AMA Implementation in the US
A Supervisory Perspective

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Agenda

- Basel II implementation in the U.S.
- The AMA framework
- Aspects of US supervisory strategy
  - Recent regulatory exercises
  - Some challenges
- Where US Banks stand vis-a-vis oprisk modeling
  - Frameworks
  - Data
  - Exposure estimates
- Focus on scenarios and internal data modeling

Disclaimers and caveats

- Portions of this presentation are based on information gathered from institutions on a voluntary basis.
- Some information is now dated, so results may not reflect current practices.
- Comments should not be taken as statements of official policy of the Federal Reserve System or other US regulatory bodies.

Basel II implementation in the US

- The Basel II NPR and request for comment on the reporting package was published in the Federal Register on September 25, 2006
  - 120-day comment period
  - Draft NPR was approved by the Federal Reserve in March 2006 and available for public review
- Mandatory banks (assets of $250 billion or more or foreign exposure of $10 billion or more), opt-in banks, nonopt-in banks
  - U.S. agencies propose to adopt only the advanced IRB and AMA approaches
- U.S. leverage ratio will be retained

Basel II implementation in the US

- Industry reaction to March 30 draft
  - Conservative elements create competitive disadvantage
  - Standardized approach as an option
  - 10 percent benchmark language
  - Transitional floors
  - Downturn LGD
  - Leverage ratio requirement
  - 1.06 calibration factor
  - Home-host issues
  - Various Technical issues (e.g.,definition of default)

Basel II implementation in the US

- Transitional arrangement in the New Accord
  - Parallel run in 2007
  - Floors phased in over two years with 90% and 80% limits
  - Floors linked to minimum capital
- U.S. transitional arrangements
  - Parallel run in 2008
  - Floors phased in over three years with 95%, 90%, and 85% limits
  - Floors linked to risk-weighted assets

Assessing AMA Progress in the US

Some relevant regulatory exercises

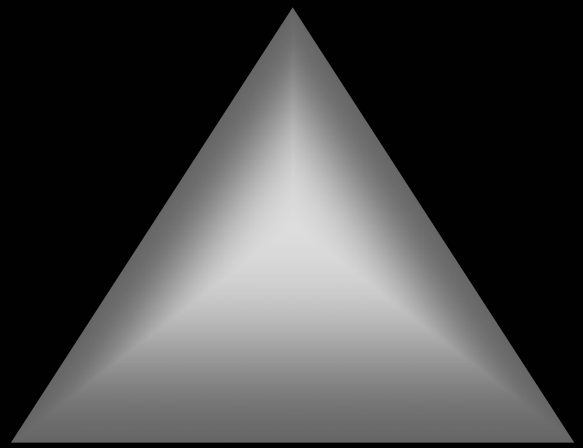
- Recent exercises helped assess banks' progress in governance, data and quantification.
- AMA Benchmarking Exercise (2004)
  - "Deep dive" reviews aimed at understanding management and measurement of operational risk at US potential mandatory institutions.
- QIS-4 (2005)
  - Objective was to understand the likely effect of proposed Basel II MRC standards.
- Loss Data Collection Exercise (2005)
  - Objective was to better understand the OpRisk exposure estimates reported in QIS-4, as well as the completeness of the underlying loss data.

Expected OR governance structure

Board and Senior Management

Oversight

Reporting



Corporate OpRisk Management Function
⇒ *Standards*

Business Lines
⇒ *Implementation*

Internal Audit
⇒ *Validation*

Governance observations

- Benchmarking exercise found that governance framework implementation varied, but good progress noted in most institutions.
  - Differences mainly a reflection of differences in legacy approach to risk management.
  - Centralized vs. Decentralized
- Reporting processes at all organizational levels were still evolving.
  - Firms struggling with turning “data” into information
  - Aggregating disparate business line metrics into firm-wide view

Governance – cont'd

- Testing and verification of the operational risk framework was the least developed function:
  - At most banks, Internal Audit had not audited their firm-wide operational risk framework
  - Certain aspects of the framework (e.g., RCSAs) can't be fully audited/tested until they are in production.
  - Scarce quantification skills cited as limiting factor for independent model validation and review.

Data overview: the four “elements”

- Internal Loss Data
  - Understand firm’s experience
- External Loss Data
  - Understand industry’s experience
- Scenario Analysis
  - Understand potential exposure
- Business Environment & Internal Control Factors (BEICFs)
  - Link to risk management

Internal loss data: LDCE overview

- LDCE requested full internal loss data underlying the QIS4 results.
  - 23 participants submitted an average of 4 years' loss data each
  - 1.5 Million losses totaling $26 Billion
- LDCE helps us understand the quantity and quality of data at participating institutions.
  - Descriptive statistics
  - Logic checks
  - Identification of unusual/atypical patterns
  - Data benchmarking

LDCE descriptive statistics

# of Losses ≥ $10,000	# of Firms	Total # of Losses ≥ $10,000	Total Loss Amt. ($M)
0 – 250	6	640	$212
250 – 1,000	5	2,253	$283
1,000 – 2,500	8	13,404	$8,151
2,500+	4	39,469	$17,275
Total	23	55,766	$25,920

Loss frequency analysis

Event Type Distribution of LDCE Losses

Losses = $10,000 Occurring in Years When Data Capture Appears Stable

	Internal Fraud	External Fraud	Empl. Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Bus. Disruption & System Failures	Execution, Delivery & Process Mgmt.	Other	Total # Losses Per Year
Corporate Fin.	3.5%	5.1%	18.5%	23.9%	0.7%		38.3%	10.1%	59
Trad. & Sales	0.7%	0.4%	2.3%	2.7%	0.4%	3.3%	90.2%		1,335
Retail Banking	4.0%	59.5%	6.2%	7.3%	0.9%	0.4%	20.4%	1.1%	11,049
Cmcl. Banking	1.1%	60.2%	3.4%	7.0%	0.1%	0.6%	27.2%	0.4%	935
Pmt. & Set.	14.5%	12.3%	3.9%	0.8%	0.2%	1.2%	67.0%	0.1%	820
Agency Svcs.	0.1%	0.7%	0.8%	6.1%	0.2%	2.8%	89.3%		929
Asset Mgmt.	0.1%	14.1%	4.3%	5.5%	0.0%	1.5%	74.6%		449
Retail Brok.	1.8%	3.2%	19.1%	45.5%		0.1%	30.3%		1,333
Other	5.4%	21.6%	22.0%	5.0%	1.5%	0.3%	43.4%	0.9%	1,462
All BL's	3.8%	41.8%	7.6%	9.2%	0.7%	0.7%	35.3%	0.8%	100.0%

Note: A small fraction of losses (3.2%) were fraud losses not separately categorized as internal or external fraud. These losses were allocated to the internal and external fraud categories based on the aggregate distribution of internal and external fraud losses within each business line.

Loss severity analysis

Figure 1. LDCE Loss Severity by Basel Business Line

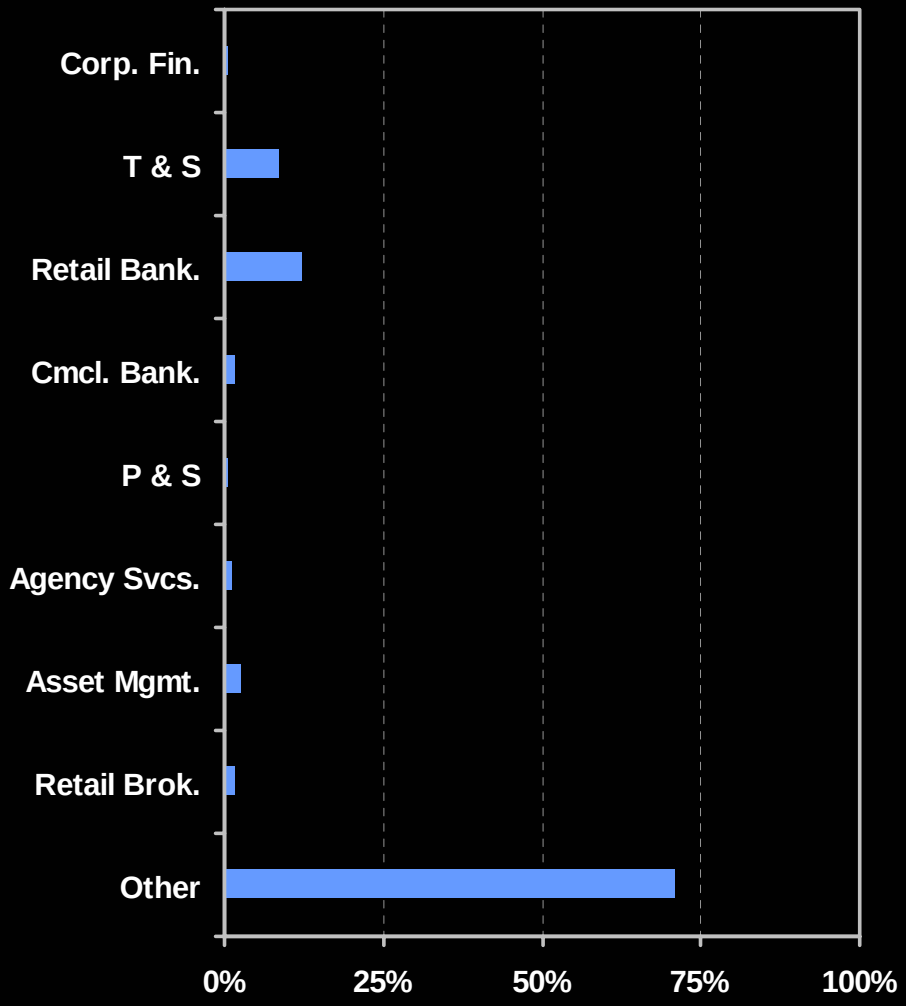
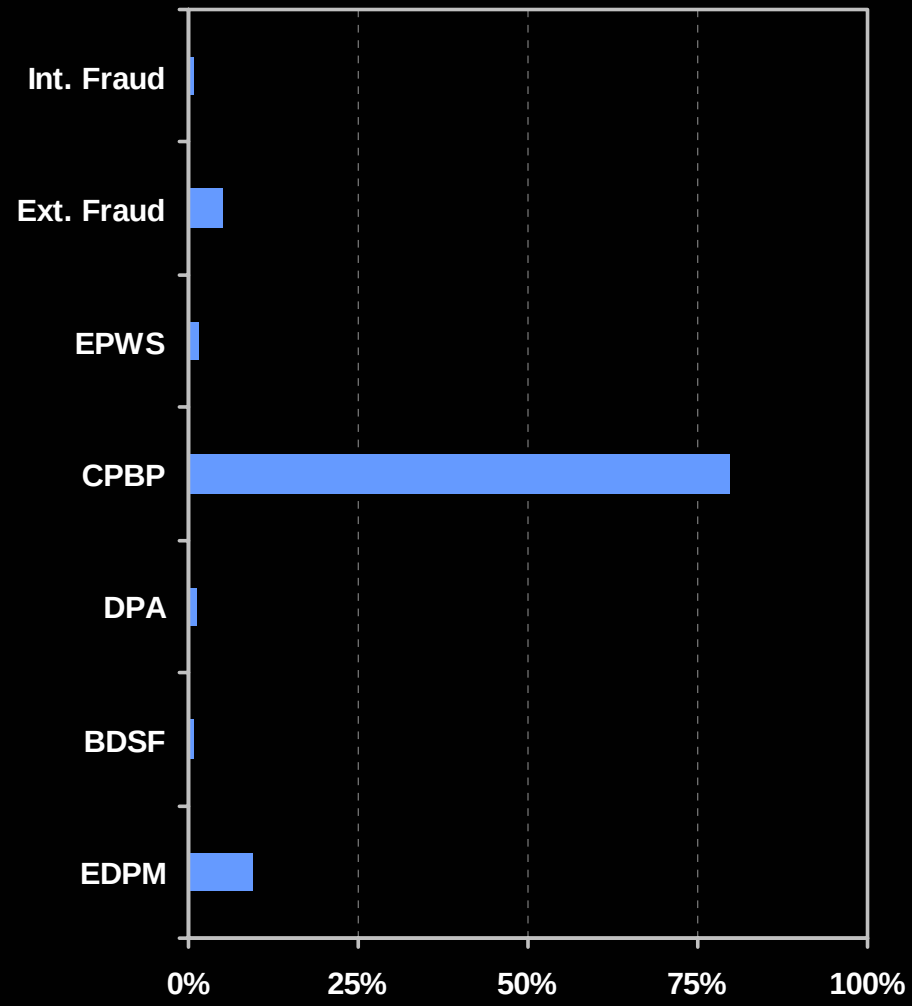


Figure 2. LDCE Loss Severity by Basel Event Type



* The following abbreviations are used: EPWS denotes Employment Practices and Workplace Safety; CPBP denotes Clients, Products and Business Practices; DPA denotes Damage to Physical Assets; BDSF denotes Business Disruption and System Failures; and EDPM denotes Execution, Delivery and Process Management.

Loss frequency analysis

Annualized LDCE loss frequency per Trillion dollars in Assets.

	Losses ≥ $20k	Losses ≥ $1M
Firms w. ≥ 1,000 losses		
Median	1760	35
Interquartile Range	(1530 – 2180)	(22 – 46)
Firms w. < 1,000 losses		
Median	1230	33
Interquartile Range	(910 – 2100)	(0 – 38)

- Consistency may reflect thorough data collection processes at many LDCE participants.
- It may also reflect that oprisk has certain inherent features that are constant across institutions.

LDCE Conclusions

- The exercise was a success given the breadth of participation and the amount of data collected.
- Results provide a reasonable basis for characterizing the industry's operational loss experience.
  - For example, we found that loss frequency appears to scale well with Total Assets and other exposure indicators.
- Data appear sufficiently rich to support serious analysis of outstanding issues.

External Loss Data

- External data were an input for more than half of the QIS-4 banks with AMA-like frameworks.
  - Sources most often observed were “public” datasets and consortia.
  - Use of external data varies considerably.
- External data challenges
  - Relevance / event selection
  - Loss scaling.
  - Completeness (for public datasets)
  - Loss detail (for consortia)

BEICFs

- Benchmarking and QIS-4 found that most banks have some tool to assess BEICF.
  - However, only half of the QIS-4 banks with AMA-like frameworks incorporated BEICFs for capital purposes.
- The level of granularity varied within and across institutions.
- Some progress was noted in linking the BE&ICF tool with actual loss experience.

Scenario analysis: potential lessons from behavioral economics and decision science.

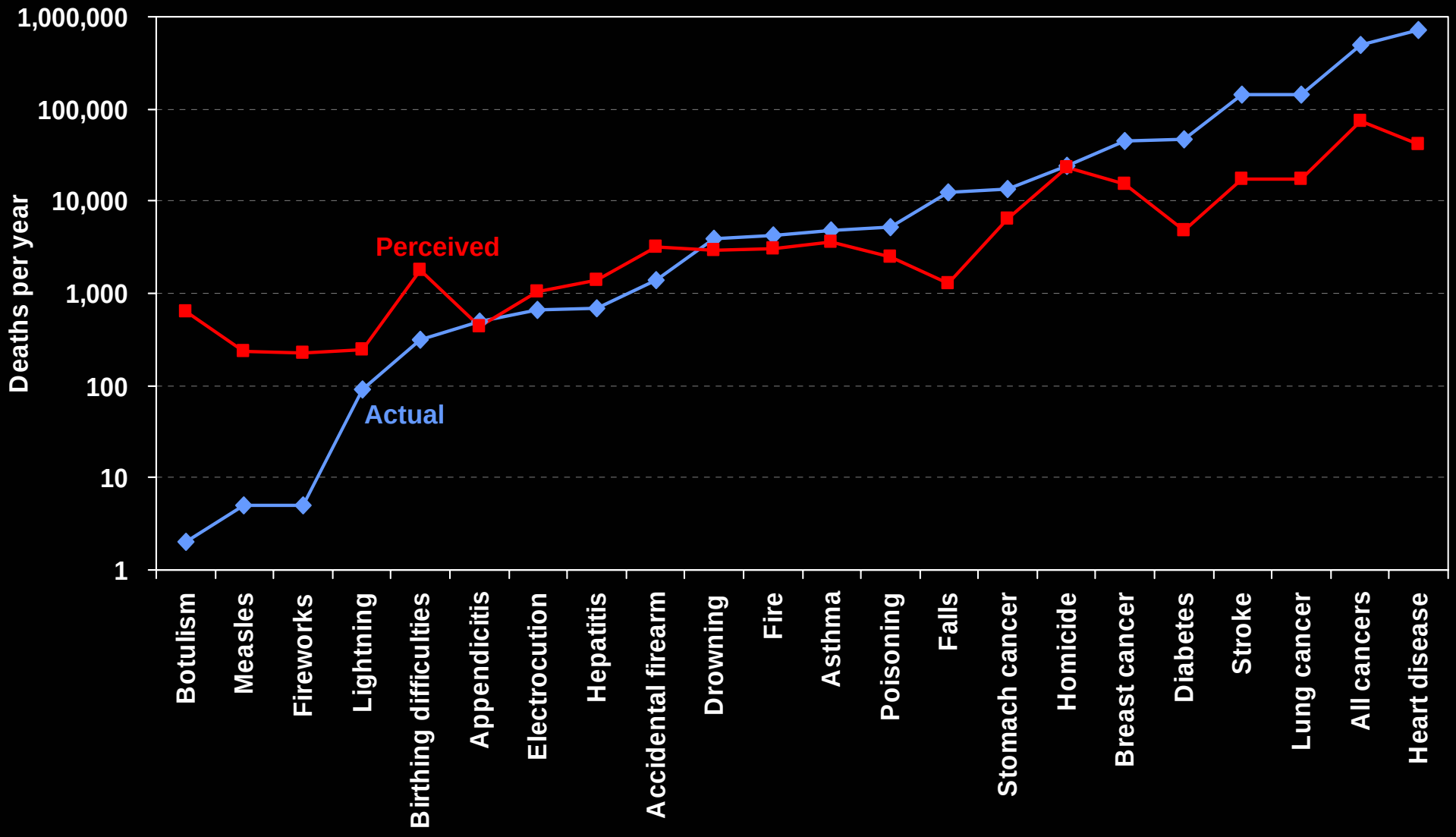
Scenario Analysis

- Scenario analysis was identified as a significant input at about half of QIS-4 participants with AMA-like frameworks.
- There was wide variation in the construction and granularity of scenarios.
- Significant challenges remain
  - Aggregating scenarios
  - Overcoming biases

Lessons from behavioral economics

- Kahneman and Tversky have written extensively about the psychology of choice
- In their Science article (1981), they illustrate that people's assessments of probabilities can be subject to significant systematic errors.
- Understanding such "cognitive biases" is relevant to establishing good scenario analysis.

Overestimating small probabilities



Source: Jahn K. Hakes and W. Kip Viscusi, 2003, Dead Reckoning: Demographic Determinants of the Accuracy of Mortality Risk Perceptions. Discussion Paper No. 431, Harvard Law School.

Anchoring

- Individuals anchor, or overly rely, on specific information or a specific value. Usually once the anchor is set, there is a bias toward that value.
- An experimental example:
  - A number between 0 and 100 was determined using a wheel of fortune in the subjects' presence.
  - Subjects were then asked to estimate the percentage of African countries in the UN using the above number as a starting point.
  - The experiment found that subjects who received higher starting point numbers on average provided higher estimates.

Overconfidence

- Alpert and Raiffa (1969) performed experiments in which subjects were asked a series of almanac-type questions.
  - e.g., “What is the distance from the Sun to the Earth?”
  - Subjects provided their best guess as to the answer, together with a 1-99 confidence interval.
- Subjects significantly overestimated the accuracy of their responses.
  - True value fell outside the 1-99 interval 41% of the time
- Overconfidence fell in subsequent rounds of the experiment.
  - Answers outside 1-99 fell from 41% in round 1 to 23% in round 2.

Challenges for scenario analysis

- Scenarios can be influenced by:
  - How questions are asked
  - What information is provided
  - How the information will be used
- Validation should consider how scenarios were conducted and how consistent the results are with internal and external data.
- Can appropriate framing and greater awareness of bias better capture expert opinion?
- How many corrective protocols have been developed, and how helpful would they be in Scenario Analysis?

Quantification

Quantification Overview

- In QIS-4, progress was seen in AMA implementation
  - Some institutions beginning to have credible, risk-sensitive measures of operational risk exposure.
  - 14 institutions reported using AMA-like frameworks.
- Institutions appeared to be converging toward LDA-type approaches.
  - Considerable variation in model specifics across institutions.
- Significant bank and supervisory challenges remain in building and validating AMA frameworks.

Use of the four elements

- There is also variation in the weights assigned to each element, and not all banks employ all four elements of the AMA framework.
  - The majority of the 14 banks with AMA-like frameworks used internal data as a direct input.
  - Half of the 14 used external data as a direct input.
  - The majority did not use scenario analysis.
  - Half reported a qualitative adjustment.
- There was considerable variation in both the quantitative techniques underlying each element.
- Finally, there was variation in the mechanics of how the elements were combined.

Combination of elements

- There are many potential ways of combining the four elements.
  - Swiss cheese method
  - Elements used as validation
  - Direct data blending
    - Some care is required here.
  - Explicit weighting
    - Parameters or results
  - Judgment
  - Combination via the simulation process
- Note. The above is simply a list of possible approaches one could envision which may or may not currently be in use. Inclusion of an approach does not necessarily constitute supervisory endorsement.

Unit of measure

- The level of AMA granularity seen in QIS-4 varied significantly, with the number of units of measure ranging from 1 to over 100.
- Several banks submitted only ‘top of the house’ AMA capital computations.
- The others computed capital at LOB or loss event type level, or some combination of the two.

Dependence

- Institutions in benchmarking exercise were taking varying approaches to estimating diversification effects, all rudimentary.
  - Correlation levels relied more on judgment rather than statistical analysis.
- QIS-4 results showed a range of diversification benefits.
  - Over one-half of the AMA-like banks in QIS-4 assumed no dependence across business lines and event types.
  - The average capital benefit obtained from taking diversification into account was 33% of undiversified capital.
- There was a relationship between diversification effects and the number of units of measure.

Expected Losses

- Institutions indicated in the Benchmarking Exercise that they preferred a UL-only approach.
- However, the majority of the 14 participants with AMA-like frameworks submitted QIS-4 oprisk exposure estimates on a EL+UL basis.
  - Less than half of the banks with working AMA frameworks provided specific estimates of EL.
  - Answers to questions posed in QIS-4 regarding support of EL offsets for operational risk were limited and not very useful.
  - Only one institution attempted to show that EL included small operational losses.

Risk Mitigation

- Approximately half of the banks in QIS-4 estimated the impact of risk mitigation (insurance) on operational risk exposure in some manner.
- Most did so on an ex-post basis, not embedding the effects of insurance into their capital model.
- Benchmarking observations indicated that banks had done little work to map coverage and determine probability of coverage, payment, etc.
- Given the multiple approaches taken, comparisons of relative impact of risk mitigants could not be made.

Overall QIS - 4 Results

- Federal regulators released summary findings of QIS-4 on February 24, 2006:
  - Results indicated that aggregate minimum risk-based capital requirements* would fall 15.5% for the 26 QIS-4 participants when moving from the current Basel I-based framework to a Basel II-based framework.
  - The results also showed material dispersion in minimum risk-based capital requirements across institutions and portfolios.
- Results also showed that Operational Risk accounted for 10.5% of Basel II MRC.

* This number refers to the effective minimum risk-based capital requirement.

QIS - 4 results for Oprisk

QIS-4 Oprisk Capital as % of Total Assets and Gross Income

14 Respondents with AMA-like Frameworks

	Oprisk Capital ÷ Total Assets	Oprisk Capital ÷ Gross Income
Unadjusted Oprisk Capital		
Median	0.43%	11.04%
Interquartile Range	(0.37% – 0.53%)	(8.41% – 12.67%)
Oprisk Capital Adjusted for EL, Insurance, Qualitative Adj. and Dependence		
Median	0.43%	9.46%
Interquartile Range	(0.37% – 0.70%)	(7.41% – 14.22%)

Financial data as of 12/31/04. Gross Income is calculated as the sum of Net Interest Income and Total Noninterest Income, minus Insurance and Reinsurance Underwriting Income and Income from other Insurance and Reinsurance.

Current Research Topics in Operational Risk

Motivation

- Variation was seen in AMA inputs, in the structure of AMA models, and in the outputs.
- Developing benchmark models would help to understand the above result.
  - Is there a better way to evaluate the AMA framework and resulting exposure estimates than by scaling by assets, existing capital, or gross income?
- Better benchmarks would be helpful in several other regards:
  - Cross-bank comparisons
  - Validation
  - Understanding the effects of different modeling choices

Results from QIS-4/LDCE

Oprisk Capital ($ Millions) Divided by the Average Annual Number of Losses Exceeding Various Thresholds

	Losses ≥ $20k	Losses ≥ $1MM
Median	3.0	134.6
Interquartile Range	(2.6 – 4.4)	(103.8 – 167.0)

Results from recent research

- QIS-4 and Benchmarking exercise suggested that banks were making significant progress in the collection and analysis of internal data.
- There is also a limited – but growing – body of research on the statistical modeling of internal data.
- A recent paper by Dutta and Perry (DP) covers some of the major statistical issues.
  - "A Tale of Tails: An Empirical Analysis of Loss Distribution Models for Estimating Operational Risk Capital" by Kabir Dutta and Jason Perry, Federal Reserve Bank of Boston.

DP Research questions

- How to measure operational risk exposure using LDA on internal loss data?
  - DP consider 7 banks' data from 2005 LDCE.
- Which severity techniques fit the loss data and result in meaningful capital estimates?
- Which commonly used techniques do not fit the loss data?
- Is there a single model that can be used in all cases?
  - consistently in some cases
- How do exposure estimates compare with firms' Assets and Gross Income?

Loss severity models considered

- Parametric distributions: exponential, Weibull, gamma, loglogistic, truncated lognormal, and GPD
- General class distributions: GB2, g-and-h distributions
  - The g-and-h is a transformation of the standard normal variable:

$$X_{g,h}(Z) = A + B(e^{gZ} - 1)\exp(hZ^2/2)/g$$

- Extreme Value Theory (EVT)
  - Pickands-Balkema-de Haan Theorem: (under certain conditions) the limit distribution of scaled excesses over a high threshold is a generalized Pareto distribution (GPD):

$$\mathrm{GPD}_{\xi,b}(x) = \begin{cases} 1 - (1 + \xi x/b)^{-1/\xi} & \xi > 0 \\ 1 - \exp(-x/b) & \xi = 0 \end{cases}$$

- Empirical (historical) sampling

DP performance criteria

- Does the model fit well statistically (KS, QQ, etc...)?
- Are the exposure estimates not obviously implausible?
- Is the model well specified?
- Is it simple?
- Does the model perform consistently across banks, business lines, event types?
- Is the model robust, or can small variations in the data lead to large variations in capital?

DP enterprise level exposure estimates

Enterprise level results from Dutta and Perry (2006)

	Reasonable Results		Distributions that Rarely Fit the Data			Distributions that Generally Yielded Unreasonable Capital Estimates				
	g-and-h	Emp	Exp	Gamma	Weibull	EVT5%	GPD	Llogis	Lnorm	GB2
Goodness of Fit Results										
# Banks Modeled	7	7	7	7	7	7	7	7	7	7
# Banks that Fit	7	7	0	0	0	6	5	4	5	5
Summary Statistics of Capital Estimates as a Percentage of Gross Income for All Models										
25th Percentile	6.5	1.2	1.3	0.6	2.3	147.5	71.1	62.6	4.5	61.9
Median	16.8	2.3	2.4	0.6	6.1	648.5	90.9	63.4	16.3	97.2
75th Percentile	18.7	4.6	5.3	0.8	27.3	2763.6	192.3	137.3	418.7	160.9
Capital Estimates as a Percentage of Gross Income for Models that Fit (Frequency)										
0 - 50%	7	7	-	-	-	2	-	-	2	2
50 - 100%	-	-	-	-	-	-	2	2	-	1
100 - 200%	-	-	-	-	-	-	1	1	1	1
200 - 1000%	-	-	-	-	-	2	1	1	1	-
1000%+	-	-	-	-	-	2	1	-	1	1

Conclusions from DP

- Flexibility is needed to model operational loss data
- Some distributions, including EVT, resulted in unreasonably large capital estimates
- g-and-h helps to summarize the shape of the data numerically
- g-and-h resulted in reasonable capital estimates
- Operational risk can be modeled

Concluding Thoughts

Review of topics covered

- Basel II implementation in the U.S.
- The AMA framework
- Aspects of US supervisory strategy
- Where US Banks stand vis-a-vis oprisk modeling
  - Frameworks
  - Data
  - Exposure estimates
- Focus on scenarios and internal data modeling

Next steps – a very partial list

- Continuing the push towards better and more comprehensive loss data collection (internal and external).
- Robustifying the scenario analysis process, with a focus on minimizing respondent bias.
- Obtaining metrics to better understand bank exposure estimates.
- Ongoing research on modeling issues.

Selected References

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“A Tale of Tails: An Empirical Analysis of Loss Distribution Models for Estimating Operational Risk Capital,” by Kabir Dutta and Jason Perry, http://www.bos.frb.org/economic/wp/wp2006/wp0613.htm

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