Basel II Operational Risk Modeling Implementation & Challenges

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Outline

- Bank Capital and Basel II
- Op Risk – Definition & Basel II requirements
- Op Risk – Modeling: Nature of the Problem
- Op Risk – Modeling: Range of Practice
- Modeling Issues
- Other challenges/next steps

Bank Capital

- Banks hold capital to absorb unforeseen losses on a going-concern basis
- Higher the capital, the lower the chance of insolvency (analogous to the well-known ruin probability problem in actuarial literature)
- Strong capital levels reduce the potential for bank failures and promote financial stability by reducing chances of systemic failures

Bank Capital (cont'd)

In its broadest sense, capital represents the excess of a financial institution's assets over its liabilities:

$$K_0 = V_0 - L_0$$

We think of a bank as choosing K_0 s.t., the odds of the fair value of assets exceeding the fair value of liabilities, the next period, equals a specific probability, say 0.999

$$\Pr(V_1 > L_1) = 0.999$$

Objectives of Basel II

- Safety and Soundness
  - Ensure consistency with fundamental banking principles yet recognize innovation
- Balance
  - Attempt to incorporate a reasonable trade-off between enhanced risk-sensitivity and implementation burden
- Aggregate Capital Level
  - Roughly maintain the current amount of capital in the banking system

Structure of Basel II

- Pillar I: Minimum Capital Requirements
  - A series of approaches of increasing complexity
  - Pillar I capital covers credit risk, market risk, and operational risk
- Pillar II: supervisory review of capital adequacy
  - Banks should have a process for assessing their overall capital adequacy in relation to their risk profile and a strategy for maintaining their capital levels
  - Risks that are not fully captured by the Pillar 1 process (*e.g.*, credit concentration risk, liquidity risk, etc.)
  - Factors that are not taken into account by the Pillar 1 process (*e.g.*, interest rate risk in the banking book, business and strategic risk)
  - Factors external to the bank (*e.g.*, business cycle effects)

Structure of Basel II (cont'd)

- Pillar III: market discipline by allowing market participants to assess key pieces of information on the capital adequacy of the institution
  - scope of application,
  - capital
  - risk exposures
  - risk assessment processes

Solvency II vs. Basel II

- Capital framework for insurers
- Main concern is the liability risk that arises from the nature of insurance business; Basel II is concerned with asset risks.
- Traditional insurance risks such as underwriting risk have no equivalent in banking
  - However, techniques used to model this type of risk are often used to model op risk.
  - These actuarial models are known as the Loss Distribution Approach (LDA) in op risk modeling

Solvency II vs. Basel II (cont'd)

- Different capital adequacy approach:
  - Solvency II emphasizes the run-off approach as opposed to the going-concern approach for Basel II
  - TailVaR (ES) is the risk measure under Solvency II; VaR under Basel II
- Model risk is explicitly recognized along with other risk categories (IAA 2002)

Defining Operational Risk

- The risk of loss resulting from inadequate or failed internal processes, people and systems,or from external events.
- 7 loss types including: Fraud, Business Practices, Errors, System Failures, Physical Damage.
- Well-known losses: Madoff/Santander, SocGen, 9/11, ...

Pillar I for Operational Risk

Alternative approaches provided to accommodate different levels of bank sophistication:

Basic Indicator Approach	Standardized Approach (SA)	Advanced Measurement Approach
▪ Supervisor – specified parameters ▪ Bank-wide measure ▪ Exposure = GI * 15% ▪ No specific criteria, but banks "encouraged" to comply with 2003 Sound Practices Paper	▪ Supervisor – specified parameters ▪ Business line based ▪ Exposure = GI * Beta ▪ Beta = 12% -18% ▪ Qualifying criteria regarding governance, risk management, and risk assessment.	▪ Bank – defined model/framework ▪ Significant flexibility ▪ Supervisor – defined standards ▪ Qualifying criteria

Why require capital for operational risk?

- Operational losses are an important source of risk for banks. It may be as high as the capital charge for market risk.
- The following table provides the distribution of economic capital used, in 2006, by risk type, as disclosed by some of the largest global banks

Distribution of Economic Capital (EC) by Risk Type

2006	Economic Capital			
Bank	Credit Risk	Market Risk	Operational Risk	Total
Citigroup	55%	32%	12%	100%
Credit Suisse*	89%		11%	100%
Deutsche Bank	54%	22%	24%	100%
JPMC	59%	26%	15%	100%

Source: 2006 Annual Reports, Balta (2009)

*Credit Suisse did not disclose separate EC for credit and market risks. Instead, it reports "position risk" which combines both.

Why require capital for operational risk?

2004 LDCE Results

Total Loss Amount ($ Millions), Annualized
By Business Line and Event Type
Sample 1: Losses ≥ $10,000 Occurring in Years When Data Capture Appears Stable

	Internal Fraud	External Fraud	Employ-ment Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Business Disruption & System Failures	Execution, Delivery & Process Mgmt	Other	Fraud	Total	Percent of Total
Corporate Finance	11.9	0.2	2.2	25.5	0.0		4.2	0.6	0.0	44.7	0.5%
Trading & Sales	8.5	***100.9***	4.3	***370.9***	0.3	5.0	***238.8***		12.9	741.6	8.6%
Retail Banking	35.9	***237.3***	75.3	***346.8***	8.8	17.8	***316.2***	5.6	22.8	1,066.4	12.3%
Commercial Banking	0.6	60.4	2.8	67.2	0.1	0.2	24.1	0.2	3.5	159.2	1.8%
Payment & Settlement	7.2	10.9	2.1	1.0	0.2	1.9	24.1	0.0	4.1	51.4	0.6%
Agency Services	1.3	0.8	1.6	5.5	0.7	1.5	85.5			97.0	1.1%
Asset Management	0.1	1.6	2.1	***181.4***	0.0	0.7	32.8		0.5	219.3	2.5%
Retail Brokerage	2.2	1.5	28.4	81.0		0.0	22.0		6.0	141.1	1.6%
Other	8.9	25.5	29.6	**5,820.5**	***110.7***	38.1	84.9	3.9	0.5	6,122.5	70.8%
Total	76.6	439.1	148.3	6,899.7	120.8	65.3	832.7	10.2	50.4	8,643.2	100.0%
Percent of Total	0.9%	5.1%	1.7%	79.8%	1.4%	0.8%	9.6%	0.1%	0.6%	100.0%	
	Legend: Cells with more than 1% of losses are bold and italicized. Cells with more than 5% of losses are bold and underlined.										

AMA – Regulatory Requirements

- Basel II does not specify a specific approach or distributional assumptions.
- However, it should meet the following regulatory requirements:
  - capture potentially severe tail events
  - appropriately weight each of the 4 "elements": internal data, external data, scenarios and BEICFs
  - consider dependence
  - quantify at the 99.9th confidence level over a one year horizon
  - granularity of the model – commensurate with the risk profile of the bank
  - minimum five years of data

LDA – Nature of the Problem

Let i index the unit of measure, which may be business line, event type, etc. . .
Given the frequency process $N_t(i)$ and the severity process $X(i)$, the aggregate loss $S_t(i)$ for the unit of measure i is a compound process defined as:

$$S_t(i) = \sum_{n=1}^{N_t(i)} X_n(i)$$

Let G_i be the distribution function of the random sum $S_t(i)$ and X be *iid* positive random variables. Then, the aggregate loss distribution for the unit of measure i is denoted by

$$G_i(x) = P\left(S_t(i) \leqslant x\right)$$

LDA – Nature of the Problem (cont'd)

The minimum regulatory capital (MRC) for op risk is calculated as a quantile of the G at the confidence level α=0.999:

$$VaR_\alpha(i) = G_i^{\leftarrow}(\alpha) = \inf\{x \mid G_i(x) \geqslant \alpha\}$$

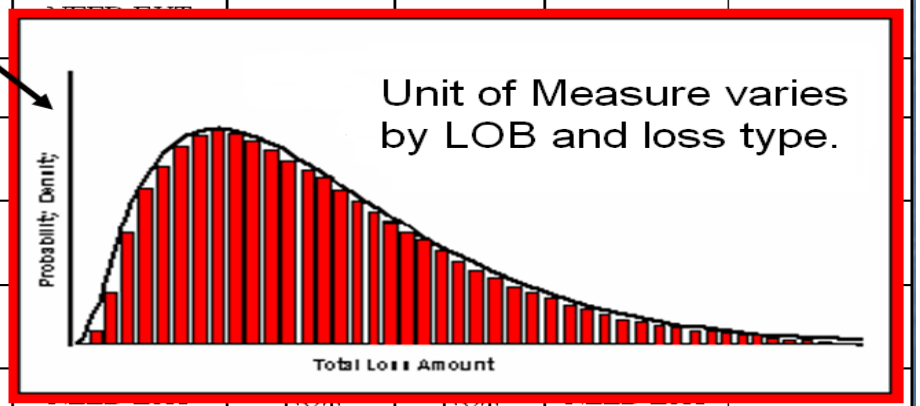
Unless dependence is explicitly modeled, the firm-wide capital charge for operational risk is

$$VaR_\alpha = \sum_{i=1}^{I} VaR_\alpha(i)$$

LDA – Nature of the Problem (cont'd)

Loss distributions vary across loss types and lines of businesses.
Calculate MRC for all UOM and aggregate for firm-wide MRC.

Line of Business	Internal Fraud	External Fraud	Employment Practices and Workplace Safety	Clients, products, and Business Practices	Damage to Physical Assets	Business Disruption and System Failures	Execution, Delivery, and Process Mgmt
Corp Finance	●	●	NEED EXT DATA	●	●	●	●
Trading and Sales	●	●	NEED EXT DATA	●	●	●	●
Retail Banking	●	●					
Commercial Banking	●	●					
Payment and Settlement	●	NEED EXT DATA					
Agency Services	●	NEED EXT DATA					
Asset management	●	●					
Retail Brokerage	●	●	DATA	EXT DATA	EXT DATA	DATA	



Status of Quantification (2007 ROP)

- Significant differences remain across institutions in terms of level of development of the AMA framework, the amount of progress being made, and the techniques being applied.
  - Two banks have well-developed models including documentation and a credible and systematic approach for weighting the four elements.
  - Approximately half of the banks have a working model with further refinement needed in the model, documentation and/or weighting the four elements.
  - The remaining institutions are in earlier stages of development.

Operational Risk Models
Literature Review

The existing literature on operational risk focuses, broadly, on two issues:

1. estimation of operational risk loss processes using either extreme value theory or parametric loss distributions (*e.g.*, Chavez-Demoulin *et al.*, 2006; de Fontnouvelle *et al.*, 2004; de Fontnouvelle *et al.*, 2005)
2. application of these estimates to the determination of economic capital, (*e.g.*, Moscadelli, 2004)

Data Threshold for Internal Data

Current Practice

- Most of the institutions use a data threshold below which they do not collect detailed event level information
- They have different thresholds for collection, quantification and enrichment of internal loss data, with $10,000 continuing to be the most common for quantification; and that thresholds sometimes vary by line of business

Issues

- The data threshold should be low enough to allow for a good fit for the frequency and severity distributions
- How significant are the biases the threshold introduces in modeling and its impact on capital?
- Would fitting a truncated distribution address the bias?

External Data

- Two types of data sources: Data consortiums (*e.g.*, ORX) and vendors (*e.g.*, Fitch, SAS)
- Vendor data tends to have reporting bias towards large losses: Higher the loss, higher the probability the loss is reported.
  - Reporting bias causes overestimation of capital. De Fontnouvelle *et al.* (2003) treat the truncation points as a r.v. to correct for the bias.
- Consortiums have uniform data truncation, but still consists of heterogeneous group of banks
  - Is the severity of loss dependent on the size of the bank?
- Combination of elements
  - Is there a statistically defendable way to scale external data?
  - Cope & Labbi (2008) investigates using quantile regression to scale severities from a heterogeneous group of banks

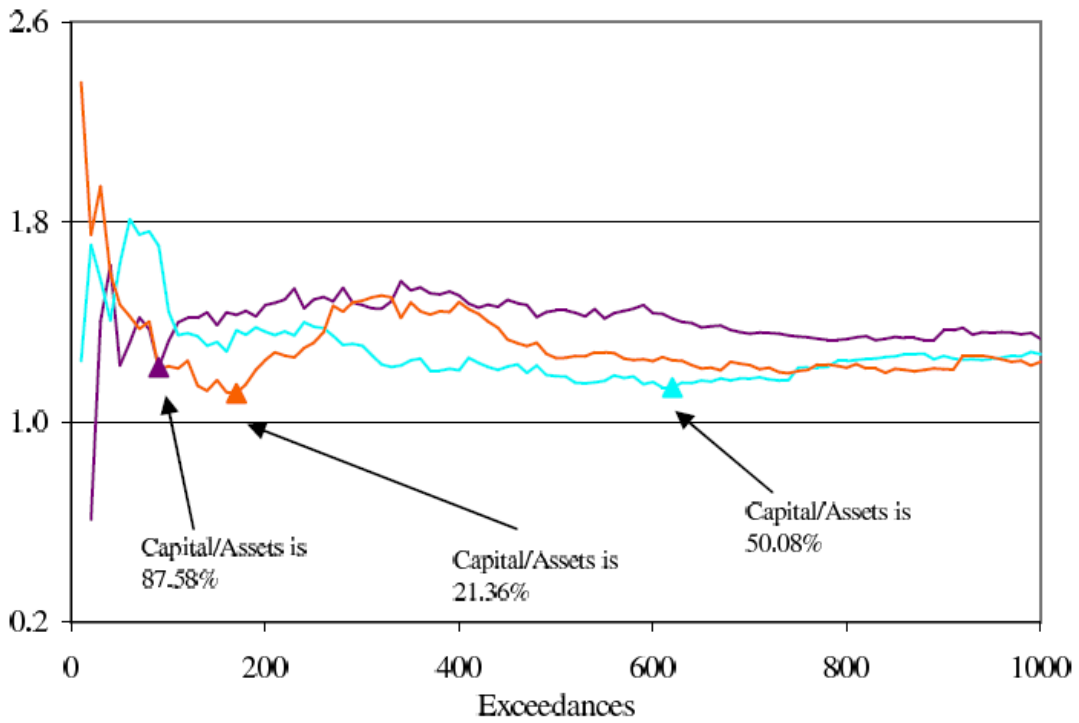
Model Selection Criteria

Need for a selection criteria for severity distributions that meets both the theoretical and the practical concerns. Dutta and Perry (2006) propose the following:

1. Goodness-of-fit - Statistically, how well does the method fit the data?
2. Realistic - If a method fits well in a statistical sense, does it generate an output commensurate with the risk profile/business mix of a bank ?
3. Model stability - Are the characteristics of the fitted data similar to the loss data and logically consistent?
4. Model simplicity - Is the method easy to apply in practice, and is it easy to generate random numbers for the purposes of loss simulation?
5. Model flexibility - How well is the method able to reasonably

Extreme Value Theory

GPD Estimates of ξ by Exceedances: In the following example, Dutta & Perry (2006) show the difficulty of getting reasonable capital estimates at any threshold.



Outliers - Incorporation of catastrophe risk into the capital framework

- Institutions have introduced various mechanisms to limit the impact of outliers:
  - Traditional caps
  - Constrained optimization
  - Robust estimation.
- Some of these techniques may be cause for concern, to the extent that they result in an unsupported reduction in capital.

Dependence

- Within the LDA, it is typically assumed that the X's are all independent of each other and are also independent of N_t.
- The need for explicit dependence assumptions is most obvious when one calculates enterprise exposure from unit of measure exposures.
- Co-dependence between risk cells
  - Frequency dependence
  - Severity dependence

Dependence (cont'd)

- Researchers need to show if/how dependence structures can be estimated using limited data.
  - If judgement is necessary, how can this be incorporated in a rigorous manner?
- How much dependence do we really think there is in operational risk?
  - Intuition suggests that operational losses are by nature idiosyncratic.
  - However, history provides multiple examples of seemingly unrelated tail events occurring at or near the same time.
- Modeling tail co-dependence.
  - Most banks use Gaussian copulas for the sake of convenience.

Model Validation

- Validation should include the following components: evaluation of conceptual soundness, process verification and benchmarking, outcomes analysis.
- Model uncertainty may manifest itself in volatile model output
- Validation and the role judgment
- Developing credible benchmarks for operational risk exposure would help to better understand exposure to operational risk (LDCE 2008)

Other Challenges/ Next Steps

- Achieving the right balance between models and management judment is a challenge.
- Choosing unit of measure.
- Understanding of and controlling for the cognitive biases is a hurdle for using scenarios
- Allocation of capital to business lines

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