



**Actuaries
Summit**
**get involved,
get ahead**
20 – 21 May 2013
Hilton Sydney



Innovations in Operational Risk

Joshua Corrigan, Milliman Principal

Agenda

- Introduction
- Traditional Assessment Methods
- Structural Modelling



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Section 1

INTRODUCTION

Milliman Research Report

- Recently published global research report, authored by myself and Paola Luraschi (Milan) with input from global consultants
 - Available for download at <http://au.milliman.com/perspective/operational-risk-modelling-framework.php>
- All developed markets
- Current and emerging techniques
- Operational risk assessment is a hot topic in the finance industry and coming under increasing stakeholder scrutiny

Milliman Research Report

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Operational risk modelling framework



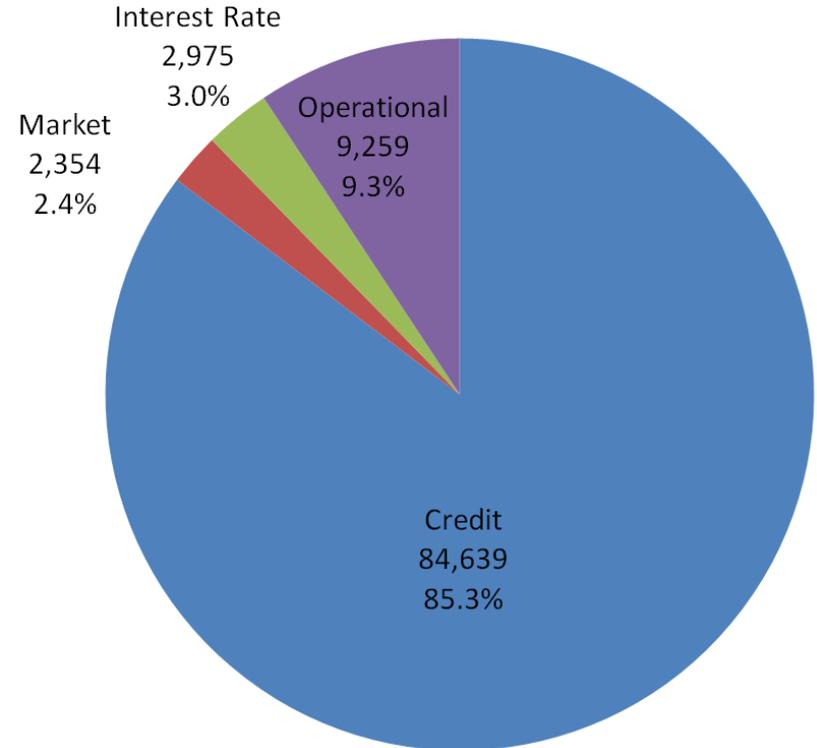


Operational Risk Capital

Graph shows aggregate required risk capital of top 4 Aussie banks as at end-2012 (99.9% VaR in AUD Billions)

Op risk capital approximately double the aggregate of interest rate and market risk

Roughly, wealth management accounts for around 10% of this = \$0.9Bn



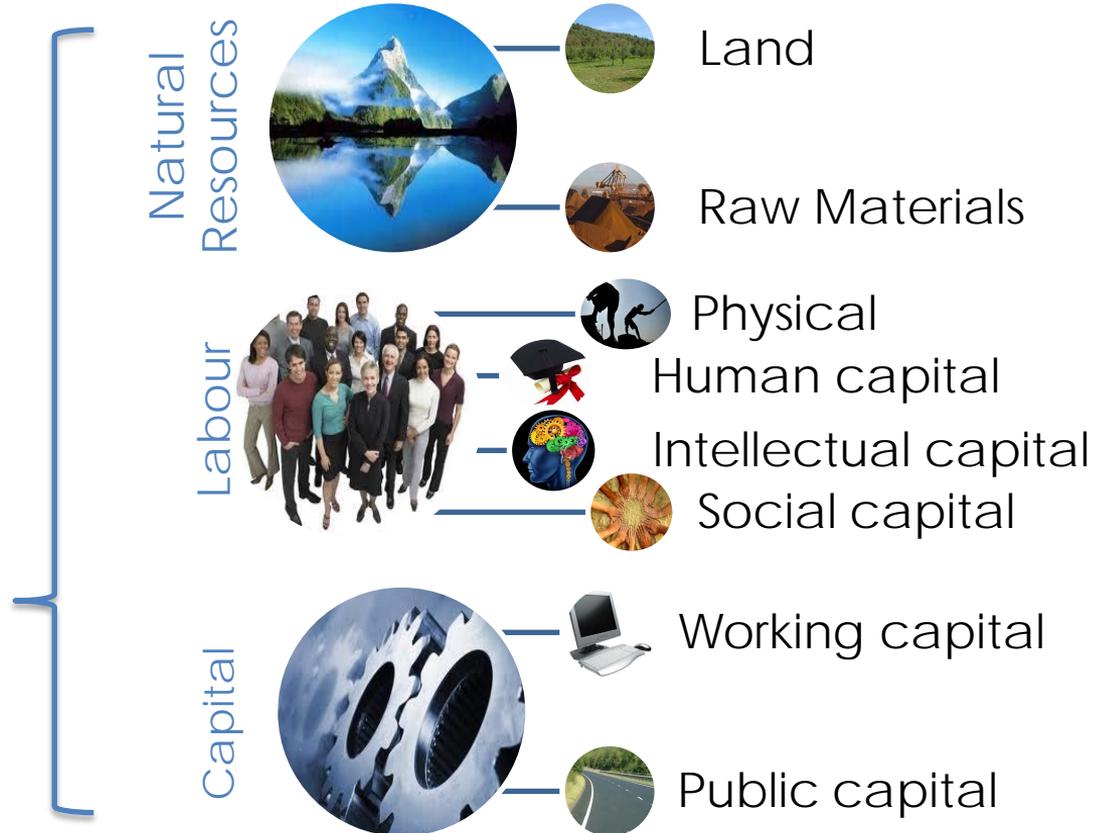
A Definition

Typical

"the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events"

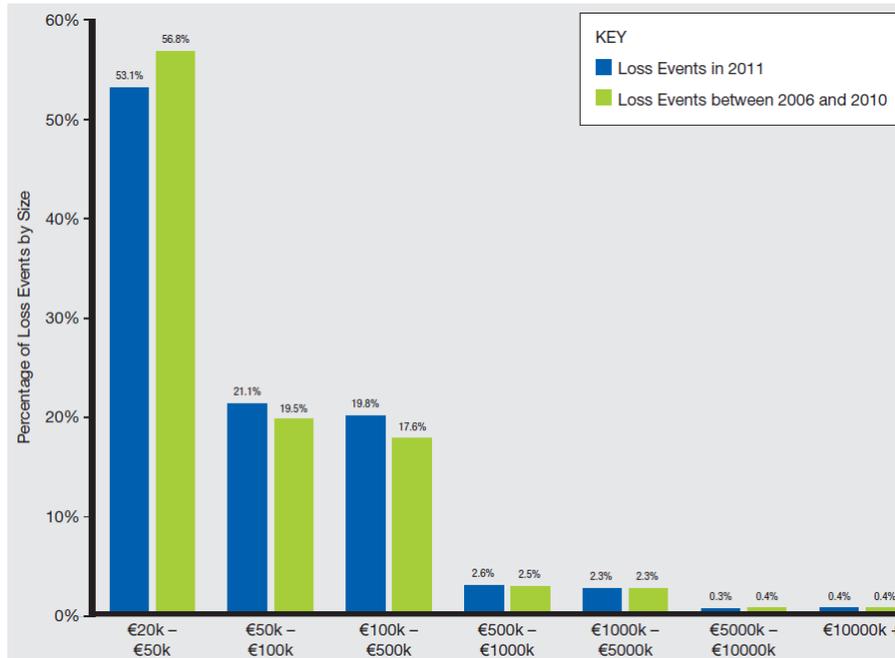
Fundamental

"the risk of loss resulting from inadequate or failed productive inputs used in an operational activity"

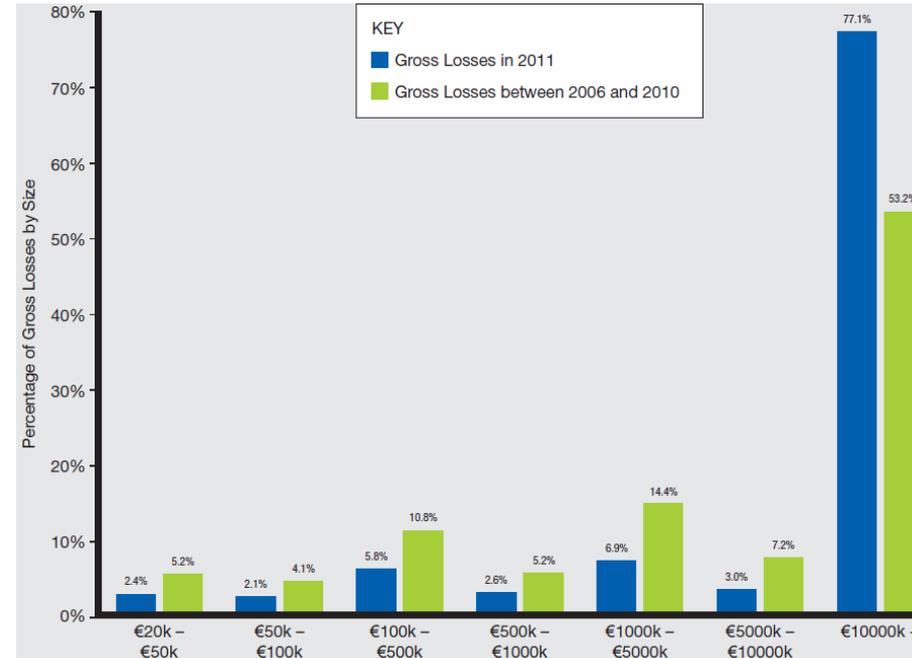


Nature of Operational Risk Events

Distribution of Number of Events by Size (ORX)



Distribution of Total Gross Loss by Size (ORX)





Derivative Operational Risk Loss Events

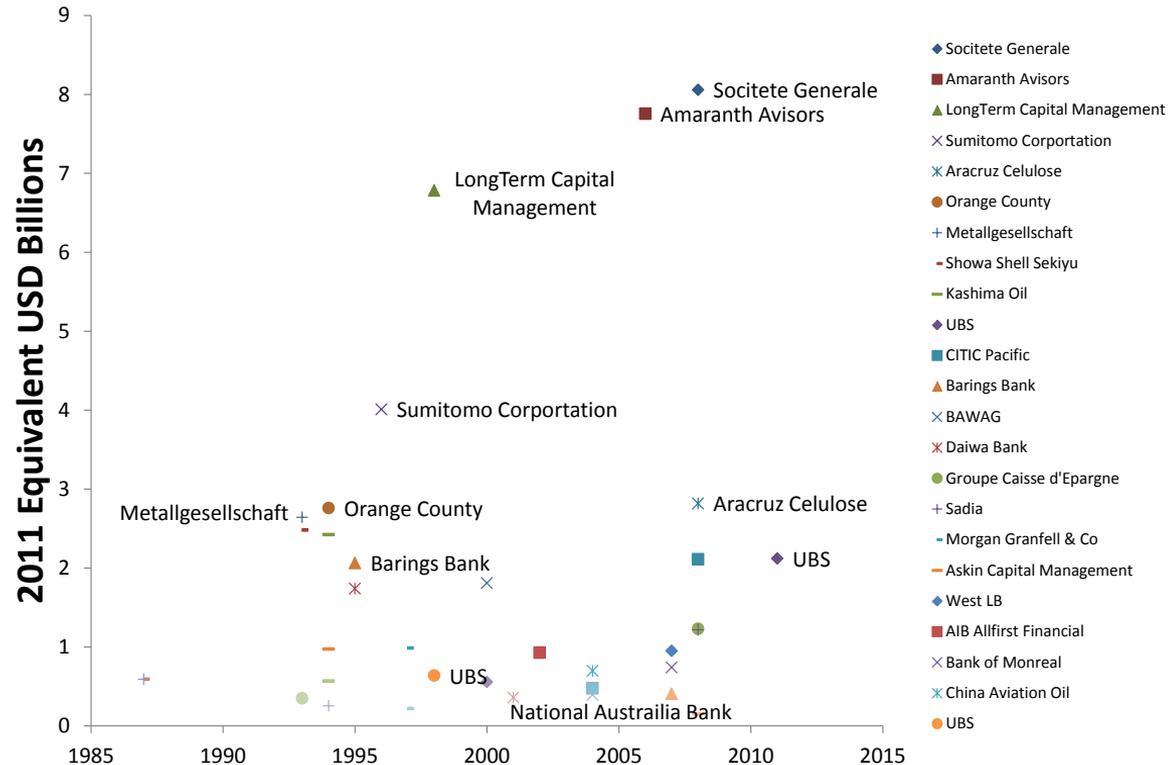
Derivative losses seem to show no sign of abating in term of either frequency or severity

How can we understand these events?

Are they homogenous or heterogeneous?

Are they relevant to my company?

How can we understand the next emerging operational risk event?



Financial and Physical Consequences



Industry	Low Severity High Likelihood	Medium Severity Medium Likelihood	High Severity Low Likelihood
Banking	ATM failures	Online security breach	Rogue trader
Insurance	Claims processing	Regulatory compliance failure	Mis-selling Mis-pricing
Mining	Transport service interruption	Environmental contamination	Mine collapse
Energy	Meter reading errors	Environmental contamination	Oil spill Gas plant fire

It's all about the loss generation mechanisms, which are highly heterogeneous.
Is the system generating the LGM stable or dynamic?

Section 2

TRADITIONAL ASSESSMENT METHODS



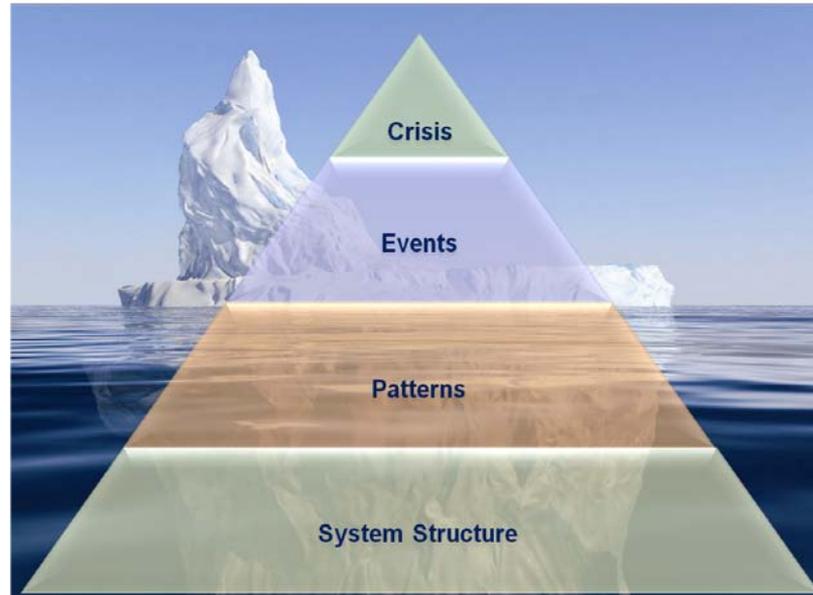
Model Framework Choices

Risk identification, assessment, monitoring, mitigation, appetite etc. all depend upon the perspective taken.

Traditional and statistical frameworks focus mainly on above the water line items, appropriate for stable systems.

New complex systems based frameworks focus on dynamic systems, below the line items, embracing:

- Holism
- System drivers and dynamics
- Non-linearity
- Human bias
- Emergence



Basic
Indicators

Standard
Formulas

Scenario
Analysis

LDA

Causal
Models

Basic Indicator and Standard Formula

Operational risk capital scales in line with broad business metrics such as:

- Gross income
- Premiums, claims, expenses
- Liabilities, Assets / AUM
- Capital

Assumes stable loss generation mechanisms (LGM)

Simple, transparent, cheap, but... main problem is that it isn't linked to the LGM itself !

- Rough proxy only
- No incentive to manage op risk
- Enables gaming of the system

Country / Sector	Indicator	Factor (indicative)
Global, Basle II	Gross income	12% to 18%
EU, Solvency II	BSCR, premiums, liabilities, expenses	Floored at 30% of BSCR + 25% UL expenses
Australia, LAGIC	Premium, liabilities, claims	Varies for Life vs General
Japan, SSR	"BSCR"	3% if P&L < 0 2% if P&L > 0
South Africa, SAaM	BSCR, premiums, liabilities, expenses	Varies for Life vs General; Floored at 30% of BSCR + 25% UL expenses
Taiwan, RBC	Premiums, AUM	0.5% life, 1% annuity, 1.5% other, 0.25% AUM
USA, Europe ex EU, Other Asia, Russia, NZ	None!	

Quant Risk Assessment or Scenario Analysis

Common method currently used

Typical method used for Australian Superannuation entities (SPS 114)

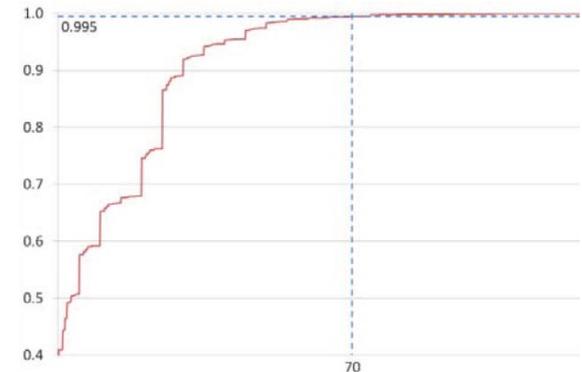
- ORFR must reflect the size, business mix and complexity of the entity's business operations

Forward looking and transparent, but suffer from:

- selection bias
- the when to stop problem
- human bias (e.g. 1 in 1000 event?)
- rubbery inter-relationship assumps
- lack of uncertainty
- allowance for complexity
- no ability to use inference

1. Hypothesize loss severity and likelihood of possible scenarios
2. Generally assume scenario independence, use generalized binomial distribution to estimate loss distribution and thus capital (VaR / CTE).
3. Or assume linear dependence, use correlations

SCENARIO	SEVERITY (M)	LIKELIHOOD (P.A.)
1	5	5.00%
2	10	1.00%
3	1	3.00%
4	10	1.00%
5	10	1.00%
6	10	5.00%
7	20	5.00%
8	5	5.00%
9	5	5.00%
10	30	0.50%
11	25	0.25%
12	75	0.10%
13	10	0.10%





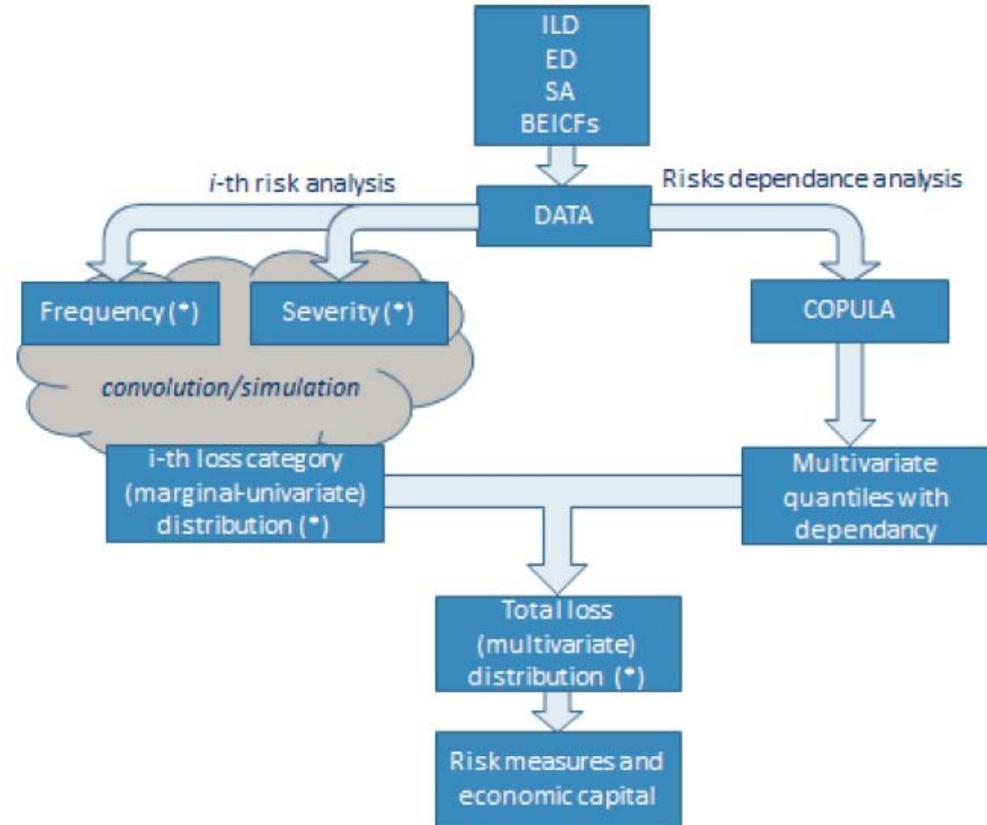
Loss Distribution Approach (LDA)

Basle II allows for the use of an Advanced Measurement Approach (AMA) with regulatory approval.

Current common practice in leading banks (including the big 4 in Aus).

Distribution calibration leverages multiple data sources:

- Internal loss data (ex-post)
- External loss data (ex-post)
- Scenario analysis (ex-ante)
- Business environment and internal control factors (ex-post, current, ex-ante)

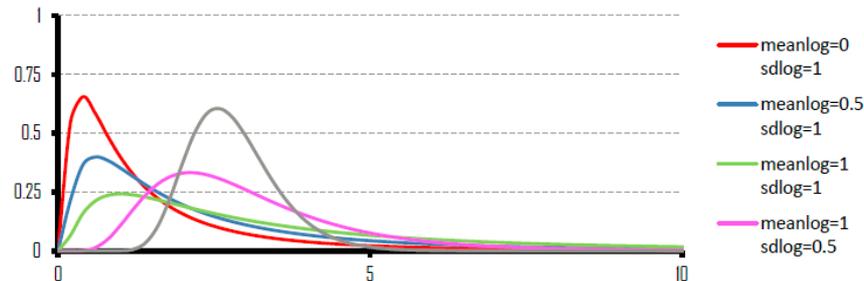


LDA Distribution Choices

Severity Distributions

- Continuous: Lognormal, Pareto, Gamma, Weibull

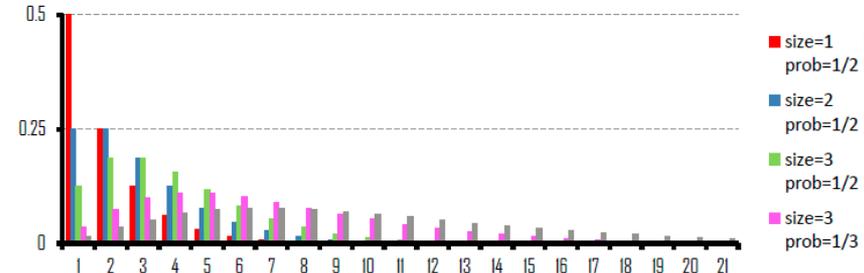
Lognormal



Frequency Distributions

- Discrete: Poisson, Negative Binomial

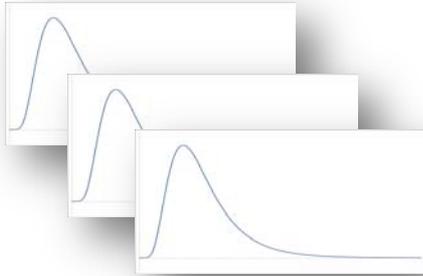
Negative Binomial



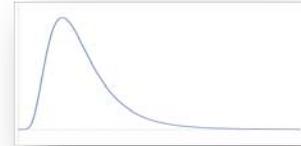
- Choice of prior distribution critical for low frequency events

Aggregation Issues

- Typically simulate the compounding effect of variation and uncertainty through statistical models with dependency structures (correlations, copulas)
- “Thing” being modelled is a complex adaptive system, exhibiting emergence
- Historical data therefore irrelevant for many behaviours



$$\rho = \begin{pmatrix} 1 & \cdots & \rho_{1n} \\ \vdots & \ddots & \vdots \\ \rho_{n1} & \cdots & 1 \end{pmatrix}$$



Models are not often used to understand “modal” behaviours...they are used to understand extremes. But the mechanisms of these behaviours are likely to be different to those seen often and are likely to adapt over time. Emergent behaviour requires us to focus on interactions, but these modelling methods artificially set these.



An Anthropological Study of Op Risk

1. Modeler meets "The Business"



2. "The Business" imparts wisdom



3. "The Business" is shown the model



4. "The Business" gets on with life





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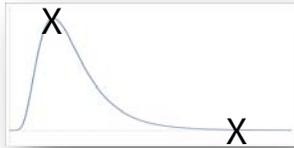


Section 3

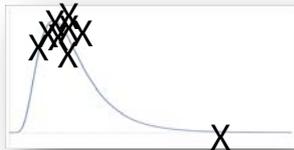
STRUCTURAL MODELLING

Modelling Adaptive Systems

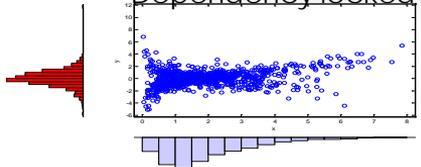
Parametric shape assumed



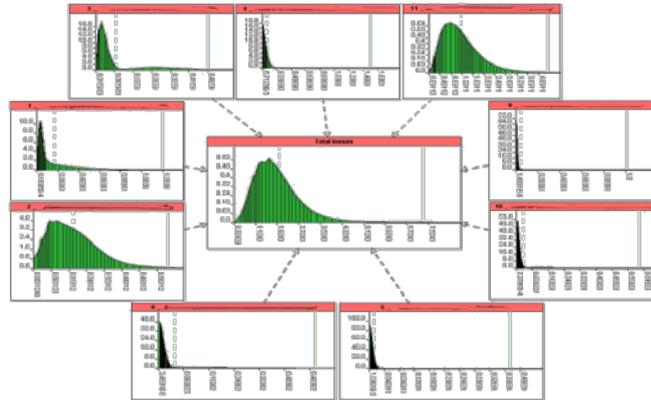
Fit to historical data



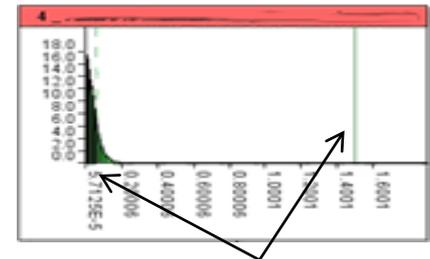
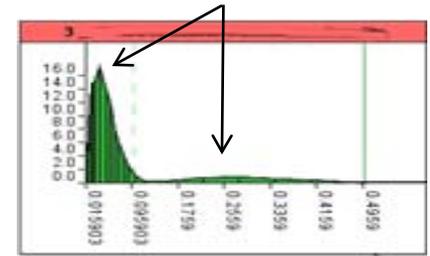
Dependency locked in



Real distributions show far more variety of outcomes



Experts know that behaviours of this risk have two modes of operation



Experts know that this risk is nearly always benign but has a nasty sting in the tail



Structural / Causal Models

Loss outcomes are conditioned upon the underlying states of the drivers / risks constituting the LGM system

“System” in the context of a complex adaptive system

Designed to capture the important dynamics actually driving operational risk

Incorporates and leverages the beneficial features of SA and LDA

1. Elicit system structure

2. Identify critical drivers

3. Define driver states

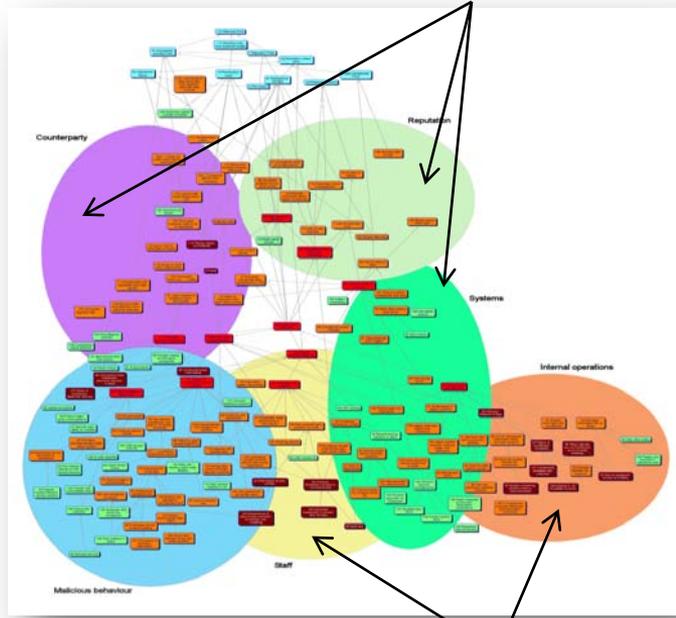
4. Define inter-relationships

5. Aggregation and analysis



Scenario Construction

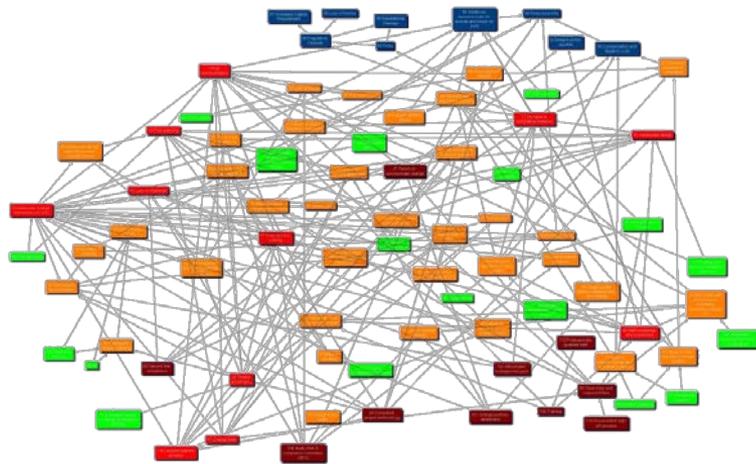
Scenarios must move through these areas



Scenarios must start in these areas

- Test the model dynamics by creating scenarios
- Scenarios derived from understanding of “real” system
 - Extreme dynamics
 - Causal flows
 - Build up of interrelating risk factors

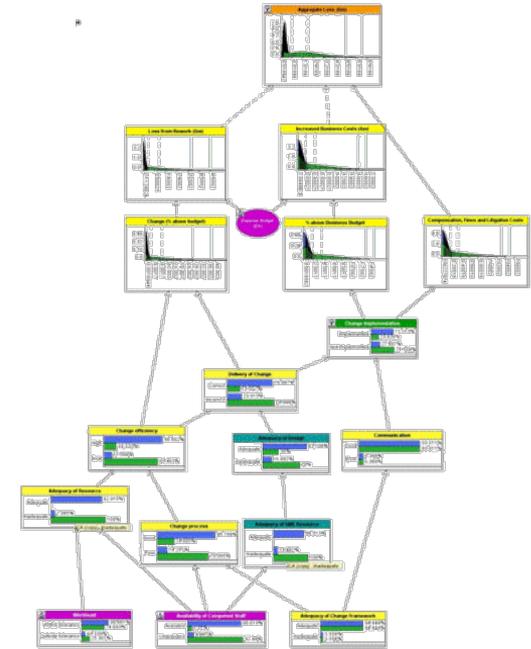
Identifying important drivers and dynamics



Example system structure by scenario

Graph & network theory

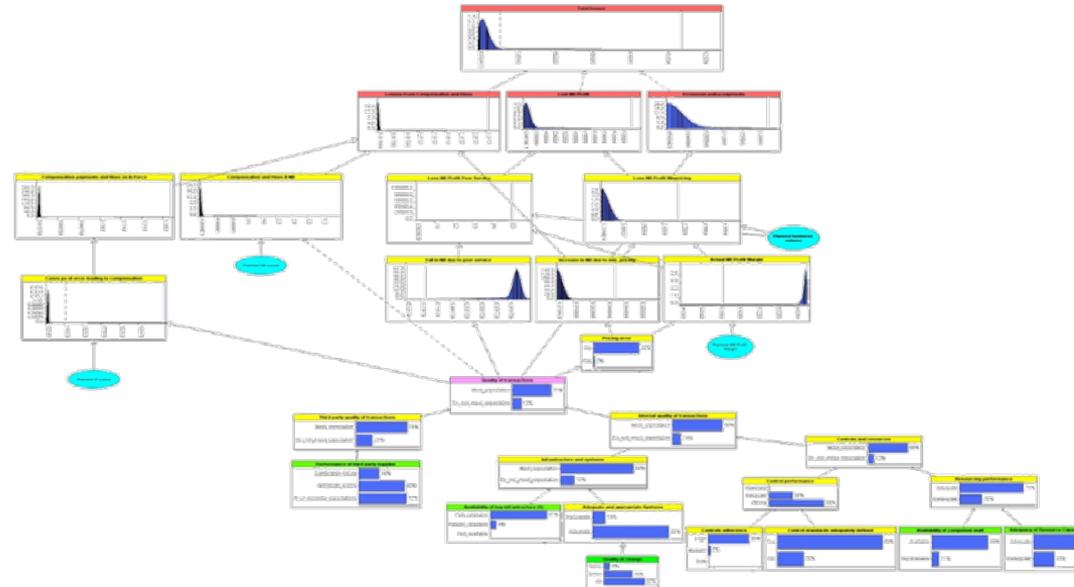
 Complex systems science





Bayesian Networks

- Describing outcomes (e.g. capital) in terms of drivers means you can “explain” different outcomes in a real way
- No need for correlation (it is an output)



Aggregate
scenario
outcome

Contributing
outcomes

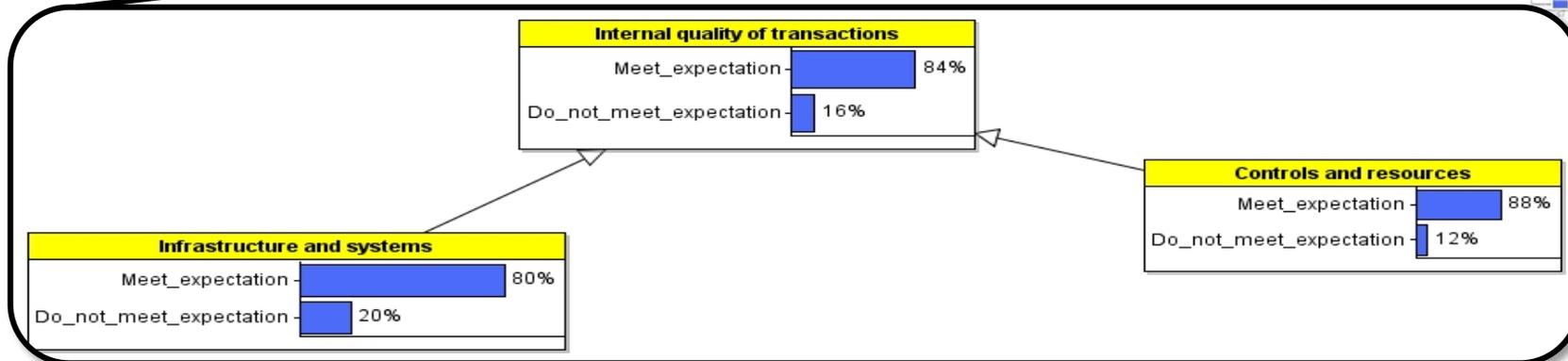
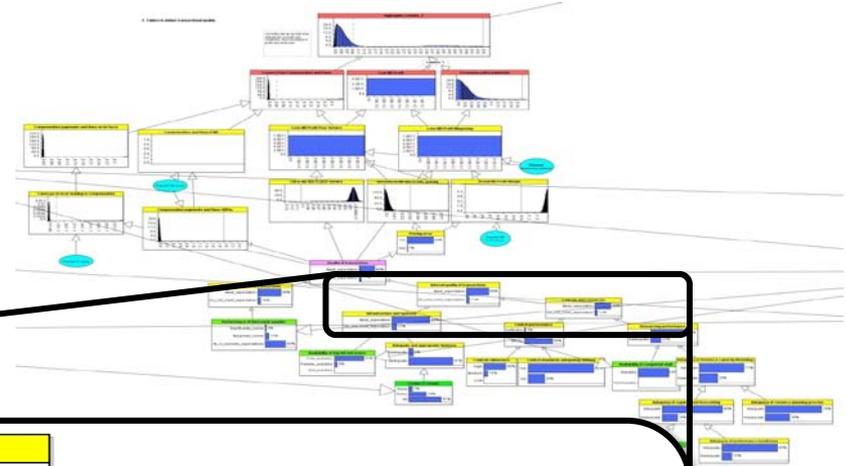
Scenario
dynamics



Model the Way Experts Think and the Business Behaves

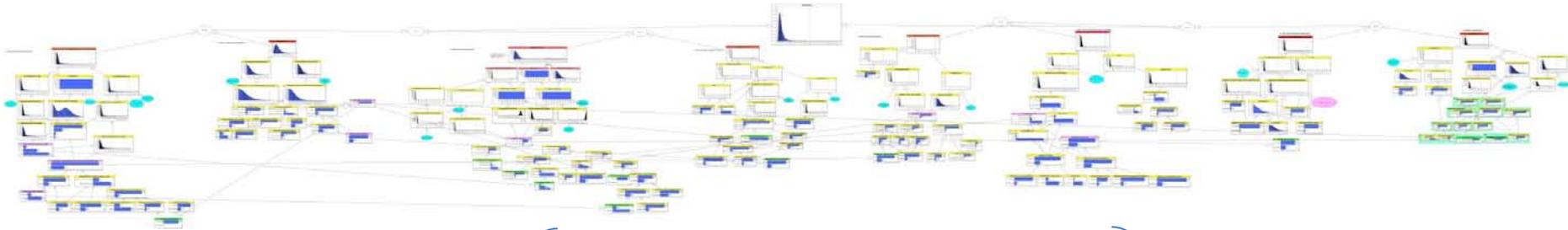
It is easier to explain how likely it is you will meet transaction quality expectations if you know whether your systems are working and your controls work.

Experts find it easier to give “conditional” estimates.



Dependency, Interrelationships and Aggregation

- Causal models capture intricate interactions using conditional behaviours
- Can determine equivalent "correlations" to validate or produce parameter estimates for other models

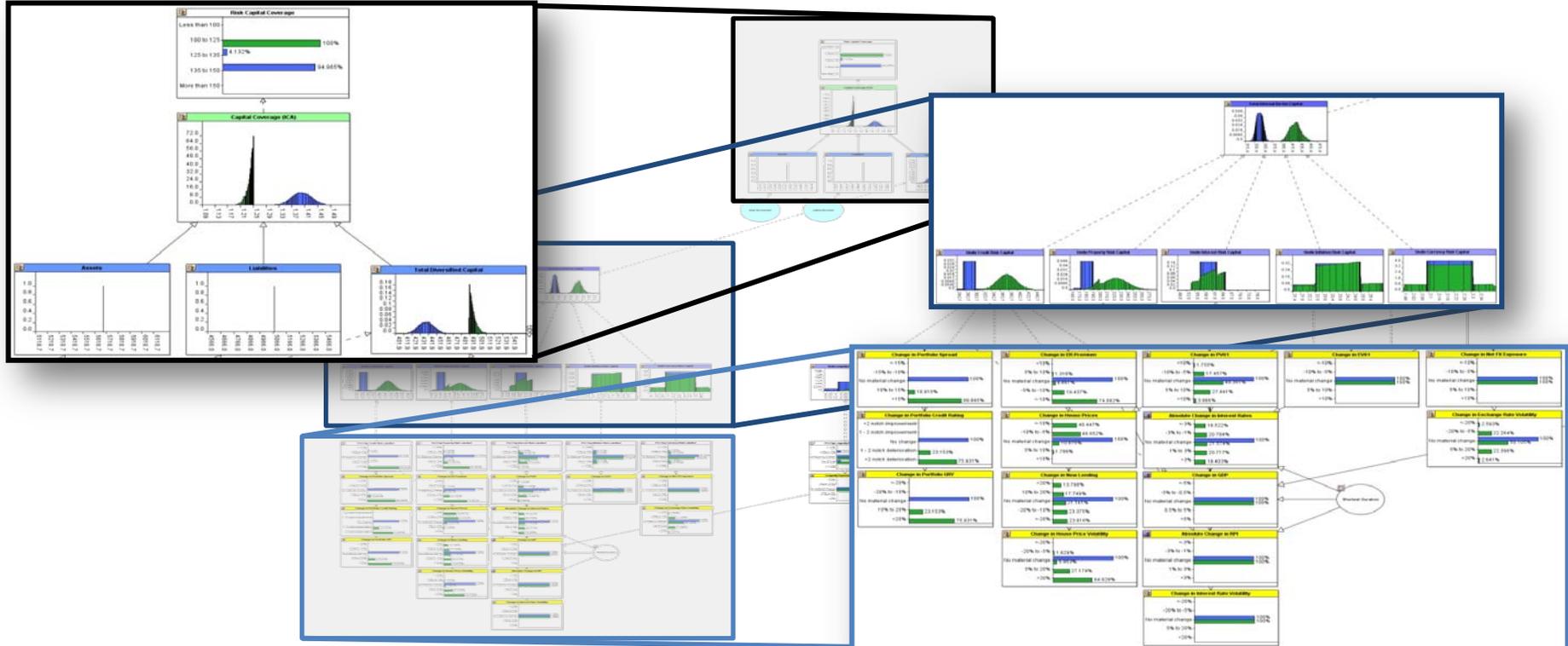


$\rho =$

1	0	0.023035	0	0.0043	0	0	0.000013
0	1	-0.000001	0.00048	0	0	0	0
0.023035	-0.000001	1	0	0.011645	0.044774	0.00211	0.000397
0	0.00048	0	1	0	0	0	0
0.0043	0	0.011645	0	1	0	0	0.000007
0	0	0.044774	0	0	1	0.004908	0.000026
0	0	0.00211	0	0	0.004908	1	0.000001
0.000013	0	0.000397	0	0.000007	0.000026	0.000001	1



Scenario Testing: How Could I Breach Appetite?

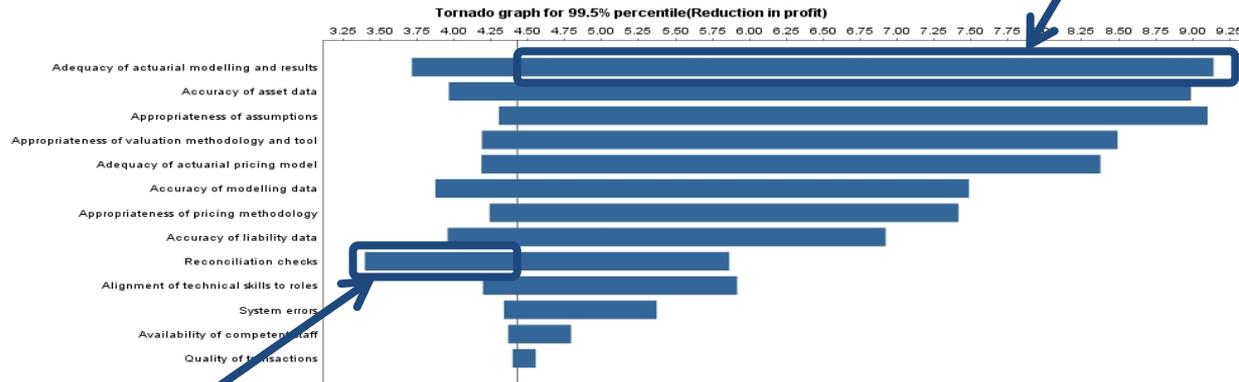




Asking/Answering Questions

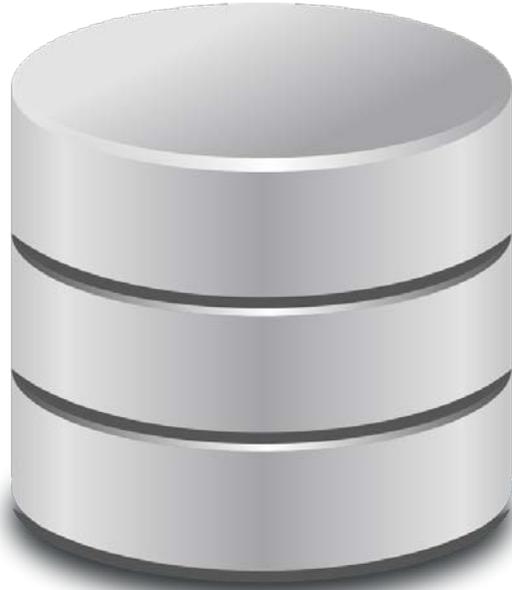
- Stress / scenarios
- Sensitivity
- What if

Biggest potential to make tail worse



Biggest potential to make tail better

Professional Developments and Loss Databases



ORX is the established global database collector and provider for operational risk for the banking community, and ORIC in the UK for insurance companies. Nothing exists for insurance or wealth management, outside of those entities that are divisions of banks.

ORX is designed to meet the needs of banks first.

We, the Actuaries Institute RMPC and associated Operational Risk Working Party, is investigating the creation of a LDC service for the Australian wealth management industry serving the operational risk needs of:

- Life and General insurers
- Superannuation funds
- Wealth managers

Regulatory harmonisation?



Call to Action

1. Actuaries to get involved in operational risk
2. Focus on how operational risk frameworks can add value to management decisions focused on:
 1. Explanation, not just prediction
 2. Profitability and capital
 3. Business resilience
 4. Trade-offs between these
3. Push the boundaries for the use of new techniques where appropriate, rather than replicate simple techniques that are lacking

Questions / Comments?