



SOCIETY OF ACTUARIES

**Life 2008 Spring Meeting
June 16-18, 2008**

**Session 26, Economic Capital: How to Do It and
How to Use It**

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Economic Capital

SOA Life Spring Meeting
Session 26
June 16, 2008

Marc Slutzky



Introduction

- Emerging Trend - many US life insurers are developing Economic Capital models
- Many of these models are not yet robust enough to encompass all of the appropriate risks
- Methodology used to calculate economic capital is still emerging and may differ from company to company

Strategic Risk Management

- Risk Management Culture, built on
 - Risk Control Processes
 - Emerging Risk Management
 - Risk and Economic Capital Models

- Setting of Risk Appetite
 - Driving Risk Tolerance and Risk Preferences
 - Influencing Risk Limits
 - All Interacting

- EC is the measurement tool

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Why Economic Capital?

- How much risk is it appropriate for an enterprise to take?

- Defining risk and determining an appropriate risk profile has become complicated and requires robust tools

- A fundamental risk-management activity for the enterprise

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Determining Economic Capital

- Quantifies the capital needed as a cushion against risks/losses.
- Allocate capital appropriately among its products
- Maintaining insufficient capital jeopardizes the viability of the enterprise
- Retaining too much capital or allocating it ineffectively hampers the enterprise's ability to compete.
- Economic capital gives managers a means to evaluate and integrate the risks the organization faces.

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EC Models

- EC models can quantify the risk-reward tradeoff of strategic choices where conventional tools can't.
 - Provide a distribution of loss outcomes for different risk scenarios based on stochastic or probabilistic analysis.
 - Managers can compare the risks associated with a product, for example, and quantify its capital needs.
- Deterministic models provide a limited range of loss outcomes with no information about the distribution - no longer adequate
- Need more sophisticated risk-assessment tools that could measure the impact of risk scenarios on their strategic choices

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Advantages of EC Modeling

- Stochastic EC models overcome these shortcomings - provide information on the probability of loss outcomes.
- However, only a narrow band of extreme scenarios—those worst-case outcomes in the tail of the distribution - are analyzed to determine their impact.
- Scenarios can be aggregated across product lines,
 - determine whether offsetting or diversification benefits will mitigate certain risks
 - will losses across lines deepen under a certain scenario.
- This ability shifts the management paradigm to a risk-adjusted platform

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Modeling Internal Hedges and Diversification Benefits

- Do products in a portfolio have an offsetting effect under a given loss scenario?
- If an increase in interest rates bolsters the performance of an insurer's disability products, for example, but depresses annuity results, do the benefits exceed the costs?
 - Traditional measures lack the capacity to quantify the diversification benefits of an insurer's product portfolio.
- Similarly, is there a reduction in LTC benefits if mortality rates increase or a pandemic occurs?
- Conventional tools, relying heavily on industry ratios and averages, don't allow managers to look beyond general comparisons of capital adequacy.

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Rating Agency Views of EC Models

- Many metrics acceptable
- EC should reflect all major risks and allow directly for risk mitigation
 - Show explicitly – demonstrate that risks are not assumed away
- Explicitly calculate diversification benefits – should be identifiable
- Model robustness and execution
- Strong ERM rating requires strong SRM practice in place
- Model validation

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Emerging Rating Agency Issues

- Validation Tests
- Roll forward
- New Business
- Comparables
- What risk models used

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Relationship Between Solvency II Internal Capital and Economic Capital Models

- Expected that 3 tests will need to be passed for regulatory acceptance of Internal Models on an ongoing basis
 - Use Test
 - Calibration Test
 - Statistical Quality Test

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Methodology - Metrics: Long Term Approach

- I have used a long-term runoff approach to determine EC, consistent with developments in C3-Phase II and Principles Based Approach to reserves.
 - ✓ PV of greatest accumulated deficit over 30 year horizon
- The long term runoff approach used for liabilities is different from the one year Economic Balance Sheet approach used by many European companies
 - ✓ Economic Balance Sheet approach looks at fair value of assets and liabilities at the end of one year. To develop a Fair Value of liabilities, long term modeling must be performed as in the long term approach.
- CTE approach may be used for business risks, where capital is set at the average of the worst 1% of losses over 30 years
 - ✓ For Strategic and Operational failure risks, a different approach may be used

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Methodology – Models and Scenarios

- Business unit profits projected including credit defaults and migration
 - separately from gains and losses on assets backing capital
- Projections and aggregations may assume full consolidation of companies in the group and fungibility of capital, or some independence
- Strategic failure risk and operational failure risk projected separately
- Synchronized scenarios are run across all lines of business – scenario reduction techniques used to choose a manageable number of scenarios to run
- Aggregation across a scenario (or set of scenarios) allows positive results from favorable lines of business to offset negative results from unfavorable lines

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Strategic Risk Analysis

- Strategic Risks analyzed as an element of the EC Process
- Managements are concerned with their ability to understand and allow for strategic risks and emerging risks.
 - Taleb suggests that paying attention to emerging risks is the most important management responsibility
- Getting managers to articulate and understand the underlying causes in the operational or strategic loss chain of events is a fundamental part of defining such risks
 - research has shown that such understanding of the risks actually lowers a company's ultimate risk exposure. Despite their often sudden occurrence, most operational and strategic risks have a history and emerge over time.

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Strategic Risk Discussion

- Based on the discussions, analysts and managers can develop realistic risk probabilities and perform statistical analyses that show the interaction of risks and how risks are correlated. Moreover, these discussions typically promote an understanding of what levers trigger certain events and how management can intervene to mitigate their effects.
- The initial step in the process is to develop an analysis of all of the potential business risks (financial risks) operational risks and strategic risks.
- This list serves to seed the risk discussions with the levels of management, many of whom have never been involved with risk discussions before.

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Strategic Risk Identification

- Significant strategic risks and threats were identified
- First Meeting - A free form process of discussing the company's goals and objectives, and how each of the identified risks could affect achieving the goals.
- No subject off limits – questions and responses from managers and facilitators
 - After the meeting, risk maps were prepared
- Second Meeting – Review, discuss and build on the results of the first meeting.
 - Present results, discuss, see if we got the maps and scenarios right
 - Clarify Terminology - Even in this small group, differences in interpretation exist
- Redraw maps and scenarios – Build new maps at each stage

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Strategic Risk Review

- Meet again with ERM/EC Team and begin to parameterize the scenarios
 - Input from businesses to develop parameters
- Review and Comment on Scenarios
- Eliminate duplication
- Run scenarios through several iterations of the aggregation model developed

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Strategic Risk - Process

- Redoing the process over multiple years may be useful in understanding how emerging risks are captured.
- Second and subsequent years may be more concentrated process - more detail captured in areas which are becoming more relevant
- Even having only applied CRisALIS at a high level, we were able to identify potential sources of emerging risk, which management could then explore in more detail as an actual type of that risk begins to emerge.
- Some areas of risk in the market may be advantages for company due to certain features of their business model. Some of their "advantages" arise from things which are risks for others.
 - an "emerging risk" identified through this approach may not always be a negative for the particular organization - it could be a strategic advantage.

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Strategic Risk – Highlights of the Process

- Highlights of the process:
 - accessible to management without the need for lots of technical preparation, form filling, etc. simply think about their business and its context
 - repeatable so risk exposure can be tracked over time to identify emerging risk areas
 - facilitates the linkage of these emerging risks into economic or regulatory risk capital
 - by talking to a cross-section of staff, the exposure to changes in participants is very limited
 - it is relatively rapid
 - it can be applied at different levels of detail so key business areas could be explored in more detail if desired
 - enables "hard to quantify" risk sources to be brought into calculations

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Thank you

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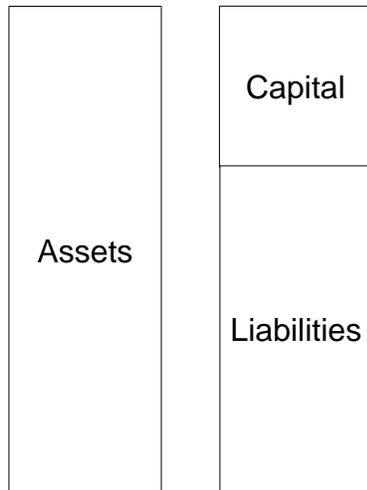


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Session 26
Economic Capital: How to Do It and How to Use It

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June 16, 2008



What is economic capital?

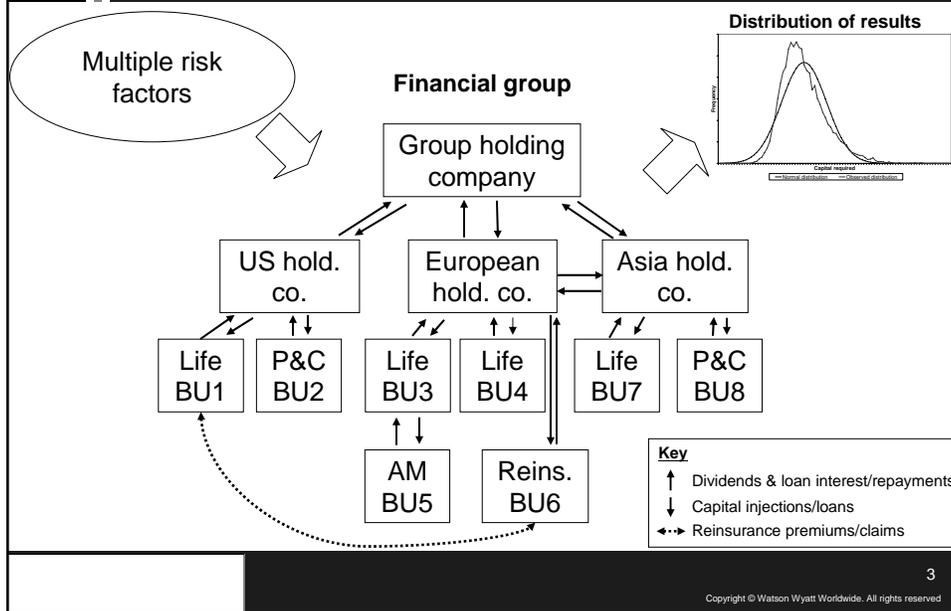


Capital represents a buffer to absorb risks

Key questions are:

- How to define capital?
- Buffer against which risks?
- Over what time horizon?
- How large a buffer is needed?
- What substitutes for capital today should be modeled?

What we are trying to model



Recognizing the difficulties

- Real world risk environment
 - Shifting conditions
 - Lack of (relevant) data/basis risk
 - Insufficient granularity of data
 - Possible tail dependency
 - Fat tails
- Company model
 - Uncertain dynamic policyholder behavior
 - Complicated management actions
 - Complex organizational structures and external influences (eg tax)
- Key metrics (eg technical provisions)
 - Lack of unbiased "best estimates" for non-financial risks
 - Incomplete or illiquid markets
 - Uncertainty over how to approximate MVM for non-financial risks
 - Lack of closed form solutions/computing power

A common approach to EC calculation

1. Calculate base balance sheet

Base	\$m
Assets	1200
Liabilities	1000
Surplus	200

Final

	\$m
Surplus	200
EC	59

2. Recalculate base balance sheet in scenarios or apply factors to get capital for each risk

For example:

Equity down	\$m
Assets	1000
Liabilities	840
Surplus	160

3. Apply aggregation formula

Matrix C

	Eq	Int.	R.E.	Cred	Eq vl	Mort	Lps	Op
Equity	1.0	-0.2	0.5	0.5	0.7	0.0	-0.5	0.6
Int.	-0.2	1.0	-0.1	0.3	0.0	0.0	0.1	-0.1
R.E.	0.5	-0.1	1.0	0.2	0.5	0.0	0.0	0.2
Credit	0.5	0.3	0.2	1.0	0.0	0.0	0.0	0.2
Eq vl	0.7	0.0	0.5	0.0	1.0	0.0	-0.4	0.5
Mort	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Lapse	-0.5	0.1	0.0	0.0	-0.4	0.0	1.0	0.0
Op	0.6	-0.1	0.2	0.2	0.5	0.0	0.0	1.0

Capital

Equity	40
Interest	10
Real Estate	5
Credit	5
Equity vol	10
Mortality	5
Lapse	10
Operational	15
Total	100

Vector A

$EC = (A^T \times C \times A)^{0.5}$
 $EC = \sqrt{\sum A_i^2 + \sum \rho_{ij} A_i A_j}$

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Setting the economic capital confidence level

Average cumulative issuer weighted default rates 1970-2006

	1 year	2 years	3 years	5 years	30 years	1 year EC
Aaa	0.00%	0.00%	0.00%	0.10%	1.19%	0.01%
Aa	0.01%	0.02%	0.04%	0.18%	1.93%	0.03%
A	0.02%	0.09%	0.22%	0.47%	4.24%	0.10%
Baa	0.18%	0.51%	0.93%	1.94%	11.36%	0.50%
Ba	1.21%	3.22%	5.57%	10.21%	35.09%	N/A
B	5.24%	11.30%	17.04%	26.79%	54.42%	N/A

Source: Moody's "Default Report – 2007 Annual Default Study – Excel data" (February 2007)

However, historical default rates may be inconsistent with the measure of ruin

Building models for risks

Risk type	Most common methodology	Comments
Market	Statistical model	Fit distribution to historical data or use economic scenario generator
Credit	Statistical model	Fit distribution to limited historical data or use 3 rd party model
Life insurance	Expert opinion & quantitative	Limited data so greater uncertainty, mortality often uses expert views
Non-life insurance	Quantitative & qualitative	Analysis of own and market experience, external models (eg cat)
Correlations	Quantitative & qualitative	Quantitative for market risks, largely qualitative for other risks
Liquidity	Scenario testing	Historical and prospective scenarios

Operational and strategic risks to be discussed by Patricia and Marc

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The building blocks of the model

Data layer

Market prices Policy details A/L details Historical risk info
 Expert risk info Management decision process Risk log

Calculation layer

Market consistent ESG Projection system Real world ESG
 Model cell generator

Reporting layer

Aggregation tool Validation process Reporting templates

Accuracy vs practicality vs transparency

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Economic capital model review & validation

Solvency II approach	S&P approach
<ul style="list-style-type: none"> ■ Statistical quality standards ■ Calibration standards ■ Use test ■ Validation standards ■ Profit & Loss attribution ■ Documentation standards 	<ul style="list-style-type: none"> ■ Assumptions ■ Methodology ■ Data quality ■ Process and execution ■ Results ■ Testing and validation

Statistical quality standards

Data	<ul style="list-style-type: none"> ▪ Relevance ▪ Accuracy & consistency ▪ Completeness ▪ Adjustments ▪ Credibility 	
Parameters & assumptions	Regular checks on: <ul style="list-style-type: none"> ▪ Support from data ▪ Uncertainty levels ▪ Areas of judgment ▪ Consistency 	Using: <ul style="list-style-type: none"> ▪ Goodness of fit ▪ Sensitivities ▪ Benchmarking ▪ Backtesting ▪ Out-of-sample testing
Methodology	Regular checks on: <ul style="list-style-type: none"> ▪ Appropriateness 	Using: <ul style="list-style-type: none"> ▪ Attribution analysis ▪ Benchmarking

Calibration standards

Calibration & methodology

Regular checks on:

- Appropriateness
- Consistency with standards

Using:

- Benchmarking
- Analyses of changes

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Use test

Governance

Covering:

- Roles and responsibilities
- Controls
- Documentation
- Management information
- Management understanding

Expectations of:

- Challenge & review
- Control & validation policies/processes
- "White-room" standards
- Timely MI
- Training

Application

Covering:

- Business planning
- Decision-making
- Performance measurement/reward
- Pricing, SAA, TAA, reinsurance etc

Expectations of:

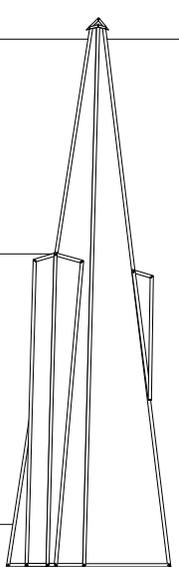
- Capital allocation
- Risk appetite and limits
- Risk adjusted return metrics
- Usage across organization

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Questions

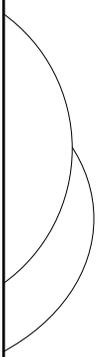




Operational Risk

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Overview

- ✓ What is Operational Risk?
- ✓ Notable recent Operational Risk losses
- ✓ Why the interest in Operational Risk?
- ✓ What makes Operational Risk so different?
- ✓ Measuring Operational Risk
- ✓ Modeling Operational Risk Losses

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What is Operational Risk?

Basel Committee Operational Risk Definition

“The risk of loss resulting from inadequate or failed internal processes, people and systems or from external events”

- ✓ Intuitively, operational risk losses arise from the breakdown of the production processes that constitute a financial institution’s value chain, producing goods and services for customers.¹

1. “The Market Value Impact of Operational Risk Events: U.S. Banks and Insurers”, Cummins, Lewis and Wei, December 2004.

What is Operational Risk?

(cont’d)

Operational risk losses are characterized by seven event factors associated with:

- ✓ **Internal Fraud:** misappropriation of assets, tax evasion, intentional mismarking of positions, bribery, insider trading on an employee’s own account
- ✓ **External Fraud:** theft of information, computer hacking damage, forgery, check kiting
- ✓ **Employment Practices and Workplace Safety:** discrimination, workers compensation, employee health and safety, organized labor activity, general liability

This and next slide: Basel Committee on Banking Supervision

What is Operational Risk?

(cont'd)

- ✓ **Damage to Physical Assets:** earthquakes, fires, floods, vandalism, terrorism
- ✓ **Business Disruption & Systems Failures:** utility disruptions, software failures, hardware failures, telecommunication problems
- ✓ **Execution, Delivery & Process Management:** data entry errors, accounting errors, failed mandatory reporting, negligent loss of client assets, incomplete legal documentation, vendor disputes
- ✓ **Clients, Products & Business Practice:** market manipulation, antitrust, improper trade, product defects, fiduciary breaches, money laundering, improper trading activities on the firm's account

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What is Operational Risk?

(cont'd)

Operational Risk does NOT include:

- ✓ **Strategic Risk**
 - the risk of a loss arising from a poor strategic business decision
- ✓ **Reputational Risk**
 - damage to an organization through loss of its reputation or standing
- ✓ **Systemic Risk**
 - non-diversifiable risk characterized by the breakdown of the entire financial system or major components
- ✓ **Market or Credit Risks**
- ✓ **Only systems or IT related risks**

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Notable Recent Operational Risk Losses

- ✓ Sumitomo Bank - **\$2.6 billion loss**: A copper trader amasses unreported losses over three years. The bank's reputation is severely damaged.
- ✓ Barings Bank - **\$1.3 billion loss**: A derivatives trader incurs unreported losses over two years. Barings goes bankrupt.
- ✓ Morgan Grenfell Asset Management - **\$720 million loss**: A fund manager exceeds his guidelines. The parent company compensates investors.

This slide: Phillippe Jorion, Financial Risk Manager Handbook, 3rd edition, pg. 576.

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Notable Recent Operational Risk Losses

(cont'd)

- ✓ Prudential - **\$2 billion loss**: Restitution to settle allegations of sales abuses over 13 years.²
- ✓ State Farm - **\$1.2 billion**: Settled with policyholders as a result of a breach of contract lawsuit.³
- ✓ Various Funds - **\$2.3 billion**: Hedge Fund Canary Capital Partners and a number of mutual funds settled after being accused of facilitating market timing.⁴

2. "Regulators Announce Settlement with Ten Wall Street Firms.", Wall Street Journal, April 28, 2003.

3. Lohse, Deborah, 1999. "Policyholders of State Farm Mutual are Awarded \$730 Million in Damage.", Wall Street Journal, October 11, 1999.

4. Phillippe Jorion, Financial Risk Manager Handbook, 3rd edition, pg. 650.

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Why the interest in Operational Risk?

- ✓ An enhanced level of transparency in firm financial reporting
- ✓ Rising levels of exposure to operational risk driven by globalization, industry consolidation and increasingly complex products and production technologies used by financial services firms
- ✓ Regulators encouraging market discipline as a regulatory device, i.e. Basel II, Solvency II, PBR
- ✓ Legislation tightening accounting standards – i.e. Sarbanes-Oxley in the US

This slide: "The Market Value Impact of Operational Risk Events: U.S. Banks and Insurers", Cummins, Lewis and Wei, December 2004.

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What Makes Operational Risk so Different?

As opposed to market, credit and/or underwriting risks, operational risks are:

- ✓ usually not willingly incurred
- ✓ mostly internal and not easily diversifiable
- ✓ not readily laid off in liquid trading markets
- ✓ not as easily identified, understood, measured, estimated or mitigated
- ✓ more qualitative rather than quantitative
- ✓ operational risk management is akin to TQM

These are some reasons why the measurement and modeling of Operational Risk is so difficult.

This slide: "Operational Risks in Financial Services: An Old Challenge in a New Environment", Doerig, Vice Chairman, Credit Suisse Group, January 2001.

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What Makes Operational Risk so Different?

(cont'd)

Potential operational risk losses can be practically unbounded:

- ✓ Observed loss amounts are not simply related to firm size
- ✓ Losses are not capped, e.g. by exposure limits or stop loss scenarios
- ✓ Some evidence of a deep-pockets premium, e.g. lawsuits and regulatory settlements
- ✓ Often significant time lags between cause and effect
- ✓ Risks often only recognized “after the fact”
- ✓ Loss severity distributions are fat-tailed

This slide: “AMA Implementation at Citigroup, Where we are and Outstanding Questions”, Federal Reserve Bank of Boston Conference, May 20, 2005.

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Measuring Operational Risk

(cont'd)

Various approaches for measuring operational risk can be employed:

- ✓ Top-Down Models use data at the broadest level, firm or industry-wide data, to determine required capital that is then allocated to business units.
- ✓ Bottom-Up Models aggregate individual unit or process-level data to determine the risk profile of the institution. Leads to a better understanding of the root causes of operational risk.
- ✓ Combination of the two. Preferred.

This slide: Phillippe Jorion, Financial Risk Manager Handbook, 3rd edition, pg. 581.

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Measuring Operational Risk

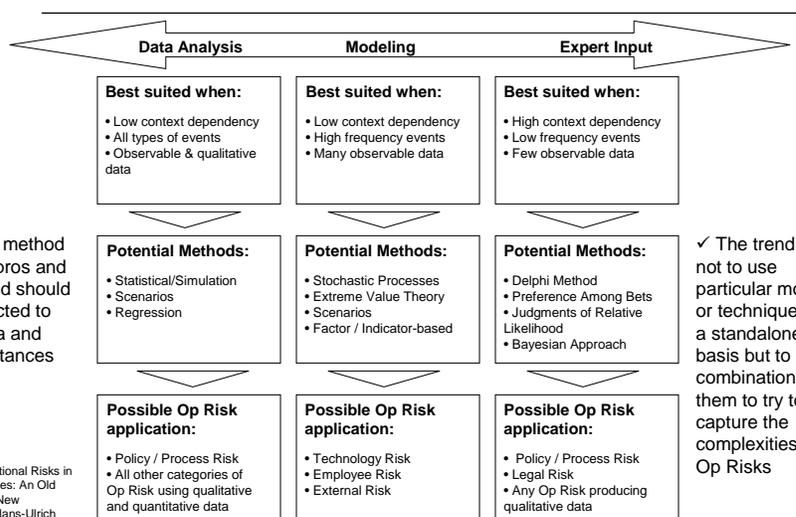
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Quantification/measurement generally involves looking at four aspects of a phenomenon:

- ✓ Its size, severity or intensity
- ✓ Its frequency
- ✓ Its context dependency – whether the event is unique or has regularities in occurrence
- ✓ Its correlation with other events – several operational risk events are highly interrelated

This slide: "Operational Risks in Financial Services: An Old Challenge in a New Environment", Doerig, Vice Chairman, Credit Suisse Group, January 2001.

Modeling Operational Risk Losses



✓ Each method has its pros and cons and should be selected to suit data and circumstances

✓ The trend is not to use particular models or techniques on a standalone basis but to use combinations of them to try to capture the complexities of Op Risks

This pg. "Operational Risks in Financial Services: An Old Challenge in a New Environment", Hans-Ulrich Doerig, Vice Chairman, Credit Suisse Group, January 2001.

Modeling Operational Risk Losses

(cont'd)

Overview of most discussed methods in the Operational Risk debate:

- ✓ Factor-derived quantification models – apply causal factors to predict level of risk. Relatively good for predicting levels of risk but not loss amounts.
- ✓ Statistical/simulation models use probability distributions of actual loss frequencies and severities. Issues with applicability of external data (low freq. high sev.) which drive tail shapes.
- ✓ Loss-scenario/qualitative models use subjective loss estimates based on the “institutional knowledge” of key experts.

This slide: "Operational Risks in Financial Services: An Old Challenge in a New Environment", Doerig, Vice Chairman, Credit Suisse, 2001. SOA Spring 2008

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Thank You.