

Model Risk: Daring to open up the black box

Yvonne Taylor and Louise Witts

03 June 2014

Model Risk Working Party (1)

Background

- A model risk research project was established by the IFoA ERM Research and Thought Leadership Committee in October 2013
- The model risk project was initiated by a member-led research working party (the "model risk working party")
- The remit of the working party was to consider:
 - can a quantitative risk model itself be a source of risk?
 - how should decision-making reflect the potential of the decision tool (model) itself introducing more risk?

3

4

So, can a quantitative risk model itself be a source of risk?



03 June 2014

Real world & industry miscalculations

Mars Climate Orbiter



Millennium Bridge



ONS 2011



Herding



Reinhart & Rogoff



Trains - Laidlaw/SCNF



5

Model Risk Working Party (2)

Objectives

- · Raise industry awareness and understanding of model risk
- Develop a framework for measuring and managing model risk
- · Foster good practice around governance and control of models

Progress to date

- We've established a set of questions to explore
- · We don't have all the answers yet!
- · This presentation summarises our progress so far

We welcome your views on whether we're answering the right set of questions

03 June 2014

Agenda

- A simple, clear definition of model risk
- How the risk culture of an organisation or model user can affect attitude to model risk
- How existing risk management frameworks could be used to manage model risk
- Criteria for assessing materiality of model risk
- Practical case studies to illustrate the theory
- · Good practice around governance and control of financial models

3

But what is a Model?







03 June 2014

Definition of a Model

- "A representation of some aspect of the world which is based on simplifying assumptions. A model is defined by a specification that describes the matters that should be represented and the inputs and the relationships between them, implemented through a set of mathematical formulae and algorithms, and realised by using an implementation to produce a set of outputs from inputs in the form of data and parameters." – BAS Technical Actuarial Standard Modelling, 2010
- "A quantitative method, system, or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates" OCC / Fed Guidance on Model Risk Management, 2011

03 June 2014

Definition of Model Risk

- Model risk is the risk of adverse consequences from actions or decisions based on incorrect or misused model outputs and reports
- Model risk can lead to financial loss, poor business and strategic decision making, or damage to reputation
- · Model risk occurs primarily for three reasons:



Risk culture: The 4 quadrants of model users (1)

User	Beliefs and characteristics	Focus
Cynical	Management intuition and expertise will trump that of modellers	Unknown-knowns
Naive	Direct link of model results to decisions, expert judgement downplayed	Known-knowns
Pragmatic	Model results treated as advisory, one of several pieces of evidence used for decision making	Known-unknowns
Pessimistic	Models irrelevant in decision making; models bound to be wrong	Unknown-unknowns

Different model users generate different model (or non-model) risks

Model users with different styles have different opinions of each other

Risk culture: The 4 quadrants of model users (2)



Risk culture: The 4 quadrants of model users (3)



03 June 2014

Risk culture: The 4 quadrants of model users (4)

 No one quadrant in isolation can be successful without the challenge / control from the other quadrants

Conclusions

Good governance will include representation of each group

Governance needs to address the needs of different users to get a good outcome

Validation needs to address the possible challenges from each quadrant

Risk management framework for model risk

Area of framework	Principles
Ownership	The risk team is responsible for the model risk management framework, the chief executive is responsible for managing model risk
Model inventory	To be maintained by the framework owner but populated and updated by model owners
Risk appetite	Setting appetite and tolerance limits for model risk
Materiality assessment	To be carried out in order to put a sensible limit on the number of models the framework applies to
Oversight categories	Governance, data quality, changes, use, assumptions / expert judgements, methodology, performance, validation, documentation, external models and data
Governance standards	Required for each of the oversight categories ('watered down' version of regulatory standards where appropriate)
Risk reporting	All model owners will need to assess how well they are managing the risks / operating the controls on a periodic basis, e.g. quarterly via risk self assessment process (owned by risk team)

15

Assessing materiality of Model Risk (1)

Where does model risk arise?

- · Model risk arises from a decision using information derived from model outputs, when:
 - this information is "wrong" (i.e. the information is not what is intended)
 - the purpose for which the information is being applied is not an appropriate use of the model

Scope

 Include all models being used within business and support processes and also any models produced for third party use (customers and regulators)

Definition of materiality

- The risk is material if the information from the model could influence the decision-making or judgement of the intended users of that information
 - it equally applies to outcomes for a third party (customer, regulator, public)

Could the information from the model drive a different decision?

03 June 2014





Assessing materiality of Model Risk (3)

Assessment of whether the model could drive a different decision

Assume a model will be controlled unless:

- Its contribution to the <u>model application</u> is sufficiently small (not only of point in time but also over the foreseeable future)
- No concentrations of risk
- · Model is stable and not likely to give very different results
- · Low interconnectedness with other models

Assessing materiality of Model Risk (4)

Model application and metric for assessment

Process	Metric	Process	Metric
Reserving	Total reserves	Transactions	£M of price
Regulatory capital	Capital requirement	Forecasting	Total PBT
EEV / MCEV	Total EEV / MCEV	Benefit illustration	Sales volumes
Product pricing	Total NB PBT	Experience analysis	Total BEL
ALM	Percentage of BEL	Reinsurance	Reinsurance premiums

Working Party case studies (1)

Proxy models

- · We are an insurer and we want to revalue assets and liabilities quickly under many stress scenarios
- · Running full valuations in the "heavy model" takes a long time
- So we perform a moderate number of "fitting" scenarios in the heavy model and then fit a smooth formula (the "proxy model"), usually a polynomial, through those scenarios
- To check the proxy model is working, we also generate "out of sample" scenarios, separate from those used in the fitting, for which we run both the proxy model and the heavy model and compare the results

Working Party case studies (1) continued

Proxy models key questions the working party aim to address

- · How many out-of-sample tests are needed to assess how accurate the proxy model is?
- How best to construct the out-of-sample tests and the fitting tests?
- How can we use the out-of-sample test errors to construct confidence bounds for proxy model errors where we haven't done heavy model runs?





Working Party case studies (2)

Longevity models



03 June 2014

[Source for chart: Currie et al, 2013] 21

Working Party case studies (3)

Investment advice models

Assessment of Model Risk as a Consequence of Key Assumptions		
MODEL/PRODUCT:	GENERIC LS FUND	
	PROBABILITY	IMPACT
OVERALL RISK		
MORTALITY RISK		
TRADING RISK		
LIQUIDITY RISK		
INSURANCE RISK		
EXPENSE RISK		
ECONOMIC RISK		
LEGAL RISK		
SPECIFIC RISK		

Key	PROBABILITY	IMPACT
	Low	Minor
	Medium	Medium
	High	Severe

Governance and control of financial models

	OVERALL RISK RATING	
	GOVERNANCE	
	DATA QUALITY	
	MODEL CHANGES	
ries	MODEL USE	
tegoi	ASSUMPTIONS - STANDARD	
nt Ca	ASSUMPTIONS - EXPERT JUDGEMENT	
rsigh	MODEL METHODOLOGY	
Ove	MODEL PERFORMANCE (AvE)	
	MODEL VALIDATION	
	MODEL DOCUMENTATION	
	EXTERNAL MODELS AND DATA	

Key	RISK LEVEL
	Minor
	Medium
	Severe

03 June 2014

Applying the standard risk management cycle



03 June 2014

12/11/2014

Model Risk management: Different to standard?

Should model risk be managed in the same way as other risks?

Do you already capture model risk in your operational risk frameworks?

Do you build in prudence to calibrations?

Who should own model risk?

How do you assess materiality?

03 June 2014

25

26

Model Risk: Still work to do.... Education, Education Education!

03 June 2014



Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

```
03 June 2014
```