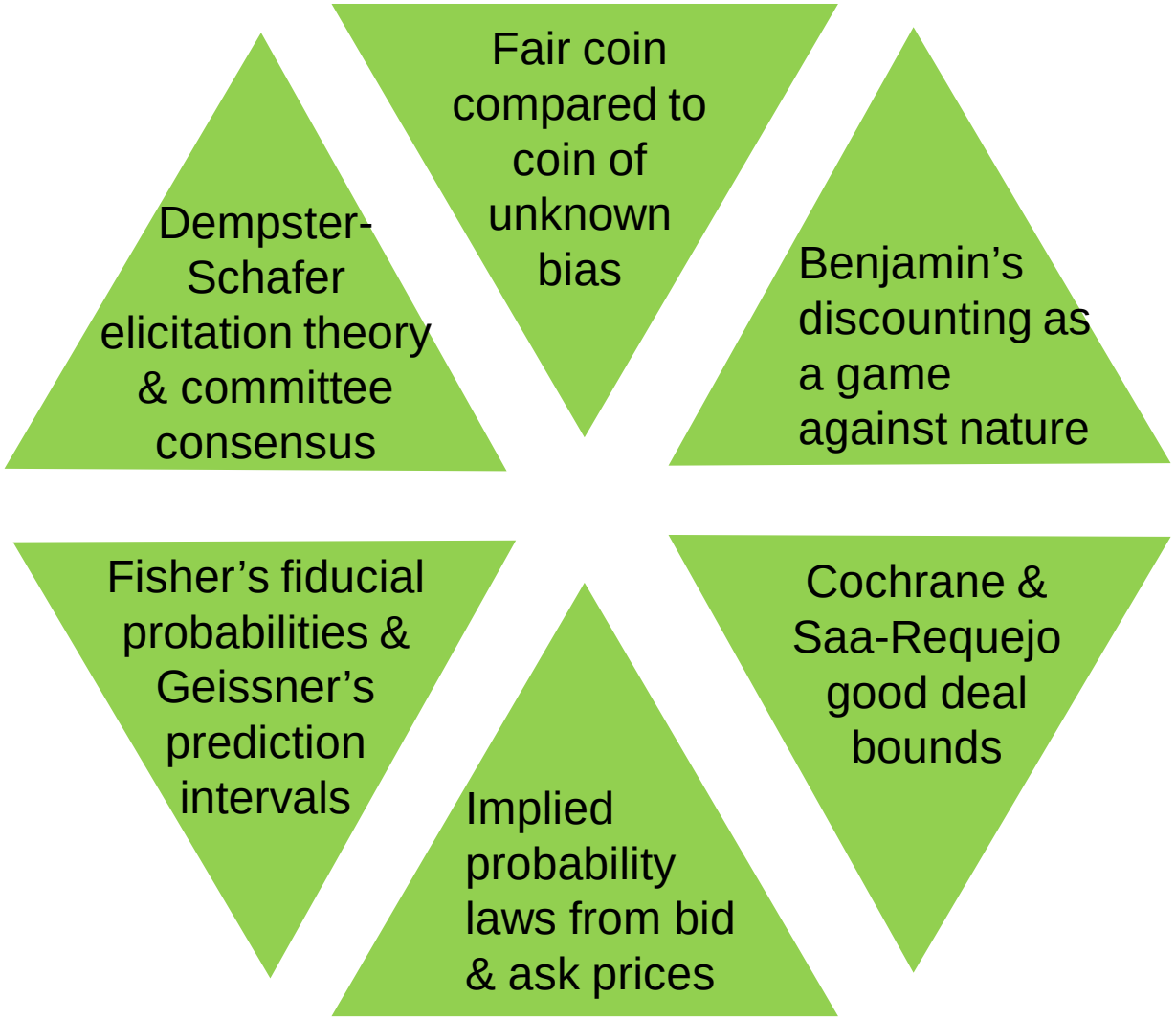
Category	Example	Bias
Cyclical (point in time estimates)	Mis-identification of hidden state variables, excluding “irrelevant” historic periods	Symmetric dampeners, judgements about underlying investment value and correction of distorted or illiquid markets
Data	Incomplete or inaccurate	Falsification or selective submission of data. Underwriting bias such as winners curse. Exaggerate benefit of lessons learns or effectiveness of recently imposed controls.
Exposure (proxy model)	Mis-statement of asset and liability sensitivity to combined moves in risk drivers	Constructing hedges to minimise stated VaR; devising “easy” stress test that are known to pass. Lack of preparation for out-of-test stresses.
Computation	Roundoff in floating point calculations; differential equation discretisation, simulation sampling error	Debug effort focuses on commercially unacceptable output.

Correcting for Bias

Bias correction requires detailed knowledge of the business processes underlying data and model construction.

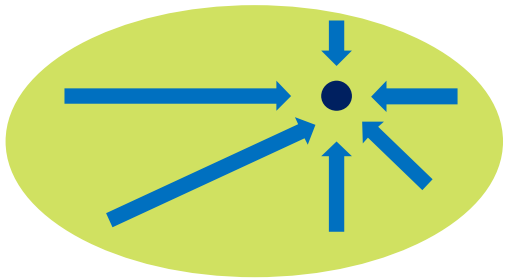


Pointers to a New Way of Thinking about Models
A Single Law is Not Enough

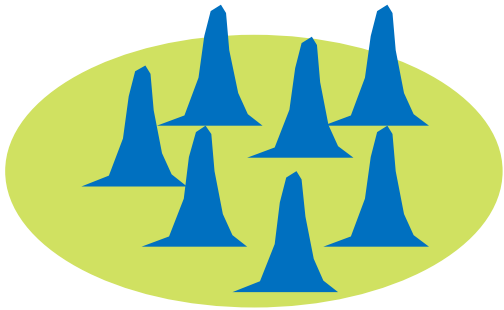


From a Single Probability Law to Worst of Convex Sets of Laws

- Single Law



Collection of laws averaged to one point using a Bayesian prior



Calculate VaR under set of laws and make decisions under worst case

2012 Var Practice

Possible Future allowing for Ambiguity

Points for Discussion

- Current VaR technology seeks to identify a “single” model but is that the only approach?
- Robustness: showing your approach works approximately under a broad set of models rather than relying on knowing the “right” model?
- Is it too prudent to take the worst case of several models, rather than a Bayesian average?
- Standard formula capital uses “worst of two” and “maximum credit” in many places. This is not consistent with any single model but could be articulated as the worst of a convex set of laws.
- How might stakeholders differ on what makes a “good” VaR calculation?

Acknowledgements and Disclaimers

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Disclaimer

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