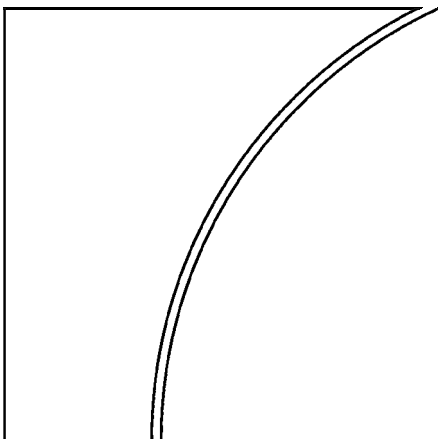Basel Committee
on Banking Supervision

Results from the 2008
Loss Data Collection
Exercise for Operational
Risk

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BANK FOR INTERNATIONAL SETTLEMENTS

Contents

Results from the 2008 Loss Data Collection Exercise for Operational Risk

I.   Executive Summary

The 2008 Loss Data Collection Exercise (LDCE) was conducted by the Operational Risk Subgroup of the Standards Implementation Group (SIGOR).[1] It is the first international effort to collect information on all four data elements that are used in the Advanced Measurement Approach (AMA) for operational risk in the Basel II Framework. The results are discussed in two related papers. The current paper focuses on internal loss data, scenario analysis and operational risk capital. Business environment and internal control factors (BEICFs), external loss data, and AMA range of practice results are presented in a separate paper entitled "Results of the Range of Practice Questionnaire for Key Elements of Advanced Measurement Approaches."[2]

The LDCE and Range of Practice results provide a unique opportunity to assess operational risk data and practices across regions, thus furthering SIGOR's goal of promoting consistency in implementation of the Basel II Accord. The findings also present an opportunity for banking institutions to compare their operational risk management frameworks with those of other institutions and to identify potential areas for improvement.

A total of 121 banks from 17 countries participated in the 2008 LDCE and 119 banks provided internal loss data.[3] Forty-two of these banks used the AMA, 51 used the Standardised Approach (TSA), and 20 used the Basic Indicator Approach (BIA). For the purposes of this paper, institutions are considered either AMA or non-AMA.[4] Given the broad participation in this exercise, the results can be viewed as generally representative of the banking industry, although some care should be taken when interpreting results presented at a more granular level.

Some of the paper's main findings are discussed below. Additional results for internal loss data, scenario analysis and capital benchmarking follow.

- Overall, banks have made considerable progress in the collection and use of internal loss data since the previous international LDCE was conducted in 2002.

- The frequency of internal losses of €20,000 or more varies significantly across regions when the data are scaled by various exposure indicators. For example, the typical (median) Japanese bank has a much lower frequency of losses compared with other regions, while typical banks from North America and Brazil/India have a higher frequency of losses.[5] This variation in internal loss frequency may explain

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[1]   The Operational Risk Subgroup of the Accord Implementation Group (AIGOR) changed its name to SIGOR in February 2009.

[2]   The Range of Practice paper is available at www.bis.org.

[3]   Banks could choose to participate in the full exercise or to submit information for only certain parts of the exercise.

[4]   The non-AMA group consists of banks using TSA and BIA as well as eight non-AMA institutions that were not classified as the BIA and TSA are not available in the United States.

[5]   This paper uses the phrase "typical bank" to denote the median value calculated across a group of banks. Exposure indicators considered in this analysis were consolidated assets, gross income, Tier 1 capital, and regulatory operational risk capital.

some of the regional differences in the combination of data elements in the Range of Practice results.

- Despite the regional variation in loss frequency noted above, there is some consistency in the severity distribution of operational losses across regions.[6]

- Most banks' scenario data extends the tail of the loss distribution beyond the point at which they have experienced internal losses. At many banks, the number of scenarios greater than €10 million is approximately twenty times larger than the number of internal losses that are greater than this amount.

- Although the number of large scenarios significantly exceeds the number of large internal losses, for AMA banks the frequency of large losses implied by scenarios and internal data are broadly consistent.

- AMA banks have a higher frequency of internal losses greater than €100,000 than non-AMA banks, even when the data are scaled by exposure indicators. Some of this difference may be explained by the fact that AMA banks generally are larger, more complex banks with more mature loss data collection processes.

- Operational risk capital for non-AMA banks is higher than for AMA banks, regardless of the exposure indicator used for scaling. For the typical AMA bank, the ratio of operational risk capital to gross income (10.8%) is significantly below the BIA alpha (15%) and also below the range of TSA betas (12-18%). Also, the amount of capital relative to the frequency of large losses is generally higher at non-AMA banks than at AMA banks.[7]

Internal Loss Data

Participating institutions were asked to submit a minimum of three years of internal loss data that they viewed to be reasonably complete. Analysis of the internal data provides an improved understanding of operational risk exposure and facilitates comparisons of operational risk capital levels and actual loss experience. Compared to the previous international LDCE, which took place in 2002, the current LDCE had a larger number of participating banks and collected a significantly higher number of internal losses. As most institutions provided data up to 31 December 2007 or 31 March 2008 in the 2008 LDCE, results do not reflect the impact of recent turmoil in the financial markets.

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[6] As measured by the 95th percentile of internal losses for those banks that had at least 20 losses of €20,000 or more.

[7] This finding holds across all regions when large losses are defined as losses of at least €100,000.

**Figure 1. Number of Internal Losses and Loss Amount Reported by
2008 LDCE Participants**

Region (Number of Participants)*	All Losses		Losses ≥ €20,000		Average per Institution Losses ≥ €20,000	
	Number	Amount (€millions)	Number	Amount (€millions)	Number	Amount (€millions)
Australia (11)	27,621	1,092	3,347	1,005	304	91
Europe (60)	1,674,456	20,799	76,079	19,768	1,268	329
Japan (18)	324,623	953	2,502	804	139	45
North America (21)	6,141,939	33,291	64,635	30,209	3,078	1,439
Brazil/India (9)	2,426,679	3,465	25,319	1,917	2,813	213
All (119)	10,595,318	59,600	171,882	53,703	1,444	451

*Number of participants submitting internal loss data; South African banks are included in the Europe region.

Figure 1 reports summary statistics for the internal loss data submitted. Some notable findings for internal loss data are as follows:

- Participating institutions submitted a total of 10.6 million internal losses with an overall loss amount of €59.6 billion. The largest 20 losses collected for this exercise totaled €17.6 billion and accounted for 29.5% of the overall loss amount. The majority of losses of €20,000 or more was submitted by institutions in Europe and North America.

- The business line with the highest loss frequency and total loss amount was Retail Banking. This result is consistent with the results from the 2002 LDCE and reflects that Retail Banking continues to be a primary business line for most participants. The second highest loss frequency was reported in Retail Brokerage, which was somewhat surprising given that participants reported a small proportion of income from this business.

- As anticipated, the Basel event types with the highest frequency of losses were Execution, Delivery, and Process Management (EDPM), followed by External Fraud. The event type with the highest annual loss amount was Clients, Products, and Business Practices (CPBP).[8] Consistent with the 2002 LDCE, there were few losses reported for Business Disruption and System Failures and Damage to Physical Assets.

- The typical bank experienced 0.82 losses per year of €20,000 or more for each billion euros in consolidated assets, with similar results seen for both AMA and non-AMA banks. The total loss amount for the typical bank for losses of €20,000 or more was €155,555 per year for each billion euros in consolidated assets. For the typical AMA bank, the loss amount was €196,655, which was higher than the loss amount of €116,838 for the typical non-AMA bank.

- Insurance recoveries were reported for a small proportion of losses with the typical bank reporting insurance recoveries for 2.1% of losses. However, for those losses with an insurance recovery, the typical bank reported a recovery rate of 74.6%. For

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[8] The cross-bank medians of the percent distribution across event types show that events related to EDPM had the highest loss amount rather than CPBP, indicating that a few firms with very large CPBP losses are driving the overall results for this event type.

loses of €20,000 or more, AMA banks had a much smaller number of losses with recoveries than non-AMA banks.

Scenario Data

The 2008 LDCE was the first time that banking supervisors collected scenario analysis data on an international basis. Participating banks were asked to provide scenario data using one of three templates that was most consistent with their scenario approach: the individual approach, the interval approach, and the percentile approach. The collection of scenario data enables national supervisors to compare scenarios across jurisdictions as well as to assess how scenarios relate to internal loss data. Main findings for scenario data include the following:

- Sixty-five of the 121 LDCE participants submitted a total of 9,687 scenarios.

- The median number of scenarios used in participating banks' operational risk frameworks was 115 scenarios. There was significant variation across banks and regions in both the number and size of scenarios used, reflecting different uses and levels of reliance on scenarios for quantification and risk management.

- The expected annual frequency of losses exceeding €88 million for the typical bank was 1-in-100 years and the expected annual frequency of losses exceeding €194 million was 1-in-1000 years.

- The typical bank had the largest proportion of scenarios in the Unallocated business line (36%), which includes group-wide scenarios, and in Retail Banking (28%).[9] By event type, the typical bank had the highest proportion of scenarios related to EDPM (29%) and CPBP (20%).

- As highlighted in the first section, most banks' scenario data extends the tail of the loss distribution beyond the point at which they have experienced internal losses.

Capital Estimates

As highlighted above and as seen in Figure 2 below, the operational risk capital estimates of AMA banks are lower than those of non-AMA banks, while AMA banks have a higher frequency and severity of large losses than non-AMA banks, even when the data are scaled by exposure indicators. Some of this difference between AMA and non-AMA banks may reflect the fact that AMA banks generally are larger, more complex banks with more mature loss data collection processes. Given that gross income is not a risk-sensitive measure, Figure 2 also reports operational risk capital relative to the annual frequency of losses above €100,000. Across all regions, the amount of capital relative to the frequency of large losses is lower at AMA banks than at non-AMA banks.[10] There is significant variation across regions in capital relative to the frequency of large losses. The higher ratios of capital to losses for Japan reflect the limited loss experience of banks in this region.[11]

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[9] The unallocated business line includes scenarios that cover more than one business line as well as scenarios for which no business line information was provided.

[10] When large losses are defined as losses above €1,000,000, this finding holds for all regions except North America, where the capital-to-frequency ratio is slightly higher at AMA banks than at non-AMA banks.

[11] The low results for Brazil/India are explained by two primary factors: banks in Brazil are allowed to use the Alternative Standardised Approach (ASA) and gross income earned by Brazilian banks is usually high. Under

Figure 2. Capital Estimates by Geography[12]

	Operational Risk Capital as a Percentage of Gross Income		Operational Risk Capital divided by Frequency of Losses ≥ €100,000 (€ millions)	
	AMA	Non-AMA	AMA	Non-AMA
Australia	7.8%	13.9%	21.1	30.8
Europe	10.7%	12.1%	12.5	19.7
Japan	12.4%	14.6%	87.0	213.7
North America	11.6%	13.1%	15.4	21.1
Brazil/India	NA	7.5%	NA	3.6
All Regions	10.8%	12.8%	16.9	28.9

Other findings regarding capital estimates are as follows:

- As highlighted in Figure 2, the typical AMA bank has a ratio of operational risk capital relative to gross income that is lower than the 15% alpha for the BIA and the range of betas (12%-18%) used in TSA.[13]

- For AMA banks, use of insurance as a capital offset is limited with only a few banks calculating such an offset.

- Expected losses (EL) account for about 11% of operational risk capital at the typical participating bank. The use of EL offsets is limited, with half of participants taking no capital offset, and three quarters of participants taking an offset of less than 1% of operational risk capital.

- The modelling of dependence at the typical bank results in a modest (8.3%) increase in capital relative to the assumption of full independence.

Considerations for Interpretation of Results

This paper presents a wide range of results on internal data, scenario analysis and operational risk capital. The results are based on data provided by participating institutions, and every effort has been made to ensure accuracy and analytical rigor. Nonetheless, as with any large scale data collection exercise, the findings presented are subject to certain limitations. These limitations include the following:

1. The robustness of this paper's results depends on the completeness and accuracy of the internal loss data provided by participating institutions. Some results may be affected to the extent that banks provided incomplete loss data. For example, the findings related to loss frequency at AMA versus non-AMA banks may in part reflect less mature data collection at the latter group of institutions.

2. Banks' raw scenario data have in some instances been fitted to parametric models in order to facilitate analysis and compare results across institutions. Some of the

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the ASA, capital for Retail Banking and Commercial Banking is calculated as a percentage of total loans and advances rather than business line gross income.

[12] Results for operational risk capital divided by frequency of losses ≥ €100,000 are the inverse of certain results presented in table ILD9.

[13] The comparison of operational risk capital relative to gross income in this paper is based on one year of gross income while capital calculated using the BIA and TSA is based on a three-year average of gross income.

results could be biased if these parametric models are not an accurate representation of the raw data, or if they differ too significantly from participants' scenario methodologies.

3.   Results relating to operational risk capital depend critically on the three exposure indicators selected: consolidated assets, consolidated Tier 1 capital, and consolidated gross income. The results should be interpreted with some degree of caution, given that these exposure indicators are imperfect measures of actual operational risk exposure. In addition, the exposure indicators used in this paper are based on 2007 amounts and the current market crisis may have a considerable impact on the future size of these indicators.

4.   The figures in this paper generally are stated at the same number of decimal places as reported in the tables. The figures have been rounded to a certain number of decimal places that was selected for ease of reading and comprehension rather than level of statistical significance.

II.   Introduction

This paper summarises the operational risk information collected in the 2008 International Loss Data Collection Exercise (LDCE) conducted by the Operational Risk Subgroup of the Standards Implementation Group (SIGOR). The primary objective of the exercise was to further the understanding of both supervisors and banking institutions regarding outstanding operational risk implementation issues, as well as to promote consistency in addressing these issues across jurisdictions. The exercise was open to banking organisations at the group-wide level that are using or implementing one of the three Basel II approaches for calculating operational risk capital: the Advanced Measurement Approach (AMA), the Standardised Approach (TSA) or the Basic Indicator Approach (BIA). Participation was voluntary and banking institutions could choose to participate in the full exercise or submit information only for certain sections of the exercise.

The 2008 LDCE is the first international effort to collect information on all four data elements– internal loss data, external loss data, scenario analysis, and business environment and internal control factors (BEICFs) – used in an AMA. The LDCE also collected supporting qualitative information, exposure indicators, capital estimates, and range of practice (ROP) information on how operational risk is measured and managed. This paper focuses on internal loss data, scenario analysis and operational risk capital. External loss data, BEICFs and AMA range of practice results are presented in a separate paper titled, "Results of the Range of Practice Questionnaire for Key Elements of Advanced Measurement Approaches."[14]

A total of 121 institutions from 17 countries participated in the exercise and 119 institutions provided internal loss data. In aggregate, 10.6 million internal losses totalling €59.6 billion were collected. Sixty-four institutions participated in the scenario analysis portion of the exercise and about half of these institutions submitted scenario data using the individual approach.

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[14]   "Results of the Range of Practice Questionnaire for Key Elements of Advanced Measurement Approaches, Operational Risk Subgroup of the Standards Implementation Group, Basel Committee on Banking Supervision, Bank for International Settlements (BIS), June 2009. The paper is available on the BIS website at www.bis.org.

The paper is organised as follows. Section III provides background information on the 2008 LDCE. Section IV provides an overview of participants. Section V discusses the internal loss data portion of the exercise and includes information on the methodology used to standardise individual submissions as well as summary data and analysis of frequency and severity. Section VI provides information on scenario analysis, including the methodology for standardising scenario templates and data on the number, frequency, and severity of scenarios. Section VI also provides some comparisons between internal loss data and scenario data. The final section, Section VII, provides analysis on regulatory operational risk capital by comparing capital to exposure indicators and large losses. This section also considers the use of expected loss offsets, risk mitigants, and correlation adjustments in an AMA framework.

III.   Background

The 2008 LDCE was the third international data collection effort for operational risk. The internal loss data component of this exercise was similar to two previous LDCEs conducted by the Basel Committee on Banking Supervision (BCBS). The first LDCE was called the Quantitative Impact Study (QIS): Operational Risk Data (Tranche 2).[15] It collected internal loss data for the three-year period 1998-2000 from 30 banks in 11 countries. The second LDCE (the 2002 LDCE) collected internal loss data for the year 2001 from 89 participating banks in 19 countries.[16] Since these international exercises were conducted, several countries have found it worthwhile to conduct an updated LDCE at the national level.[17]

The 2008 LDCE consisted of three parts. The first part, Attachment A, consisted of templates for submission of internal loss data and scenario analysis data along with a series of questions to provide information on the processes underlying these two data elements. The second part, Attachment B, requested information on exposure indicators and capital estimates. Exposure indicators included consolidated assets, gross income, and Tier 1 capital as well as business line gross income.[18] The final part, Attachment C, contained ROP questions regarding operational risk modelling, external loss data, and BEICFs. Participating banks were asked to submit their LDCE information to their national supervisors by 30 June 2008.[19]

The data collection and analysis process for the 2008 LDCE was structured to preserve the confidentiality of the data submitted using procedures employed in previous BCBS exercises including the 2002 LDCE and QIS-4.[20] (See Annex A for additional discussion of data

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[15] "Results of the Second Quantitative Impact Study," Basel Committee on Banking Supervision, November 2001. The paper can be obtained at http://www.bis.org/bcbs/qis/qishist.htm.

[16] "The 2002 Loss Data Collection Exercise for Operational Risk: Summary of the Data Collected," Risk Management Group, Basel Committee on Banking Supervision, March 2003. The paper can be obtained at http://www.bis.org/bcbs/qis/ldce2002.htm.

[17] LDCEs conducted at the national level include exercises by the United States in 2004 and Japan in 2007.

[18] Given the sensitive nature of the data in Attachment B, the data remained with the participating institution's national supervisor where it was used to construct benchmarks. The data security protocols are more fully discussed in Annex A. Data Security and Confidentiality.

[19] The exercise requested that internal loss data be submitted as of 31 March 2008 or 31 December 2007 if data for March were not yet available. Exposure indicators and capital estimates were requested for 2007.

[20] The title of QIS-4 is the "National Impact Studies and Field Tests in 2004 or 2005". The exercise was voluntary for member countries and the details of the studies varied across the countries that participated.

security procedures used for the 2008 LDCE.) This process was consistent with SIGOR's objective to provide useful benchmarks to the industry while preserving confidentiality. In order to achieve this balance, the majority of results in this paper are reported as cross-bank medians (referred to in the tables as 'median'). Where possible, the interquartile range, is also provided to give an indication of the variability of the data. The interquartile range is the range of values between the 25th percentile and the 75th percentile that contains half the banks in the sample. This paper uses the phrase "typical bank" to denote the median value calculated across a group of banks. As an additional measure to preserve confidentiality, quantiles are not presented unless there are data from at least four banks for a given item.

IV.   Overview of Participants

The Summary Table I provides an overview of the number of participants and the composition of their business activities. A total of 121 institutions from 17 countries participated in the exercise. For the purposes of this paper, an institution's operational risk approach is considered either AMA or non-AMA. Of the 121 institutions, 42 are considered AMA banks and 79 are considered non-AMA banks.[21] Of the non-AMA banks, 51 use TSA and 20 use the BIA. The remaining 8 non-AMA banks were not classified by approach since the BIA and TSA were not available approaches in the United States. Participating institutions were placed into one of five regions: Australia, Europe, Japan, North America, and Brazil/India. Europe was the largest region by number of countries and number of participants. The European region consists of Belgium, France, Germany, Italy, Luxembourg, Netherlands, Poland, Spain, Switzerland, and the United Kingdom. South Africa also is included in the European region for the purposes of this paper. The North American region includes Canada and the United States. The composition of the remaining regions is reflected by their titles.

The bottom panel of the Table Summary I provides an overview of participants' business line composition. The panel reports the cross-bank median of business line gross income as a percent of consolidated gross income. For the typical participating bank, Retail Banking and Commercial Banking are the primary business lines with gross income from these activities accounting for 44.2% and 24.6% of consolidated gross income, respectively. A similar result is seen across most regions with the exception of Japan whose participants had a greater percentage of gross income from Commercial Banking rather than Retail Banking.[22] Overall, Agency Services had the lowest median ratio of business line gross income to consolidated gross income (1.1%). Across regions as well, Agency Services contributed only a small proportion of total gross income for the typical bank.[23]

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[21] An AMA bank refers to a bank that is targeting or has implemented the AMA approach in its implementation of Basel II. Thus, some of the banks considered to be AMA for the purposes of this paper have not yet received formal supervisory approval to use an AMA. There are no AMA banks in Brazil/India that participated in this exercise.

[22] Part of this difference may be explained by different distinctions between Retail Banking and Commercial Banking in Japan.

[23] Cases where there are results from fewer than four banks are denoted by "." in the LDCE tables. This includes the results for Agency Services and Asset Management in the Australia region in Summary Table I. Results for Retail Brokerage are also not reported for Australia as losses that occur in this business line are allocated to other business lines for the purpose of capital calculation.

V.   Internal Loss Data

A.   Internal Loss Data Methodology

Participating institutions were asked to submit a minimum of three years of internal loss data (ie data on individual loss events) that they view to be reasonably complete. AMA institutions were asked to submit data that at a minimum covered the time period used to quantify their operational risk capital charge, which may be longer than three years. The internal data template requested certain information for each loss event including a reference number, three dates related to the loss (date of occurrence, date of impact, and date of discovery[24]), the Basel business line and event type, gross loss amount, gross loss amount net of non-insurance recoveries, and the amount of any insurance recoveries.

As the data were provided according to each institution's loss data collection processes, steps were taken to standardise the data into consolidated datasets suitable for descriptive and statistical analysis. The tables in this paper utilise one of two standardised datasets. The first dataset, the aggregate dataset, was used to provide summary statistics on the internal loss data submitted. The aggregate dataset was constructed by converting loss amounts into euros using exchange rates as of 31 March 2008 which are provided in Annex B and aggregating transactions with the same reference number into one event.[25] This aggregation was done for institutions that did not submit event data to facilitate analysis at the event level rather than the transaction level.[26] Event level analysis was necessary to gain an understanding of the true frequency and severity of loss events.

The second dataset, the stable dataset, is a subset of the aggregate dataset and contains data from a stable time period for each bank.[27] The development of the second dataset was necessary to ensure that the sampling properties of the data were as consistent as possible over time. Generally, when an institution implements a loss data collection process, there is a phase-in period during which early quarters of data collection show significant volatility in the number of losses collected. As the data collection process becomes more mature, the quarterly loss frequency tends to become more stable. To determine the stable time periods, each participating institution's data were examined and a time period over which loss frequency appeared relatively stable was selected.

Throughout the internal data section of this paper comparisons are made between results from the 2008 LDCE and the 2002 LDCE. While it is interesting to compare the two studies to gain an understanding of trends in the data over time, there are several limitations to making this comparison. First, many of the tables in the 2008 exercise included data for losses greater than €20,000, while a threshold of €10,000 was used for many of the tables in the 2002 LDCE. In addition, the 2002 LDCE collected data for only one year while the 2008 LDCE requested a minimum of three years of internal loss data.

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[24]   Within individual countries, banks may have different practices regarding which date is used for operational risk quantification efforts. The dates used in this paper reflect the most commonly used date for each country.

[25]   Loss amounts were not adjusted for inflation.

[26]   In addition, some participants noted in Attachment A that their loss data included certain types of high frequency/low severity losses that were summed and included as one loss record. These losses were removed from the dataset as they do not represent individual loss events.

[27]   The stable loss period for each institution represents the time series of contiguous quarters for which there were no extreme changes in the number of losses between quarters. The resulting dataset contains different time periods of data for different institutions. Thus, for tables where annualisation was required, data were annualised according to the number of years of stable data for each institution.

B. Overview of Internal Loss Data

The internal loss data (ILD) collected in the 2008 LDCE is summarised in Tables ILD1 through ILD14.[28] These tables present consolidated results for all participating banks, AMA and non-AMA banks, and banks by region.[29] Table ILD1 provides a summary of the internal data submitted by loss data collection threshold using the aggregate dataset. A total of 10.6 million losses worth €59.6 billion were collected. The first column of the table reports ranges for loss data collection thresholds used for all or most business lines.[30] A majority of institutions (87) reported thresholds less than €10,000. The most common threshold was between €0 and €1,000 as 34 banks indicated a threshold within this range. Ten institutions reported a zero threshold and 22 institutions did not provide a threshold.

Table ILD1 also reports data collection thresholds by region. Thresholds in Europe, Japan, and Brazil/India were generally lower than thresholds reported in other regions. For the institutions that provided information on thresholds, 31 of the 44 European institutions (70%) reported thresholds of less than €5,000 while all 18 of the Japanese institutions used thresholds of less than €1,000. Thresholds in Brazil/India were less than €1,000 as well. However, three European institutions reported thresholds of €20,000 or more. In North America, thresholds were a little higher with 13 out of 19 (68%) institutions using a threshold between €5,000 and €10,000. Australian banks reported thresholds of various sizes. Given the variety of thresholds, certain tables in this report consider only losses of €20,000 or more to provide more consistent results.

Table ILD2 provides a summary of the internal data submitted based on the number of losses provided by each institution using the aggregate dataset. Sixty-six institutions provided more than 2,500 losses which comprised 99.5% of the total number of losses submitted and 92% of the total loss amount.[31] Almost all AMA institutions are included in this category as 36 of the 41 (88%) AMA institutions submitted more than 2,500 losses.

The right side of Table ILD2 provides a summary of losses after applying a €20,000 common threshold. Of the 10.6 million losses submitted, 171,882 (1.6%) were at least €20,000. These losses totaled €53.7 billion and contributed 90% of the total loss amount. The majority of the loss data of €20,000 or more was submitted by institutions in North America and Europe. The 21 North American institutions submitted 38% of the losses and 56% of the total loss amount for losses of €20,000 or more. The 60 European institutions provided 44% of the losses and 37% of the loss amount for losses of €20,000 or more.

Table ILD3 provides the distribution of losses of €20,000 or more by year in the aggregate dataset.[32] While banks submitted data covering different time periods, the majority of banks submitted data for at least the three-year period from 2005-2007. Twenty-four institutions submitted data for years prior to 2002. A few losses were reported for the 1970s and the 1980s, but these losses appear to be isolated events that pre-dated any systematic loss data collection process. A comparison of AMA and non-AMA banks yields some interesting results by number of losses and loss amount per institution. For a given year, the number of losses

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[28] Loss amounts in the tables refers to the gross loss net of non-insurance recoveries unless specified otherwise.

[29] The majority of results by approach and by region are not included with this paper, but are contained in Annex E: LDCE Tables.

[30] Most institutions (84) indicated using one group-wide data collection threshold. Those that had more than one threshold generally set different thresholds based on business line.

[31] Forty-nine institutions provided at least 5,000 losses.

[32] For the majority of ILD tables, results by approach and by region can be found in Annex E: LDCE Tables.

per AMA bank was more than three times the number of losses per non-AMA bank and the loss amount per AMA bank was generally at least six times the loss amount per non-AMA bank. Part of this difference could be related to differences in business activities, if one were to assume that most AMA banks are larger, more complex institutions. Some of this difference may also be explained by more mature loss data collection processes at AMA banks, particularly as in many jurisdictions AMA banks have completed a thorough AMA supervisory approval procedure. (Differences between AMA and non-AMA banks are explored further in Section D. Internal Data and Exposure Indicators where loss frequencies and amounts are adjusted for institution size.) The results by region show that the total loss amount for North America was very high in 2002 and the highest of any year reported across regions. [33] This can be attributed to a few large losses related to accounting fraud at several corporate clients of North American banking institutions.[34]

Although not presented in Table ILD3, it is useful to consider the length of the time series of the stable data provided by each institution. Most institutions (69) provided stable data for more than three years, but less than five years. Twenty-six banks had at least five years, but less than seven years of stable data. Seven banks had seven or more years of stable data while 17 banks had less than three years. These results together with results from ILD2 and ILD3 indicate that banks have made considerable progress in the collection of internal loss data since the previous international LDCE was conducted in 2002.

C. Analysis of Frequency and Severity

Table ILD4A provides data on the frequency of annualised losses by business line and event type after applying a €20,000 common threshold to the stable dataset.[35] For each business line/event type combination the sum of annualised frequencies and the percent distribution across event types are presented. The majority of losses (55.8%) occurred in Retail Banking, followed by Retail Brokerage with 10.3% of the losses. Less than 3% of the losses were reported in each of the following business lines: Corporate Finance, Payment & Settlement, Agency Services, and Asset Management. These results are consistent with the 2002 LDCE which reported that 64% of losses occurred in the Retail Banking, indicating that Retail Banking continues to be a primary business line for most participants.[36] By event type, the highest frequencies were related to Execution, Delivery, and Process Management (EDPM) (30.6%) and External Fraud (26.3%) events. Losses related to Damage to Physical Assets (DPA) and Business Disruption and System Failures (BDSF) each had 2% or less of annual frequency. These results differ slightly from the 2002 LDCE where the majority of losses (44%) were attributed to External Fraud followed by EDPM (35%). This apparent shift may reflect increased efforts by banks to capture losses relating to event types other than External Fraud as many banks had existing processes to collect External Fraud losses prior to implementing an operational loss data collection program. Thus in early years of data collection, collection of External Fraud losses may have been more complete.

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[33] As most institutions provided data up to 31 December 2007 or 31 March 2008, results do not reflect the impact of the recent turmoil in the financial markets.

[34] These losses were reported in the Corporate Finance business line and Clients, Products, and Business Practices event type.

[35] To obtain the results presented in Tables 4 and 5, the loss data for each participating institution was annualised separately. Thus, an institution's number of losses and total loss amount were divided by the number of years of stable data for that institution.

[36] The 2002 LDCE figure is calculated using losses of at least €10,000. The 2008 LDCE included data on losses of at least €20,000 for this table.

While the most common event type for the majority of business lines was EDPM, the most common event type for Retail Banking was External Fraud. The business line/event type combination with the most frequent losses was Retail Banking/External Fraud which had an annualised frequency of 7,312 losses. The consistency of this result with the results from the prior LDCE is not surprising given the nature of the retail banking business. For Corporate Finance and Retail Brokerage, the most common event type was Clients, Products, and Business Practices (CPBP), whereas in the 2002 LDCE, EDPM was the most common event type for these two business lines. The majority of losses in the Unallocated category, which includes losses related to multiple business lines or corporate functions, were Employment Practices and Workplace Safety (EPWS) events. For many institutions, losses related to EPWS are allocated to the corporate center rather than a specific business line.

There are some frequency differences across regions. The most frequent losses were related to External Fraud for Australian and North American banks and to EDPM for European and Japanese banks. The results for Brazilian/Indian banks differed as the most frequent losses were related to EPWS. In interpreting these results for the Brazil/India region it is important to note that the data are strongly affected by Brazilian losses in EPWS, particularly for losses over €20,000, as these losses are associated with labour litigation which is a relevant issue in Brazil.

Table ILD5A provides data on the sum of annualised loss amounts by business line and event type for losses that are greater than or equal to €20,000 in the stable dataset. For each business line/event type combination the sum of annualised loss amounts and the percent distribution across event types are presented. Retail Banking had the highest annual loss amount of €3.1 billion, representing 32% of the total loss amount. Based on the results in Table ILD4A, this large loss amount may be related to the relatively higher frequency of losses in Retail Banking. The 2008 results for the loss amount by business lines show many differences with the 2002 LDCE results. While the percentage of the loss amounts appears comparable for Retail Banking (29% in 2002), it differs substantially for some of the other business lines. The prior LDCE showed that the majority of the total loss amount was related to Commercial Banking (35%), which largely reflects 2001 losses related to DPA events. As the 2008 LDCE focused on a different time period, the loss amount for Commercial Banking was only 8% of the total loss amount. There also was substantial difference between the two studies with respect to the loss amount for Corporate Finance. The loss amount for Corporate Finance was only 2% of the total loss amount in 2002 compared with 28% in the 2008 exercise. These differences likely reflect the inclusion of some large Corporate Finance losses that have occurred since the 2002 LDCE and may also reflect improvements in banks' data collection processes.

By event type, the highest annualised sum of losses (€5.1 billion) was for CPBP events. CPBP events contributed 52% of the annualised loss amount and only 18% of the annualised frequency, which suggests that CPBP losses tend to be larger than those related to other event types. The lowest loss amounts were related to DPA and BDSF, both of which accounted for less than 2% of the total annual loss amount. Corporate Finance/CPBP was the business line/event type combination that had the highest annual loss amount. These results appear to differ from the 2002 LDCE where the majority of the total loss amount was attributed to EDPM (30%) followed by DPA (29%).[37] The results for DPA were significantly lower in the 2008 LDCE as DPA was 29% of the total loss amount in the 2002 LDCE

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[37] The larger annualised loss amount for CPBP in the 2008 LDCE is driven by a few firms with very large CPBP losses. This is evident from Table 5B in Annex E, which provides cross-bank medians of the sum of annualised loss amounts by business line and event type. This table shows that for the median bank events related to EDPM had a higher proportion of the annualised loss amount.

compared to 1% in the current LDCE. This change likely reflects the difference in the time periods of the underlying data in each exercise and particularly the large influence of losses related to the 2001 terrorist attacks in the United States.

The results for Table ILD5A are similar for AMA and non-AMA banks. The main difference is that the proportion of loss amount related to CPBP events for AMA banks (57%) is higher than the proportion for non-AMA banks (31%). Also, non-AMA banks reported higher proportions of annualised loss amounts in External Fraud and EPWS. The analysis across regions shows that EDPM losses constitute the highest percentage of the total loss amount in Australia and Japan and CPBP losses account for the majority of the loss amount in Europe and North America. For Brazil/India, the largest percentage of the loss amount was related to EPWS events, which as previously discussed is related to the high frequency of labour litigation losses in Brazil. By business line, losses in Retail Banking account for the largest percentage of the total loss amount for most regions, with two exceptions. The highest value of losses is in Commercial Banking for Japan and Corporate Finance for North America.

Table ILD6 reports the distribution of the number of internal losses and the gross and net loss amounts across severity buckets.[38] The percentages are reported as medians across participating institutions. The results show that the vast majority (91.29%) of losses at the typical (median) bank are less than €20,000. Although the largest severity bucket (losses of €100 million or more) accounts for only 0.02% of the total number of losses at the median bank, losses in this bucket account for 41.79% of the total gross loss amount. In fact, the largest 20 losses collected in this exercise totaled €17.6 billion and accounted for 29.5% of the total loss amount.

Inspection of the results by region indicate that while all regions have the greatest number of losses in the €0–20,000 range, there is significant variation across the regions in the proportion of gross loss amount in this bracket. For Japanese banks, the median proportion of the gross loss amount in the €0–20,000 bracket was 74.97% compared with only 8.16% for North American banks. The medians for banks in Australia, Europe, and Brazil/India are 28.77%, 23.81%, and 45.74% respectively. Part of this difference in the results between Japanese and North American banks can be explained by the fact that Japanese banks generally have lower thresholds for collection of internal loss data, while North American banks generally have higher thresholds as seen in table ILD1.

Tables ILD7 provides the mean, median, and interquartile range (25th-75th percentiles) for the severity distribution of internal losses across institutions. Results for percentiles of the loss severity distribution were calculated on a bank-wide basis for the 100 participants that provided at least 20 losses of €20,000 or more. The median of the 95th percentile was €418,400, meaning that half of the institutions had a 95th percentile greater than this amount and that the other half had a 95th percentile less than this amount. The wide interquartile range for the 95th percentile from €217,391 to €627,196 indicates a high degree of variability across institutions. The interquartile ranges are narrower for lower percentiles, which suggests that severity across banks was more consistent at the 25th and 50th percentiles. A comparison between the percentiles of AMA and non-AMA banks indicates that the two groups have similar results for the 25th and 50th percentiles, while AMA banks have higher loss amounts at the 75th and 95th percentiles. While the results across regions suggest that the internal loss severity distribution is broadly stable, percentiles may be impacted by the exclusion of banks with less than 20 losses of €20,000 or more.

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[38] The results for losses less than €20,000 are not complete as loss data collection thresholds differ across participants.

The results in Table ILD7 reflect losses across all business lines. Table ILD8 reflects a more granular view by grouping losses by Basel business line. The table reports percentiles of the loss severity distribution for the banks that reported at least 20 losses of €20,000 or more in a given business line. The quantiles at the 95th percentile indicate that there are significant differences in the severity distributions across business lines. The heaviest-tailed business line is Corporate Finance with a median 95th percentile of €4,668,696, which is much higher than the median 95th percentile of the other business lines. The interquartile range of €2,049,520 to €13,932,205 indicates significant variability across the 95th percentiles of banks conducting Corporate Finance activities and also highlights that losses in this business line can be quite large. The Corporate Finance results reflect the experience of North American and European banks as banks in other regions either were not in the corporate finance business or did not have at least 20 losses in the business line and thus were excluded from the table. Table ILD8 shows that larger losses were also experienced in Trading and Sales, which had the second largest median 95th percentile of €727,946. Retail Banking and Payment & Settlement had the smallest median severity at the 95th percentile.

D.   Internal Data and Exposure Indicators

The LDCE requested 2007 information on four bank-wide exposure indicators: consolidated assets, consolidated gross income, consolidated Tier 1 capital, and total reported regulatory operational risk capital as well as gross income by business line. These exposure indicators are used to scale certain results to facilitate comparisons across institutions. Tables ILD9 and ILD10 report on the relationship between internal loss frequency and the exposure indicators and Tables ILD11 and ILD12 consider the relationship between annualised loss amounts and these exposure indicators. In Table ILD9, the first row of the Annualised Number of Losses ≥ €20,000 indicates that across all banks, the median frequency of losses of €20,000 or more divided by consolidated assets was 0.82 per year per billion euros of consolidated assets. This figure indicates that the typical bank experienced 0.82 losses per year of €20,000 or more for each billion euros in consolidated assets. The interquartile range for this frequency-to-assets ratio indicates that half of the banks experienced between 0.36 and 1.66 losses of at least €20,000 per year per billion euros of consolidated assets.

Table ILD9 also indicates that across all banks, the median frequency of losses of €20,000 or more divided by Tier 1 capital was 18.9 per year per billion euros of Tier 1 capital, with an inter-quartile range of 6.3 to 32.5. The broad interquartile range for the Tier 1 capital measure shows that the frequency for losses of €20,000 or more across banks varied significantly as the 75th percentile was five times the frequency at the 25th percentile. A similar interpretation holds true for measures of consolidated group-wide gross income and total reported regulatory operational risk capital. For all banks, the median loss frequency for losses exceeding €20,000 divided by consolidated group-wide gross income was 26.6 with an interquartile range of 9.7 to 44.4, and the median loss frequency for losses exceeding €20,000 divided by total reported regulatory operational risk capital was 217.9 with an interquartile range of 96.2 to 402.9.

A number of observations can be made about this table. As shown in the right-hand column of the table, internal loss experience is limited for losses of €10 million or more. In addition, the frequency of losses of €20,000 or more varies significantly across regions. When loss frequency is scaled by exposure indicators, the typical Japanese bank had a substantially lower frequency of losses compared with other regions, while typical banks from North America and Brazil/India have a higher frequency of losses. This variation in internal loss frequency may explain some of the regional differences in the combination of data elements in the Range of Practice results. There are also some differences between AMA and non-AMA banks for large losses across exposure indicators. While loss frequency is about the same for losses of €20,000 or more across the two approaches, the median frequency of

losses of €100,000 or more divided by operational risk capital for AMA banks of 59.1 losses was greater than the median frequency of 34.6 for non-AMA banks. For larger losses of €1 million or more, the frequency for AMA banks for all four exposure indicators was two to three times greater than the frequency for non-AMA banks. Some of these differences between AMA and non-AMA banks may be explained by the fact that AMA banks generally are larger, more complex banks. AMA banks also have more mature loss data collection processes, particularly as most AMA banks have passed a thorough AMA supervisory approval procedure.

While Table ILD9 considered bank-wide loss frequency across all business lines, Table ILD10 provides frequencies at the business line level normalised by business line gross income. The business lines with the highest median frequencies for losses of €20,000 or more were Retail Banking and Retail Brokerage. The median institution in Retail Banking experienced 31.6 annual losses of €20,000 or more per billion euros of gross income from Retail Banking. Similarly, the median institution in Retail Brokerage experienced 33.7 losses of €20,000 or more per billion dollars of retail brokerage income. For losses greater than €1 million, Retail Banking also had the highest relative frequency with a median of 0.35 losses per billion euros of retail banking income, followed by Trading and Sales with a median of 0.24 losses per billion euros of income from trading and sales activities.

There were differences in the results for AMA and non-AMA banks in the frequency of business line losses as a percentage of business line gross income. For AMA banks, the median was the highest for Retail Brokerage at 46.8 for losses of €20,000 or more. For non-AMA banks, the highest median frequency for losses of €20,000 or more occurred in Retail Banking with 31.5 losses per billion euros of income from retail banking activities.

Table ILD11 considers the relationship between the annualised loss amount for losses greater than or equal to €20,000 and the four exposure indicators. The table indicates that for all banks, the total loss amount for the typical bank was €155,555 per year for each billion euros in consolidated assets. As was true with the frequency results in Table ILD9, AMA banks had higher annual loss amounts than non-AMA banks relative to all four indicators. There also was significant variation across the regions, with the ratios for Japan substantially lower than the ratios for other regions.

Table ILD12 reports annualised loss amounts for losses of €20,000 or more normalised by business line gross income. The business lines with the highest frequency of losses of €20,000 or more in ILD10 were also the business lines with the highest losses amounts in ILD12. For example, in ILD12 the business line with the highest loss amount for all banks was Retail Brokerage with a median of €5.97 million. For AMA banks, the highest loss amount was also reported in Retail Brokerage with a median of €6.22 million. For non-AMA banks, the largest loss amount was for Retail Banking with a median of €3.42 million. By region, Australia and Japan had the highest medians were reported in Retail Banking, although Australia's loss amount was over six times Japan's loss amount.[39] The highest loss amount for Europe was in Retail Brokerage and for North America was in Agency Services.

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[39]   For certain business lines the medians for Japan equal zero, which indicates that the median bank was in the business line, but did not have any losses of €20,000 or more. The results for the Brazil/India region include data for only Retail Banking.

E. Insurance Recoveries

Tables ILD13 and ILD14 provide a summary of insurance recovery data. Participants were asked to provide the total amount of insurance recoveries associated with each loss in their internal data submission as well as an indication of whether the loss was covered by an insurance policy. Results reflecting insurance coverage are not presented in this paper as the quality of this indicator differed across banks. It appears that a number of banks have had some difficulties mapping insurance coverage to individual loss events. As a result, there is some uncertainty arising from the insurance coverage indicator. Some banks may consider that insurance coverage existed for all losses with a positive recovery and that no coverage existed for all losses with €0 recovery. Alternatively, other banks may consider that insurance coverage existed, even if there was a €0 recovery.[40] A review of the data shows that about half of the banks that provided insurance data indicated a positive recovery for every loss with insurance coverage.[41] Given this uncertainty regarding the insurance coverage indicator, the datasets used for Tables ILD13 and ILD14 include data from participating institutions that reported insurance recovery information for at least one loss.

The first column of ILD13 reports the number of losses with insurance recoveries as a percent of the total number of losses. The second column provides the recovery rate for losses with insurance recoveries, which is the total amount of insurance recoveries divided by the total amount of losses with an insurance recovery.[42] In the third column, the amount recovered as a percent of the total loss amount is calculated as the total amount of insurance recoveries divided by the total value of all losses. These three ratios were estimated both for losses of any size and for losses above €20,000.[43]

There were 88 institutions that reported insurance recovery information for one or more losses and 80 institutions that reported insurance recovery information for at least one loss of €20,000 or more. As shown in the first column of ILD13, only a small proportion of losses had an associated insurance recovery. The medians indicate that 2.1% of all losses and 4.2% of losses of €20,000 or more were offset to some degree by an insurance recovery. The results for insurance recoveries in the 2002 LDCE were similar. In the prior LDCE it was reported that insurance claims were filed for 2.1% of all losses and 1.4% of losses greater than €10,000.[44] An amount was recovered for 1.7% of all losses and 1.1% of losses greater than €10,000. In the second column of ILD13, the median recovery rate is 74.6% for all losses and 70.5% for losses of €20,000 or more, indicating that for losses with insurance recoveries, at least half of the banks had a significant portion of the loss amount offset by insurance. The results in the third column suggest that a small percent (about 3.0%) of the total amount of internal losses is recovered through insurance.

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[40] For example, banks could indicate that coverage existed based on the loss event in general, although the loss in question fell outside of the deductible/policy.

[41] A bank was considered as providing insurance data if they provided at least one loss with insurance coverage or at least one loss with a positive insurance recovery.

[42] For Tables ILD13 and ILD14, the total value of losses in the denominator is calculated using the loss amount net of non-insurance recoveries.

[43] A review was also conducted for internal losses of €1 million or more with insurance recoveries to analyse recovery experience on large losses. However, as there were only 88 reported losses of €1 million or more with insurance recoveries, the results were not included in this paper.

[44] When comparing insurance recovery results for this exercise and the 2002 LDCE, it is important to note that the 2008 results are calculated as cross-bank medians, while the results from the 2002 LDCE were calculated at the aggregate level.

Institutions using an AMA approach had a much lower ratio of losses with recoveries compared to non-AMA banks, but reported similar recovery rates. The lower ratio of losses with recoveries may reflect the nature of losses at AMA banks as AMA banks may be more likely than non-AMA to experience larger, non-insurable events. There were some regional differences in the number of recoveries and recovery rates for losses of €20,000 or more.[45] Japan's results indicate relatively more insurance recoveries, with a median number of losses with recoveries of 11.1%. North American institutions reported the smallest number of losses with insurance recoveries (0.8%) and the lowest recovery rate (59.2%). Australian institutions also reported a smaller number of losses with insurance recoveries (1.2%) than banks in other regions.

Table ILD14 shows insurance recovery patterns across event types for losses of €20,000 or more.[46] Insurance recoveries were most commonly mapped to losses classified as DPA. A typical bank had 27.9% of their DPA losses associated with an insurance recovery. This is not surprising as property insurance is a standard insurance policy purchased by banks. External Fraud losses had the second highest median ratio of losses with insurance recoveries (8.84%). For all other event types, more than half of banks had no recoveries associated with their losses. Recovery rates ranged from 62.94% for Internal Fraud losses to 91.32% for Employment Practices and Workplace Safety losses. For the amount recovered as a percent of the total loss amount, median ratios were zero in all event types except for DPA with a ratio of 19.83%, External Fraud (7.17%) and EDPM (0.01%).

VI.   Scenario Analysis Results

A.   Scenario Analysis Methodology

The 2008 LDCE presented the first opportunity to analyse scenario data across the banking industry. Participating banks were asked to provide scenario data using one of three templates that was most consistent with their scenario approach: the individual approach, the interval approach, and the percentile approach. Output from the individual scenario approach consists of one severity estimate linked with a probability of occurrence (frequency) for each scenario. The interval approach output consists of frequency estimates for a series of distinct severity ranges. The percentile approach results in severity estimates for specified percentiles of a loss distribution. Institutions were asked to submit raw scenario data that were the direct output of a workshop or other method used to generate scenario data. Participating banks were asked to submit scenario results for either: (i) all scenarios used in the measurement and management of operational risk or (ii) at least the twenty largest scenarios across the organisation as well as the five largest scenarios for each of the seven level I Basel II event types.[47]

As with internal loss data, certain steps were taken to standardise the scenario data into a consolidated dataset suitable for descriptive and statistical analysis. Severity estimates were

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[45]   Results for Brazil/India are not presented in Tables ILD13 and ILD14 as there were less than four banks reporting insurance recovery data.

[46]   Table ILD14 includes data from banks that report at least one positive insurance recovery in their internal loss data submission and that report at least one loss in the event type.

[47]   Banks submitting only their largest scenarios were asked to include the 20 largest scenarios with a mean annual frequency greater than 0.001 and the 5 largest scenarios in each event type with a mean annual frequency greater than 0.001.

converted into euros and scenarios that impacted more than one business line were remapped to the Unallocated business line.[48]

B.   Overview of Scenario Data

This section provides a summary of the scenario data focusing on the number of scenarios submitted. The next section provides analysis based on the severity and frequency of the scenarios. Table S1 provides a summary of the submitted scenario data. Sixty-five of the 121 LDCE participants provided scenario data.[49] The individual approach was the most commonly used approach with 34 of 65 (52%) banks using this approach. Eighteen banks used the percentile approach and 13 used the interval approach. The individual approach was the most commonly used approach in Australia, Japan, and North America. The percentile and individual approaches were both common approaches in Europe, with 15 and 13 banks respectively.

Table S1 provides the median and the interquartile range for the number of scenarios reported for the LDCE, which may not include all the scenarios used by the banks in their operational risk frameworks. The median number of scenarios reported for all participating banks was 36 scenarios. The medians were generally similar across most regions with the exception of Japan, which had a higher median of 50 scenarios reported. The interquartile range indicates that half of the banks reported between 21 and 58 scenarios.

Table S1 also provides results for the total number of scenarios currently in use within an institution's operational risk framework (Scenarios Used). The results show that the median number of Scenarios Used by participating banks was 115 scenarios. There was significant variation across banks in the number of scenarios used as evidenced by the interquartile range of 41 to 600 scenarios. Some of this variation can be explained by regional differences. Japanese banks reported a median of 673 Scenarios Used, while the median for North American banks was 71 scenarios. The median number of Scenarios Used was 204 for Australian banks and 95 for European banks.

Panels A-C of Table S1 provide summary information by scenario approach. In addition to providing more granular data on the number of scenarios reported and used, these panels report the number of severity percentiles and number of intervals used. For example, if a bank using the percentile approach provided severity data for the 75th, 90th and 99th percentiles, the bank was viewed as using three percentiles. The median number of severity percentiles for banks using the percentile approach was four, with a narrow interquartile range indicating that at least three quarters of these banks used four or fewer percentiles. Of the 18 banks reporting under the percentile approach, eight used the 99th percentile as the highest percentile and seven used the 99.9th percentile. For those using the interval approach, the median number of intervals used was six intervals.

The bottom rows of Panels A-C indicate the maximum severity (ie the largest estimated loss amount) for each approach. The largest scenario reported for the individual approach was €101.2 billion and €1.2 billion for the percentile approach. For the interval approach, the largest scenario had a lower bound of €634 million and a higher bound of infinity.[50] If

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[48]   Loss amounts were converted using exchange rates as of 31 March 2008 which are provided in Annex B.

[49]   One bank provided scenario data using two scenario approaches.

[50]   The procedure for determining the largest scenarios varied by approach. For the individual approach, the largest scenarios were determined using the reported loss amounts. The largest scenarios were determined for the percentile approach using the loss amounts for the highest percentile provided and for the interval

scenarios with an upper bound of infinity are excluded, the largest scenario reported in the interval approach had a lower bound of €506 million and an upper bound of €1.1 billion.

Table S2 reports the proportion of all Scenarios Used by business line and by event type.[51] The results indicate that the Unallocated business line, which includes group-wide scenarios, had the largest proportion of scenarios with a median of 36.0%. Retail Banking had the next largest proportion of scenarios with a median of 27.6%. The smallest proportion of scenarios submitted was in Agency Services. For all regions the two largest proportions of scenarios across business lines were in Unallocated and Retail Banking with the exception that Japan's largest proportions were in Retail Banking and Asset Management. With respect to event type, the highest proportion of scenarios was related to EDPM and CPBP events for all regions.

Table S3 provides data on the distribution of the 20 largest scenarios for each bank across business lines and event types, and is intended to illustrate where banks perceive their key risks. Results for these large scenarios in Table S3 are similar to the results for all scenarios in Table S2. By business line/event type combination, the largest number of scenarios was 90 in Unallocated/EDPM and 88 in Unallocated/DPA. This is not surprising as the Unallocated category includes group-wide scenarios. Aside from the Unallocated category, the largest number of scenarios reported was 65 in Retail Banking/CPBP. There were six business line/event type combinations that contained only one scenario and one combination that contained no top 20 scenarios (Payment & Settlement/EPWS).

Table S4 provides a summary of common scenario descriptions gathered from the largest scenarios provided by each bank. This table is based on descriptions from a subset of the banks submitting scenarios, as not every institution provided detailed descriptions.[52] It was constructed by assigning short descriptions to each scenario and selecting the three descriptions most often cited by banks within a given event type and business line.[53] Results are reported only if there were a sufficient number of scenarios in a given event type/business line to determine common descriptions across institutions. Thus, Retail Brokerage is not presented as there were an insufficient number of scenarios for each event type. Actual scenario data have been rounded to preserve confidentiality such that the severity range approximates the minimum and maximum severity reported for a given description. The majority of scenarios included in this table exhibit wide ranges from minimum to maximum severity. Such broad ranges are not surprising given that the sample includes data from banks in many jurisdictions, of widely varying sizes and risk profiles.

Panel A of Table S4 summarises results for Internal Fraud. The most common scenario in this category was Unauthorised Trading in Trading & Sales with severity ranging from €1 million to €1.2 billion. The most common Internal Fraud description across business lines was Embezzlement, which also had a wide range of severity estimates both within and across business lines. Two general themes are evident in Panel B, which reports External

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approach using the median values of the highest interval reported. For scenarios that have an upper bound of infinity, the lower bound was used to determine severity.

[51] For banks that provided all scenarios, the tables are based upon the number of scenarios provided. For banks that did not provide all of their scenarios, the tables are based upon data reported in Attachment A.

[52] Banks using the interval approach generally did not provide scenario descriptions and a few other banks either did not provide descriptions or submitted Basel Level I event types as a description.

[53] If there was an equal number of banks for a particular description, the scenarios were chosen based upon the maximum amount reported. If an institution reported multiple scenarios with similar descriptions, only the institution's largest scenario was included to ensure a cross-bank perspective.

Fraud data. Loan Fraud is a common description in five business lines.[54] It is interesting that loan fraud is included in operational risk scenarios as it would generally be expected to be credit risk for Basel II purposes. The inclusion of scenarios related to loan fraud may be due to different definitions across regions regarding credit risk related operational risk losses. Cybercrimes, which included hacking, was another External Fraud scenario considered across a number of institutions.

The results for EPWS suggest that institutions generally view these scenarios at the group level rather than at the business line level as there was sufficient data to present results for only two business lines other than Unallocated. Discrimination-related issues and lawsuits were the most common scenario considered in this event type. For scenarios related to CPBP, there are a number of commonalities across business lines. Regulatory Breach, which includes failure to comply with laws and regulations, was one of the most common scenarios in four business lines.[55] The remainder of the table presents results for DPA, BDSF, and EDPM. Descriptions of top scenarios in DPA are straightforward and reflect damage to building and premises and natural disasters. BDSF scenarios were concentrated on IT system, server, or software failures. A range of descriptions were reported in EDPM, although the most common scenarios were related to human error.

C.   Analysis of Scenario Frequency and Severity

The previous section's discussion of scenario analysis focused on the number of scenarios submitted. This section considers scenario frequency, severity, and results that take both frequency and severity into account.[56] In Table S5, scenario frequencies for each business line are provided as the average percent distribution across event types. For example, the frequency for Retail Banking/External Fraud indicates that banks with Retail Banking scenarios had an average frequency of 28.4% associated External Fraud events. In Retail Brokerage, the highest average frequency (44.6%) was reported for CPBP events. Aside from these two business lines, all business lines had the highest average scenario frequency associated with EDPM events.

It is interesting to compare this table to ILD4A, which provides the percent distribution of internal loss frequency across event types, as the results are quite similar. For all business lines except Corporate Finance and Unallocated, the business line/event type combinations with the highest frequency of internal losses corresponded with the business line/event types with the highest scenario frequencies. For example, in Trading & Sales the highest internal loss frequency (76.7%) was associated with EDPM and the highest scenario frequency was also associated with EDPM (42.4%). A similar relationship exists across the other business lines where there is correspondence between the frequency of internal losses and scenarios in that the internal data frequency is higher than the scenario frequency.

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[54] Loan Fraud is presented in four business lines in Table S4 and was also a common description in Retail Banking, although not among the three most frequent scenarios for Retail Banking.

[55] Regulatory Breach may not include noncompliance with money laundering regulations as a number of institutions viewed this as a distinct scenario.

[56] Frequency refers to how often a scenario will occur during a given time period. For example, an annual frequency of 0.001 refers to a loss that would occur at least once every 1,000 years.

Panel A of Table S6 examines the reported severity or size of the top 20 scenarios reported by participating institutions.[57] For each institution, the 25th, 50th, 75th and 95th percentiles of their top 20 scenarios were calculated. (These percentiles correspond to the 15th, 10th, 5th and 1st largest scenarios respectively.) The results in the table represent the cross-bank medians and interquartile ranges for each of these percentiles. The purpose of this table is to provide an indication of the size of scenarios, as well as how these scenario sizes vary across banks and across regions.

The first row of the table indicates that banks' largest scenarios are typically about €65 million (as seen from the median value of the 95th percentile), while their 10th largest scenario is typically about €25 million. There appears to be significant cross-bank variation, especially with respect to the 95th percentile (or largest) scenario. This is evident from the interquartile range for the largest scenario (95th percentile) which runs from €25.0 million to €317.7 million.

Panel A also suggests some variation across regions in the size of the largest scenarios provided. This observation should be tempered with caution due to the cross-bank variation noted above (indicated by the size of the interquartile ranges). However, it does appear that Australian banks provided larger extreme scenarios than banks in other regions, while Japanese banks provided smaller scenarios.

Panel B of Table S6 presents the size distribution of all scenarios reported by participating institutions.[58] This allows us to consider not only the extreme scenarios reported in Panel A, but also the smaller scenarios that more likely correspond to the body of the loss distribution. The first row of this table shows that banks' large (95th percentile) scenarios are typically about €50 million, that their medium (50th percentile) scenarios are about €5 million, and that their small (25th percentile) scenarios are about €2 million. As with Panel A, there is significant cross-bank variation in the size of scenarios reported. The Panel B results indicate that when all scenarios are considered, North American banks appear to have larger tail scenarios as the typical North American bank had a 95th percentile of €81.1 million.

Further examination of results for the 25th percentile in Panel B suggests one possible factor behind the cross bank variation seen in these results. For example, the interquartile range for North American banks' 25th percentile runs from €0.8 million to €100.7 million. This extremely wide range suggests that some banks may have large scenario assessment thresholds.[59] In general, one would expect the 25th percentile of a bank's scenario severity distribution to lie relatively close to its chosen assessment threshold. So if assessment thresholds across banks ranged from €100,000 to €100 million, the sort of cross-bank variation seen in the 25th percentiles in Panels A and B could be generated. The issue of assessment thresholds is revisited later in this section.

Panels C and D of Table S6 are provided to facilitate a comparison between the size of scenarios and internal losses. As expected, scenario estimates are much larger than losses in internal data. As shown in Panel D, the 95th percentile of the Top 20 scenarios was 5.6 times the 95th percentile from internal data for half of the banks. The interquartile range of

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[57] See footnote 47 for details on the determination of the largest scenarios. Some of the results in Table S6 are the same for different percentiles. This result is driven by interval approach banks, which can have many top scenarios all with the same interval (and thus the same value).

[58] To provide meaningful results, this table only includes data from banks that submitted all of their scenarios.

[59] If scenario participants are asked to consider only scenarios above a minimum amount, then this amount is referred to as the assessment threshold.

1.6-29.0 indicates that there are significant differences across banks. Also as expected, the difference between scenario estimates and internal losses was more pronounced for tail events as shown in the right column of Panel D. For the typical banks, the 1-in-1,000 year loss implied by scenarios was 27.2 times the 95th percentile of the Top 20 internal losses.

The previous tables gave an understanding of the sizes of scenarios that banks are using in their operational risk frameworks. However, they did not tell us anything about the implied loss severity distribution. This is because the previous tables weighted each scenario equally, whereas in the calculation of a severity distribution that is aggregated across a bank, business line or event type, the scenarios are weighted according to the frequency with which they occur.[60] Considering the scenario-implied severity distributions will potentially allow us to make more meaningful comparisons across banks, business lines, event types and regions. It will also facilitate direct comparison with results from internal data.

Calculating the implied severity distribution requires a more complex analytical approach than the simple approach previously used for characterising the size of each scenario. Accurate characterisation of the severity distribution requires a measure that captures the full amount of information associated with each scenario – as opposed to a summary statistic such as the loss amount for the highest percentile. This is not an issue for the individual scenario approach, as the information for each scenario consists of one frequency assessment and one severity assessment. However, for the percentile and interval approaches, probability distributions were fit to all of the data points provided for each scenario (ie the intervals and interval frequencies for the interval approach, and the frequency and percentiles for the percentile approach). This procedure not only allows for a more complete capture of the scenario information, but also facilitates the expression of this information in a common format that can then be aggregated and reported across banks. A detailed description of the procedure for calculating scenario-implied severity distributions can be found in Annex C.

As discussed under Table S6, the observed wide interquartile ranges may be partially due to differences in the assessment threshold across banks.[61] Although comprehensive data on banks' assessment thresholds are not available, their effects can be reduced by considering the conditional severity distribution of scenarios greater than or equal to €1 million.[62] The results in Table S7, characterise the scenario-implied severity distributions conditional on losses exceeding €1 million to adjust for potential differences in assessment thresholds across banks. The results were calculated by first estimating the scenario severity distribution for each bank (and also for each business line and event type within each bank) conditional on losses exceeding €1 million, and then calculating the 25th, 50th, 75th, and 95th percentiles of each bank's scenario severity distributions. The medians of these percentiles as well as the interquartile ranges are reported in Table S7. The first row of Table S7 describes the scenario severity distribution for the typical (median) bank. For this typical

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[60] To see this point, consider the following example. Suppose that a bank considers two scenarios under the individual approach. The first scenario is a €1 million loss that occurs on average once a year. The second is a €100 million loss that occurs once every one hundred years on average. For this example, the 50th percentile of the scenario size distribution (as reported in Tables S6) would be €50.5 million, while the 50th percentile of the scenario severity distribution would be €1 million.

[61] Due to the assessment threshold issue, the business line and event type results are not reported.

[62] Calculating the conditional severity distribution is straightforward in the case of individual scenarios. (Only those individual scenarios that are greater than or equal to €1 million are considered.) For the interval and percentile approaches, the fitted distributions are adjusted in the usual manner to account for truncation at €1 million. The conditional frequency for these scenarios is obtained by multiplying the raw frequency by the probability of exceeding €1 million.

bank, the 95th percentile of the conditional severity distribution is €19.0 million. The 25th, 50th and 75th percentiles are €1.5 million, €2.3 million and €4.3 million, respectively. Panel A of Table S7 reports results by region.[63] From the 95th percentile results, it appears that the banks in Australia/Japan are providing larger tail scenarios than banks in the other regions. This hypothesis is supported by the interquartile range of €20.0 million-€56.4 million, which lies above the medians for the other regions.

The results by business line in Panel B suggest that the scenario severity distribution for the Unallocated category has the heaviest tail (as measured by the 95th percentile). Aside from the Unallocated category, the business line with the highest median for the 95th percentile was Agency Services and the business line with the lowest median was Retail Brokerage. In Panel C the results by event type indicate that the Unallocated event type has the highest severity at the 95th percentile.

A comparison of the scenario results to the equivalent results for internal losses in Panel D of S7 shows that the results are strikingly similar for the 25th, 50th and 75th percentiles, although the interquartile ranges are wider for the scenario data.[64] However, there is a difference at the 95th percentile with a value of €19.0 million for scenario data compared to €14.1 million for internal loss data with a significantly wider interquartile range for the scenario data.

Table S8 reports the 1-in-100 year loss, which is the amount L_{100} such that the expected annual frequency of losses greater than or equal to L_{100} is 0.01. The table also considers the 1-in-1000 year loss L_{1000}. These quantiles are interesting to consider for several reasons. First, these measures focus on the tail, which avoids the previously-discussed issues related to assessment thresholds. Second, the focus on the tail facilitates the incorporation of data from banks that reported only their top 20 losses, provided that the combined frequency of these losses exceeds 0.01 or 0.001. Third, L_{100} and L_{1000} explicitly combine elements of both frequency and severity, and is thus more relevant to the concept of regulatory capital than either frequency or severity considered in isolation.[65]

However, this approach does have a drawback that should be mentioned. In particular, there is evidence both within this study and elsewhere that operational loss frequency scales with bank size. Because of the way L_{100} and L_{1000} are defined and calculated, variation in bank size will lead to cross-bank variation in frequency, which will in turn lead to cross-bank variation in these measures. (Intuitively, this just means that a large bank will tend to have more losses exceeding any particular threshold than a small bank.) This potential sensitivity to bank size will complicate the interpretation of results for L_{100} and L_{1000}.

Turning now to the results themselves, the first row of Table S8 shows that the typical bank has a 1-in-100 expected frequency of losses exceeding €88.4 million, and a 1-in-1000 expected frequency of losses exceeding €194.4 million. The interquartile ranges reveal significant variation in results across participating institutions. The remaining rows of Table

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[63] For this table, Australia and Japan were combined into one region to preserve the anonymity of individual bank data.

[64] The dataset for internal losses includes the same banks and the same threshold of €1 million.

[65] Indeed, L_{1000} can be considered a lower bound for K_{1000}, the 99.9[th] percentile of the aggregate loss distribution based on the raw scenario assessments provided for this exercise. To see this, observe that by definition, at least one loss exceeding K_{1000} is expected to occur once in 1000 years. Since the aggregate loss must always be greater than or equal to the largest individual loss, we know that the aggregate loss is also expected to exceed L_{1000} with a frequency of at least 0.001. Thus, the bank would need at least L_{1000} to cover aggregate losses at the 1-in-1000 year frequency. Note that to the extent that the raw scenario inputs are not directly input into the capital model, L_{1000} may not be a strict lower bound for operational risk capital.

S8 indicate the possible variation across regions, business line and event types. However, it is important to bear in mind that the reported interquartile ranges are wide, which implies that many apparent differences between medians may not be meaningful. However, it does appear that North America generally has a higher loss amounts with an expected annual frequency of 1-in-100 years than other regions. Across business lines and event types, L_{1000} appears larger for the Unallocated business line and the Unallocated event type.

D.   Comparison of Internal Data and Scenario Results

The collection of scenario data provides an opportunity to compare the results of scenario data with internal data to gain an increased understanding of the relationship between these two data elements. One such comparison can be made by analyzing the scenario frequency results in Table S9 and internal data frequencies in Table ILD9, both of which are scaled by exposure indicators. Consider the first column in Panel A of Table S9, which reports the ratio of the frequency of scenario losses exceeding €1 million to total assets, where total assets are expressed in trillions of euros. Looking at the results for all banks, we see that the typical bank is expected to experience 27.5 losses annually in excess of €1 million per trillion euros in assets. The associated interquartile range (6.5–96.2) is wide indicating large variation in scenario frequency across banks. The remainder of Table S9 can be interpreted in a similar manner.

In Table S10 certain frequency results from Tables S9 and ILD9 are reproduced to facilitate a comparison between internal data and scenarios. A review of the annual frequencies of losses of at least €10 million shows that the scenario-based frequency equals 49.4 per trillion euros in gross income compared with an internal data frequency of 0. This indicates that the median bank has no internal data for losses of €10 million or more and thus must rely on other data elements. A similar pattern is seen across regions with the exception of North America, which has a median internal data frequency of 100.0 for losses exceeding €10 million. The results for losses exceeding €1 million for AMA and non-AMA institutions show that the ratios for scenarios and internal data are closer together for AMA banks (639.9 versus 815.8) than for non-AMA banks (993.2 versus 288.0). This is also true for losses of €10 million or more, but the differences are more pronounced as non-AMA banks had a median internal data frequency of zero. Also, the interquartile ranges for the scenario frequencies of AMA banks are narrower than for non-AMA banks. These findings of greater consistency within and across AMA banks may result from the AMA banks having better developed systems and processes for both internal data and scenario analysis than the non-AMA banks, particularly as in many jurisdictions AMA banks have completed a thorough AMA supervisory approval procedure. As the interquartile ranges in this table are wide the apparent differences discussed may not be significant.

Tables S11 and S12 compare the number and frequency of large losses from scenario data with the number and frequency of large losses from internal data. Table S11 considers the number of losses above a threshold that is fixed across banks. The threshold is €10 million when all event types are considered and €1 million at the event type level. The Number column of Table S11 compares the number of scenarios above the threshold with the total number of scenarios plus internal data points above the threshold. The first row of the Number column indicates that at the median bank, scenarios account for 93.8% of the total number of losses (internal data plus scenarios) above the €10 million threshold. The associated interquartile range suggests that this predominance of scenarios is characteristic of most banks in the sample. The predominance of scenarios is also robust across event types and generally across regions.

The Frequency column of the table compares the implied annual frequencies of scenarios and internal data above the applicable threshold. The first row of the table indicates that

scenarios account for 70.9% of the joint above-threshold frequencies of scenarios and internal data combined. The predominance of scenarios was consistent across event types and regions, although somewhat less so than the results seen in the Number column. Indeed, there are two regions (Australia and North America) where scenarios account for roughly half of the joint frequency.

The above results are consistent with some beliefs regarding the relationship between scenarios and internal data. In particular, one view is that scenarios may be used to "fill in the tail" of internal data. Focusing on the tail, it is not surprising to see more scenarios than internal data. Thus, some correspondence may be likely between implied scenario frequencies and internal data frequencies in the data for a large number of banks, although such a correspondence may not hold at the individual bank level. The results from the right hand side of Table S11 are broadly suggestive of this pattern. Although the scenario frequencies are somewhat higher, they are not wholly inconsistent with the frequencies based on internal data.

Rather than considering a common threshold across banks, Table S12 bases the threshold on the scenario data provided by each bank. In particular, the LDCE instructions asked banks to report at least the top 20 scenarios bank-wide, as well as the top five scenarios for each event type. We thus set the threshold for each bank as the value of the twentieth largest scenario for bank-wide analysis, and as the value of the fifth largest scenario for analysis at the event type level.

The results presented in Table S12 are similar to those in Table S11 when all event types are considered together. However, the results by event type were markedly higher in the predominance of scenarios over internal data. In most instances, the typical bank has no internal data above the scenario-defined threshold. The reasons for this difference are not entirely clear. However, the results of Tables S11 and S12 taken together do suggest that many banks are indeed using scenarios to "extend the tail of the distribution" beyond the point at which they have experienced actual losses.

VII.   Capital Analysis

A.   Operational Risk Capital

This section provides analysis relating to the amount of regulatory operational risk capital reported by participating banks. Some variability in the reported amounts of operational risk capital is expected and is fully consistent with the inherent flexibility of the AMA framework. In addition, the analysis does not consider the unique business risks or control environments existing within each reporting institution, which presumably would affect the variability of reported capital.

Table C1 considers the relationship between reported regulatory operational risk capital (operational risk capital) and three exposure indicators (consolidated assets, Tier 1 capital, and consolidated group-wide gross income).[66] The median ratio of operational risk capital to assets for all participants is 0.33%. This figure implies that the typical bank holds 33 cents of operational risk capital for each €100 of assets. The interquartile range indicates that half of reporting banks reported an operational risk capital-to-assets ratio between 0.24% and

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[66]   Data for regulatory operational risk capital and the other exposure indicators reflect 2007 data, and thus do not reflect the results of the market crisis. This may have an impact on the future size of these indicators.

0.47%. Results are presented for Tier 1 capital and gross income and can be interpreted in a similar manner. The median of operational risk capital to Tier 1 capital was 7.51% with an interquartile range of 5.21% to 10.25%. The median ratio of operational risk capital to gross income equaled 12.27% with an interquartile range of 10.58% to 14.96%.

As indicated by the medians in Table C1, operational risk capital for non-AMA banks was generally higher than capital for AMA banks across the three exposure indicators. However, there are some exceptions to this statement on a regional basis. For North American banks, the medians for operational risk capital as a percentage of consolidated assets and Tier 1 capital were higher for AMA banks. For European banks, operational risk capital as a percentage of Tier 1 capital also was higher for AMA banks.

For all regions, operational risk capital as a percentage of gross income was higher for non-AMA banks than for AMA banks. The regional medians of operational risk capital relative to gross income for AMA banks are significantly below the 15% alpha value of the BIA and also below the range of betas (12-18%) used in the TSA. For AMA banks, the median ratio of operational risk capital to gross income equaled 10.83% with half of the AMA banks in the range of 8.38% to 13.83%. Non-AMA banks reported a median of 12.79% with half of the non-AMA banks in the range of 11.33% to 15.03%. As evident from the table all participants from Brazil/India were non-AMA institutions. For these institutions, operational risk capital as a percentage of gross income is lower than the levels reported for other regions, but this observation does not hold for operational risk capital relative to assets and Tier 1 capital. These somewhat contradictory results seem to be related to gross income, which is impacted by two primary factors: banks in Brazil are allowed to use the Alternative Standardised Approach (ASA) and gross income earned by Brazilian banks is usually high.[67]

Table C2 reports the maximum loss amount and the average of the five largest losses from internal loss data relative to operational risk capital for AMA banks. The table indicates that for the median AMA bank, the maximum loss represents approximately 4% of operational risk capital. The interquartile range for all AMA banks indicates that half of the banks report a maximum loss amount ratio between 1.6% and 11.4%. Not surprisingly, there was fairly wide dispersion in this relationship, with Japan having the lowest relative ratio (2.6%) and North America and Australia having the highest (5.8% and 5.7% respectively). When considering the average of the five largest losses, the average was 2.4% of AMA capital for the typical bank. The range of this ratio across regions showed similar dispersion to the maximum loss ratio, with Japan again having the lowest relative ratio (0.9%) and North America having the highest (4.2%). In evaluating these results, it is worth noting that the measures of large losses used (maximum loss amount and the average of the five largest losses) are inherently volatile. The distribution of these measures depends significantly on the number of years of internal data submitted and thus is not consistently comparable across institutions.

B.   Expected Loss, Dependence, and Risk Mitigant offsets to Capital

The Basel II Accord allows an AMA bank to reduce its regulatory operational risk capital via expected loss offsets and other risk mitigants, if it can demonstrate to its national supervisor that the offsets have been appropriately accounted for and measured.[68] AMA banks may

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[67] Under the ASA, capital for Retail Banking and Commercial Banking is calculated as a percentage of total loans and advances rather than business line gross income. While the beta factors in the ASA are the same as for TSA banks, the betas are multiplied by a scaling factor of 0.035.

[68] Risk mitigants are subject to additional supervisory expectations. Please see paragraphs 677-679 – Risk Mitigation in the June 2006 *Basel II: International Convergence of Capital Measurement and Capital*

also be permitted to use internally determined correlations among operational risk losses, if they can validate their correlation assumptions using appropriate quantitative and qualitative measures.[69] Table C3 presents results relating to expected loss (EL) and EL offsets, offsets from risk mitigants including insurance, and correlation as well as information on partial use.[70] Data regarding the use of expected loss, expected loss offsets, and risk mitigants are limited; thus, only very broad observations can be made from the results.

Only European and North American AMA banks provided data on EL included in AMA regulatory capital. European AMA banks include significantly more EL in their AMA capital than do North American AMA banks. The median ratio of included EL to AMA capital was 13.5% in Europe and 7.8% in North America. Some of this difference could be related to a higher frequency of small losses in European AMA banks, which increases the potential pool of losses that comprise EL.

Table C3 also shows that the use of the EL offset is extremely limited with very few banks estimating such an offset. The median of the EL offset to AMA capital was 0.0% for all regions, which indicates that at least half of institutions claimed no EL offset whatsoever. The values of the 75th percentiles indicate that only a few European banks have calculated an EL offset and the amount is small relative to AMA capital. In Europe, the 75th percentile EL offset is 3.4% of AMA capital.

Only a few North American and European banks have calculated an insurance offset. When used, insurance offsets are small relative to AMA capital. The median ratio of insurance offsets to AMA capital (without insurance offsets) was 0.0% for all regions. The 75th percentiles of the ratio of insurance offsets to AMA capital are 5.2% and 5.4% for Europe and North America, respectively. No banks participating in the 2008 LDCE reported data on other risk mitigants.

Only European and North American banks reported any correlation adjustment to their AMA capital estimates.[71] Table C3 considers two measures of the impact of correlation assumptions on operational risk capital. The first measure, AMA regulatory capital divided by AMA regulatory capital assuming full independence, is the amount by which the assumed correlation increases capital relative to the assumption of full independence (0% correlation). These results indicate that relative to a benchmark model of full independence, the median AMA bank made an 8.3% upward adjustment to reflect dependence. The second measure of correlation is the amount by which assumed dependence decreases capital relative to the assumption of 100% correlation (ie summing capital across operational risk categories (ORCs)). The results indicate that relative to the benchmark 100% correlation, the median bank decreases capital by 22.4% due to diversification effects across ORCs. Interestingly, neither measure of the impact of dependence displays much variation across these two regions, once the wide interquartile ranges are taken into account.

Standards: A Revised Framework - Comprehensive Version for specific regulatory requirements (Basel II Accord).

[69] See paragraph 669(b) of the Basel II Accord.

[70] A partial use approach can be used in some jurisdictions. It allows banks to adopt an AMA for a majority of their operational risk exposures while using the BIA or TSA for the remaining exposures until exposures for the entire bank can be transitioned to an AMA.

[71] This paper uses the term "correlation" informally to describe the various forms of dependence that banks seek to model under their AMA frameworks. Such informal use of the term "correlation" is not meant to imply that operational risk dependence structures can be fully captured via a covariance matrix structure.

Only Japanese and European banks provided partial use data. The median value of operational risk capital from partial use to regulatory operational risk capital for European banks was 19.5% with a wide interquartile range from 6.7% to 34.7%. Japanese banks reported a median of 14.8% with an interquartile range from 10.4% to 16.3%. These results indicate that European banks that have not fully adopted an AMA have a higher proportion of capital from partial use compared to Japanese banks.

VIII.   Conclusion

The 2008 LDCE was the first international effort to collect information on all four data elements used in the AMA. The participation of 121 banks of varying sizes and risk profiles from 17 countries provided a valuable opportunity to gain insights into industry loss experience and current operational risk practices. The data facilitated comparisons between AMA and non-AMA banks as well as comparisons across regions. The results of the exercise indicate that banks have made considerable progress in the collection and use of internal loss data since the 2002 LDCE.

Given the broad participation in this exercise, the results can be viewed as generally representative of the banking industry, although some care should be taken when interpreting results presented at a more granular level. As with any large scale data collection exercise, the findings presented are subject to certain limitations including the completeness and accuracy of the data provided by participating institutions. In addition, data submitted in this exercise generally reflect information through 2007 and therefore do not reflect the recent turmoil in financial markets.

This paper together with the Range of Practice paper provides observations regarding variations in banks' operational risk loss experiences, practices, and capital levels. These results provide an opportunity for banks to understand industry practices and consider potential areas for improvements in their own operational risk frameworks. The topics highlighted in these papers will continue to be examined by SIGOR with the goal of promoting consistency in implementation of the Basel II Framework.

Members of the SIG Operational Risk Subgroup

Chairman: Kevin Bailey, Office of the Comptroller of the Currency, United States

Australian Prudential Regulation Authority	Harvey Crapp Michael Booth Sarah He Emily Watchhorn Shane Wilson
Banking, Finance and Insurance Commission, Belgium	Jos Meuleman
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Annex A

Data Security and Confidentiality

The 2008 LDCE preserved the confidentiality of the data submitted using procedures employed in previous BCBS exercises including the 2002 LDCE and QIS-4. The data submitted by each institution was maintained by its national supervisor in a secure environment with access restricted to authorised staff.

Upon receipt of submissions, national supervisors took numerous steps to anonymise the data and information received in Attachments A and C.[72] Each national supervisor sent anonymised LDCE and Range of Practice data (Attachments A and C) to the BCBS's secure website where the BCBS Secretariat served as custodian of the data.

The raw data on exposure indicators and capital in Attachment B was separated from other LDCE data and remained with the national supervisor. Each national supervisor used the Attachment B data to calculate certain benchmark ratios, which were then shuffled across participants within that country to further enhance the anonymity of each bank. The shuffled results were submitted to the BCBS Secretariat and used to calculate certain aggregate and regional results as well as results by capital approach (AMA or non-AMA).

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[72] These included replacing each participant's name with a numeric code, converting all currency amounts to euros, and removing text in comment fields that could potentially lead to identification of an institution.

Annex B

Exchange Rates Used for Currency Conversion in LDCE

Currency Code	Currency Unit	EUR per Unit
AUD	Australia Dollars	0.577655349
BRL	Brazil Reais	0.362522464
CAD	Canada Dollars	0.616025116
CHF	Switzerland Francs	0.637730826
GBP	United Kingdom Pounds	1.256585141
INR	India Rupees	0.015810269
JPY	Japan Yen	0.006336486
PLN	Poland Zlotych	0.284127611
USD	United States Dollars	0.632758598
ZAR	South Africa Rand	0.077770091

(1)   Belgium, France, Germany, Italy, Luxembourg, Netherlands, and Spain use the euro as their currency.

(2)   The exchange rates used were for 31 March 2008.

Annex C

Details of Calculations for the Analysis of Scenario Data

This memorandum describes the calculation of certain inputs to LDCE tables S5D (Loss severity conditional on losses exceeding €1 million), S5F (Loss severity – accumulative frequencies), S6 (Annual scenario frequencies scaled by exposure indicators) and S7A-B (Scenario counts compared to internal data counts and scenario frequencies compared to internal data frequencies).

Table S5D requires the calculation of various percentiles of the scenario-implied severity distribution. Tables S5F, S6 and S7A-B require the calculation of the frequency of scenario losses above various thresholds. Each of these calculations is described in turn below.

(i)　Calculating a percentile of the implied loss severity distribution

Calculating the Xth percentile of the implied severity distribution is straightforward for banks using the individual scenario approach. We simply considered all of the individual scenarios submitted by the bank, and then calculated the Xth percentile of these (on a frequency-weighted basis) in the usual manner.[73]

Calculation of the Xth percentile was more complex for banks using the interval approach. The calculation is performed via the following steps:

1.　The first step is to fit a parametric severity distribution to each interval scenario submitted. For this purpose we chose the lognormal distribution.[74] For each scenario (consisting of several scenario intervals), we estimated the lognormal parameters using maximum likelihood for interval censored data.[75] We thus obtained the estimated Cumulative Distribution Function (CDF) for that scenario.

2.　There were a few instances where it was not possible to obtain results using the estimation described in section 1 immediately above. One such instance occurred when a scenario had only one interval with nonzero frequency. Another such instance occurred when the maximum likelihood algorithm failed to converge to a solution. In these instances, we used the interval frequencies and midpoints to specify a discrete distribution.

3.　The above two steps would allow us to calculate the Xth percentile of the severity distribution for each interval scenario provided. However, we wish to calculate the Xth percentile at the bank-wide level, or at another aggregated level such as a business line or an event type. To do so, we used Monte Carlo Simulation to generate a distribution at the

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[73]　We considered only scenarios with an average annual frequency of 0.001 or greater.

[74]　The assumption of a particular severity distribution is somewhat restrictive. However, in our experience the lognormal is a distribution that banks do frequently use for various purposes, and that tends to fit well to actual loss data.

[75]　This is implemented via SAS PROC LIFEREG.

aggregate level. Inputs to the Monte Carlo Simulation consisted of a frequency for each scenario estimated using a Poisson distribution and severity as calculated in steps 1 and 2 above. We then calculated the Xth percentile from the simulated distribution in the usual manner.

We also relied on distribution fitting in the case of banks using the percentile approach. We first fit a lognormal distribution to each scenario using a quantile matching method. To introduce some notation, suppose that Bank X reports N distinct percentiles, each of which is denoted P_i and where the corresponding quantile value is denoted Q_i. (For example, a scenario i with a 75th percentile of €11 mn would result in $P_i = 0.75$ and $Q_i = 11,000,000$.) Letting $q_i = \log(Q_i)$ and letting $F^{-1}(\mu, \sigma, P_i)$ denote the inverse CDF of the normal distribution, we seek values of μ and σ that minimise the sum of squared errors between fitted and reported quantiles:[76]

$$(\mu, \sigma) = \text{argmin} \sum\nolimits_{i = 1 \text{ to } N} (q_i - F^{-1}(\mu, \sigma, P_i))^2$$

After fitting a lognormal distribution to each scenario provided, we used Monte Carlo Simulation as described in section 3 above to calculate the Xth percentile of the aggregate distribution.

(ii)   Calculating the frequency of scenario losses above various thresholds

This calculation was also performed differently depending on which of the three scenario approaches a bank used. To simplify exposition, suppose that we are calculating the frequency of all losses greater than or equal to a threshold of €10 million at Bank X.

The calculation is straightforward if Bank X uses the individual scenario approach. In this case, we simply identified all scenarios with a loss amount greater than or equal to €10 mn, and summed the frequencies of these scenarios to obtain the aggregate frequency of scenarios exceeding €10 mn.

The calculation was again more complex for banks using the interval approach. The fundamental problem is one of interpolation, which is necessary because the €10 mn threshold will generally fall in the interior of one of the scenario intervals. In this case, the scenario data alone are insufficient to identify the frequency of losses exceeding €10 mn.

1.   We begin by identifying all scenario intervals (SL, SH) for Bank X such that SL > €10 mn. As the entire interval exceeds the threshold, the raw frequencies reported for each such interval can be summed directly into the aggregate frequency of scenarios exceeding the threshold.

2.   Next, we identify all scenario intervals such that $SL < €10 \text{ mn} < SH < \infty$. Denoting the raw frequency for the interval (SL, SH) by λ_{raw}, we can calculate the frequency for the adjusted interval (10, SH) as $\lambda_{adj} = \lambda_{raw} * (S_H - 10)/(S_H - S_L)$. The adjustment accounts for the fact that only some of the scenario losses in such intervals will actually exceed the scenario

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[76]   In the case where Bank X reported the mean of the severity distribution in addition to various percentiles, we also considered the distance between the reported mean and the fitted mean in the estimation of μ and σ.

threshold. The adjusted frequencies can then be summed directly into the aggregate frequency of scenarios exceeding €10 mn.

3. Lastly, we consider the case where SL < €10 mn and SH = ∞. In this case, calculation of the frequency of scenario losses exceeding €10 mn cannot proceed without some sort of estimation about the implied severity distribution for the scenario in question. To do this, we assume that scenario losses follow a lognormal distribution.[77] For each scenario (consisting of several scenario intervals) we estimate the lognormal parameters using maximum likelihood for interval censored data.[78] We can then obtain the fitted lognormal CDF for each scenario. Let Λ denote the overall scenario frequency, which is the sum of interval frequencies λ across all intervals associated with a particular scenario. We calculate the frequency for the adjusted interval (10, SH) as $\lambda_{adj} = \Lambda*(1-CDF(10))$. These adjusted frequencies can be summed directly into the aggregate frequency of scenarios exceeding €10 mn.

Calculating frequencies above a threshold is also complex for banks using the percentile approach. As with the interval approach, the fundamental problem is one of interpolation. Consider, for example, a scenario for which the €10 mn threshold corresponds exactly to one of the reported percentiles P. In this case, the frequency of losses above the threshold will simply be $\lambda*(1-P)$, where λ denotes the reported frequency for the scenario in question. The general case, however, is more complicated and we proceed by estimating a lognormal distribution using the quantile-matching technique introduced in Section i above. Using the estimated values of μ and σ, we calculate the approximate frequency of scenario losses exceeding €10 mn as $\lambda*(1-F(\mu, \sigma, log(10)))$. These frequencies can be summed directly into the aggregate frequency of scenarios exceeding €10 mn.

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[77] The assumption of a particular severity distribution is somewhat restrictive. However, in our experience the lognormal is a distribution that banks do frequently use for various purposes, and that tends to fit well to actual loss data. Note also that this lognormal assumption impacts only the small proportion of intervals where SH is infinite.

[78] This is implemented via SAS PROC LIFEREG.

Annex D

Abbreviations Used in Report and Tables

AMA	Advanced Measurement Approach
ASA	Alternative Standardised Approach
BCBS	Basel Committee on Banking Supervision
BDSF	Business Disruption and System Failure
BEICF	Business, environment, and internal control factors
BIA	Basic Indicator Approach
CDF	Cumulative Distribution Function
CPBP	Clients, Products, and Business Practices
DPA	Damage to Physical Assets
EDPM	Execution, Delivery, and Process Management
EPWS	Employment Practices and Workplace Safety
EL	Expected loss
ILD	Internal loss data
LDCE	Loss Data Collection Exercise
N	Number
NA	Not available
ORC	Operational risk category
QIS	Quantitative Impact Study
ROP	Range of practice
S	Scenario
SIGOR	Operational Risk Subgroup of the Standards Implementation Group
T	Threshold
TSA	The Standardised Approach
X	Variable defined in table

Summary Table I
2008 Loss Data Collection Exercise Summary

Participant Summary	All Participants	Australia	Europe	Japan	North America	Brazil / India
Number of LDCE participants	121	11	60	18	23	9
Participants by Capital Approach						
AMA	42	5	20	7	10	0
Non-AMA	79	6	40	11	13	9

Business Line Gross Income as a Percent of Consolidated Gross Income (Results Reported as Medians)	All Participants	Australia	Europe	Japan	North America	Brazil / India
Corporate Finance	2.1%	1.1%	3.0%	0.9%	4.2%	0.5%
Trading & Sales	7.7%	11.1%	11.4%	3.2%	4.8%	8.8%
Retail Banking	44.2%	51.3%	42.3%	20.3%	49.5%	38.4%
Commercial Banking	24.6%	17.2%	24.9%	54.0%	17.5%	21.0%
Payment & Settlement	2.1%	4.9%	0.7%	4.9%	1.1%	3.4%
Agency Services	1.1%	.	0.7%	2.5%	2.2%	1.3%
Asset Management	4.0%	.	3.4%	0.6%	4.0%	6.7%
Retail Brokerage	2.8%	na	2.3%	3.0%	4.7%	0.2%

Note 1. Cases where there are results from fewer than four banks are denoted by "." in the tables.

Table ILD1
Loss Data Collection Thresholds Used by 2008 LDCE Participants

Loss Data Collection Threshold (T) for All or Most Business Lines	Number of Participants	Number of Losses		Amount of Losses	
		Number	% of All Losses	€Millions	% of Total Loss Amount
€0	10	277,467	3%	600	1%
€0 < T < €1,000	34	6,459,802	61%	11,187	19%
€1,000 ≤ T < €5,000	22	398,144	4%	9,254	16%
€5,000 ≤ T < €10,000	21	122,923	1%	22,474	38%
€10,000 ≤ T	10	73,561	1%	7,208	12%
Threshold Not Provided	22	3,263,421	31%	8,878	15%
All	119	10,595,318	100%	59,600	100%

Table ILD1
Loss Data Collection Thresholds Used by 2008 LDCE Participants

Loss Data Collection Threshold (T) for All or Most Business Lines	Panel A: Number of Participants by Approach and Region							
	AMA	Non-AMA	Australia	Europe	Japan	North America	Brazil / India	All
€0	3	7	1	2	6	1	0	10
€0 < T < €1,000	8	26	0	12	12	4	6	34
€1,000 ≤ T < €5,000	8	14	4	17	0	1	0	22
€5,000 ≤ T < €10,000	8	13	3	5	0	13	0	21
€10,000 ≤ T < €20,000	7	0	2	5	0	0	0	7
€20,000 ≤ T	2	1	0	3	0	0	0	3
Threshold Not Provided	5	17	1	16	0	2	3	22
All	41	78	11	60	18	21	9	119

Table ILD2
Number of Losses and Total Loss Amount Reported by 2008 LDCE Participants

Number of Losses (N)	Number of Participants	Number of Losses	Amount of Losses (€Millions)	Number of Losses ≥ €20,000	Amount of Losses ≥ €20,000 (€Millions)
0 ≤ N < 250	10	996	50	364	45
250 ≤ N < 1,000	22	13,248	1,453	3,319	1,409
1,000 ≤ N < 2,500	21	35,167	3,263	10,475	3,168
2,500 ≤ N < 5,000	17	58,504	5,080	14,501	4,953
5,000 ≤ N	49	10,487,403	49,754	143,223	44,127
All	119	10,595,318	59,600	171,882	53,703

Table ILD2
Number of Losses and Total Loss Amount Reported by 2008 LDCE Participants

Panel A: Detail by Region	Number of Participants	Number of Losses	Amount of Losses (€Millions)	Number of Losses ≥ €20,000	Amount of Losses ≥ €20,000 (€Millions)
Australia	11	27,621	1,092	3,347	1,004
Europe	60	1,674,456	20,799	76,079	19,768
Japan	18	324,623	953	2,502	804
North America	21	6,141,939	33,291	64,635	30,209
Brazil / India	9	2,426,679	3,465	25,319	1,917
All Regions	119	10,595,318	59,600	171,882	53,703

Table ILD2
Number of Losses Reported by 2008 LDCE Participants

Number of Losses (N)	Panel B: Number of Participants by Approach and Region							
	AMA	Non-AMA	Australia	Europe	Japan	North America	Brazil / India	All Regions
0 ≤ N < 250	1	9	1	9	0	0	0	10
250 ≤ N < 1,000	3	19	3	13	1	2	3	22
1,000 ≤ N < 2,500	1	20	3	8	3	7	0	21
2,500 ≤ N < 5,000	9	8	3	6	3	4	1	17
5,000 ≤ N	27	22	1	24	11	8	5	49
All	41	78	11	60	18	21	9	119

Table ILD3
Loss Data by Year

All Participants	pre-2002	2002	2003	2004	2005	2006	2007	2008
Number of Losses	14,017	10,216	13,691	22,152	33,216	36,386	36,622	5,582
Total Loss Amount (€Millions)	3,829	12,069	4,562	7,212	9,740	7,446	7,875	971
Number of Institutions Reporting	24	35	55	68	108	115	117	84
Number of Losses per Institution	584	292	249	326	308	316	313	66
Total Loss Amount per Institution (€Millions)	160	345	83	106	90	65	67	12
Average Loss per Institution (€Millions)	0.27	1.18	0.33	0.33	0.29	0.20	0.22	0.17

Panel A: AMA Participants	pre-2002	2002	2003	2004	2005	2006	2007	2008
Number of Losses	9,721	8,835	11,301	17,070	22,476	24,755	24,182	3,568
Total Loss Amount (€Millions)	3,512	11,967	4,271	6,613	7,514	5,910	5,997	720
Number of Institutions Reporting	16	26	31	36	40	41	41	32
Number of Losses per Institution	608	340	365	474	562	604	590	112
Total Loss Amount per Institution (€Millions)	219	460	138	184	188	144	146	23
Average Loss per Institution (€Millions)	0.36	1.35	0.38	0.39	0.33	0.24	0.25	0.20

Panel B: Non-AMA Participants	pre-2002	2002	2003	2004	2005	2006	2007	2008
Number of Losses	4,296	1,381	2,390	5,082	10,740	11,631	12,440	2,014
Total Loss Amount (€Millions)	317	101	292	599	2,226	1,536	1,878	251
Number of Institutions Reporting	8	9	24	32	68	74	76	52
Number of Losses per Institution	537	153	100	159	158	157	164	39
Total Loss Amount per Institution (€Millions)	40	11	12	19	33	21	25	5
Average Loss per Institution (€Millions)	0.07	0.07	0.12	0.12	0.21	0.13	0.15	0.12

Note 1. Losses of €20,000 or more.

Note 2. 2008 reflects only a partial year.

Table ILD 4A
Sum and Distribution of Annualised Loss Frequencies by Business Line and Event Type

	Internal Fraud	External Fraud	Employment Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Business Disruption & System Failures	Execution, Delivery & Process Management	All	Business Line Losses as Percent of All Losses
Corporate Finance	3.5	11.5	21.6	100.2	2.4	4.6	69.1	212.9	0.7%
	1.7%	5.4%	10.2%	47.0%	1.1%	2.2%	32.5%		
Trading & Sales	32.2	31.7	96.9	398.6	12.2	157.6	2,400.6	3,129.9	9.6%
	1.0%	1.0%	3.1%	12.7%	0.4%	5.0%	76.7%		
Retail Banking	979.4	7,311.9	3,203.4	2,381.0	245.4	293.8	3,743.4	18,158.3	55.8%
	5.4%	40.3%	17.6%	13.1%	1.4%	1.6%	20.6%		
Commercial Banking	69.6	710.4	104.3	504.4	30.1	65.2	1,196.8	2,680.8	8.2%
	2.6%	26.5%	3.9%	18.8%	1.1%	2.4%	44.6%		
Payment & Settlement	20.5	185.3	23.3	50.7	21.7	37.5	386.0	725.1	2.2%
	2.8%	25.6%	3.2%	7.0%	3.0%	5.2%	53.2%		
Agency Services	11.3	94.5	12.8	44.9	5.9	26.8	698.9	895.0	2.7%
	1.3%	10.6%	1.4%	5.0%	0.7%	3.0%	78.1%		
Asset Management	10.7	19.1	30.3	96.5	1.9	22.9	522.8	704.2	2.2%
	1.5%	2.7%	4.3%	13.7%	0.3%	3.2%	74.2%		
Retail Brokerage	196.5	75.9	149.4	2,247.0	2.4	16.1	672.7	3,359.9	10.3%
	5.8%	2.3%	4.4%	66.9%	0.1%	0.5%	20.0%		
Unallocated	50.5	124.7	2,072.4	91.6	61.0	17.8	280.1	2,698.2	8.3%
	1.9%	4.6%	76.8%	3.4%	2.3%	0.7%	10.4%		
All	1,374.3	8,564.9	5,714.5	5,914.9	382.9	642.3	9,970.5	32,564.3	100.0%
	4.2%	26.3%	17.5%	18.2%	1.2%	2.0%	30.6%		

Note 1. Losses of € 20,000 or more in the stable dataset.
Note 2. First row for each business line: Sum of annualised loss frequencies.
Note 3. Second row for each business line: Distribution of losses across event types.

Sum and Distribution of Annualised Loss Amounts (€Millions) by Business Line and Event Type

	Internal Fraud	External Fraud	Employment Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Business Disruption & System Failures	Execution, Delivery & Process Management	All	Business Line Loss Amount as Percent of Total
Corporate Finance	6.6	3.2	16.2	2,565.1	0.1	0.6	146.7	2,738.5	28.0%
	0.2%	0.1%	0.6%	93.7%	0.0%	0.0%	5.4%		
Trading & Sales	145.8	4.5	30.3	384.7	2.7	23.8	732.6	1,324.4	13.6%
	11.0%	0.3%	2.3%	29.0%	0.2%	1.8%	55.3%		
Retail Banking	198.5	607.9	305.6	1,263.6	34.0	48.0	670.6	3,128.0	32.0%
	6.3%	19.4%	9.8%	40.4%	1.1%	1.5%	21.4%		
Commercial Banking	84.7	112.8	23.1	262.4	3.3	12.7	241.2	740.2	7.6%
	11.4%	15.2%	3.1%	35.5%	0.4%	1.7%	32.6%		
Payment & Settlement	7.1	18.1	2.3	18.7	8.0	5.8	194.4	254.4	2.6%
	2.8%	7.1%	0.9%	7.3%	3.2%	2.3%	76.4%		
Agency Services	2.5	8.1	1.7	92.3	46.7	15.4	89.8	256.5	2.6%
	1.0%	3.2%	0.7%	36.0%	18.2%	6.0%	35.0%		
Asset Management	27.0	2.3	6.1	74.9	0.6	3.6	128.3	242.9	2.5%
	11.1%	1.0%	2.5%	30.8%	0.3%	1.5%	52.8%		
Retail Brokerage	89.8	6.7	31.1	294.6	0.4	1.0	71.5	495.1	5.1%
	18.1%	1.4%	6.3%	59.5%	0.1%	0.2%	14.4%		
Unallocated	38.5	16.3	167.1	166.8	38.3	7.6	154.0	588.5	6.0%
	6.5%	2.8%	28.4%	28.3%	6.5%	1.3%	26.2%		
All	600.5	780.0	583.4	5,123.1	134.0	118.4	2,429.2	9,768.5	100.0%
	6.1%	8.0%	6.0%	52.4%	1.4%	1.2%	24.9%		

Note 1. Losses of € 20,000 or more in the stable dataset.
Note 2. First row for each business line: Sum of annualised loss amounts.
Note 3. Second row for each business line: Distribution of loss amounts across event types.

Table ILD6
Distribution of Loss Amount by Severity of Loss

Severity of Loss	Cross-Bank Median of Distribution Across Severity Brackets			Total	
	Number of Losses	Gross Loss Amount	Gross Loss Amount Net of Non-Insurance Recoveries	Number of Losses	Gross Loss Amount (€Millions)
€0 ≤ X < €20,000	91.29 %	26.26 %	18.86 %	9,897,083	12,164
€20,000 ≤ X < €100,000	6.52 %	12.63 %	15.66 %	121,533	5,178
€100,000 ≤ X < €1 Million	1.83 %	19.37 %	21.35 %	30,598	8,085
€1 Million ≤ X < €2 Million	0.15 %	5.48 %	6.12 %	1,688	2,401
€2 Million ≤ X < €5 Million	0.12 %	9.05 %	9.10 %	1,116	3,570
€5 Million ≤ X < €10 Million	0.04 %	6.87 %	7.90 %	404	2,827
€10 Million ≤ X < €100 Million	0.04 %	15.55 %	17.39 %	333	8,243
€100 Million ≤ X	0.02 %	41.79 %	43.51 %	41	21,752
All				10,052,796	64,221

Note 1. X = severity of loss, based on gross loss net of non-insurance recoveries.
Note 2. All losses in the stable dataset.
Note 3. Results for losses less than €20,000 are not complete as loss data collection thresholds differ across participants.
Note 4. Median calculations include only banks with losses in each particular severity category. If a bank reports no losses in a category, it is not included in the calculation.

Table ILD7
Loss Severity (€)

		25th Percentile	50th Percentile	75th Percentile	95th Percentile
All Participants	Mean	28,966	46,864	101,685	566,674
	Median	27,632	41,916	82,608	418,400
	(25th-75th)	(26,045-29,006)	(37,716-48,242)	(67,395-110,045)	(217,391-627,196)
AMA	Mean	29,244	46,976	103,314	706,403
	Median	27,626	42,454	92,565	476,708
	(25th-75th)	(25,901-28,811)	(37,601-47,457)	(75,395-110,032)	(347,840-660,188)
Non-AMA	Mean	28,788	46,792	100,643	477,338
	Median	27,900	41,246	79,895	350,000
	(25th-75th)	(26,090-29,447)	(37,830-48,398)	(65,000-110,058)	(196,403-560,844)
Australia	Mean	28,048	45,730	89,795	529,669
	Median	28,883	41,781	75,966	476,708
	(25th-75th)	(26,572-29,168)	(40,436-50,303)	(63,333-115,553)	(249,845-612,800)
Europe	Mean	29,761	48,654	106,372	545,477
	Median	27,341	41,765	82,004	400,000
	(25th-75th)	(25,901-30,000)	(37,407-50,000)	(69,513-112,803)	(200,000-641,592)
Japan	Mean	29,156	50,288	133,908	1,135,930
	Median	27,890	42,357	95,093	511,815
	(25th-75th)	(25,848-31,771)	(38,603-47,010)	(83,979-116,019)	(346,170-770,249)
North America	Mean	27,935	43,218	89,428	503,177
	Median	27,900	43,234	84,462	425,214
	(25th-75th)	(26,457-28,811)	(38,491-46,710)	(73,580-110,032)	(341,753-599,101)
Brazil / India	Mean	26,770	41,277	80,092	320,707
	Median	26,472	37,962	65,100	201,416
	(25th-75th)	(25,367-28,458)	(36,440-48,087)	(58,498-102,862)	(150,025-604,542)

Note 1. Losses of € 20,000 or more in the stable dataset.

Note 2. Includes banks with at least 20 losses of €20,000 or more.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table ILD8
Loss Severity (€) by Business Line

All Participants		25th Percentile	50th Percentile	75th Percentile	95th Percentile
Corporate Finance	Median	54,135	108,450	519,855	4,668,696
	(25th-75th)	(38,366-61,061)	(81,140-324,764)	(237,284-1,423,707)	(2,049,520-13,932,205)
Trading & Sales	Median	32,400	59,850	143,502	727,946
	(25th-75th)	(27,983-39,223)	(44,313-80,999)	(102,393-221,161)	(502,023-1,411,850)
Retail Banking	Median	27,000	39,650	77,451	295,897
	(25th-75th)	(25,310-28,540)	(35,670-46,000)	(62,651-93,043)	(187,124-481,046)
Commercial Banking	Median	29,014	46,783	104,495	594,135
	(25th-75th)	(25,862-32,883)	(38,095-62,082)	(75,197-153,098)	(287,630-868,453)
Payment & Settlement	Median	28,287	40,805	76,922	253,103
	(25th-75th)	(25,800-31,997)	(36,302-46,895)	(64,437-115,795)	(142,633-798,285)
Agency Services	Median	28,347	44,873	90,815	400,088
	(25th-75th)	(26,499-31,484)	(40,205-54,123)	(79,827-129,981)	(278,024-665,613)
Asset Management	Median	30,601	53,427	121,025	617,673
	(25th-75th)	(27,851-32,225)	(46,149-59,000)	(89,442-170,766)	(420,725-1,233,495)
Retail Brokerage	Median	29,100	49,974	103,000	424,258
	(25th-75th)	(26,105-33,452)	(38,728-64,846)	(69,493-129,581)	(210,050-710,472)
Unallocated	Median	28,875	47,552	92,124	557,748
	(25th-75th)	(27,399-31,638)	(42,000-63,276)	(79,879-135,141)	(312,884-3,186,126)

Note 1. Losses of € 20,000 or more in the stable dataset.

Note 2. Includes banks with at least 20 losses of €20,000 or more in a business line.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Annualised Loss Frequencies Normalised per €Billion of
Assets, Tier 1 Capital, Gross Income and Operational Risk Capital

All Participants			Annualised Number of Losses ≥ €0	Annualised Number of Losses ≥ €20,000	Annualised Number of Losses ≥ €100,000	Annualised Number of Losses ≥ €1,000,000	Annualised Number of Losses ≥ €10,000,000
Consolidated Assets	All	Median	8.9	0.82	0.19	0.013	0.000
		(25th-75th)	(3.2-47.1)	(0.36-1.66)	(0.07-0.33)	(0.000-0.032)	(0.000-0.002)
	AMA	Median	6.9	0.77	0.20	0.018	0.001
		(25th-75th)	(2.3-19.2)	(0.39-1.60)	(0.09-0.32)	(0.009-0.039)	(0.000-0.003)
	Non-AMA	Median	12.8	0.86	0.16	0.009	0.000
		(25th-75th)	(3.7-66.4)	(0.21-1.76)	(0.04-0.34)	(0.000-0.028)	(0.000-0.001)
Consolidated Tier 1 Capital	All	Median	195.6	18.9	3.6	0.23	0.000
		(25th-75th)	(54.3-972.7)	(6.3-32.5)	(1.4-6.6)	(0.00-0.76)	(0.000-0.052)
	AMA	Median	144.9	19.5	5.1	0.61	0.038
		(25th-75th)	(49.7-433.0)	(10.4-34.8)	(2.1-7.6)	(0.19-0.96)	(0.005-0.096)
	Non-AMA	Median	232.3	17.4	2.8	0.16	0.000
		(25th-75th)	(63.6-1,070.8)	(3.9-29.7)	(1.0-5.9)	(0.00-0.46)	(0.000-0.030)
Consolidated Gross Income	All	Median	319.3	26.6	5.8	0.40	0.000
		(25th-75th)	(85.2-1,590.1)	(9.7-44.4)	(2.4-8.8)	(0.00-1.05)	(0.000-0.084)
	AMA	Median	208.4	27.3	7.2	0.82	0.059
		(25th-75th)	(79.0-564.6)	(17.0-38.3)	(3.8-9.6)	(0.23-1.18)	(0.017-0.113)
	Non-AMA	Median	353.9	23.8	4.7	0.29	0.000
		(25th-75th)	(87.6-1,961.1)	(9.2-48.9)	(2.1-8.3)	(0.00-0.71)	(0.000-0.037)
Reported Regulatory Operational Risk Capital	All	Median	2,958.9	217.9	46.6	4.7	0.00
		(25th-75th)	(722.3-12,704.8)	(96.2-402.9)	(22.3-78.4)	(0.6-9.4)	(0.00-0.70)
	AMA	Median	2,303.1	250.7	59.1	6.4	0.58
		(25th-75th)	(646.1-4,323.2)	(147.0-406.7)	(35.0-86.6)	(3.0-10.9)	(0.10-0.99)
	Non-AMA	Median	4,066.7	209.0	34.6	2.1	0.00
		(25th-75th)	(858.7-21,527.7)	(54.0-373.9)	(13.3-70.5)	(0.0-8.2)	(0.00-0.37)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Note 2. All losses in the stable dataset.

Annualised Loss Frequencies by Business Line Normalised
per €Billion of Business Line Gross Income

All Participants		Annualised Number of Losses ≥ €0	Annualised Number of Losses ≥ €20,000	Annualised Number of Losses ≥ €100,000	Annualised Number of Losses ≥ €1,000,000	Annualised Number of Losses ≥ €10,000,000
Corporate Finance	Median	18.3	5.9	1.4	0.00	0.000
	(25th-75th)	(7.2-91.7)	(2.2-14.5)	(0.0-5.8)	(0.00-1.14)	(0.000-0.000)
Trading & Sales	Median	127.3	16.4	4.6	0.24	0.000
	(25th-75th)	(48.3-434.7)	(3.0-35.0)	(0.0-12.6)	(0.00-2.03)	(0.000-0.000)
Retail Banking	Median	550.1	31.6	5.7	0.35	0.000
	(25th-75th)	(121.6-2,494.0)	(17.5-52.7)	(2.5-10.2)	(0.00-0.94)	(0.000-0.053)
Commercial Banking	Median	80.1	9.8	2.2	0.16	0.000
	(25th-75th)	(39.7-363.6)	(3.3-22.2)	(0.7-4.9)	(0.00-0.56)	(0.000-0.000)
Payment & Settlement	Median	414.6	9.6	0.3	0.00	0.000
	(25th-75th)	(77.8-2,412.3)	(0.4-78.3)	(0.0-11.5)	(0.00-0.00)	(0.000-0.000)
Agency Services	Median	278.4	28.1	1.5	0.00	0.000
	(25th-75th)	(86.7-1,132.4)	(0.0-75.7)	(0.0-19.4)	(0.00-0.49)	(0.000-0.000)
Asset Management	Median	68.8	13.7	3.9	0.22	0.000
	(25th-75th)	(22.6-271.4)	(6.8-27.0)	(1.2-7.2)	(0.00-0.77)	(0.000-0.000)
Retail Brokerage	Median	449.9	33.7	4.4	0.00	0.000
	(25th-75th)	(68.1-1,268.4)	(2.5-99.5)	(0.0-18.7)	(0.00-1.21)	(0.000-0.000)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Note 2. All losses in the stable dataset.

**Annualised Loss Amount Normalised per €Billion of
Assets, Tier 1 Capital, Gross Income and Operational Risk Capital**
(Results Reported as Medians)

		Annualised Sum of Losses ≥ €20,000					
		All	**Australia**	**Europe**	**Japan**	**North America**	**Brazil / India**
Consolidated Assets	All	155,555	170,747	129,811	13,750	387,437	394,482
	AMA	196,655	230,369	186,528	25,242	504,497	
	Non-AMA	116,838	94,121	108,300	8,820	224,287	394,482
Consolidated Tier 1 Capital	All	2,932,878	3,882,245	3,375,191	291,174	5,498,439	5,422,736
	AMA	5,640,662	5,760,028	6,376,932	551,558	12,128,746	
	Non-AMA	1,968,878	2,016,744	1,968,878	141,086	4,704,457	5,422,736
Consolidated Gross Income	All	4,860,322	5,550,147	5,125,736	726,431	8,076,643	7,711,110
	AMA	7,584,901	7,291,251	8,139,055	1,584,286	12,235,052	
	Non-AMA	4,162,786	3,211,629	3,527,860	486,563	7,024,900	7,711,110
Reported Regulatory Operational Risk Capital	All	43,268,410	29,093,167	56,283,482	5,708,683	67,153,605	177,956,321
	AMA	63,408,911	84,100,786	84,049,051	18,896,063	73,898,537	
	Non-AMA	29,093,167	21,440,604	39,381,024	3,245,737	54,602,027	177,956,321

Note 1. All participants in Brazil / India are non-AMA.

Note 2. All losses in the stable dataset.

Table ILD12
Annualised Business Line Loss Amount Normalised
per €Billion of Business Line Gross Income
(Results Reported as Medians)

Business Line	Annualised Sum of Losses ≥ €20,000							
	All	AMA	Non-AMA	Australia	Europe	Japan	North America	Brazil / India
Corporate Finance	1,453,304	1,438,608	1,468,001	706,399	1,453,304	0	6,694,979	.
Trading & Sales	3,786,142	5,781,951	2,546,769	2,431,366	5,750,152	0	11,379,563	.
Retail Banking	4,478,410	5,947,269	3,420,738	6,131,233	5,143,796	973,561	4,840,447	10,009,826
Commercial Banking	1,535,393	2,798,003	808,896	803,963	2,798,003	150,475	2,124,121	.
Payment and Settlement	723,872	3,040,560	503,487	344,310	3,104,078	0	6,186,067	.
Agency Services	3,571,847	4,716,309	1,062,478	.	3,874,664	0	14,990,905	.
Asset Management	2,480,506	3,517,073	1,579,916	.	1,845,116	176,625	6,832,125	.
Retail Brokerage	5,967,705	6,219,380	2,649,763	na	10,312,207	0	9,053,200	.

Note 1. All losses in the stable dataset.

Table ILD13
Insurance Recoveries
Institutions Reporting Insurance Recoveries

All Participants		**Percent of Losses with an Insurance Recovery**	**Recovery Rate for Losses with Recoveries**	**Amount Recovered as a Percent of Total Loss Amount**
All Losses	Median	2.1%	74.6%	3.1%
	(25th-75th)	(0.4% - 8.3%)	(59.3% - 89.9%)	(1.3% - 9.5%)
Losses ≥ €20,000	Median	4.2%	70.5%	3.0%
	(25th-75th)	(1.3% - 15.6%)	(53.2% - 87.1%)	(0.7% - 11.8%)

Note 1. Includes data from banks reporting at least one insurance recovery in the stable dataset.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Note 3. Percent of Losses with an Insurance Recovery is calculated as the number of losses that had insurance recoveries divided by the total number of losses.

Note 4. Recovery Rate for Losses with Recoveries is calculated as the total amount of insurance recoveries divided by the total loss amount on losses that had insurance recoveries. (Loss amounts refer to gross loss net of all non-insurance recoveries.)

Note 5. Amount Recovered as a Percent of Total Loss Amount is calculated as the total amount of insurance recoveries divided by the total loss amount on losses both with and without insurance recoveries. (Loss amounts refer to gross loss net of all non-insurance recoveries.)

Insurance Recoveries by Event Type
Institutions Reporting Insurance Recoveries

All Participants		Percent of Losses with an Insurance Recovery	Recovery Rate for Losses with Recoveries	Amount Recovered as a Percent of Total Loss Amount
Internal Fraud	Median	0.00%	62.94%	0.00%
	(25th-75th)	(0.00% - 3.37%)	(36.36% - 79.58%)	(0.00% - 2.00%)
External Fraud	Median	8.84%	77.91%	7.17%
	(25th-75th)	(0.43% - 33.50%)	(58.30% - 96.21%)	(0.44% - 29.23%)
Employment Practices & Workplace Safety	Median	0.00%	91.32%	0.00%
	(25th-75th)	(0.00% - 0.30%)	(44.14% - 100.00%)	(0.00% - 0.35%)
Clients, Products & Business Practices	Median	0.00%	67.73%	0.00%
	(25th-75th)	(0.00% - 0.07%)	(31.40% - 85.41%)	(0.00% - 0.03%)
Damage to Physical Assets	Median	27.91%	81.28%	19.83%
	(25th-75th)	(0.00% - 57.69%)	(67.00% - 93.20%)	(0.30% - 51.35%)
Business Disruption and System Failures	Median	0.00%	85.35%	0.00%
	(25th-75th)	(0.00% - 0.00%)	(61.54% - 95.73%)	(0.00% - 0.17%)
Execution, Delivery & Process Management	Median	0.00%	71.64%	0.01%
	(25th-75th)	(0.00% - 0.80%)	(45.70% - 92.27%)	(0.00% - 0.33%)

Note 1. Losses of € 20,000 or more in the stable dataset.

Note 2. Includes banks reporting at least one insurance recovery.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Note 4. Percent of Losses with an Insurance Recovery is calculated as the number of losses that had insurance recoveries divided by the total number of losses.

Note 5. Recovery Rate for Losses with Recoveries is calculated as the total amount of insurance recoveries divided by the total loss amount on losses that had insurance recoveries. (Loss amounts refer to gross loss net of all non-insurance recoveries.)

Note 6. Amount Recovered as a Percent of Total Loss Amount is calculated as the total amount of insurance recoveries divided by the total loss amount on losses both with and without insurance recoveries. (Loss amounts refer to gross loss net of all non-insurance recoveries.)

Table S1
Scenario Analysis Summary

Summary		All Regions	Australia	Europe	Japan	North America	Brazil / India
Total Number of Participants		121	11	60	18	23	9
Number of Participants Not Submitting Scenarios		56	4	28	7	8	9
Number of Participants Submitting Scenarios		65	7	32	11	15	0
Participants by Scenario Approach:							
Individual Approach		34	4	13	9	8	0
Percentile Approach		18	2	15	0	1	0
Interval Approach		13	1	4	2	6	0
Number of Scenarios Reported	Median	36	33	36	50	35	.
	(25th-75th)	(21 - 58)	(26 - 113)	(20 - 56)	(33 - 59)	(22 - 81)	.
Number of Scenarios Used in	Median	115	204	95	673	71	.
Operational Risk Framework	(25th-75th)	(41-600)	(141-600)	(36-437)	(50-1,491)	(23-215)	.
Panel A: Individual Approach		**All Regions**	**Australia**	**Europe**	**Japan**	**North America**	**Brazil / India**
Participants using Individual Approach		34	4	13	9	8	.
Number of Scenarios Reported	Median	30	26	20	50	26	.
	(25th-75th)	(20-50)	(22-79)	(20-36)	(24-52)	(23-56)	.
Number of Scenarios Used in	Median	108	.	56	441	29	.
Operational Risk Framework	(25th-75th)	(29-684)	.	(20-437)	(46-1,446)	(23-301)	.
Maximum Severity (€Millions)		101,224	404	1,931	101,224	12,320	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Scenario Analysis Summary

Panel B: Percentile Approach		All Regions	Australia	Europe	Japan	North America	Brazil / India
Participants using Percentile Approach		18	2	15	0	1	.
Number of Scenarios Reported	Median	36	.	36	.	.	.
	(25th-75th)	(31-51)	.	(32-67)	.	.	.
Number of Scenarios Used in	Median	153	.	153	.	.	.
Operational Risk Framework	(25th-75th)	(42-869)	.	(33-3,844)	.	.	.
Number of Severity Percentiles	Median	4	.	4	.	.	.
	(25th-75th)	(2-4)	.	(2-5.25)	.	.	.
Maximum Severity (€Millions)	(Percentile)	1,198 (0.99)	.	1,198	.	.	.

Panel C: Interval Approach		All Regions	Australia	Europe	Japan	North America	Brazil / India
Participants using Interval Approach		13	1	4	2	6	.
Number of Scenarios Reported	Median	58	.	57	.	57	.
	(25th-75th)	(42-88)	.	(54-66)	.	(40-85)	.
Number of Scenarios Used in	Median	183	.	158	.	101	.
Operational Risk Framework	(25th-75th)	(88-401)	.	(85-322)	.	(71-215)	.
Number of Intervals Used in	Median	6	.	5	.	6	.
Operational Risk Framework	(25th-75th)	(4-7)	.	(3-7)	.	(5.3-6)	.
Maximum Severity (€Millions)							
Interval with highest upper bound	(low:high)	(634:Infinity)	.	(10:500)	.	(316:Infinity)	.
Interval with highest non-infinite upper bound	(low:high)	(506:1,110)	.	(10:500)	.	(158:316)	.
Interval with highest midpoint	(low:high)	(506:1,110)	.	(10:500)	.	(158:316)	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S2
Proportion of Scenarios by Business Line and Event Type

Panel A: Proportion of Scenarios by Business Line		All Regions	Australia	Europe	Japan	North America
Corporate Finance	Median	5.3%	6.5%	4.4%	5.2%	7.2%
	(25th-75th)	(1.2%-10%)	(2.8%-10.2%)	(0.1%-7.8%)	(1.7%-10%)	(4.8%-11%)
Trading & Sales	Median	8.1%	5.7%	7.0%	6.8%	10.3%
	(25th-75th)	(4.6%-19%)	(4.4%-42.9%)	(2.5%-19%)	(5.3%-14.6%)	(6.8%-16.5%)
Retail Banking	Median	27.6%	21.9%	37.8%	24.7%	25.2%
	(25th-75th)	(15.7%-44.3%)	(11.2%-33%)	(16%-56.1%)	(19.8%-29.3%)	(12.5%-35.2%)
Commercial Banking	Median	16.0%	18.0%	16.3%	17.1%	12.2%
	(25th-75th)	(11.9%-22.2%)	(13.3%-22.7%)	(12.3%-22.2%)	(16%-29.1%)	(3.3%-20.8%)
Payment & Settlement	Median	5.6%	8.4%	5.6%	3.9%	4.3%
	(25th-75th)	(1%-8.9%)	(7.6%-9.2%)	(0%-8.9%)	(3.4%-7.3%)	(0.6%-12.5%)
Agency Services	Median	2.9%	0.7%	2.0%	7.0%	11.5%
	(25th-75th)	(0.9%-12.3%)	(0.7%-0.7%)	(0%-6.3%)	(1%-16.1%)	(3.5%-17.1%)
Asset Management	Median	10.0%	21.4%	4.4%	18.4%	12.6%
	(25th-75th)	(1.4%-20.8%)	(0.7%-23%)	(1.4%-11.5%)	(0.1%-24.1%)	(4.7%-20.8%)
Retail Brokerage	Median	3.8%	7.1%	2.2%	3.4%	9.5%
	(25th-75th)	(1.2%-12.2%)	(0%-14.3%)	(0.4%-10.8%)	(1.8%-7.1%)	(1.7%-12.5%)
Unallocated	Median	36.0%	36.0%	34.6%	17.9%	55.0%
	(25th-75th)	(14.3%-66.7%)	(14.3%-61.7%)	(5.3%-66.7%)	(9.8%-26%)	(35.5%-76.2%)

Note 1. Table reports results based on scenario data provided and / or responses to Attachment A, Question 2.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S2
Scenarios by Business Line and Event Type

Panel B: Proportion of Scenarios by Event Type		All Regions	Australia	Europe	Japan	North America
Internal Fraud	Median	12.3%	19.0%	11.2%	14.7%	11.5%
	(25th-75th)	(8.8%-19.3%)	(16%-19.9%)	(7.6%-17.9%)	(12%-20.3%)	(9.6%-22.1%)
External Fraud	Median	9.0%	10.4%	8.8%	6.0%	10.1%
	(25th-75th)	(6.1%-13.3%)	(10.2%-12.1%)	(6.2%-15.1%)	(3.5%-10.2%)	(8.1%-13.8%)
Employment Practices & Workplace Safety	Median	5.0%	7.7%	4.9%	2.8%	8.9%
	(25th-75th)	(2.8%-9.5%)	(3.8%-22.4%)	(3%-7.8%)	(1.2%-4%)	(5%-14.2%)
Clients, Products, & Business Practices	Median	19.6%	19.9%	17.9%	18.0%	22.5%
	(25th-75th)	(13%-26.7%)	(15.6%-26.8%)	(12.4%-25%)	(13.5%-21.8%)	(18.3%-34.4%)
Damage to Physical Assets	Median	5.8%	2.8%	6.3%	11.1%	5.3%
	(25th-75th)	(2.7%-9.5%)	(2.4%-3.3%)	(3.1%-8.7%)	(2.4%-36.1%)	(2.7%-8.7%)
Business Disruption & System Failures	Median	9.9%	6.1%	10.5%	12.2%	4.8%
	(25th-75th)	(5%-13.8%)	(4.4%-11.3%)	(6.3%-13%)	(7.3%-26%)	(4.2%-9.9%)
Execution, Delivery & Process Management	Median	29.2%	30.5%	33.1%	26.0%	29.2%
	(25th-75th)	(17.7%-42.6%)	(20.6%-38.1%)	(17.7%-51.4%)	(14.6%-31%)	(19%-35.2%)

Note 1. Table reports results based on scenario data provided and / or responses to Attachment A, Question 2.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S3
Aggregate Number of Top 20 Scenarios
by Business Line and Event Type

Business Line	Event Type								Total	Percent of Total
	Internal Fraud	External Fraud	Employ-ment Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Business Disruption & System Failures	Execution, Delivery & Process Manage-ment	Un-allocated		
Corporate Finance	7	8	1	26	5	1	10	1	59	5%
Trading & Sales	31	6	2	24	7	11	21	0	102	8%
Retail Banking	40	40	7	65	27	29	49	1	258	21%
Commercial Banking	16	10	1	30	5	7	44	0	113	9%
Payment & Settlement	10	6	0	8	1	9	9	0	43	3%
Agency Services	11	6	1	14	1	21	26	0	80	6%
Asset Management	10	4	3	16	4	3	22	0	62	5%
Retail Brokerage	12	4	2	15	5	4	12	0	54	4%
Unallocated	69	43	36	78	88	49	90	17	470	38%
Total	206	127	53	276	143	134	283	19	1,241	100%
Percent of Total	17%	10%	4%	22%	12%	11%	23%	2%	100%	

Note 1. The results are calculated from scenarios that rank among the top 20 scenarios from each bank. The proportion is the number of scenarios for an event type divided by the total number of scenarios in the Top 20.

Table S4
Common Scenario Descriptions by Business Line and Event Type

Panel A: Internal Fraud	Severity (€Millions)	
	Minimum	**Maximum**
Corporate Finance		
Loan fraud	0.20	60
Embezzlement	0.10	10
Failure to follow procedures/limits	0.10	1
Trading & Sales		
Unauthorized trading/rogue trader	1.00	1,200
Misappropriation of assets	1.20	140
Breach of trading limits	0.75	1
Retail Banking		
Theft of customer data/information	0.10	340
Embezzlement	0.75	30
Theft of assets	0.10	15
Commercial Banking		
Fraudulent transfer of funds	30.00	80
Embezzlement	3.00	100
Theft of customer funds	0.10	15
Payment & Settlement		
Payment fraud	0.75	75
Theft of client funds or assets	0.01	60
Asset Management		
Unauthorized trading activities	0.30	15
Unallocated		
Embezzlement	0.75	12,000
Misuse of confidential information	5.00	120
Misappropriation of assets	0.75	100

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

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Table S4

Common Scenario Descriptions by Business Line and Event Type

</div>

Panel B: External Fraud	Severity (€Millions)	
	Minimum	**Maximum**
Corporate Finance		
Client misrepresentation of information	0.20	173
Theft	1.00	17
Loan fraud	0.10	0.2
Trading & Sales		
Loan fraud	0.00	55
Cybercrime	3.00	30
Forgery	2.00	4
Retail Banking		
Cybercrime	0.01	600
Check fraud	1.75	100
Theft of information/data	0.10	350
Commercial Banking		
Fraudulent transfer of funds	2.50	60
Credit product fraud (loans, letters of credit, guarantees)	1.00	130
Payment & Settlement		
Payment fraud	5.00	65
Unallocated		
Loan fraud	40.00	1,500
Cybercrime	1.00	625

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

Table S4
Common Scenario Descriptions by Business Line and Event Type

Panel C: Employment Practices & Workplace Safety	Severity (€Millions)	
	Minimum	**Maximum**
Trading & Sales		
Discrimination	0.10	37
Occupational accident	0.10	1
Retail Banking		
Occupational accident	0.50	20
Discrimination	0.10	20
Environmental issue	0.05	7
Unallocated		
Pandemic	5.00	30
Wrongful termination	0.20	10
Discrimination	0.10	160

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

Table S4
Common Scenario Descriptions by Business Line and Event Type

Panel D: Clients, Products & Business Practices	Severity (€Millions)	
	Minimum	Maximum
Corporate Finance		
Regulatory breach	2.00	60
Compromised customer information	10.00	175
Fiduciary breach	1.00	700
Trading & Sales		
Fiduciary breach	100.00	500
Regulatory breach	3.00	90
Compromised customer information	2.00	50
Retail Banking		
Regulatory breach	4.00	120
Mis-selling	0.20	200
Compromised customer information	1.00	8,600
Commercial Banking		
Noncompliance with money laundering regulations	2.50	60
Regulatory breach	1.50	120
Mis-selling	1.00	30
Asset Management		
Mis-selling	0.20	20
Unallocated		
Client suitability	5.00	250
Noncompliance with money laundering regulations	10.00	950

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

Table S4
Common Scenario Descriptions by Business Line and Event Type

Panel E: Damage to Physical Assets	Severity (€Millions)	
	Minimum	**Maximum**
Trading & Sales		
Business continuity failure	65.00	220
Damage to building and premises	0.10	900
Retail Banking		
Fire	30.00	65
Flood	1.00	400
Damage to building and premises	0.00	620
Commercial Banking		
Damage to building and premises	0.01	400
Natural disaster	1.00	20
Unallocated		
Natural disaster	40.00	1,950
Terrorist attack	3.00	1,500
Earthquake	1.00	600

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

Table S4
Common Scenario Descriptions by Business Line and Event Type

Panel F: Business Disruption and System Failure	Severity (€Millions)	
	Minimum	Maximum
Trading & Sales		
IT system failure	1.00	30
Retail Banking		
IT system failure	0.01	90
Utility outage	0.20	20
Commercial Banking		
Offshoring/Outsourcing risk	3.00	30
IT system failure	0.50	130
Payment & Settlement		
IT system failure	1.00	200
Failure of payments infrastructure	1.00	15
Agency Services		
IT system failure	1.00	120
Asset Management		
IT system failure	1.00	30
Unallocated		
IT system failure	1.00	120

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

Table S4
Common Scenario Descriptions by Business Line and Event Type

Panel G: Execution, Delivery & Process Management	Severity (€Millions)	
	Minimum	Maximum
Corporate Finance		
Inaccurate/Incomplete contract	0.20	55
Transaction error	0.30	10
Staff error in lending process	1.00	10
Trading & Sales		
Data entry error	0.02	40
Model risk	1.00	60
Retail Banking		
Pricing error	1.00	200
Failure of external supplier	8.00	950
Commercial Banking		
Failure to follow procedures	0.50	100
Lost or incomplete loan documentation	1.00	175
Processing error	1.00	100
Payment & Settlement		
Data entry error	1.00	330
Failure to follow procedures	1.00	10
Agency Services		
Processing error	3.00	115
Asset Management		
Mismanagement of account assets	3.00	100
Unallocated		
Inaccurate financial statement	1.00	100,000
Failure of supplier/vendor	0.10	875
Tax noncompliance	15.00	150

Note 1. Table reports results based on the largest scenarios most frequently reported by banks.

Note 2. Business line not presented in cases of insufficient data.

Table S5
Annual Scenario Frequencies
Average Distribution Across Event Types

Business Line	Event Type								Total Frequency
	Internal Fraud	External Fraud	Employ-ment Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Business Disruption & System Failures	Execution, Delivery & Process Manage-ment	Unallocated	
Corporate Finance	11.8%	5.7%	2.1%	26.6%	1.3%	3.0%	38.4%	11.1%	39
Trading & Sales	23.1%	1.5%	0.1%	17.1%	0.1%	15.8%	42.4%	0.0%	5,846
Retail Banking	10.2%	28.4%	1.9%	18.3%	6.8%	9.9%	24.6%	0.0%	1,032,739
Commercial Banking	12.7%	21.3%	7.8%	22.5%	5.7%	4.4%	25.5%	0.0%	9,726
Payment & Settlement	3.8%	28.9%	0.0%	11.1%	0.0%	21.1%	35.1%	0.0%	262,166
Agency Services	13.0%	0.0%	3.9%	19.9%	1.1%	9.5%	52.2%	0.4%	1,642
Asset Management	18.0%	1.6%	0.4%	22.8%	0.6%	1.1%	55.6%	0.0%	3,105
Retail Brokerage	9.2%	3.5%	13.0%	44.6%	0.5%	5.1%	21.2%	3.0%	1,852
Unallocated	8.4%	5.7%	15.3%	12.7%	19.1%	5.1%	29.1%	4.5%	23,584
Total Frequency	26,830	750,263	2,719	157,112	34,073	5,963	363,734	.	.

Note 1. Table reports results based on data from banks providing all of their scenarios.

Table S6
Size Distribution of Scenarios and Comparison to Internal Data
Panel A: Top 20 Scenarios, Size Distribution by Region

€Millions		25th Percentile	50th Percentile	75th Percentile	95th Percentile
All	Median	15.8	25.3	42.1	65.2
	(25th-75th)	(3.7-54.6)	(4.7-63.4)	(9.3-138.2)	(25.0-317.7)
Australia	Median	31.8	31.8	116.3	177.6
	(25th-75th)	(15.2-56.8)	(25.0-74.4)	(42.4-150.2)	(97.9-248.0)
Europe	Median	5.8	10.7	20.6	64.1
	(25th-75th)	(1.5-32.7)	(2.4-50.7)	(5.2-89.4)	(13.4-316.1)
Japan	Median	21.0	25.3	42.1	49.9
	(25th-75th)	(6.3-63.4)	(10.8-63.4)	(20.0-63.4)	(43.2-69.7)
North America	Median	31.6	31.6	47.5	65.2
	(25th-75th)	(6.0-85.3)	(8.2-178.0)	(15.8-238.1)	(31.6-474.6)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. Table reports results based on the Top 20 scenarios submitted by participating institutions.
Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Size Distribution of Scenarios and Comparison to Internal Data
Panel B: All Scenarios, Size Distribution by Region

€Millions		25th Percentile	50th Percentile	75th Percentile	95th Percentile
All	Median	2.2	5.4	12.6	47.8
	(25th-75th)	(0.3-6.4)	(1.0-14.3)	(2.6-28.0)	(10.0-130.2)
Australia/Japan	Median	3.2	7.4	19.7	47.8
	(25th-75th)	(1.9-4.4)	(3.8-10.6)	(12.3-24.8)	(43.3-55.3)
Europe	Median	0.5	1.6	6.4	29.4
	(25th-75th)	(0.3-5.6)	(1.0-15.3)	(2.5-23.8)	(7.8-135.0)
North America	Median	9.5	9.5	9.5	81.1
	(25th-75th)	(0.8-100.7)	(2.7-150.3)	(5.1-189.8)	(11.1 - 387.6)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. Table reports results based on the Top 20 scenarios submitted by participating institutions.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th

Table S6
Size Distribution of Scenarios and Comparison to Internal Data
Panel C: Top 20 Internal Losses, Size Distribution by Region

€Millions		25th Percentile	50th Percentile	75th Percentile	95th Percentile
All	Median	0.4	0.5	0.9	6.2
	(25th-75th)	(0.1-1.8)	(0.1-2.8)	(0.2-4.8)	(0.5-23.3)
Australia	Median	0.2	0.4	0.8	5.1
	(25th-75th)	(0.1-1.4)	(0.1-2.0)	(0.2-4.4)	(0.3-12.7)
Europe	Median	0.3	0.4	0.8	5.5
	(25th-75th)	(0.1-2.6)	(0.1-3.6)	(0.3-6.9)	(0.8-25.1)
Japan	Median	0.0	0.0	0.1	0.5
	(25th-75th)	(0.0-0.1)	(0.0-0.1)	(0.0-0.6)	(0.3-6.8)
North America	Median	1.8	2.8	4.8	23.2
	(25th-75th)	(0.6-2.5)	(1.2-3.8)	(2.7-9.1)	(10.6-124.3)
Brazil / India	Median	0.4	0.7	0.8	3.0
	(25th-75th)	(0.0-0.9)	(0.0-1.0)	(0.1-1.4)	(0.3-6.3)

Note 1. Table reports results based on the Top 20 internal losses submitted by participating institutions.
Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th

Table S6
Size Distribution of Scenarios and Comparison to Internal Data
Panel D: Comparison of Large Internal Losses and Large Scenarios

€Millions		95th Percentile of Top 20 Scenarios divided by 95th Percentile of Top 20 Internal Losses	1-in-1000 Year Loss Implied by Scenarios divided by 95th Percentile of Top 20 Internal Losses
All	Median	5.6	27.2
	(25th-75th)	(1.6-29.0)	(3.8-76.1)
Australia	Median	12.3	22.9
	(25th-75th)	(5.0-34.6)	(14.7-76.1)
Europe	Median	3.5	24.7
	(25th-75th)	(1.4-25.3)	(3.8-65.7)
Japan	Median	17.6	43.3
	(25th-75th)	(5.6-52.3)	(5.6-109.6)
North America	Median	2.5	9.8
	(25th-75th)	(0.7-23.6)	(3.6-42.4)
Brazil / India	Median	.	.
	(25th-75th)	.	.

Note 1. Table reports results based on the Top 20 scenarios submitted by participating institutions.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S7
Scenario Severity (€Millions), Conditional on Severity Exceeding €1 Million

All Participants		25th Percentile	50th Percentile	75th Percentile	95th Percentile
All	Median	1.5	2.3	4.3	19.0
	(25th-75th)	(1.3-3.2)	(1.7-4.4)	(2.6-10.0)	(10.0-47.5)
Panel A: Detail by Region		**25th Percentile**	**50th Percentile**	**75th Percentile**	**95th Percentile**
Australia / Japan	Median	5.2	5.2	7.2	35.8
	(25th-75th)	(2.2-9.2)	(2.5-9.2)	(3.9-10.5)	(20.0-56.4)
Europe	Median	1.3	2.0	3.4	14.3
	(25th-75th)	(1.2-1.5)	(1.7-2.5)	(2.4-7.2)	(7.6-33.7)
North America	Median	1.6	2.8	5.2	19.0
	(25th-75th)	(1.3-3.5)	(1.7-8.2)	(2.8-15.8)	(10.5-158.2)

Note 1. Table reports results for scenarios ≥ €1million based on data from banks providing all of their scenarios.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Scenario Severity (€Millions), Conditional on Severity Exceeding €1 Million

Panel B: Detail by Business Line		25th Percentile	50th Percentile	75th Percentile	95th Percentile
Corporate Finance	Median	1.9	3.5	5.1	10.5
	(25th-75th)	(1.6-11.1)	(2.0-11.1)	(2.5-11.1)	(5.1-47.5)
Trading & Sales	Median	1.3	2.3	3.1	9.1
	(25th-75th)	(1.1-3.0)	(1.1-4.7)	(2.0-8.2)	(5.4-17.7)
Retail Banking	Median	2.0	2.2	3.2	12.4
	(25th-75th)	(1.2-3.2)	(1.7-6.3)	(2.7-11.1)	(6.9-47.5)
Commercial Banking	Median	1.4	2.0	3.6	11.2
	(25th-75th)	(1.3-1.7)	(1.8-3.2)	(2.5-7.9)	(7.9-38.9)
Payment & Settlement	Median	7.4	8.8	10.4	15.8
	(25th-75th)	(4.8-15.8)	(4.8-15.8)	(7.0-15.8)	(14.1-50.0)
Agency Services	Median	1.6	2.4	4.9	18.8
	(25th-75th)	(1.5-3.5)	(2.0-3.5)	(3.5-9.3)	(3.5-33.9)
Asset Management	Median	1.4	1.6	3.1	11.0
	(25th-75th)	(1.2-1.7)	(1.3-3.3)	(2.4-6.0)	(5.4-18.8)
Retail Brokerage	Median	2.5	3.1	3.1	6.3
	(25th-75th)	(1.2-3.1)	(1.6-3.5)	(2.7-3.5)	(5.8-7.5)
Unallocated	Median	1.5	2.9	5.8	19.1
	(25th-75th)	(1.3-5.1)	(1.9-6.3)	(3.0-11.1)	(8.0-95.0)

Note 1. Table reports results for scenarios ≥ €1million based on data from banks providing all of their scenarios.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S7
Scenario Severity (€Millions), Conditional on Severity Exceeding €1 Million

Panel C: Detail by Event Type		25th Percentile	50th Percentile	75th Percentile	95th Percentile
Internal Fraud	Median	1.5	2.5	4.3	13.9
	(25th-75th)	(1.3-3.2)	(1.8-5.1)	(3.1-12.1)	(6.0-47.5)
External Fraud	Median	1.5	2.3	3.2	7.3
	(25th-75th)	(1.2-4.8)	(1.6-5.0)	(2.4-8.2)	(5.6-44.2)
Employment Practices & Workplace Safety	Median	1.5	2.4	3.7	6.4
	(25th-75th)	(1.2-7.8)	(1.4-12.2)	(1.9-12.2)	(3.8-20.3)
Clients, Products & Business Practices	Median	1.6	2.5	5.4	17.2
	(25th-75th)	(1.3-11.1)	(1.8-11.1)	(3.0-51.9)	(7.7-109.8)
Damage to Physical Assets	Median	1.7	2.9	5.8	19.7
	(25th-75th)	(1.3-4.4)	(1.9-6.4)	(2.3-10.5)	(8.4-53.0)
Business Disruption & System Failures	Median	1.5	2.4	4.7	11.6
	(25th-75th)	(1.3-4.5)	(1.6-6.0)	(2.3-9.7)	(5.1-32.4)
Execution, Delivery & Process Management	Median	1.5	1.9	3.2	11.7
	(25th-75th)	(1.3-3.5)	(1.7-3.5)	(2.5-5.4)	(8.1-22.3)
Unallocated	Median	63.6	103.4	134.5	189.8
	(25th-75th)	(17.6-158.6)	(25.5-190.4)	(26.7-238.3)	(90.5-397.7)

Note 1. Table reports results for scenarios ≥ €1million based on data from banks providing all of their scenarios.

Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S7
Internal Loss Severity (€Millions), Conditional on Losses Exceeding €1 Million

Panel D: All Participants		25th Percentile	50th Percentile	75th Percentile	95th Percentile
All Business Lines	Median	1.5	2.5	4.5	14.1
	(25th-75th)	(1.4-1.6)	(1.9-3)	(3.5-5.8)	(6.2-19.5)
Retail Banking	Median	1.4	2.2	4.3	6.9
	(25th-75th)	(1.3-1.6)	(1.8-3.1)	(2.4-5.4)	(4.3-20.2)

Note 1. Table reports results for losses ≥ €1million based on internal loss data.

Table S8
Scenario Severity (€Millions)
Table reports loss severity such that the expected annual frequency of losses exceeding X is 1/100 and 1/1000.

All		**Accumulative Frequency = 1/100**	**Accumulative Frequency = 1/1000**
All	Median	88.4	194.4
	(25th-75th)	(19.6-362.0)	(50.4-953.4)
Panel A: Detail by Region		**Accumulative Frequency = 1/100**	**Accumulative Frequency = 1/1000**
Australia	Median	139.8	407.5
	(25th-75th)	(97.5-174.2)	(262.4-962.9)
Europe	Median	96.6	238.8
	(25th-75th)	(20.5-570.9)	(55.5-1,277.2)
Japan	Median	42.1	57.4
	(25th-75th)	(18.1-56.7)	(29.7-125.8)
North America	Median	248.1	572.5
	(25th-75th)	(24.8-497.8)	(85.2-1,331.5)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S8
Scenario Severity (€Millions)
Table reports loss severity such that the expected annual frequency of losses exceeding X is 1/100 and 1/1000.

Panel B: Detail by Business Line		Accumulative Frequency = 1/100	Accumulative Frequency = 1/1000
Corporate Finance	Median	17.1	30.3
	(25th-75th)	(5.1-50.4)	(10.2-156.0)
Trading & Sales	Median	26.0	114.4
	(25th-75th)	(10.1-84.8)	(22.3-225.4)
Retail Banking	Median	18.7	46.3
	(25th-75th)	(8.6-93.5)	(14.8-230.5)
Commercial Banking	Median	18.2	35.4
	(25th-75th)	(10.1-47.7)	(14.4-83.0)
Payment and Settlement	Median	13.7	16.0
	(25th-75th)	(6.2-27.5)	(11.1-60.9)
Agency Services	Median	11.1	40.7
	(25th-75th)	(6.3-62.8)	(4.6-81.1)
Asset Management	Median	38.1	65.4
	(25th-75th)	(6.4-88.2)	(32.4-265.1)
Retail Brokerage	Median	6.4	6.4
	(25th-75th)	(3.4-12.3)	(4.5-27.4)
Unallocated	Median	94.2	134.8
	(25th-75th)	(23.8-204.9)	(43.7-564.2)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S8
Scenario Severity (€Millions)
Table reports loss severity such that the expected annual frequency of losses exceeding X is 1/100 and 1/1000.

Panel C: Detail by Event Type		Accumulative Frequency = 1/100	Accumulative Frequency = 1/1000
Internal Fraud	Median	30.0	58.6
	(25th-75th)	(6.5-67.1)	(13.7-337.0)
External Fraud	Median	14.3	39.6
	(25th-75th)	(5.8-57.9)	(6.4-160.1)
Employment Practices & Workplace Safety	Median	11.1	11.2
	(25th-75th)	(5.4-47.8)	(5.9-76.0)
Clients, Products & Business Practices	Median	32.1	81.5
	(25th-75th)	(12.7-159.2)	(21.2-366.1)
Damage to Physical Assets	Median	17.2	54.6
	(25th-75th)	(6.6-101.8)	(19.6-401.5)
Business Disruption & System Failures	Median	11.6	25.9
	(25th-75th)	(6.3-31.6)	(7.4-85.6)
Execution, Delivery & Process Management	Median	31.8	63.4
	(25th-75th)	(10.2-80.0)	(22.1-269.1)
Unallocated	Median	160.8	319.7
	(25th-75th)	(104.1-179.6)	(207.5-454.9)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Annual Scenario Frequencies

Normalised per €Trillion of Assets, Tier 1 Capital, Gross Income and Operational Risk Capital

Panel A: Normalised per €Trillion of Consolidated Assets		Annual Scenario Frequency ≥ €1,000,000	Annual Scenario Frequency ≥ €10,000,000	Annual Scenario Frequency ≥ €100,000,000	Annual Scenario Frequency ≥ €500,000,000
All	Median	27.5	2.1	0.018	0.000
	(25th-75th)	(6.5 - 96.2)	(0.7 - 8.2)	(0.000 - 0.317)	(0.000 - 0.009)
AMA	Median	19.2	1.9	0.069	0.001
	(25th-75th)	(6.1 - 60.1)	(1.0 - 7.3)	(0.005 - 0.380)	(0.000 - 0.013)
Non-AMA	Median	28.1	2.4	0.000	0.000
	(25th-75th)	(12.2 - 199.2)	(0.4 - 8.5)	(0.000 - 0.075)	(0.000 - 0.000)
Australia	Median	.	5.1	0.120	0.000
	(25th-75th)	.	(1.5 - 20.3)	(0.047 - 0.237)	(0.000 - 0.009)
Europe	Median	27.8	1.2	0.018	0.000
	(25th-75th)	(14.5 - 224.6)	(0.3 - 6.9)	(0.004 - 0.261)	(0.000 - 0.007)
Japan	Median	.	2.1	0.000	0.000
	(25th-75th)	.	(0.8 - 2.7)	(0.000 - 0.000)	(0.000 - 0.000)
North America	Median	18.1	2.5	0.301	0.000
	(25th-75th)	(5.1 - 70.9)	(2.1 - 7.9)	(0.001 - 0.437)	(0.000 - 0.093)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S9
Annual Scenario Frequencies
Normalised per €Trillion of Assets, Tier 1 Capital, Gross Income and Operational Risk Capital

Panel B: Normalised per €Trillion of Consolidated Tier 1 Capital		Annual Scenario Frequency ≥ €1,000,000	Annual Scenario Frequency ≥ €10,000,000	Annual Scenario Frequency ≥ €100,000,000	Annual Scenario Frequency ≥ €500,000,000
All	Median	657.3	37.4	0.583	0.000
	(25th-75th)	(155.8 - 1,719.4)	(15.3 - 157.9)	(0.000 - 6.760)	(0.000 - 0.197)
AMA	Median	785.9	35.1	1.248	0.021
	(25th-75th)	(134.2 - 1,448.6)	(15.8 - 196.4)	(0.122 - 7.834)	(0.000 - 0.321)
Non-AMA	Median	649.8	47.7	0.000	0.000
	(25th-75th)	(198.0 - 2,692.6)	(13.8 - 119.9)	(0.000 - 2.472)	(0.000 - 0.000)
Australia	Median	.	137.9	3.362	0.000
	(25th-75th)	.	(32.4 - 343.8)	(1.000 - 6.903)	(0.000 - 0.195)
Europe	Median	795.3	28.1	0.720	0.004
	(25th-75th)	(445.5 - 3,201.1)	(9.2 - 135.2)	(0.093 - 7.400)	(0.000 - 0.253)
Japan	Median	.	25.7	0.000	0.000
	(25th-75th)	.	(15.3 - 46.0)	(0.000 - 0.001)	(0.000 - 0.000)
North America	Median	473.7	42.4	3.966	0.000
	(25th-75th)	(135.9 - 1,128.1)	(35.5 - 141.8)	(0.000 - 7.182)	(0.000 - 1.631)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S9
Annual Scenario Frequencies
Normalised per €Trillion of Assets, Tier 1 Capital, Gross Income and Operational Risk Capital

Panel C: Normalised per €Trillion of Consolidated Gross Income		**Annual Scenario Frequency ≥ €1,000,000**	**Annual Scenario Frequency ≥ €10,000,000**	**Annual Scenario Frequency ≥ €100,000,000**	**Annual Scenario Frequency ≥ €500,000,000**
All	Median	742.7	49.5	1.063	0.000
	(25th-75th)	(198.1 - 2,004.0)	(17.9 - 193.8)	(0.000 - 7.753)	(0.000 - 0.242)
AMA	Median	639.9	44.2	2.638	0.051
	(25th-75th)	(160.1 - 1,626.7)	(29.8 - 180.8)	(0.175 - 8.878)	(0.000 - 0.422)
Non-AMA	Median	993.2	54.1	0.000	0.000
	(25th-75th)	(340.5 - 4,530.9)	(11.4 - 267.1)	(0.000 - 3.375)	(0.000 - 0.002)
Australia	Median	.	194.2	3.205	0.000
	(25th-75th)	.	(44.3 - 807.7)	(1.265 - 4.807)	(0.000 - 0.247)
Europe	Median	841.4	36.5	1.080	0.004
	(25th-75th)	(355.1 - 4,992.9)	(8.1 - 193.3)	(0.071 - 8.732)	(0.000 - 0.265)
Japan	Median	.	132.1	0.000	0.000
	(25th-75th)	.	(43.6 - 189.9)	(0.000 - 0.003)	(0.000 - 0.000)
North America	Median	386.6	51.2	4.968	0.000
	(25th-75th)	(143.4 - 1,394.8)	(29.0 - 143.4)	(0.043 - 8.975)	(0.000 - 1.474)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Annual Scenario Frequencies

Normalised per €Trillion of Assets, Tier 1 Capital, Gross Income and Operational Risk Capital

Panel D: Normalised per €Trillion of Reported Regulatory Operational Risk Capital		Annual Scenario Frequency ≥ €1,000,000	Annual Scenario Frequency ≥ €10,000,000	Annual Scenario Frequency ≥ €100,000,000	Annual Scenario Frequency ≥ €500,000,000
All	Median	4,941.2	749.2	15.010	0.006
	(25th-75th)	(1,286.6 - 21,587.6)	(114.7 - 1,575.6)	(0.010 - 76.016)	(0.000 - 2.139)
AMA	Median	4,423.7	538.5	18.495	0.224
	(25th-75th)	(1,140.1 - 16,337.6)	(165.9 - 1,342.2)	(0.985 - 96.169)	(0.000 - 2.895)
Non-AMA	Median	6,426.1	1,341.8	0.625	0.000
	(25th-75th)	(2,358.4 - 25,254.0)	(87.7 - 1,740.2)	(0.000 - 35.993)	(0.000 - 0.010)
Australia	Median	.	864.9	25.195	0.000
	(25th-75th)	.	(505.8 - 1,321.6)	(16.188 - 88.167)	(0.000 - 3.165)
Europe	Median	7,359.2	508.3	12.213	0.031
	(25th-75th)	(3,674.0 - 32,976.5)	(80.7 - 1,987.8)	(0.813 - 60.690)	(0.000 - 2.144)
Japan	Median	.	1,365.2	0.000	0.000
	(25th-75th)	.	(296.3 - 1,575.6)	(0.000 - 0.021)	(0.000 - 0.000)
North America	Median	1,341.8	749.2	60.278	1.809
	(25th-75th)	(749.2 - 7,000.5)	(114.7 - 1,273.2)	(8.167 - 137.439)	(0.000 - 25.318)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

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Table S10

Annual Scenario and Internal Data Frequencies

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		Annual Frequency of Losses ≥ €1 Million per €Trillion Consolidated Gross Income		Annual Frequency of Losses ≥ €10 Million per €Trillion Consolidated Gross Income	
		Scenarios	**Internal Data**	**Scenarios**	**Internal Data**
All	Median	742.7	400.1	49.4	0
	(25th-75th)	(198.1-2004.0)	(0-1050.9)	(17.9-193.8)	(0-83.8)
AMA	Median	639.9	815.8	44.1	58.7
	(25th-75th)	(160.1-1,626.73)	(233.1-1,183.0)	(29.8-180.8)	(17.2-113.2)
Non-AMA	Median	993.2	288.0	54.1	0
	(25th-75th)	(340.5-4530.9)	(0-709.7)	(11.4-267.1)	(0-37.0)
Australia	Median	.	233.1	194.2	0
	(25th-75th)	.	(0-1,079.4)	(44.3-807.7)	(0-39.7)
Europe	Median	841.4	478.6	36.5	0
	(25th-75th)	(355.1-4,992.8)	(79.0-1,180.9)	(8.2-193.3)	(0-68.6)
Japan	Median	.	0	132.1	0
	(25th-75th)	.	(0-200.9)	(43.6-189.9)	(0-0)
North America	Median	386.6	815.8	51.2	100.0
	(25th-75th)	(143.4-1,394.8)	(453-1-1,193.1)	(29.0-143.4)	(33.5-137.3)
Brazil / India	Median	.	.	.	.
	(25th-75th)	.	.	.	.

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S11
Comparison of Scenarios and Internal Loss Data
Number and Frequency of Scenarios Compared to Internal Losses
Common Thresholds Across Banks

All (Scenarios and Losses ≥ €10 Million)		Number	Frequency
All	Median	0.938	0.709
	(25th-75th)	(0.667-1.000)	(0.350-1.000)
Panel A: Detail by Region (Scenarios and Losses ≥ €10 Million)		**Number**	**Frequency**
Australia	Median	1.000	0.500
	(25th-75th)	(0.947-1.000)	(0.495-1.000)
Europe	Median	0.938	1.000
	(25th-75th)	(0.500-1.000)	(0.350-1.000)
Japan	Median	1.000	1.000
	(25th-75th)	(1.000-1.000)	(1.000-1.000)
North America	Median	0.800	0.462
	(25th-75th)	(0.700-0.891)	(0.135-0.879)

Note 1. Number represents the ratio of the number of scenarios to the sum of the number of internal losses and the number of scenarios.

Note 2. Frequency represents the ratio of the frequency of scenarios to the sum of internal loss frequency and scenario frequency.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table S11
Comparison of Scenarios and Internal Loss Data
Number and Frequency of Scenarios Compared to Internal Losses
Common Thresholds Across Banks

Panel B: Detail by Event Type (Scenarios and Losses ≥ €1 Million)		Number	Frequency
Internal Fraud	Median	0.889	0.756
	(25th-75th)	(0.500-1.000)	(0.152-1.000)
External Fraud	Median	0.667	0.500
	(25th-75th)	(0.500-1.000)	(0.154-1.000)
Employment Practices & Workplace Safety	Median	0.667	0.752
	(25th-75th)	(0.500-1.000)	(0.416-1.000)
Clients, Products & Business Practices	Median	0.750	0.672
	(25th-75th)	(0.500-0.960)	(0.104-0.984)
Damage to Physical Assets	Median	1.000	0.500
	(25th-75th)	(0.500-1.000)	(0.500-1.000)
Business Disruption & System Failures	Median	1.000	1.000
	(25th-75th)	(0.643-1.000)	(0.618-1.000)
Execution, Delivery & Process Management	Median	0.636	0.711
	(25th-75th)	(0.438-1.000)	(0.141-1.000)

Note 1. Number represents the ratio of the number of scenarios to the sum of the number of internal losses and the number of scenarios.

Note 2. Frequency represents the ratio of the frequency of scenarios to the sum of internal loss frequency and scenario frequency.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Comparison of Scenarios and Internal Loss Data

Number and Frequency of Scenarios Compared to Internal Losses

Bank-Specific Thresholds Determined by the Value of the 20th Largest Scenario

All		**Number**	**Frequency**
All	Median	0.952	0.667
	(25th-75th)	(0.769-1.000)	(0.285-1.000)
Panel A: Detail by Region		**Number**	**Frequency**
Australia	Median	0.960	0.503
	(25th-75th)	(0.909-1.000)	(0.368-1.000)
Europe	Median	0.842	0.667
	(25th-75th)	(0.606-0.952)	(0.180-0.999)
Japan	Median	1.000	1.000
	(25th-75th)	(0.952-1.000)	(0.796-1.000)
North America	Median	0.870	0.500
	(25th-75th)	(0.625-1.000)	(0.222-0.620)

Note 1. Number represents the ratio of the number of scenarios to the sum of the number of internal losses and the number of scenarios.

Note 2. Frequency represents the ratio of the frequency of scenarios to the sum of internal loss frequency and scenario frequency.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Comparison of Scenarios and Internal Loss Data

Number and Frequency of Scenarios Compared to Internal Losses

Bank-Specific Thresholds Determined by the Value of the 20th Largest Scenario

Panel B: Detail by Event Type		**Number**	**Frequency**
Internal Fraud	Median	1.000	1.000
	(25th-75th)	(1.000-1.000)	(0.500-1.000)
External Fraud	Median	1.000	0.947
	(25th-75th)	(0.667-1.000)	(0.474-1.000)
Employment Practices & Workplace Safety	Median	1.000	0.576
	(25th-75th)	(0.500-1.000)	(0.425-1.000)
Clients, Products & Business Practices	Median	1.000	1.000
	(25th-75th)	(0.833-1.000)	(0.500-1.000)
Damage to Physical Assets	Median	1.000	1.000
	(25th-75th)	(1.000-1.000)	(0.500-1.000)
Business Disruption & System Failures	Median	1.000	1.000
	(25th-75th)	(1.000-1.000)	(0.708-1.000)
Execution, Delivery & Process Management	Median	1.000	0.619
	(25th-75th)	(0.714-1.000)	(0.375-1.000)

Note 1. Number represents the ratio of the number of scenarios to the sum of the number of internal losses and the number of scenarios.

Note 2. Frequency represents the ratio of the frequency of scenarios to the sum of internal loss frequency and scenario frequency.

Note 3. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Table C1
Reported Regulatory Operational Risk Capital as a Percentage of:
Assets, Tier 1 Capital and Gross Income

			All	**Australia**	**Europe**	**Japan**	**North America**	**Brazil / India**
Consolidated Assets	All	Median (25th-75th)	0.33% (0.24%-0.47%)	0.30% (0.27%-0.37%)	0.34% (0.18%-0.46%)	0.25% (0.22%-0.28%)	0.38% (0.33%-0.58%)	0.46% (0.44%-0.54%)
	AMA	Median (25th-75th)	0.27% (0.20%-0.40%)	0.29% (0.27%-0.30%)	0.23% (0.17%-0.37%)	0.20% (0.20%-0.23%)	0.49% (0.33%-0.80%)	na na
	Non-AMA	Median (25th-75th)	0.38% (0.29%-0.49%)	0.35% (0.26%-0.41%)	0.38% (0.27%-0.47%)	0.28% (0.24%-0.29%)	0.35% (0.33%-0.38%)	0.46% (0.44%-0.54%)
Consolidated Tier 1 Capital	All	Median (25th-75th)	7.51% (5.21%-10.25%)	7.11% (6.39%-7.77%)	7.97% (5.48%-10.21%)	4.88% (4.19%-5.96%)	9.18% (6.07%-11.51%)	8.02% (4.42%-9.64%)
	AMA	Median (25th-75th)	7.38% (5.30%-9.63%)	7.25% (7.11%-7.70%)	8.91% (6.53%-9.78%)	4.46% (3.51%-5.44%)	10.90% (5.45%-12.40%)	na na
	Non-AMA	Median (25th-75th)	7.62% (5.21%-10.58%)	6.72% (5.03%-9.84%)	7.66% (5.23%-10.46%)	5.13% (4.73%-6.06%)	8.53% (7.62%-9.82%)	8.02% (4.42%-9.64%)
Consolidated Gross Income	All	Median (25th-75th)	12.27% (10.58%-14.96%)	10.06% (4.46%-14.49%)	12.09% (10.72%-13.63%)	14.05% (13.08%-14.86%)	12.65% (8.59%-17.37%)	7.53% (5.19%-12.50%)
	AMA	Median (25th-75th)	10.83% (8.38%-13.83%)	7.82% (3.83%-10.06%)	10.70% (9.47%-13.36%)	12.44% (11.53%-13.39%)	11.63% (6.67%-21.76%)	na na
	Non-AMA	Median (25th-75th)	12.79% (11.33%-15.03%)	13.86% (6.96%-18.10%)	12.10% (11.42%-14.08%)	14.58% (14.00%-14.92%)	13.08% (10.69%-13.87%)	7.53% (5.19%-12.50%)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

Note 2: All participants in Brazil / India are non-AMA.

Table C2
Comparison of Large Losses to Regulatory Operational Risk Capital

AMA Participants		Maximum Internal Loss Divided by Reported Regulatory Operational Risk Capital	Average of the Five Largest Losses Divided by Reported Regulatory Operational Risk Capital
All	Median	4.1%	2.4%
	(25th -75th)	(1.6% - 11.4%)	(0.8% - 4.3%)
Australia	Median	5.7%	2.5%
	(25th -75th)	(2.6% - 6.1%)	(1.4% - 3.6%)
Europe	Median	3.9%	2.5%
	(25th -75th)	(1.3% - 10.9%)	(0.8% - 4.4%)
Japan	Median	2.6%	0.9%
	(25th -75th)	(0.7% - 4.0%)	(0.3% - 1.6%)
North America	Median	5.8%	4.2%
	(25th -75th)	(3.1% - 80.0%)	(2.1% - 32.3%)

Note 1. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.

AMA Participants			Region				
Numerator	**Denominator**		**All**	**Australia**	**Europe**	**Japan**	**North America**
Expected Loss included in AMA Capital	AMA Regulatory Capital	Median (25th -75th)	11.1% (6.0% - 19.5%)	. .	13.5% (8.5% - 22.0%)	. .	7.8% (4.1% - 15.8%)
	Annualised sum of losses ≥ €20,000	Median (25th -75th)	128.7% (60.4% - 281.3%)	. .	138.5% (99.2% - 281.3%)	. .	41.3% (27.0% - 73.6%)
Expected Loss Offset	AMA Regulatory Capital	Median (25th -75th)	0.0% (0.0% - 0.9%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 3.4%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)
	Annualised sum of losses ≥ €20,000	Median (25th -75th)	0.0% (0.0% - 9.8%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 41.2%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)
Insurance Offset	AMA Regulatory Capital (without Insurance Offsets)	Median (25th -75th)	0.0% (0.0% - 3.7%)	0.0% (0.0% - 0.0%)	0.0% (0.00% - 5.2%)	0.0% (0.0% - 0.0%)	0.0% (0.00% - 5.4%)
Offsets for Other Risk Mitigants	AMA Regulatory Capital (without Other Risk Mitigant Offsets)	Median (25th -75th)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)
Offsets for All Risk Mitigants	AMA Regulatory Capital	Median (25th -75th)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 4.0%)	0.0% (0.0% - 0.0%)	0.0% (0.0% - 0.0%)
AMA Regulatory Capital	AMA Regulatory Capital (assuming full independence)	Median (25th -75th)	108.3% (100.6% - 130.9%)	. .	120.0% (103.2% - 137.6%)	. .	110.2% (102.8% - 128.6%)
	AMA Regulatory Capital (calculated as the sum of Operational Risk Categories)	Median (25th -75th)	77.6% (52.0% - 100%)	. .	60.9% (37.5% - 100%)	100.0% (100% - 100%)	56.8% (53.7% - 80.8%)
Operational Risk Capital from Partial Use	Total Regulatory Operational Risk Capital	Median (25th -75th)	16.3% (6.4% - 23.5%)	. .	19.5% (6.7% - 34.7%)	14.8% (10.4% - 16.3%)	. .

Note 1. Offsets for All Risk Mitigants consist of the Insurance Offset and the Offset for Other Risk Mitigants.
Note 2. 25th-75th represents the interquartile range, which is the range of values (between the 25th percentile and 75th percentile) that contains half the banks in the sample.