Actuarial Techniques in Banking Operational Risk

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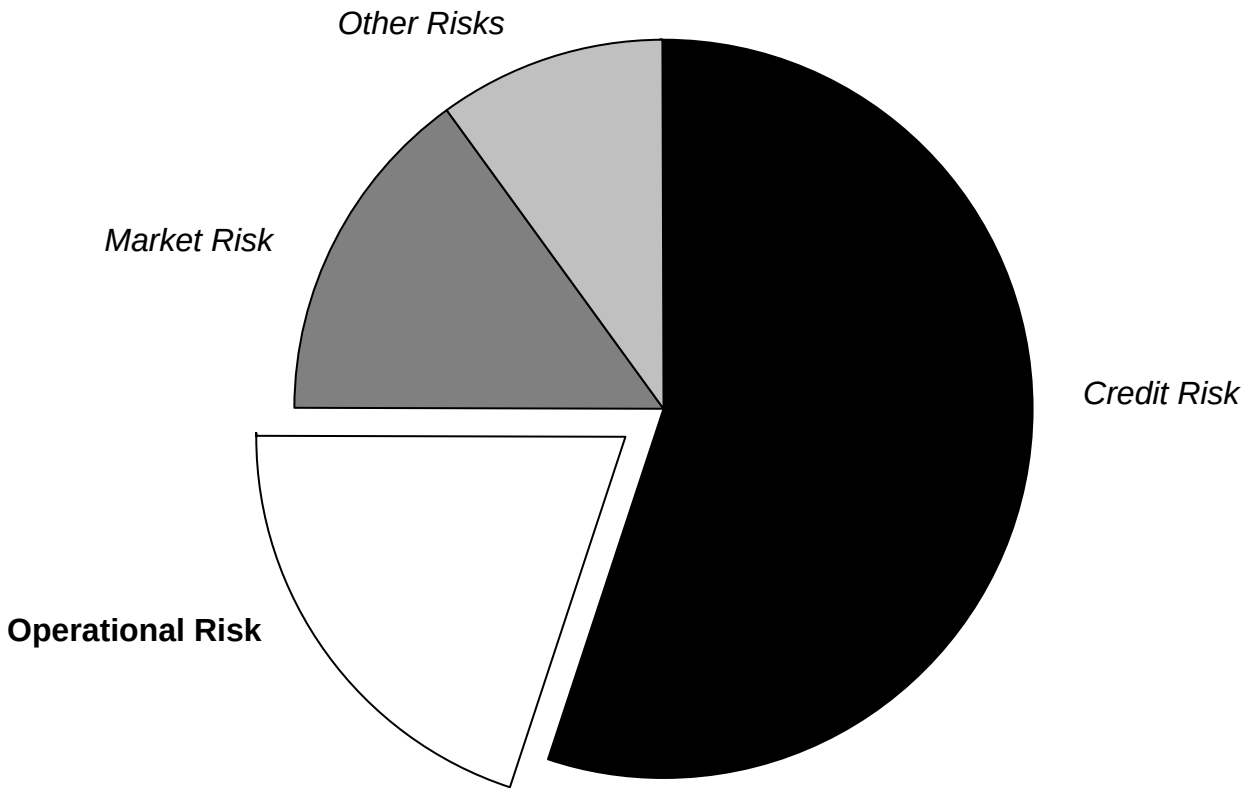
INTRODUCTION

How and why operational risk management became an important industry issue.

FIRM NAME	BUSINESS LINE - LEVEL 1	LOSS AMOUNT ($M)	DESCRIPTION
Nomura Securities International Incorporated	Trading & Sales	47.90	In July 1998, Nomura Securities International Inc, the US brokerage unit of Nomura Securities of Japan, reported that it had agreed to pay $47.9M in settlement of charges stemming from the Orange County's bankruptcy lawsuit. The suit was filed against the firm for investing municipal county funds in high risk derivatives and municipal bond trading that was illegal under California law. The Securities Exchange Commission reported that Nomura was one of the brokerage firms responsible for the county's bankruptcy. Orange County claimed to have lost $1.64 billion. The SEC stated that Nomura had lent the county huge sums of money, which it reinvested in search of high returns. Nomura also supplied the risky securities favoured by then county Treasurer and Tax Collector Robert L. Citron that plunged in value when interest rates rose sharply in 1994. The SEC also charged the firm for its role in underwriting key bonds for the county and accused Citron of illegally investing in volatile securities that were unsuitable for public funds.
ABN Amro Holding NV	Agency Services	141.00	In November 1998, ABN Amro Holding NV, a Netherlands full services bank and Europe's eighth largest banking firm, reported that it had realized a loss of 174M guilders ($141M) due to forgery, embezzlement and fraud perpetrated by four of its former employees. The four allegedly committed about 600 fraudulent transactions, making improper use of about 30 client accounts. The bank said that after uncovering the irregularities, it fired the employees and notified law enforcement officials in February, 1997. The transactions took place within the bank's trust department, whose functions included maintaining bank accounts for 600 to 800 clients living abroad. Its products included numbered bank accounts for clients whose identities were known only within the department. Employees also executed orders solely on the basis of telephone instructions. The bank said that, upon inspection, some packages in custody that supposedly contained diamonds turned out to contain false diamonds, and diamond shipment orders given by clients were sometimes accompanied by falsified invoices.
Merrill Lynch & Company	Trading & Sales	100.00	In December 1997, Merrill Lynch & Co, a US broker-dealer, reported that it had agreed to pay $100M in fines to settle charges of price fixing on the Nasdaq stock market. The Securities and Exchange Commission fined 30 Wall Street firms more than $910M in this regard. The lawsuit alleged that as many as a million investors lost billions of dollars because of collusion among the firms between 1989 and 1994. This collusion caused an artificial widening of spreads, the gap between the purchase and selling prices of stocks, thereby adding to dealer profits. The settlement also required the firms to improve trading policies and procedures. The case began in 1994, when the SEC and the Justice Department accused major Nasdaq dealers of conspiring to fix the bid-ask spreads on stock quotes resulting in extra costs to ordinary investors on their stock trades. Under the settlement, the brokerage firms with the most alleged violations agreed to pay higher fines. In making its original case, the SEC charged that major Nasdaq dealers harassed or refused to trade with others who tried to offer investors a better price for a stock.
WGZ Bank	Trading & Sales	200.37	In October 1998, Westdeutsche Genossenschafts-Zentralbank AG (WGZ-Bank), a German commercial bank, reported that it had realised a loss of DM 377 ($200.4M) due to computer fraud perpetrated by two employees over the past sixteen months. The bank has initiated a case against the two employees, who used a loophole in the bank's computer system for currency derivatives. They entered unrealistic intermediary values, which the system failed to document and managed to realise the profits in their derivative securities. The fraud was only discovered after the installation of an updated system, required under a new law, which eliminates the opportunity for such manipulation.
Korea First Bank	Commercial Banking	93.00	In April 1998, Korea First Bank, a South Korean commercial bank with operations in the US, reported that it had agreed to pay $93M in settlement of a lawsuit that charged it with wrongfully dishonoring its irrevocable letter of credits. The New York Appellate Court ruled in favour of CalEnergy Company Inc, a global energy company that manages and owns an interest in over 5000 megawatts of power generation capability among various facilities in operation, construction and development worldwide. Casecnan Water and Energy Company Inc, a subsidiary of Calenergy was executing a power project in the Philippines. Hanbo Corporation had been acting as the turnkey contractor and guarantor for the Casecnan project.KFB's letter of credit was issued as financial security for the obligations of Hanbo. The contract with Hanbo Corp. was terminated by Casecnan due to Hanbo's insolvency and other misperformance in the project, at which time Casecnan made an initial draw on the KFB letter of credit securing Hanbo's performance under the contract. Furthermore, Casecnan had made three susbsequent draws on the letter of credit, all of which were opposed by Hanbo and draws under the letter of credit were dishonoured by Korea First Bank.
Citibank	Commercial Banking	30.00	In September 1999, Citibank, a US commercial bank with global operations and unit of Citigroup, reported that it had realized a loss of $30M due to credit fraud. The firm's UK branch was one of 20 financial institutions operating in the Middle East which were the victims of fraud. Madhav Patel, an Indian businessman, allegedly deceived the bank by using forged documents to secure letters of credit guaranteeing payment for bogus transactions. The alleged fraud came to light earlier this year when Patel's British registered firm, Solo Industries, ran into financial difficulties in the Middle East. Patel, who ran several metal smelting businesses in Dubai, secured letters of credit from the firm as well as other banks to guarantee payments on shipments of metal to the United Arab Emirates. Police believe the shipments were bogus and the money was diverted elsewhere. Patel moved to London after his business collapsed in May. He has since disappeared.

Operational risk is the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. Includes hazard risk. Does not include business or strategic risk.

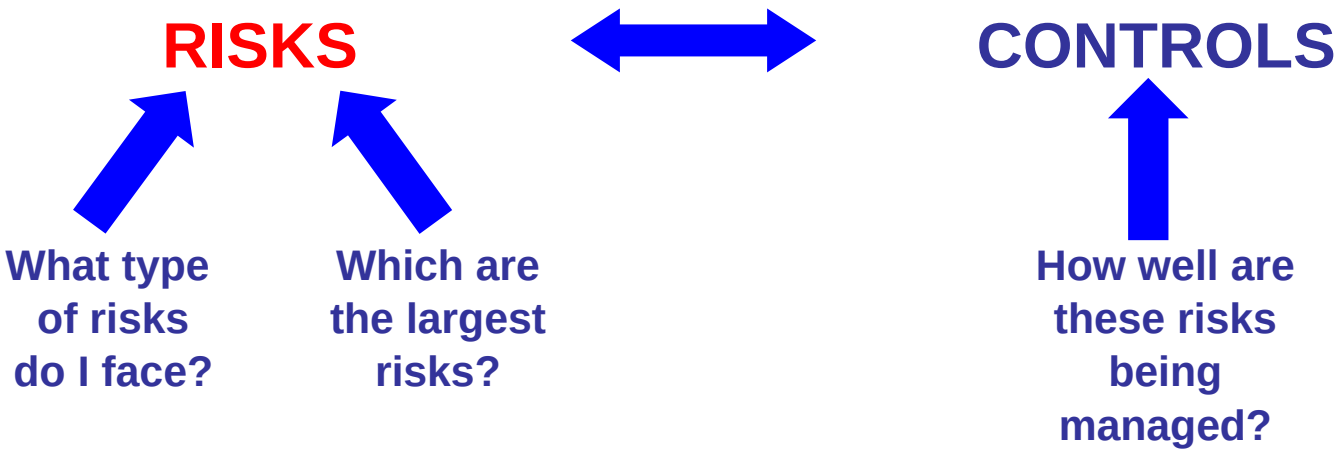


But what's driving credit risk?

"More than 80% of our Credit Risk is really just Operational Risk."

Senior Risk Officer, Large German Bank

Operational risk management is the process of optimizing the risk control relationship in the context of cost benefit analysis.



To make clear what operational risk management is really all about, we need to express it in the context of a business problem

- Consider two risks: Unauthorized Trading and Money Transfer
- Past Audits reveal that both risks are under-controlled
- To address Unauthorized Trading risk one must improve segregation of duties and audit frequency. (Solution: hire four new staff; cost = $400,000 per year)
- To address Money Transfer risk one must improve the system (Solution: buy a new system; cost = $5 million)
- You have $4 million in your budget. Where do you invest your money?

WHAT IS OPERATIONAL RISK

What is the textbook definition of risk. The best way to illustrate risk is through an example.

Security A	Guaranteed return of 10%.
Security B	50% probability of a 0% gain 50% probability of a 20% gain
Security C	50% probability of a 10% loss 50% probability of a 30% gain

Which investment has the highest expected return?

Which investment has the most risk?

How much risk is there in each investment?

Which security is the best investment?

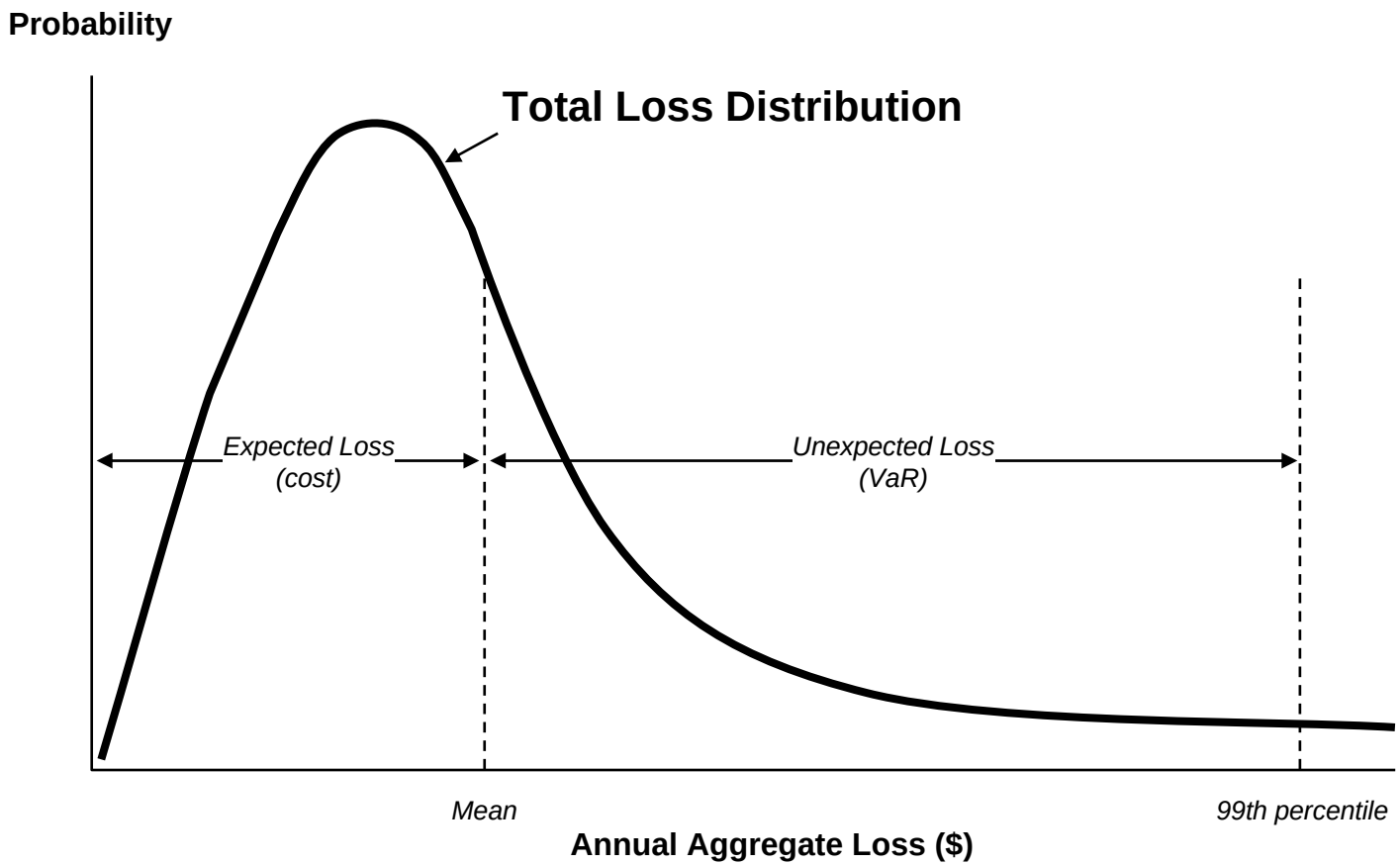
What can we conclude about risk?

- Risk has to do with uncertainty (where there is certainty there is no risk – Security A).
- Risk must be measured at a level of uncertainty (confidence level, e.g., 99%)
- However, it is often possible to ranks risks without specifying the confidence level.
  - We know that Security A is less risky than Security B which is less risky than Security C, even without knowing how much risk each investment poses at the 99% level.

What else do we know about risk?

- Risk is neither inherently good nor bad.
- A risk neutral person will consider all three investments to be of equal value
- A risk lover will choose Security C because if offers the higher possible return (30%) among choices with the same expected return (10%) and because risk increases his/her utility
- Because most people are risk averse, they require more reward for assuming more risk, so will choose Security A. (Equal return with no risk)

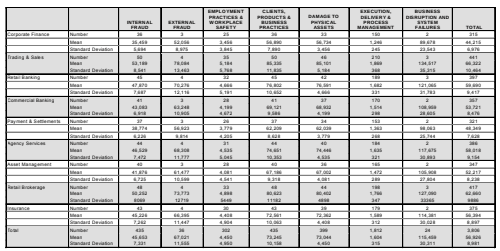
Operational risk must be defined at a specified confidence level.



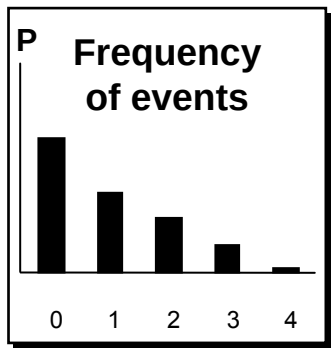
Since operational risk is measured in terms of the aggregate loss, there are two components to operational risk: Frequency and Severity. This is much more challenging than modeling market or credit risk.

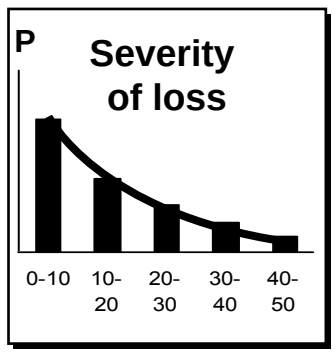
INDIVIDUAL LOSS EVENTS | **RISK MATRIX FOR LOSS DATA** | **LOSS DISTRIBUTIONS** | **VAR CALCULATION** | **TOTAL LOSS DISTRIBUTION**

74,712,345
74,603,709
74,457,745
74,345,957
74,344,576
•
•
•
167,245
142,456
123,345
113,342
94,458

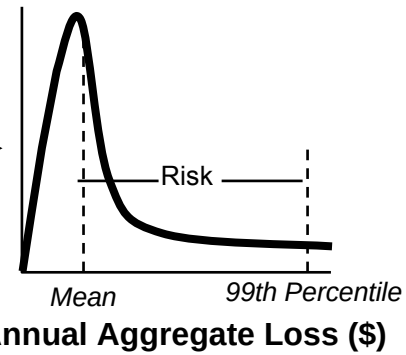


		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number	36	3	25	39	23	150	2	315
	Mean	39,459	52,036	3,456	56,990	36,734	1,246	89,678	44,215
	Standard Deviation	6,694	6,975	3,845	7,690	3,456	245	23,543	9,976
Trading & Sales	Number	50	4	32	49	42	210	3	441
	Mean	83,189	79,094	6,194	85,335	86,101	1,999	134,517	88,322
	Standard Deviation	8,541	13,453	5,766	11,835	5,184	388	35,315	15,464
Retail Banking	Number	46	4	32	49	42	189	3	397
	Mean	47,872	73,276	4,446	75,902	76,391	1,662	121,065	84,690
	Standard Deviation	7,687	12,716	6,191	13,402	4,668	331	31,783	8,417
Commercial Banking	Number	41	3	28	41	37	170	2	357
	Mean	43,082	62,248	4,199	66,121	66,932	1,514	108,968	63,721
	Standard Deviation	6,918	10,665	6,672	9,589	6,199	298	28,655	9,476
Payment & Settlements	Number	37	3	29	37	34	153	2	321
	Mean	38,774	56,923	3,779	62,209	62,039	1,363	98,063	49,349
	Standard Deviation	8,235	5,814	4,255	8,624	3,779	328	25,744	7,928
Agency Services	Number	44	4	31	44	40	184	3	386
	Mean	49,539	68,208	4,535	74,601	74,446	1,635	117,975	68,918
	Standard Deviation	7,472	11,777	6,049	10,352	4,535	321	30,893	9,154
Asset Management	Number	40	3	28	40	36	165	2	347
	Mean	41,879	61,477	4,081	67,186	67,002	1,472	106,168	62,217
	Standard Deviation	6,723	10,596	4,541	8,318	4,081	289	27,804	6,238
Retail Brokerage	Number	48	4	33	48	44	198	3	417
	Mean	80,292	73,773	4,866	80,923	80,402	1,766	127,066	82,860
	Standard Deviation	8689	12710	5449	11182	4898	347	33345	9886
Insurance	Number	43	4	30	43	39	179	2	370
	Mean	45,226	66,356	4,404	72,991	72,362	1,589	114,381	59,294
	Standard Deviation	7,242	11,447	4,904	10,063	4,404	312	30,029	8,897
Total	Number	435	36	302	435	396	1,912	24	3,806
	Mean	49,653	67,021	4,460	73,246	73,044	1,604	119,458	66,926
	Standard Deviation	7,331	11,555	4,660	10,196	4,459	315	30,311	8,961





VaR Calculator e.g., Monte Carlo Simulation Engine



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WHAT IS INHERENT RISK

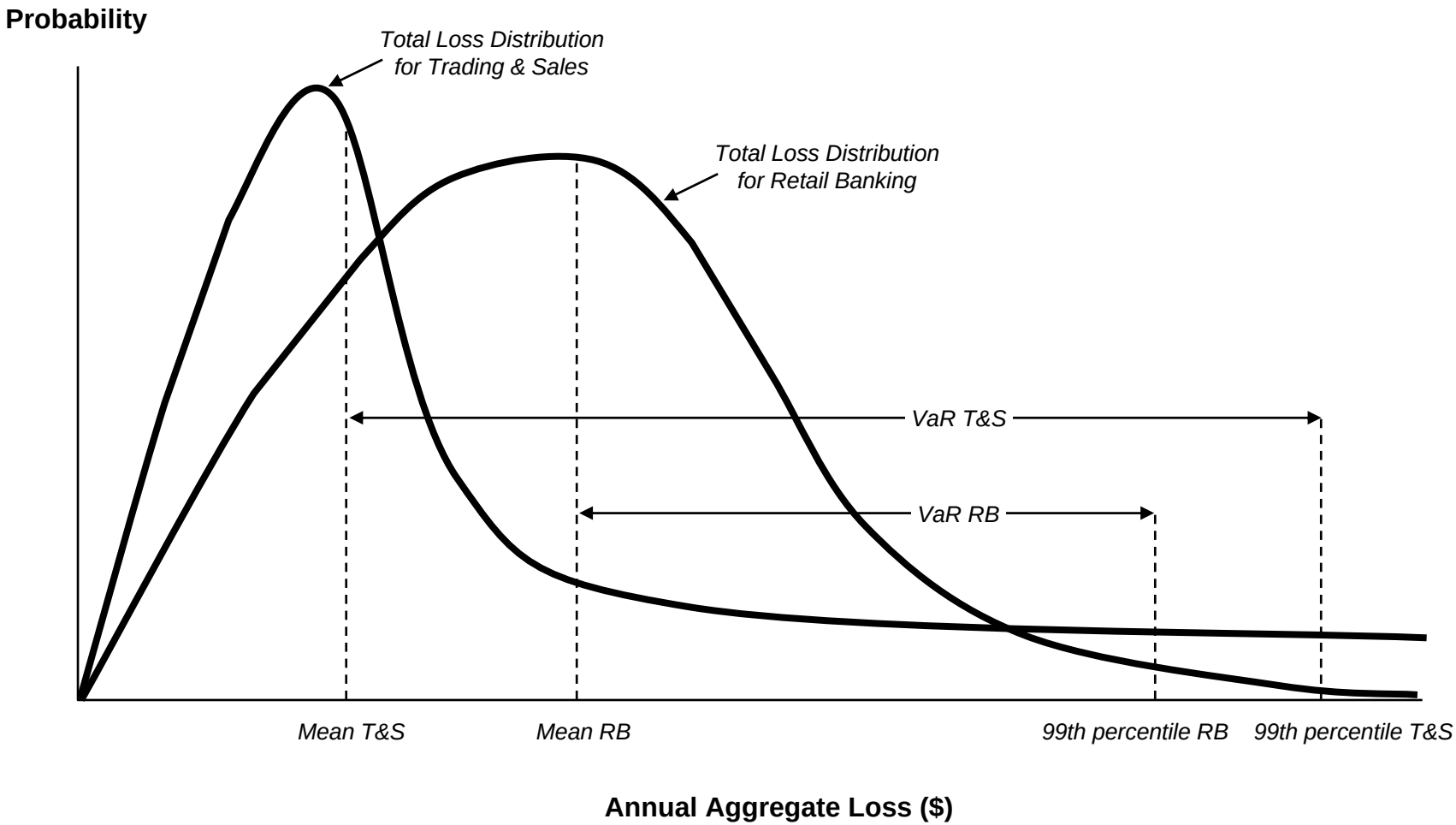
What is inherent risk?

- Is inherent risk the level of risk before controls or in the absence of controls?
  - Consider an example, if you had $1,000,000 in your bank vault and you had no controls:
    - How much would you expect to lose?
    - How much risk would you have?

What is inherent risk?

- Inherent is defined as a unique, permanent or unchangeable characteristic.
  - Therefore inherent risk must be the risk that is unique to a particular business or process.
- If the level of inherent risk changes after controls, then by definition that cannot be the level of inherent risk.

The term inherent risk has meaning when represented in a distributional context. When you factor out controls you can observe which businesses are inherently high risk and which are inherently high cost.



HOW TO CLASSIFY OPERATIONAL RISKS

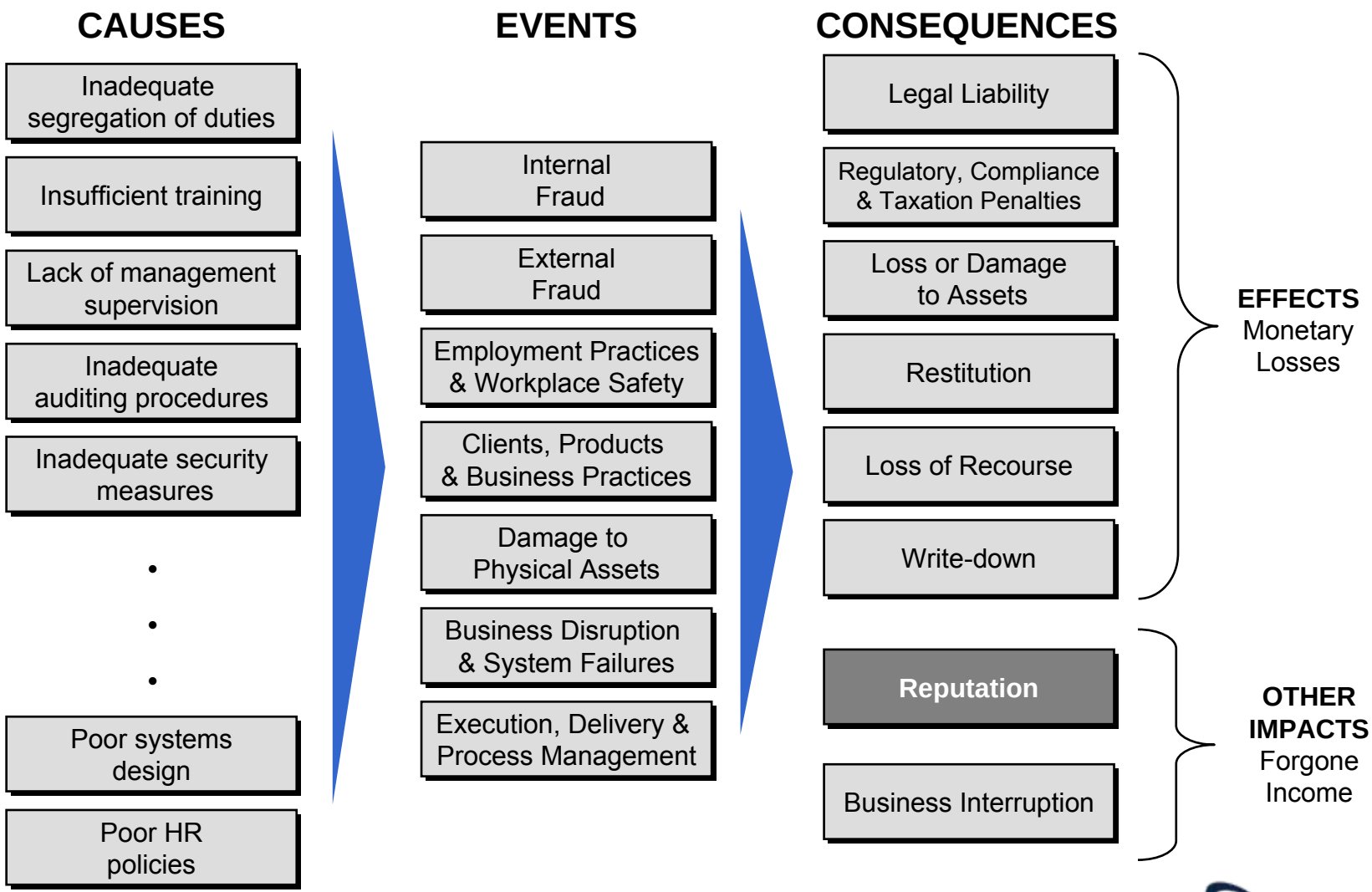
Managing operational risk requires a common language. What are the standards for defining and categorizing operational risk?

Management Information	Grouping of like items (homogenous risk types) to facilitate the management of similar risks which have similar controls
Statistical Consistency	Mutually exclusive (uncorrelated) and exhaustive (comprehensive), homogenous distributions
Logical Consistency	Must be based on natural boundaries; Examples must be consistent with definitions

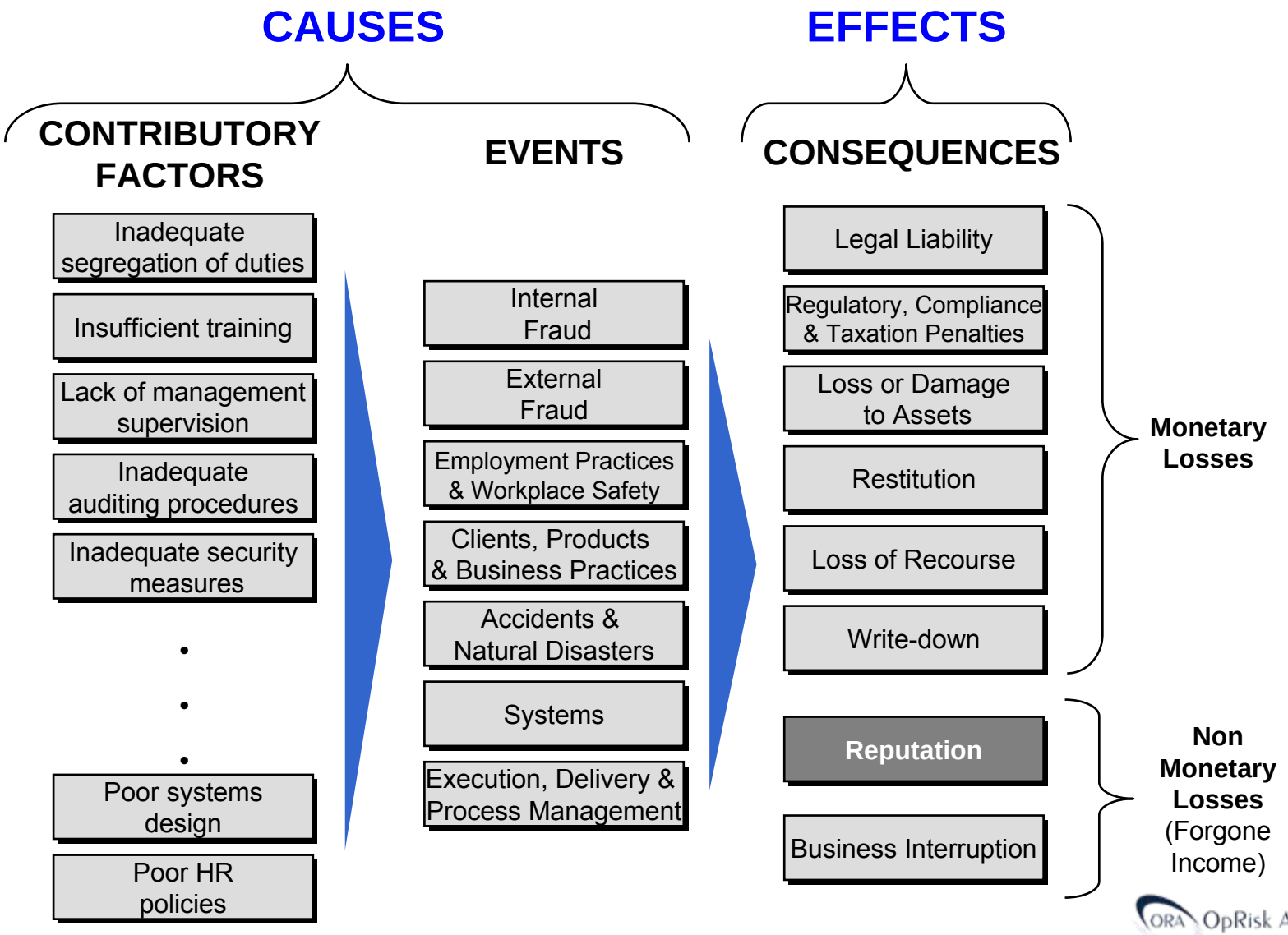
What comprises operational risk?

Transaction	Execution	Settlement	Technological
Inadequate Supervision	Information	Key Man	Lack of Resources
Reputation	Relationship	Theft	Criminal
Insufficient Training	Unauthorized Activities	Fraud	Rogue Trader
Compliance	Legal	Fiduciary	Physical Assets
Poor Management	Fixed Cost Structures	Customer	Sales Practices
		Business Interruption	People

The universe of operational is best understood in terms of its three dimensions: causes, events and consequences.



Upon further analysis, it appears that "causes" consist of both contributory factors and events (contributory factors and events together cause losses).



Event risk categories are represented in a three tier hierarchy

Primary	Secondary	Activity Examples
Internal Fraud *Losses due to acts of type intended to defraud misappropriate property, or circumvent regulations, the law or company policy, excluding diversity/discrimination events, which involve at least one internal party*	Unauthorized Activities	Transactions not reported (intentional), Transaction type unauthorized (w/monetary loss), Mismarking of position (intentional)
	Theft & Fraud	Fraud/credit fraud, worthless deposits, Theft, extortion, embezzlement, robbery, Misappropriation of assets, Malicious destruction of assets, Forgery, Check kiting, Smuggling, Accountant takeover, impersonation, Tax noncompliance, evasion (willful), Bribes/Kickbacks, Insider trading (not on firm's account)
External Fraud *Losses due to acts of type intended to defraud misappropriate property, or circumvent regulations, or the law by a third party*	Theft & Fraud	Theft/Robbery Forgery Check kiting
	Systems Security	Hacking damage, Theft of information (w/monetary loss)
Employment Practices and Workplace Safety *Losses arising from acts inconsistent with employment health or safety laws, or agreements, from payment of personal injury claims, or from diversity/discrimination events.*	Employee Relations	Compensation, benefit, termination issues, Organized labor activity, Poaching
	Safe Environment	General liability (slip and fall, etc), Employee health & safety rules events, Workers' compensation
	Diversity and Discrimination	All forms of discrimination

Event risk categories are represented in a three tier hierarchy

Primary	Secondary	Activity Examples
Clients, Products & Business Practices *Losses arising from an unintentional or negligent failure to meet a professional obligation to specific clients including fiduciary and suitability requirements), or from the nature or design of a product.*	Suitability, Disclosure & Fiduciary	Fiduciary breaches - guideline violations, Suitability - disclosure issues (know your customer etc.), Retail consumer disclosure violations, Breach of privacy, Aggressive sales, Account churning, Misuse of confidential information, Lender liability,
	Selection, Sponsorship & Exposure	Failure to investigate client per guidelines, Exceeding client exposure limits
	Advisory Activities	Disputes over performance of advisory activities
	Improper Business or Market Practices	Antitrust, Improper trade/market practices, Market manipulation, Insider trading (on firm's account), Unlicensed activity, Money Laundering
	Product Flaws	Product defects (unauthorized), Model errors
Damage to Physical Assets *Losses arising from loss or damage to physical assets from natural disaster or other events.*	Disasters and other events	Natural disaster losses, Human losses from external sources (terrorism, vandalism)
Business Disruption and System Failures *Losses arising from disruption of business or systems failures*	Systems	Hardware, Software, Telecommunications Utility outage/disruptions

Event risk categories are represented in a three tier hierarchy

Primary	Secondary	Activity Examples
Execution, Delivery & Process Management *Losses from failed transaction processing or process management, from relations with trade counter parties and vendors or from systems failures.*	Transaction Capture, Execution & Maintenance	Miscommunication, Data entry, maintenance, or loading error, Missed deadline or responsibility, Model/system misoperation, Accounting error, entity attribution error, Other task misperformance, Delivery failure, Collateral management failure, Reference data maintenance
	Monitoring and Reporting	Failed mandatory reporting obligation, Inadequate oversight, Inaccurate external report (loss incurred)
	Customer Intake and Documentation	Client permissions, disclaimers missing, Legal documents missing, incomplete
	Customer/Client Account Management	Unapproved access given to accounts (includes inadvertent access to one party on a joint account) Incorrect client records (loss incurred), Negligent loss or damage of client assets
	Trade Counter parties	Nonclient counter party misperformance, Misc. nonclient counter party disputes
	Vendors and Suppliers	Outsourcing, Vendor disputes

Placing loss data within a Business Line/Risk matrix helps reveal the risk profile of each business

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number	362	123	25	36	33	150	2	731
	Mean	35,459	52,056	3,456	56,890	56,734	1,246	89,678	44,215
	Standard Deviation	5,694	8,975	3,845	7,890	3,456	245	23,543	6,976
Trading & Sales	Number	50	4	35	50	46	210	3	398
	Mean	53,189	78,084	5,184	85,335	85,101	1,869	134,517	66,322
	Standard Deviation	8,541	13,463	5,768	11,835	5,184	368	35,315	10,464
Retail Banking	Number	45	4	32	45	42	189	3	360
	Mean	47,870	70,276	4,666	76,802	76,591	1,682	121,065	59,690
	Standard Deviation	7,687	12,116	5,191	10,652	4,666	331	31,783	9,417
Commercial Banking	Number	41	3	28	41	37	170	2	322
	Mean	43,083	63,248	4,199	69,121	68,932	1,514	108,959	53,721
	Standard Deviation	6,918	10,905	4,672	9,780	4,199	298	28,605	8,476
Payment & Settlements	Number	37	3	26	37	34	153	2	292
	Mean	38,774	56,923	3,979	62,209	62,039	1,363	98,063	48,349
	Standard Deviation	6,226	9,814	4,220	8,628	3,779	268	25,744	7,628
Agency Services	Number	44	4	33	44	40	184	2	349
	Mean	46,529	68,308	4,535	74,651	74,446	1,635	117,675	58,018
	Standard Deviation	7,472	11,777	5,045	10,353	4,535	321	30,893	9,154
Asset Management	Number	40	3	28	40	36	165	2	314
	Mean	41,876	61,477	4,081	67,186	67,002	1,472	105,908	52,217
	Standard Deviation	6,725	10,599	4,541	9,318	4,081	289	27,804	8,238
Retail Brokerage	Number	48	4	33	48	44	198	3	378
	Mean	50,252	73,773	4,898	80,623	80,402	1,766	127,090	62,660
	Standard Deviation	8069	12719	5449	11182	4898	347	33365	9886
Insurance	Number	43	4	30	43	39	179	2	340
	Mean	45,226	66,395	4,408	72,561	72,362	1,589	114,381	56,394
	Standard Deviation	7,262	11,447	4,904	10,063	4,408	312	30,028	8,897
Total	Number	710	152	268	384	351	1,598	21	3,484
	Mean	45,653	67,021	4,450	73,245	73,044	1,604	115,459	56,926
	Standard Deviation	7,331	11,555	4,950	10,158	4,450	315	30,311	8,981

RISK ASSESSEMENT

Risk can also be assessed using a likelihood-impact approach. This approach has been well documented by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

Risk Assessment

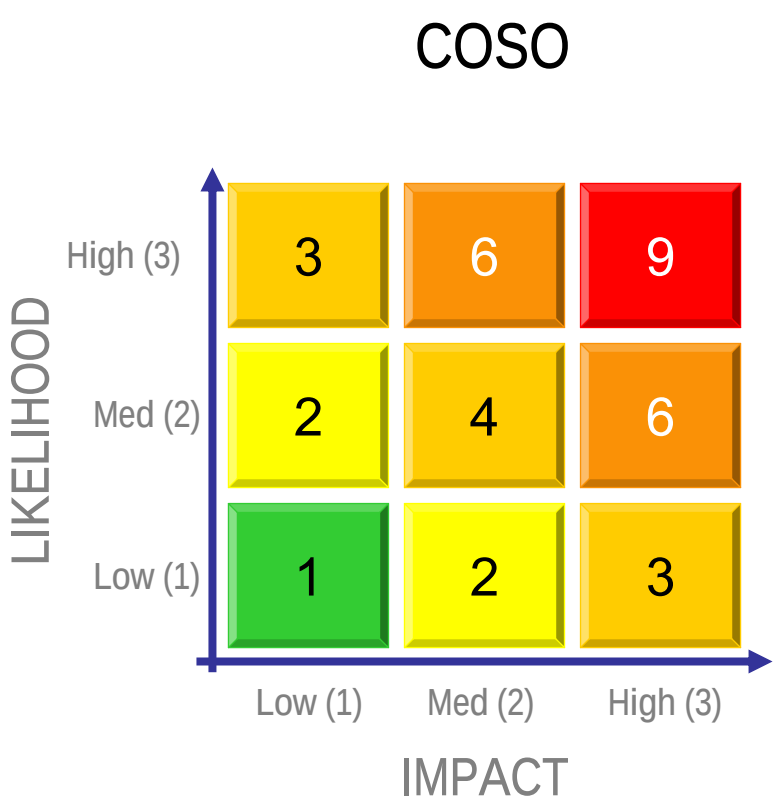
Risk assessment allows an entity to consider how potential events might affect the achievement of objectives. Management assesses events from two perspectives: likelihood and impact.

Likelihood represents the possibility that a given event will occur, while impact represents its effect should it occur. Estimates of risk likelihood and impact often are determined using data from past observable events, which may provide a more objective basis than entirely subjective estimates. Internally generated data based on an entity's own experience may reflect less subjective personal bias and provide better results than data from external sources. However, even where internally generated data are a primary input, external data can be useful as a checkpoint or to enhance the analysis. Users must be cautious when using past events to make predictions about the future, as factors influencing events may change over time.

An entity's risk assessment methodology normally comprises a combination of qualitative and quantitative techniques. Management often uses qualitative assessment techniques where risks do not lend themselves to quantification or when sufficient credible data required for quantitative assessments either are not practicably available or obtaining or analyzing data are not cost-effective. Quantitative techniques typically bring more precision and are used in more complex and sophisticated activities to supplement qualitative techniques. An entity need not use common assessment techniques across all business units. Rather, the choice of techniques should reflect the need for precision and the culture of the business unit. In any event, the methods used by individual business units should facilitate the entity's assessment of risks across the entity.

Source: COSO

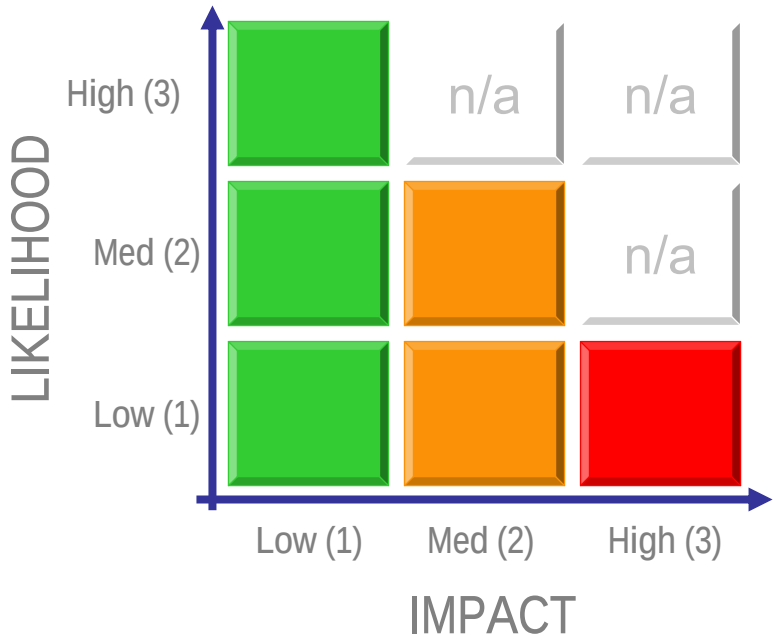
The COSO view of risk assessment is based on the likelihood and impact of a specific type of event; the output is probability weighted impact. The high risk area is in the top right corner of the matrix.



Likelihood x Impact = Risk

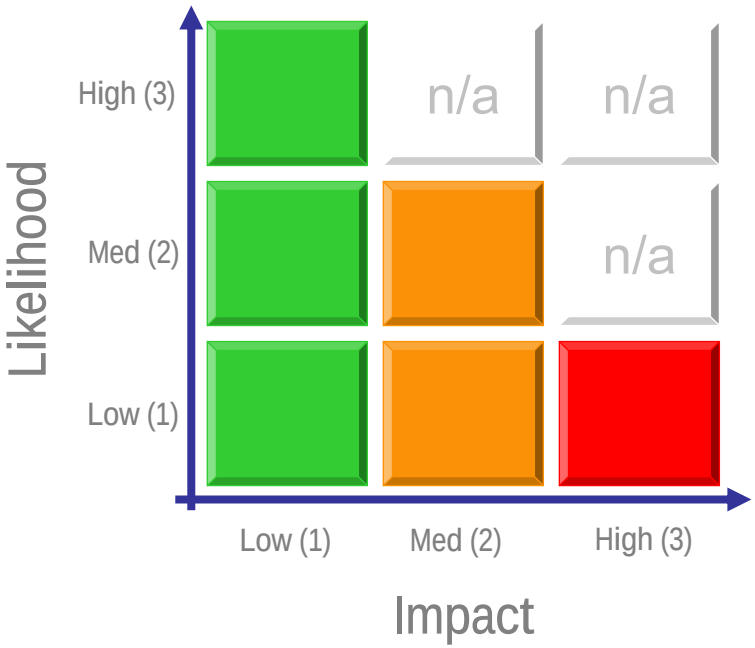
Under the risk management industry approach, the high risk area is the bottom right cell in the matrix.

BASEL II

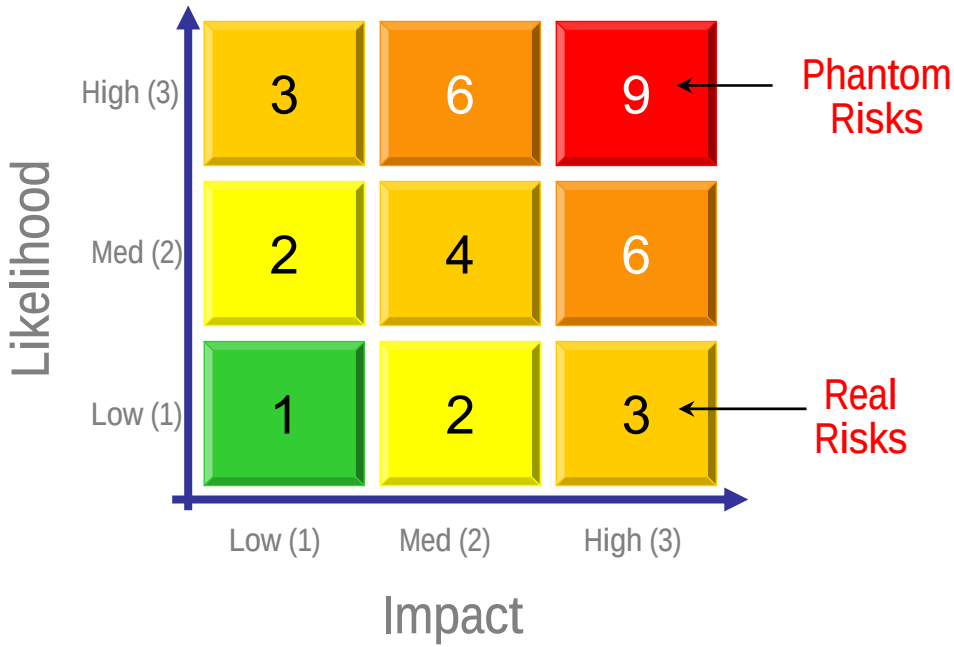


When compared, there are significant differences ….

BASEL II



COSO



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Using likelihood-impact analysis one can calculate risk results

Likelihood x Impact = Risk

Risk 1 : 10% x $10,000 = $1,000

Using likelihood-impact analysis one can calculate more than one outcome

Likelihood x Impact = Risk

Risk 1 : 10% x $10,000 = $1,000
Risk 2 : 1% x $50,000 = $ 500

Using likelihood-impact analysis one can calculate multiple outcomes

Likelihood x Impact = Risk

Risk 1 : 10% x $10,000 = $1,000
Risk 2 : 1% x $50,000 = $ 500

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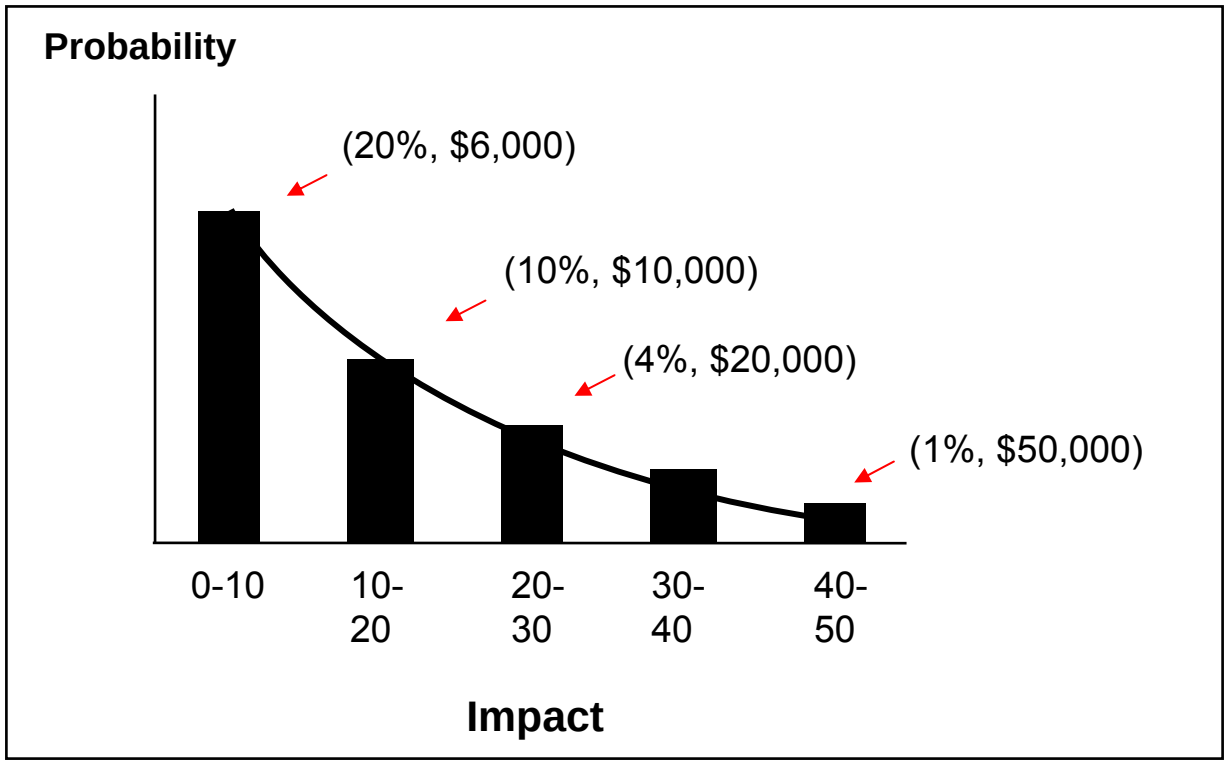
.
.

Risk 999 : 4% x $20,000 = $ 800
Risk 1000 : 20% x $ 6,000 = $1,200

The many probability and impact combinations represent a continuum

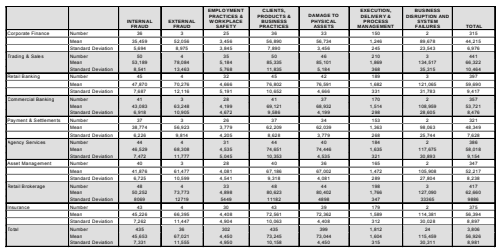


The unexpected loss is the value at risk. The expected loss is the cost of operational failure - it is the average amount of money a firm loses in sum on an annual basis.

INDIVIDUAL LOSS EVENTS

74,712,345
74,603,709
74,457,745
74,345,957
74,344,576
•
•
•
167,245
142,456
123,345
113,342
94,458

RISK MATRIX FOR LOSS DATA



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	Standard Deviation	5,694	6,975	3,845	7,890	3,456	245	23,543	9,976
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	Mean	83,189	79,094	6,194	85,335	86,101	1,999	134,517	99,322
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	Mean	67,872	73,276	4,846	79,902	76,391	1,982	121,065	89,890
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	Mean	41,879	61,477	4,081	67,186	67,002	1,472	106,168	82,217
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	Mean	50,232	73,773	4,898	80,823	80,402	1,766	127,396	62,860
	Standard Deviation	8089	12710	5449	11182	4898	347	33345	9886
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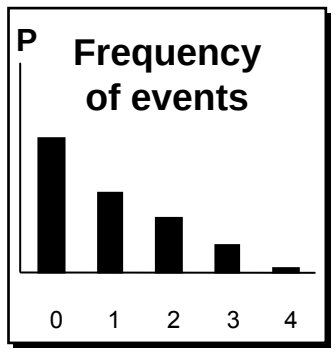
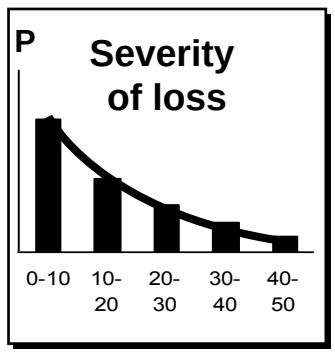
Total	Number	435	36	302	435	396	1,912	24	3,806
	Mean	45,653	67,021	4,450	73,246	73,044	1,604	115,458	69,926
	Standard Deviation	7,331	11,555	4,660	10,156	4,450	315	30,311	8,961

LOSS DISTRIBUTIONS

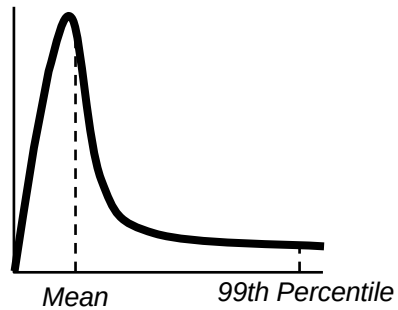




VAR CALCULATION

VaR Calculator e.g., Monte Carlo Simulation Engine

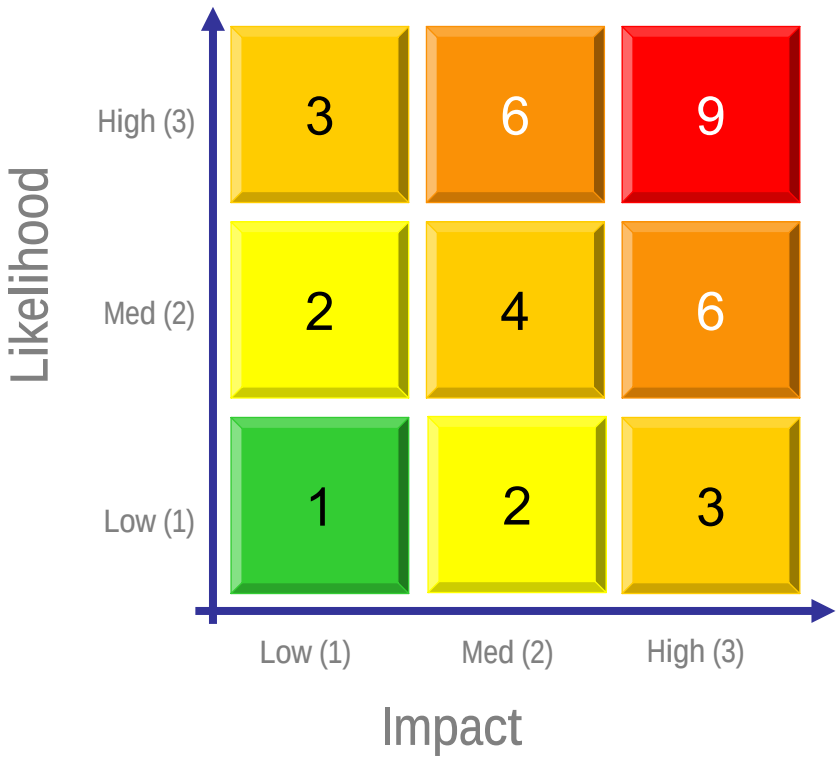
TOTAL LOSS DISTRIBUTION



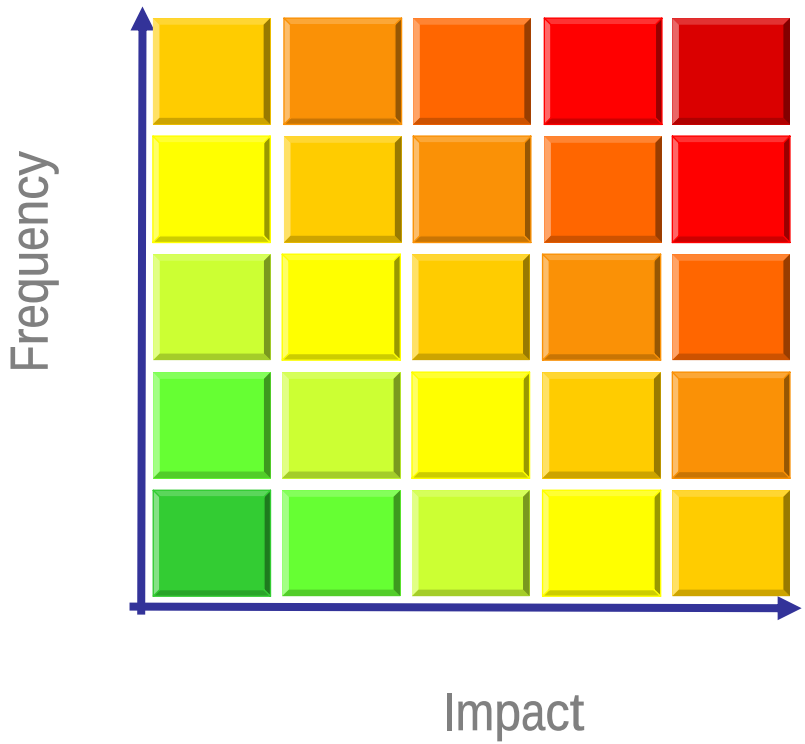
OpRisk Advisory

What is the difference between the COSO and AS/NZS 4360?

COSO



AS/NZS 4360



OpRisk Advisory

Additional comments about likelihood-impact analysis.

- What's the difference between a risk event and a loss event?

  There is no such thing as a risk event. An event is an incident that has happened; if it results in a loss then it becomes a loss event. Risk is the level of uncertainty surrounding an event or series of events.

- Likelihood-impact analysis allows you to measure the probability weighted damage from a specific event – the cost – not the risk surrounding the event and certainly not the aggregate risk from a class of events.
- Likelihood-impact analysis is more appropriate for crisis management than risk management. In crisis management one is trying to measure the magnitude of a potential loss from a specific, pre-defined event that is on the verge of taking place.
- As likelihood approaches 100%, the event becomes certain and the risk goes to zero.

Fundamentally different “world views” are driving the differences in the way banks approach operational risk management.

Traditional View

- “Operational risks are in the processes.”
- Begin by identifying the full spectrum of risks within each process.
- Assess these risks “before and after controls” to identify potential problem areas.
- Accept those risks that are not material or are adequately controlled.
- Develop action plans for those risks that need to be mitigated.

* * * * *

- Modeling operational risk is not useful for managing operational risk.
- Historical loss data is of little value for measurement purposes, because whenever a large loss takes place the organization improves its controls with respect to that risk; so that particular loss is no longer representative of the new control environment or the current risk profile.

Fundamentally different “world views” are driving the differences in the way banks approach operational risk management.

Loss Data Driven View (Basel II)

- “Operational risks manifest themselves across the entire spectrum of businesses.”
- Begin by defining the universe of operational risks using mutually exclusive and exhaustive risk categories.
- Use external historical loss data to populate a business-line/risk matrix; let the data tell you where the risks really exist.
- Measure the risks in each cell within the matrix.
- Using the same matrix calculate scores which represent the quality of the internal control environment; compare risk values and control scores.
- Optimize the risk control relationship in the context of cost benefit analysis.
- Monitor risks values and control scores as they change over time.

LOSS DATA ISSUES

Three sources of loss data may be considered

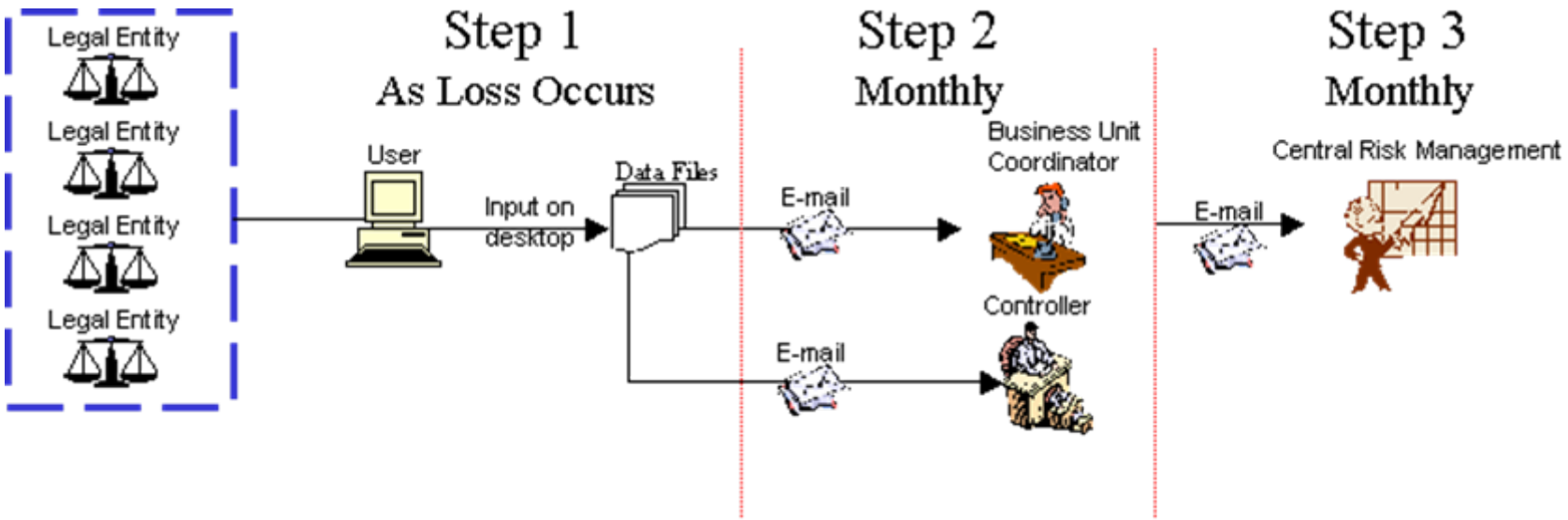
Internal Data	Data drawn directly from the entity whose risk is being measured; this is the most relevant data set, but such data is generally insufficient for most modeling and statistical analysis purposes because of the small sample size
External Pooled Data	Public and non-public data drawn from a loss data sharing consortium; this data is less relevant than internal data, but offers larger sample allowing for more accurate modeling/statistical analysis
External Public Data	Data drawn from public sources; less relevant than internal data, contains a larger set of "tail events," but subject to numerous biases – so cannot be used directly for modeling.

While one would expect that consortium data will eventually prove to be more useful than external public data, this will only be true if these initiatives reach critical mass and the data is honestly reported and consistently categorized

The use of historical data is open to criticism

- Some historical data may not be relevant because every time a large loss takes place the bank improves its controls, thus changing its risk profile
- After a restructuring many risk profiles change, thus much of the historical data may no longer be representative of the new business line structure
- Some losses have taken place during atypical circumstances, e.g., systems integrations, and are therefore not representative of the ”normal” risk environment
- External data comes from so many diverse institutions, with differing sizes, cultures, risk appetites, control structures, procedures and business mixes that very little of this loss data can be relevant to a given institution
- It will be hard to make good use of pooled external data, because it is unlikely that the data will have been reported consistently on a comprehensive basis.

A formal process for collecting loss event data must be implemented



Loss data needs to be adjusted for inflation and scaled for size

Inflation adjustment:

$10 million loss in 1990 = $12.4 million loss in 2001

Scale Adjustment:

$10 million loss when a $2 billion (revenue) bank = $13.2 million loss when a $6 billion bank[1]

$$Scaled\ Loss = L_{DB}\left[\frac{R_{\text{int}}}{R_{\text{ext}}}\right]^{n}$$

L_{DB} = Actual Loss experienced by bank

R_{ext} = Revenue of external firm

R_{int} = Revenue of firm

n = Scaling co-efficient determined by regression analysis

[1] Shih, J., A. Samad-Khan and P. Medapa, "Is the Size of an Operational Loss Related to Firm Size," *Operational Risk* (January 2000)

WHAT IS EXPECTED LOSS

What is expected loss?

- Are expected losses the small losses and unexpected losses the large losses?
  - The expected loss is a statistical concept. In risk management, expected loss is the expected value of a distribution, or the arithmetic mean of the distribution.
  - Other measures of central tendency are the median (the 50th percentile) and the mode (the most common observation).
  - In a normal distribution the mean, median and mode have the same value.
  - In a right skewed (fat tailed) distribution the mean is greater than the median, which is greater than the mode.

Why is it difficult to estimate the expected loss?

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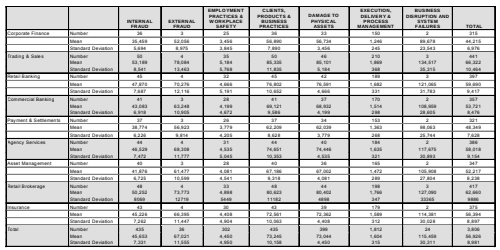

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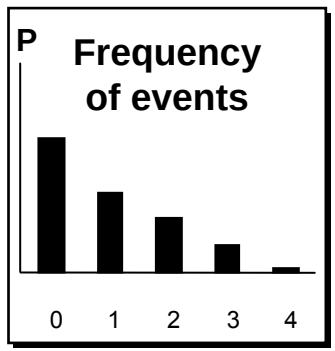
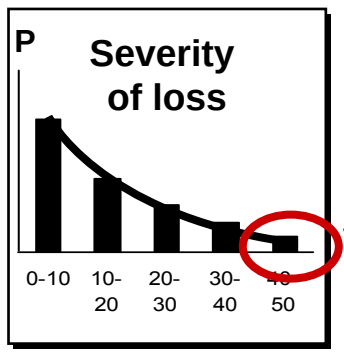
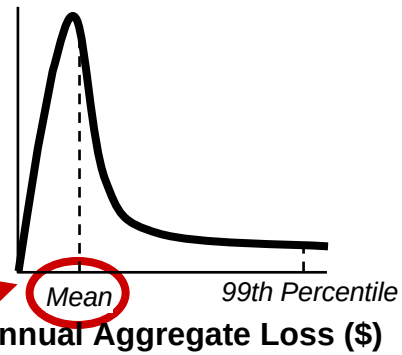




VAR CALCULATION

VaR Calculator e.g., Monte Carlo Simulation Engine

TOTAL LOSS DISTRIBUTION



What is the impact of the tail on the mean?

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Why is it important to know the value of the expected loss?

- The expected loss is part of the cost of doing business.
- In order to price a firm's products one must have a reliable estimate of the expected loss.
- Using the median value, instead of the mean will underestimate the cost of doing business. This will systematically bias product prices in high risk businesses, and will provide unrealistically optimistic profitability estimates. These inaccurate estimates could lead to bad investment decisions.

MODELING OPERATIONAL RISK

Risk is measured using internal and external loss data. The two measures of exposure are the aggregate mean and aggregate Value at Risk (VaR).

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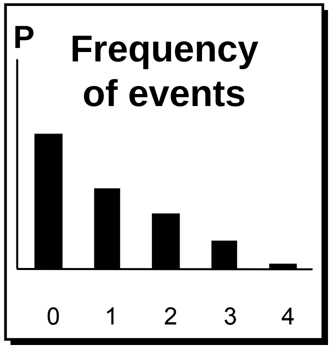

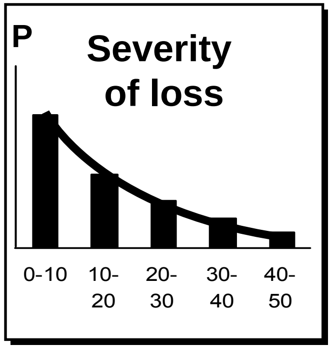

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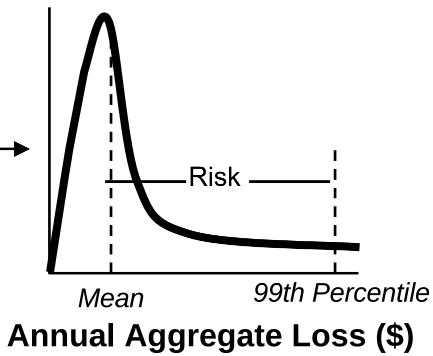

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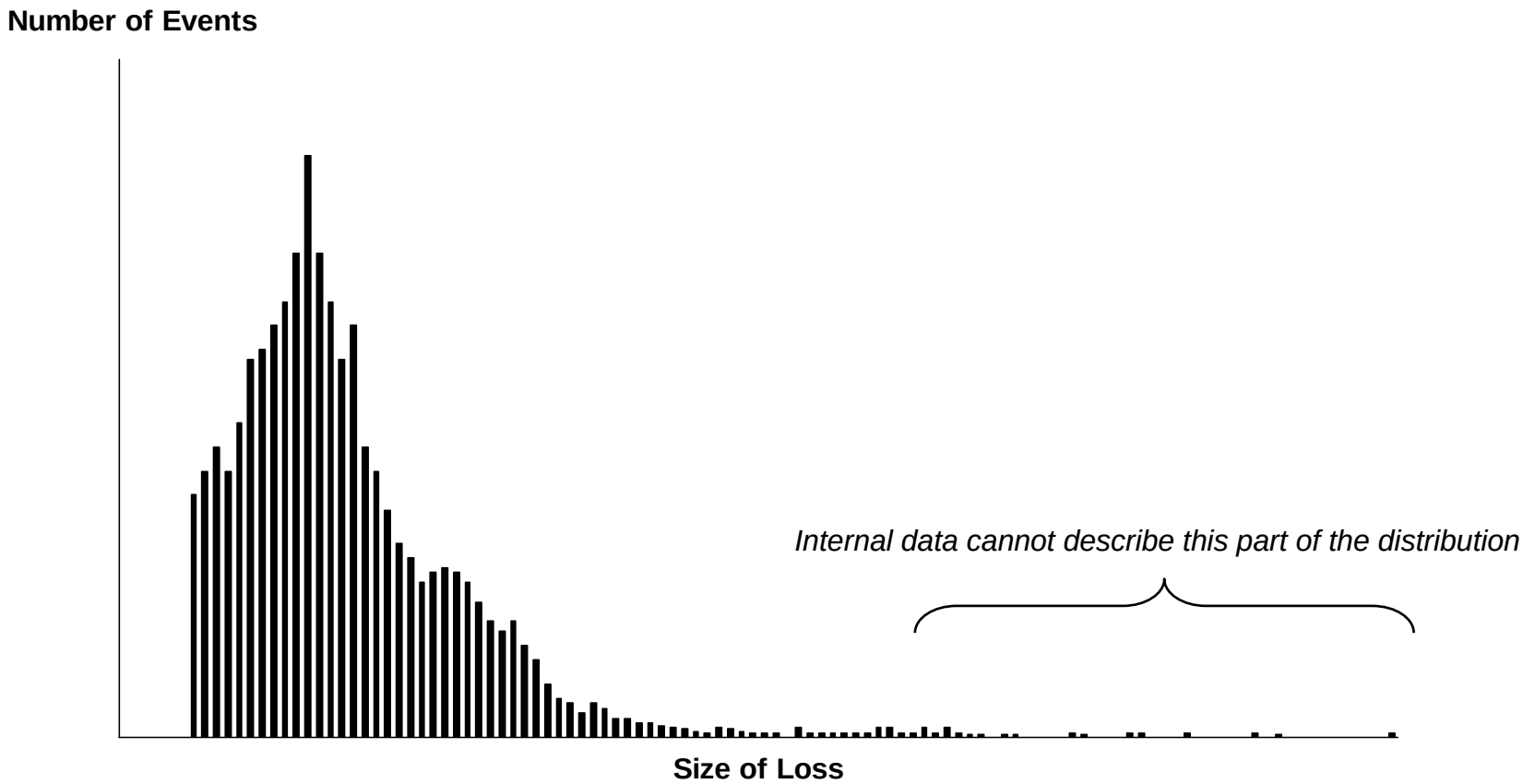
Internal data generally does not contain a sufficient number of the tail events to accurately describe that part of the distribution, therefore one needs to supplement internal data with external data



But looking at an internal data matrix one can see that some cells have "complete" information and can be modeled independently. However, the cells that represent the highest risk generally have the least data.

INTERNAL
EVENT RISK MATRIX

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Payment & Settlements	Number	37	3	[illegible]	37	34	153	2	292
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Retail Brokerage	Number	48	4	33	48	44	198	3	378
	Mean	50,252	73,773	4,898	80,623	80,402	1,766	127,090	62,660
	Standard Deviation	8069	12719	5449	11182	4898	347	33365	9886
Insurance	Number	43	4	30	43	39	179	2	340
	Mean	45,226	66,395	4,408	72,561	72,362	1,589	114,381	56,394
	Standard Deviation	7,262	11,447	4,904	10,063	4,408	312	30,028	8,897
Total	Number	710	152	268	384	351	1,598	21	3,484
	Mean	45,653	67,021	4,450	73,245	73,044	1,604	115,459	56,926
	Standard Deviation	7,331	11,555	4,950	10,158	4,450	315	30,311	8,981

There are several data issues to address in modeling operational risk

- Internal data is the most relevant source of information for measuring operation risk, but it is generally insufficient (e.g., including or excluding one loss significantly changes the results).
- One cannot directly mix internal and external data, because each loss carries with it an associated probability, which has meaning only in the context of the distribution from which it was drawn.
- All operational loss data is collected above a threshold level, making it difficult to estimate parameters for modeling.
- The body of the data generally represents a lognormal distribution, while the tail represents an extreme value distribution. It is therefore very difficult to model the entire range of losses with one theoretical distribution.
- External data comes from so many diverse institutions, with differing sizes, cultures, risk appetites, control structures, procedures and business mixes that very little of this loss data can be relevant to a given institution

How can external data be relevant to my bank?

Size	Larger institutions (and businesses) are likely to experience more losses than smaller institutions. These institutions are also likely to suffer larger losses.
Control	Institutions with weak controls are more likely to be represented in the database because they experience more losses. These institutions are also likely to suffer more large losses than well controlled institutions.
Data Capture	In publicly reported data, the larger losses are more likely to be reported that smaller losses.
Infrastructure / IT	Less technologically advanced institutions (and businesses) are likely to experience more losses than more advanced institutions. These institutions are also likely to suffer larger technology losses.
Media	Large losses more likely to be reported than small losses.
Legal Environment	The legal system in certain countries may lead to more frequent and/or larger losses.

Modeling operational risk requires the use of relevant external data

SELECTED EXAMPLES

FIRM NAME	BUSINESS LINE - LEVEL 1	BUSINESS LINE - LEVEL 2	LOSS AMOUNT ($M)	DESCRIPTION	EVENT RISK CATEGORY	SUB RISK CATEGORY	COUNTRY OF DOMICILE	SETTLEMENT YEAR
Nomura Securities International Incorporated	Trading & Sales	Sales	47.90	In July 1998, Nomura Securities International Inc, the US brokerage unit of Nomura Securities of Japan, reported that it had agreed to pay $47.9M in settlement of charges stemming from the Orange County's bankruptcy lawsuit. The suit was filed against the firm for investing municipal county funds in high risk derivatives and municipal bond trading that was illegal under California law. The Securities Exchange Commission reported that Nomura was one of the brokerage firms responsible for the county's bankruptcy. Orange County claimed to have lost $1.64 billion. The SEC stated that Nomura had lent the county huge sums of money, which it reinvested in search of high returns. Nomura also supplied the risky securities favoured by then county Treasurer and Tax Collector Robert L. Citron that plunged in value when interest rates rose sharply in 1994. The SEC also charged the firm for its role in underwriting key bonds for the county and accused Citron of illegally investing in volatile securities that were unsuitable for public funds.	Clients, Products & Business Practices	Suitability, Disclosure & Fiduciary	Japan	1998
ABN Amro Holding NV	Agency Services	Corporate Trust	141.00	In November 1998, ABN Amro Holding NV, a Netherlands full services bank and Europe's eighth largest banking firm, reported that it had realized a loss of 174M guilders ($141M) due to forgery, embezzlement and fraud perpetrated by four of its former employees. The four allegedly committed about 600 fraudulent transactions, making improper use of about 30 client accounts. The bank said that after uncovering the irregularities, it fired the employees and notified law enforcement officials in February, 1997. The transactions took place within the bank's trust department, whose functions included maintaining bank accounts for 600 to 800 clients living abroad. Its products included numbered bank accounts for clients whose identities were known only within the department. Employees also executed orders solely on the basis of telephone instructions. The bank said that, upon inspection, some packages in custody that supposedly contained diamonds turned out to contain false diamonds, and diamond shipment orders given by clients were sometimes accompanied by falsified invoices.	Internal Fraud	Theft & Fraud	Netherlands	1998
Merrill Lynch & Company	Trading & Sales	Sales	100.00	In December 1997, Merrill Lynch & Co, a US broker-dealer, reported that it had agreed to pay $100M in fines to settle charges of price fixing on the Nasdaq stock market. The Securities and Exchange Commission fined 30 Wall Street firms more than $910M in this regard. The lawsuit alleged that as many as a million investors lost billions of dollars because of collusion among the firms between 1989 and 1994. This collusion caused an artificial widening of spreads, the gap between the purchase and selling prices of stocks, thereby adding to dealer profits. The settlement also required the firms to improve trading policies and procedures. The case began in 1994, when the SEC and the Justice Department accused major Nasdaq dealers of conspiring to fix the bid-ask spreads on stock quotes resulting in extra costs to ordinary investors on their stock trades. Under the settlement, the brokerage firms with the most alleged violations agreed to pay higher fines. In making its original case, the SEC charged that major Nasdaq dealers harassed or refused to trade with others who tried to offer investors a better price for a stock.	Clients, Products & Business Practices	Improper Business or Market Practices	United States	1997
WGZ Bank	Trading & Sales	Proprietary Positions	200.37	In October 1998, Westdeutsche Genossenschafts-Zentralbank AG (WGZ-Bank), a German commercial bank, reported that it had realised a loss of DM 377 ($200.4M) due to computer fraud perpetrated by two employees over the past sixteen months. The bank has initiated a case against the two employees, who used a loophole in the bank's computer system for currency derivatives. They entered unrealistic intermediary values, which the system failed to document and managed to realise the profits in their derivative securities. The fraud was only discovered after the installation of an updated system, required under a new law, which eliminates the opportunity for such manipulation.	Internal Fraud	Systems Security	Germany	1998
Korea First Bank	Commercial Banking	Commercial Banking	93.00	In April 1998, Korea First Bank, a South Korean commercial bank with operations in the US, reported that it had agreed to pay $93M in settlement of a lawsuit that charged it with wrongfully dishonoring its irrevocable letter of credits. The New York Appellate Court ruled in favour of CalEnergy Company Inc, a global energy company that manages and owns an interest in over 5000 megawatts of power generation capability among various facilities in operation, construction and development worldwide. Casecnan Water and Energy Company Inc, a subsidiary of Calenergy was executing a power project in the Philippines. Hanbo Corporation had been acting as the turnkey contractor and guarantor for the Casecnan project.KFB's letter of credit was issued as financial security for the obligations of Hanbo. The contract with Hanbo Corp. was terminated by Casecnan due to Hanbo's insolvency and other misperformance in the project, at which time Casecnan made an initial draw on the KFB letter of credit securing Hanbo's performance under the contract. Furthermore, Casecnan had made three susbsequent draws on the letter of credit, all of which were opposed by Hanbo and draws under the letter of credit were dishonoured by Korea First Bank.	Clients, Products & Business Practices	Improper Business or Market Practices	South Korea	1998
Citibank	Commercial Banking	Commercial Banking	30.00	In September 1999, Citibank, a US commercial bank with global operations and unit of Citigroup, reported that it had realized a loss of $30M due to credit fraud. The firm's UK branch was one of 20 financial institutions operating in the Middle East which were the victims of fraud. Madhav Patel, an Indian businessman, allegedly deceived the bank by using forged documents to secure letters of credit guaranteeing payment for bogus transactions. The alleged fraud came to light earlier this year when Patel's British registered firm, Solo Industries, ran into financial difficulties in the Middle East. Patel, who ran several metal smelting businesses in Dubai, secured letters of credit from the firm as well as other banks to guarantee payments on shipments of metal to the United Arab Emirates. Police believe the shipments were bogus and the money was diverted elsewhere. Patel moved to London after his business collapsed in May. He has since disappeared.	External Fraud	Theft & Fraud	United States	1999
Credit Suisse First Boston Corporation	Corporate Finance	Corporate Finance	4.00	In May 1997, Credit Suisse First Boston Corp., a US investment bank and unit of Credit Suisse Group, reported that it had agreed to pay $4M in a settlement with 33 former investment bankers in its municipal bond unit. The former employees claimed that the firm improperly refused to pay them annual bonuses when they were terminated. CSFB took the unusual step of offering no bonuses to laid off municipal bond investment bankers after the firm shut its municipal unit in 1995, even though the bankers had worked through 1994 and had generated profts for the company. At the same time, some bankers in the mortgage-backed securities unit were paid bonuses despite a loss of about $40M at that unit.	Employment Practices and Workplace Safety	Employee Relations	Switzerland	1997
Chase Manhattan Bank	Payment and Settlement	External Clients	1.45	In January 1995, Chase Manhattan Bank, a US commercial bank, reported that it had agreed to pay $1.5M in settlement with a publishing company for having improperly endorsed checks used in an embezzlement scheme. Knight Publishing lost nearly $2M between 1985 and 1992 in a scheme run by Oren Johnson, a production supervisor at the newspaper. Johnson admitted authorizing the company to issue checks to Graphic Image, a commercial printing firm, for supplies that were never delivered. He split the money with two other men and all three pled guilty to mail fraud, money-laundering and conspiracy. Knight Publishing claimed Chase Manhattan should not have honored the checks because the endorser's name did not match the name on the checks.	Execution, Delivery & Process Management	Transaction Capture, Execution & Maintenance	United States	1995
Phatra Thanakit	Retail Brokerage	Retail Brokerage - Secondary markets	1.60	In November 1993, Phatra Thanakit, a Thailand brokerage firm, reported that it had agreed to pay 40M Bhat($1.6M) in fines as settlement of Securities Exchange of Thailand (SET) charges alleging violations of trading rules. The fine was levied over the firm's role in a technical error during trading operations. The firm, one of the five biggest brokers in the Thai stock market, was responsible for an error involving a sale order for 200 million shares in Ayudha Investment (AITCO) which had only 25 million shares outstanding. The firm said that one of its subbrokers placed a sell order for 2000 shares but a computer fault converted the order to 200 million shares. The company tried to cancel the order about 20 minutes after the order was placed on SET's computerized board and notified the exchange of the technical error. However, some 18 million shares, worth more than 2.3 billion baht, had already been matched with buying orders. The exchange called an emergency meeting at the end of the day's trading and decided to void the transactions for the 18 million shares.	Business Disruption and System Failures	Systems	Thailand	1993

Source SAS OpRisk Global Data

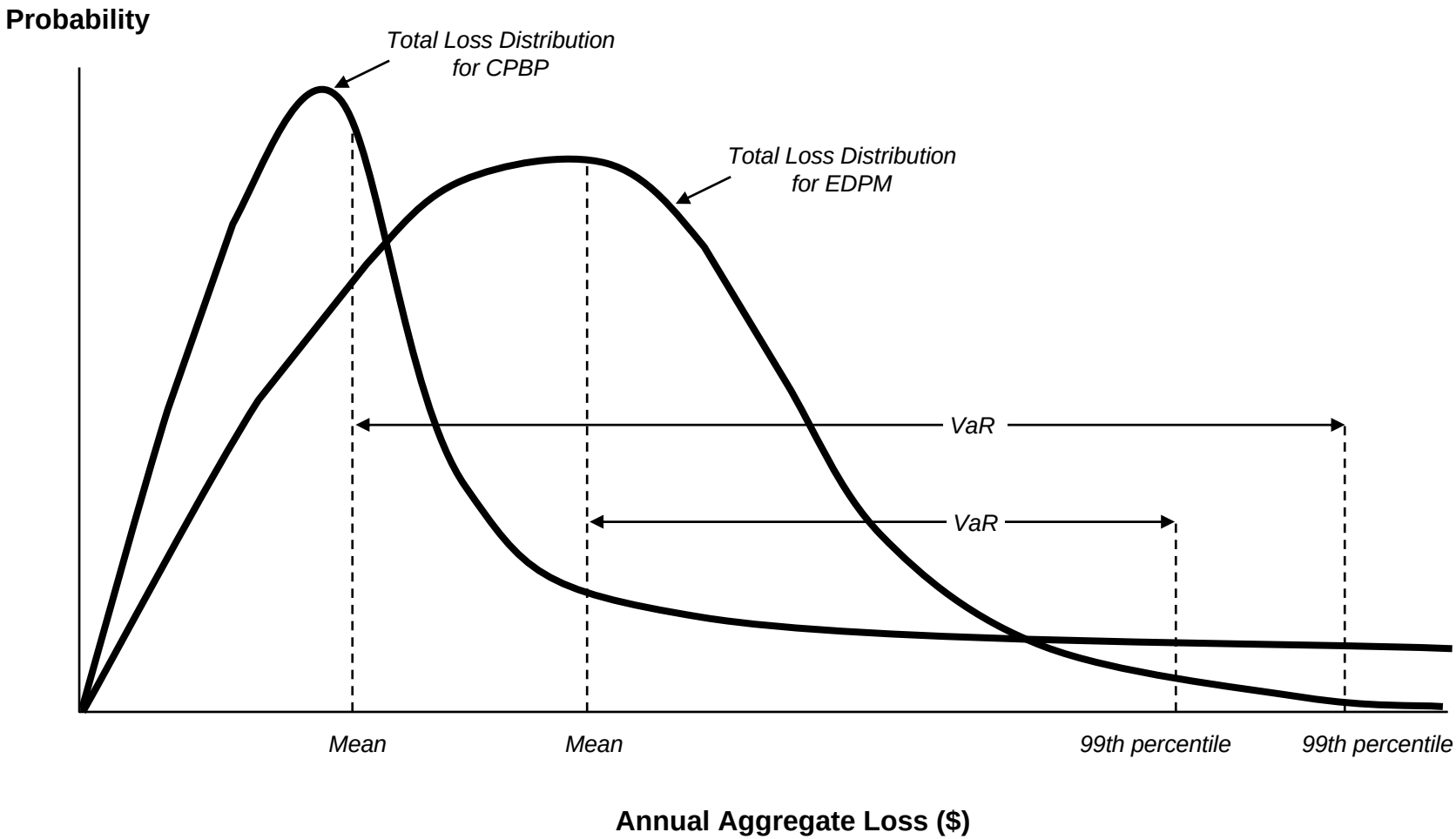
OpRisk Advisory

Internal and external loss data should be placed in separate matrixes (by business line and risk category)

EXTERNAL
EVENT RISK MATRIX

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number	362	123	25	36	33	150	2	731
	Mean	35,459	52,056	3,456	56,890	56,734	1,246	89,678	44,215
	Standard Deviation	5,694	8,975	3,845	7,890	3,456	245	23,543	6,976
Trading & Sales	Number	50	4	35	50	46	210	3	398
	Mean	53,189	78,084	5,184	85,335	85,101	1,869	134,517	66,322
	Standard Deviation	8,541	13,463	5,768	1[illegible]335	5,184	368	35,315	10,464
Retail Banking	Number	45	4	32	4[illegible]	42	189	3	360
	Mean	47,870	70,276	4,666	[illegible]802	76,591	1,682	121,065	59,690
	Standard Deviation	7,687	12,116	5,191	[illegible]	4,666	331	31,783	9,417
Commercial Banking	Number	41	3	28	[illegible]	37	170	2	322
	Mean	43,083	63,248	4,[illegible]	[illegible]121	68,932	1,514	108,959	53,721
	Standard Deviation	6,918	10,905	4,[illegible]	9,586	4,199	298	28,605	8,476
Payment & Settlements	Number	37	3	[illegible]6	37	34	153	2	292
	Mean	38,774	56,9[illegible]	[illegible]	62,209	62,039	1,363	98,063	48,349
	Standard Deviation	6,226	9,814	4,[illegible]05	8,628	3,779	268	25,744	7,628
Agency Services	Number	44	4	31	44	40	184	2	349
	Mean	46,529	68,308	4,535	74,651	74,446	1,635	117,675	58,018
	Standard Deviation	7,472	11,777	5,045	10,353	4,535	321	30,893	9,154
Asset Management	Number	40	3	28	40	36	165	2	314
	Mean	41,876	61,477	4,081	67,186	67,002	1,472	105,908	52,217
	Standard Deviation	6,725	10,599	4,541	9,318	4,081	289	27,804	8,238
Retail Brokerage	Number	48	4	33	48	44	198	3	378
	Mean	50,252	73,773	4,898	80,623	80,402	1,766	127,090	62,660
	Standard Deviation	8069	12719	5449	11182	4898	347	33365	9886
Insurance	Number	43	4	30	43	39	179	2	340
	Mean	45,226	66,395	4,408	72,561	72,362	1,589	114,381	56,394
	Standard Deviation	7,262	11,447	4,904	10,063	4,408	312	30,028	8,897
Total	Number	710	152	268	384	351	1,598	21	3,484
	Mean	45,653	67,021	4,450	73,245	73,044	1,604	115,459	56,926
	Standard Deviation	7,331	11,555	4,950	10,158	4,450	315	30,311	8,981

The term inherent risk has meaning when represented in a distributional context. When you factor out controls you can observe which businesses are inherently high risk and which are inherently high cost.



The only severity information one can obtain from external public data is relative information (model transferability) – assuming the biases are consistent across all categories

EXTERNAL
EVENT RISK MATRIX
SEVERITY PARAMETERS IN LOG TERMS

		INTERNAL FRAUD	EXTERNAL FRAUD	EXECUTION, DELIVERY & PROCESS MANAGEMENT
Corporate Finance	Number	362	123	150
	Mean	9	6	6
	Standard Deviation	6	4	2

EXTERNAL
EVENT RISK MATRIX
SEVERITY PARAMETERS IN RELATIVE TERMS

		INTERNAL FRAUD	EXTERNAL FRAUD	EXECUTION, DELIVERY & PROCESS MANAGEMENT
Corporate Finance	Number	362	123	150
	Mean	1.5	1	1
	Standard Deviation	3	2	1

From internal data we seek pivot cells – those cells that have enough information to reliably calculate severity parameters

INTERNAL
EVENT RISK MATRIX

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number	36	3	25	36	33	234	2	731
	Mean	35,459	52,056	3,456	56,890	56,734	3	89,678	44,215
	Standard Deviation	5,694	8,975	3,845	7,890	3,456	2	23,543	6,976
Trading & Sales	Number	50	4	35	50	46	210	3	398
	Mean	53,189	78,084	5,184	85,335	85,101	1,869	134,517	66,322
	Standard Deviation	8,541	13,463	5,768	11,835	5,184	368	35,315	10,464
Retail Banking	Number	45	4	32	[illegible]	42	189	3	360
	Mean	47,870	70,276	4,666	[illegible]	6,591	1,682	121,065	59,690
	Standard Deviation	7,687	12,116	5,191	[illegible]	4,666	331	31,783	9,417
Commercial Banking	Number	41	3	28	[illegible]	37	170	2	322
	Mean	43,083	63,248	4,199	[illegible]	68,932	1,514	108,959	53,721
	Standard Deviation	6,918	10,905	4,6[illegible]	[illegible]	4,199	298	28,605	8,476
Payment & Settlements	Number	37	3	[illegible]	37	34	153	2	292
	Mean	38,774	56,9[illegible]	[illegible]	62,209	62,039	1,363	98,063	48,349
	Standard Deviation	6,226	9,814	[illegible]	8,628	3,779	268	25,744	7,628
Agency Services	Number	44	4	31	44	40	184	2	349
	Mean	46,529	68,308	4,535	74,651	74,446	1,635	117,675	58,018
	Standard Deviation	7,472	11,777	5,045	10,353	4,535	321	30,893	9,154
Asset Management	Number	40	3	28	40	36	165	2	314
	Mean	41,876	61,477	4,081	67,186	67,002	1,472	105,908	52,217
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	Mean	45,653	67,021	4,450	73,245	73,044	1,604	115,459	56,926
	Standard Deviation	7,331	11,555	4,950	10,158	4,450	315	30,311	8,981

Using the pivot cell and relative parameter ratios from external data we can estimate severity parameter for all cells in a business line

INITIAL INTERNAL EVENT RISK MATRIX

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number						234		
	Mean						3		
	Standard Deviation						2		

PARAMETER RATIOS FROM EXTERNAL EVENT RISK MATRIX

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number								
	Mean	1.5	1				1		
	Standard Deviation	3	2				1		

FINAL INTERNAL EVENT RISK MATRIX

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number						234		
	Mean	4.5	3				3		
	Standard Deviation	6	4				2		

Determining the most appropriate frequency distribution

- Frequency is assumed to follow a generalized Poisson Process:

  If Mean frequency = Variance => Poisson

  If Mean frequency > Variance => Binomial

  If Mean frequency < Variance => Negative Binomial (Mixed Poisson)

Determining the most appropriate severity distribution

- Severity has been observed to have a Kurtosis (in log terms) in the range of 3-7. This suggests that using a log normal distribution would understate VAR, whereas using a Weibull distribution would overstate VAR.
- Distribution fitting through MLE – Maximum Likelihood Estimation or MDE Minimum Distance Estimation (a least squares approach):
  - Lognormal-Gamma
  - Lognormal
  - Burr
  - Generalized Pareto
  - Weibull
  - Exponential
  - Wald

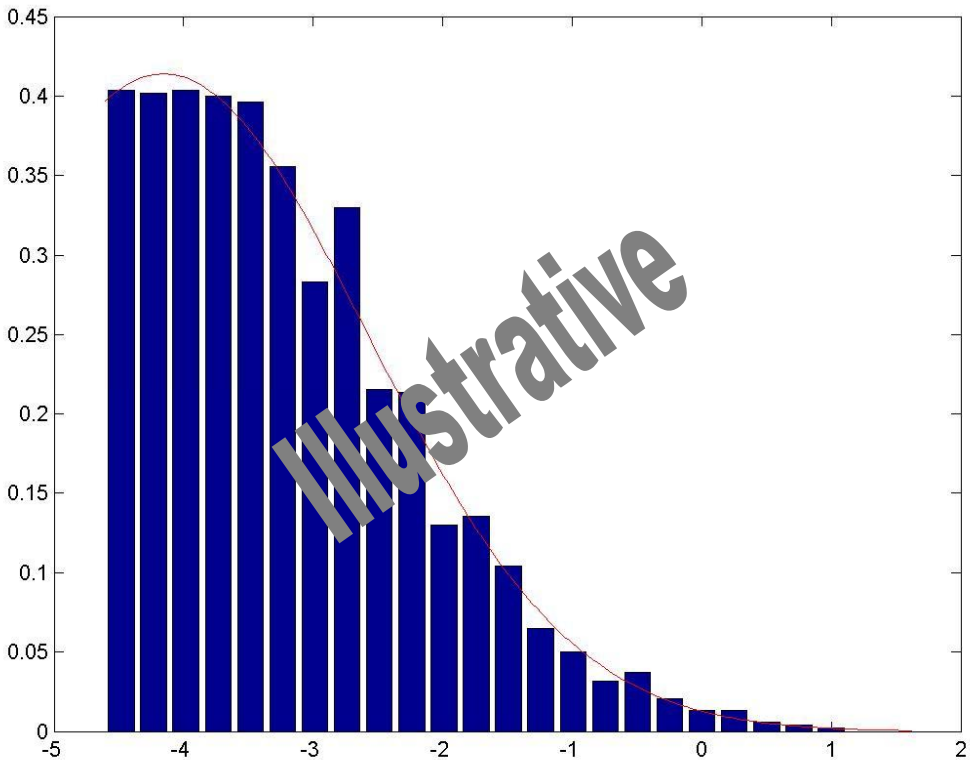
Several "goodness of fit" tests have been designed to help determine which theoretical distribution best represents the empirical data

PARAMETERS	Lognormal	Lognormal Gamma	Burr	GPD	Weibull
a	-4.320	-4.253	2.018	0.029	0.005
b	1.870	1.618	0.046	-0.678	0.183
γ		3.326	0.832		
TEST					
Anderson Darling	0.465	0.255	0.331	0.432	2.949
Kalmogorov-Smirnov	0.034	0.016	0.029	0.045	0.284
Chi Squared	18.341	11.114	14.318	19.467	228.345

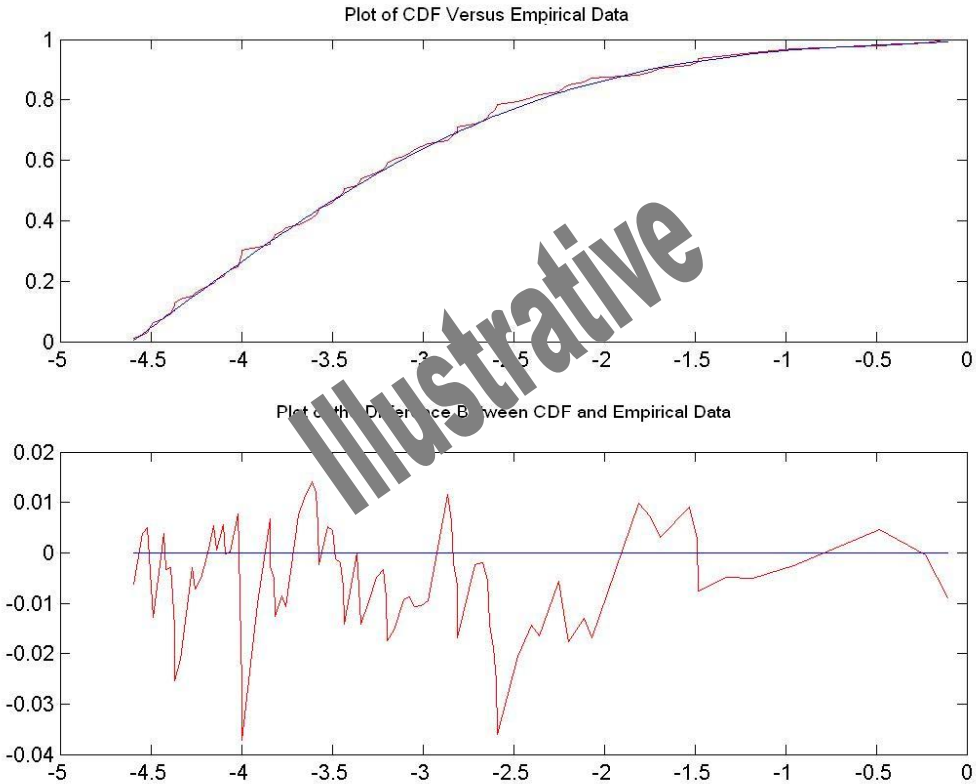
KS @ 20% Significance 0.0312

Losses represented in log terms (millions)

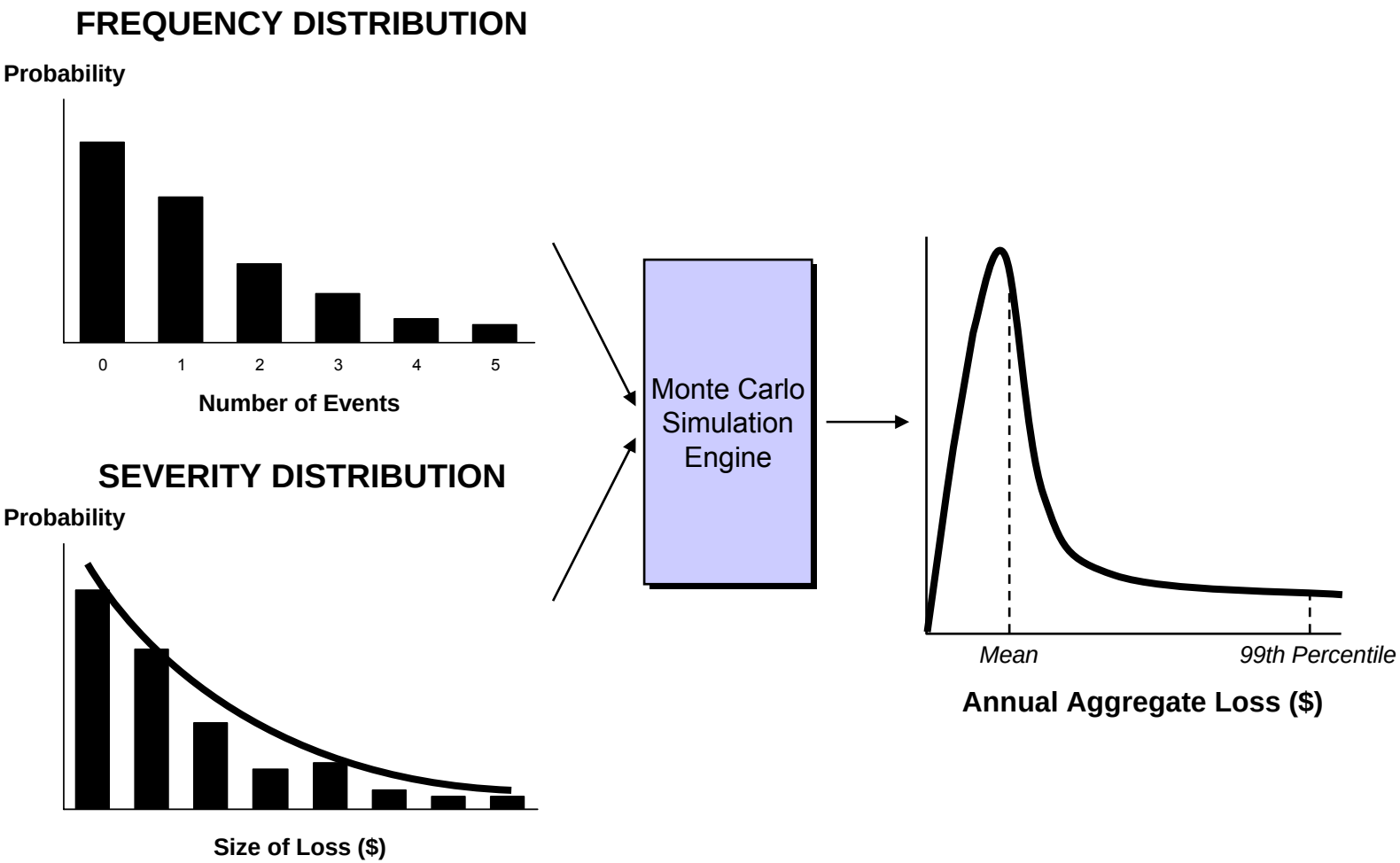
Goodness of fit results can also be viewed in graphical format (PDF vs. Empirical)



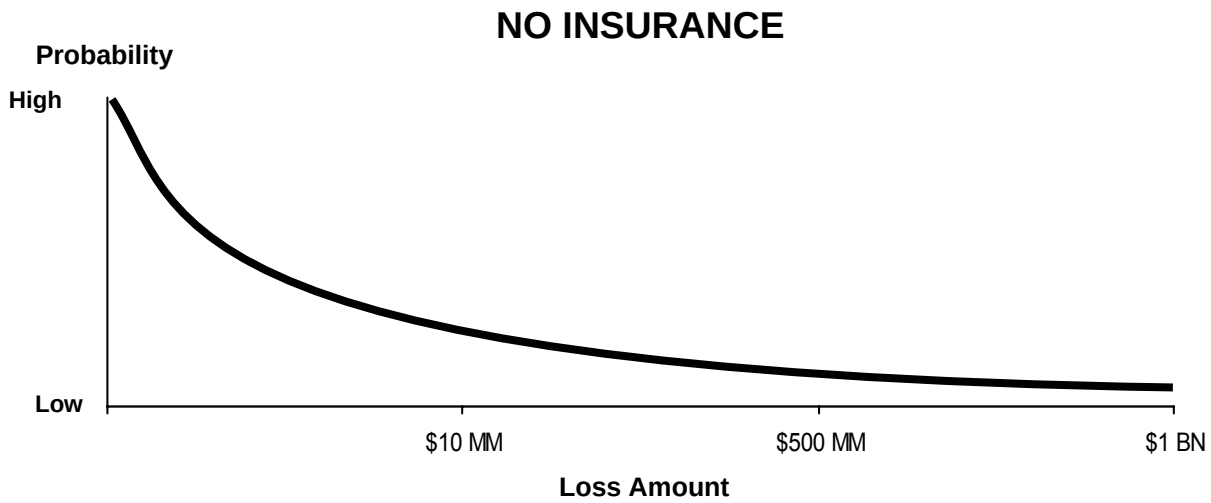
Goodness of fit results can also be viewed in graphical format (CDF and CDF Differences)

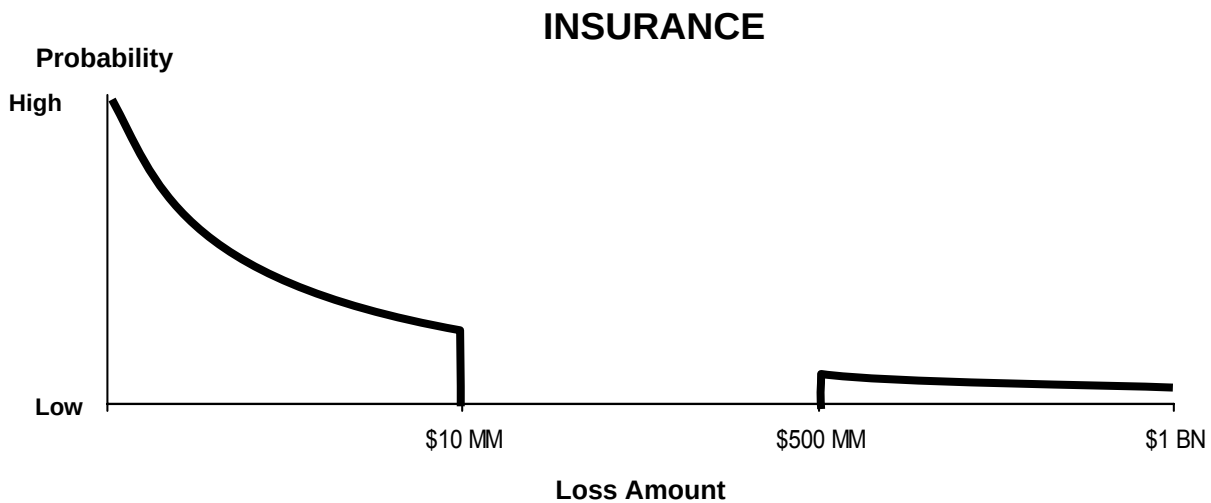


Under the LDA approach the end result is a set of frequency and severity distributions for each business and risk category



Where insurance coverage exists, the retention levels and coverage limits may be factored into the simulation process



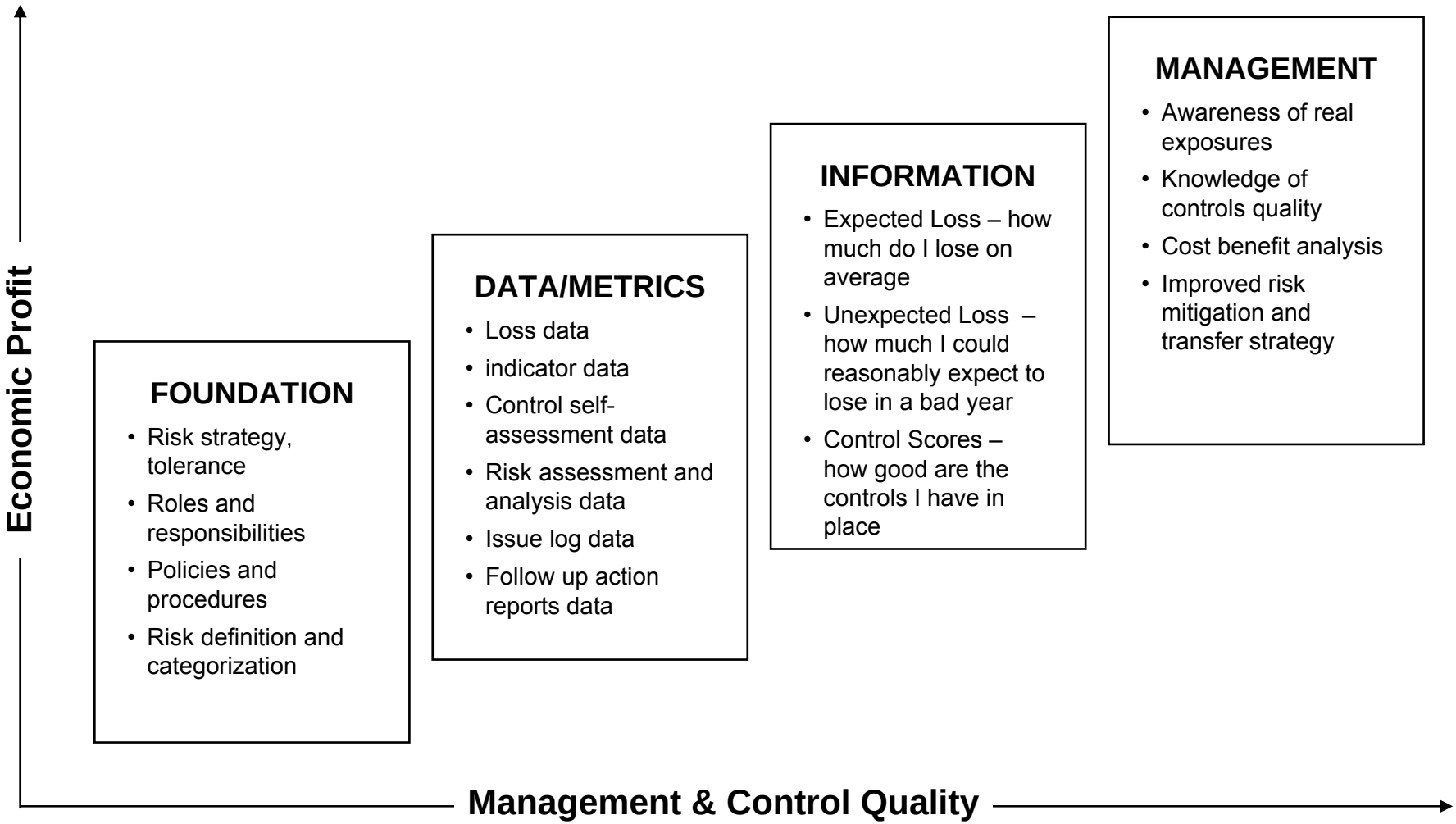


VaR results can be calculated at different confidence levels

Percentile	Lognormal	Lognormal Gamma	Burr	GPD	Weibull
99.97	324.5	759.8	[illegible]	3,193.8	12,345.0
99.95	112.5	178.2	248.6	524.4	4,356.7
99.9	78.9	[illegible]	135.3	205.7	1,706.9
99.5	14.7	[illegible]	18.0	25.8	83.8
99	8.8	9.2	9.5	8.2	26.5
95	1.9	2.1	2.0	1.7	3.0

AN INTEGRATED RISK AND CONTROL MANAGEMENT FRAMEWORK

Effectively managing operational risk requires a framework designed to turn raw operational risk data into information that supports managerial decision making.



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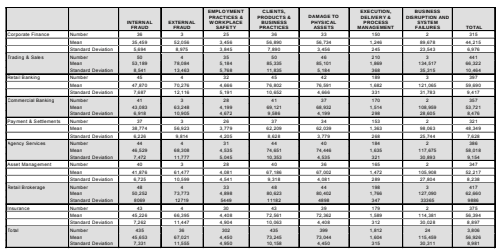
What are the key informational elements of an effective operational risk management program

Internal Loss Data	Actual losses that have taken place in your organization
External Loss Data	Actual losses that have taken place in other, similar organizations
Value at Risk	Monetary estimates of risk based on a quantitative model
Risk Assessment	Monetary estimates of risk based on a disciplined assessment process (scenario analysis)
Indicators	Measurable variable that are believed to be correlated with performance, losses, or loss variability - Key performance indicators - Loss (risk) indicators - Exposure (scale) indicators
Control Assessments	Assessment based on pre-specified criteria believed to be indicative of control quality

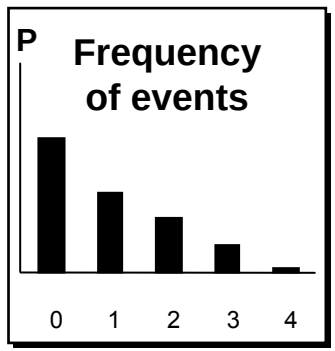
We begin be estimating risk for each business line and risk type (using a business line risk type matrix).

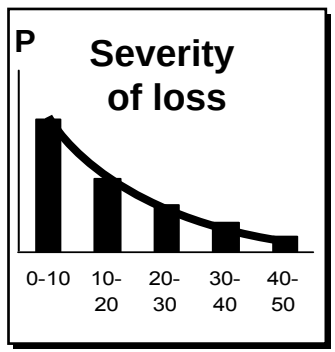
INDIVIDUAL LOSS EVENTS | **RISK MATRIX FOR LOSS DATA** | **LOSS DISTRIBUTIONS** | **VAR CALCULATION** | **TOTAL LOSS DISTRIBUTION**

74,712,345
74,603,709
74,457,745
74,345,957
74,344,576
•
•
•
167,245
142,456
123,345
113,342
94,458

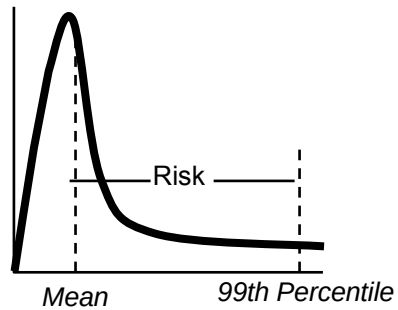


		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Number	36	3	25	39	23	150	2	315
	Mean	39,459	52,036	3,456	56,990	36,734	1,246	89,678	44,215
	Standard Deviation	5,694	8,975	3,845	7,890	3,456	245	23,543	9,976
Trading & Sales	Number	56	4	38	72	40	212	3	441
	Mean	83,189	79,094	6,194	85,335	86,101	1,999	134,517	99,322
	Standard Deviation	8,541	13,453	5,766	11,835	5,184	388	35,315	15,464
Retail Banking	Number	46	4	32	49	42	189	3	397
	Mean	67,872	73,276	4,846	79,902	76,391	1,662	121,065	84,690
	Standard Deviation	7,687	12,716	6,191	10,462	4,868	331	31,783	8,417
Commercial Banking	Number	41	3	28	41	37	170	2	357
	Mean	43,082	62,248	4,199	66,121	66,932	1,514	108,968	63,721
	Standard Deviation	6,918	10,665	6,672	9,589	4,199	298	28,655	9,476
Payment & Settlements	Number	37	3	29	37	34	153	2	321
	Mean	38,774	56,923	3,779	62,209	62,039	1,363	98,063	49,349
	Standard Deviation	8,235	9,814	4,255	8,624	3,779	328	25,744	7,928
Agency Services	Number	44	4	31	44	40	184	3	386
	Mean	49,539	68,208	4,535	74,601	74,446	1,635	117,975	68,918
	Standard Deviation	7,472	11,777	6,049	10,352	4,535	321	30,893	9,154
Asset Management	Number	40	3	28	40	36	165	2	347
	Mean	41,879	61,477	4,081	67,186	67,002	1,472	106,168	62,217
	Standard Deviation	6,733	10,596	4,541	9,318	4,081	289	27,804	6,238
Retail Brokerage	Number	48	4	33	48	44	198	3	417
	Mean	80,292	73,773	4,866	80,923	80,402	1,766	127,066	82,860
	Standard Deviation	8689	12710	5449	11182	4898	347	33345	9886
Insurance	Number	43	4	30	43	39	179	2	370
	Mean	45,226	66,266	4,404	72,991	72,362	1,589	114,381	69,284
	Standard Deviation	7,242	11,447	4,904	10,063	4,404	312	30,229	8,897
Total	Number	435	36	302	435	396	1,812	24	3,806
	Mean	45,653	67,021	4,460	73,245	73,044	1,604	116,458	66,926
	Standard Deviation	7,331	11,555	4,860	10,156	4,459	315	30,311	8,961





VaR Calculator e.g., Monte Carlo Simulation Engine



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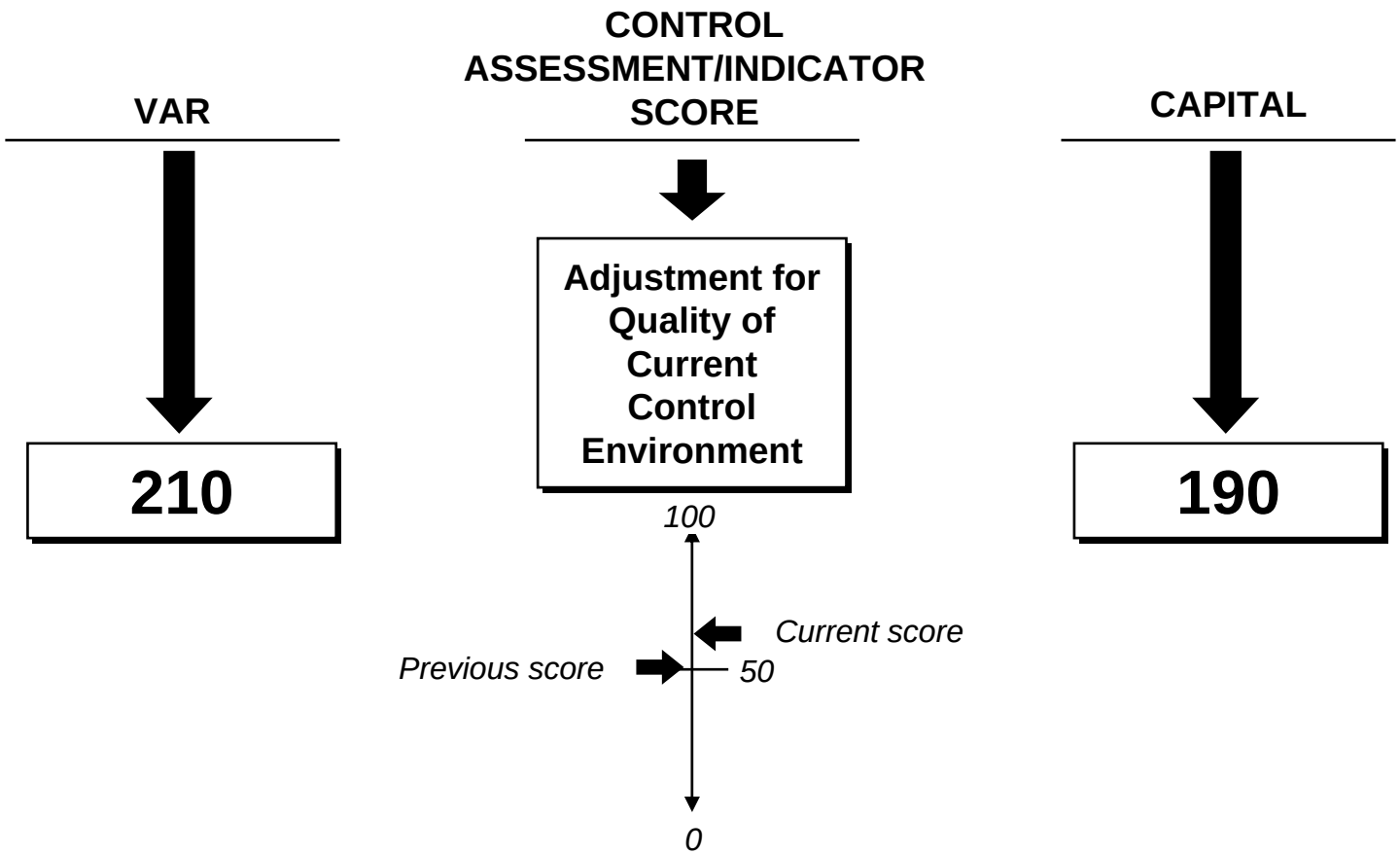
By using a common risk-control matrix, one can identify areas where each business may be over controlled or under controlled.

INTEGRATED RISK & CONTROL MATRIX

		INTERNAL FRAUD	EXTERNAL FRAUD	EMPLOYMENT PRACTICES & WORKPLACE SAFETY	CLIENTS, PRODUCTS & BUSINESS PRACTICES	DAMAGE TO PHYSICAL ASSETS	EXECUTION, DELIVERY & PROCESS MANAGEMENT	BUSINESS DISRUPTION AND SYSTEM FAILURES	TOTAL
Corporate Finance	Previous VaR	21,000,000	36,000,000	62,000,000	75,000,000	124,000,000	86,000,000	36,000,000	362,000,000
	Prev/Current Score	50 55	60 58	75 71	61 61	45 55	50 52	50 55	50 55
	Final Capital	19,000,000	35,000,000	65,000,000	75,000,000	104,000,000	83,000,000	32,000,000	326,000,000

We then look at the change in change in controls for each period, using the delta we can modify risk capital.



Linking capital to changes in the quality of internal controls provides an incentive for desired behavioral change

SCENARIO ANALYSIS

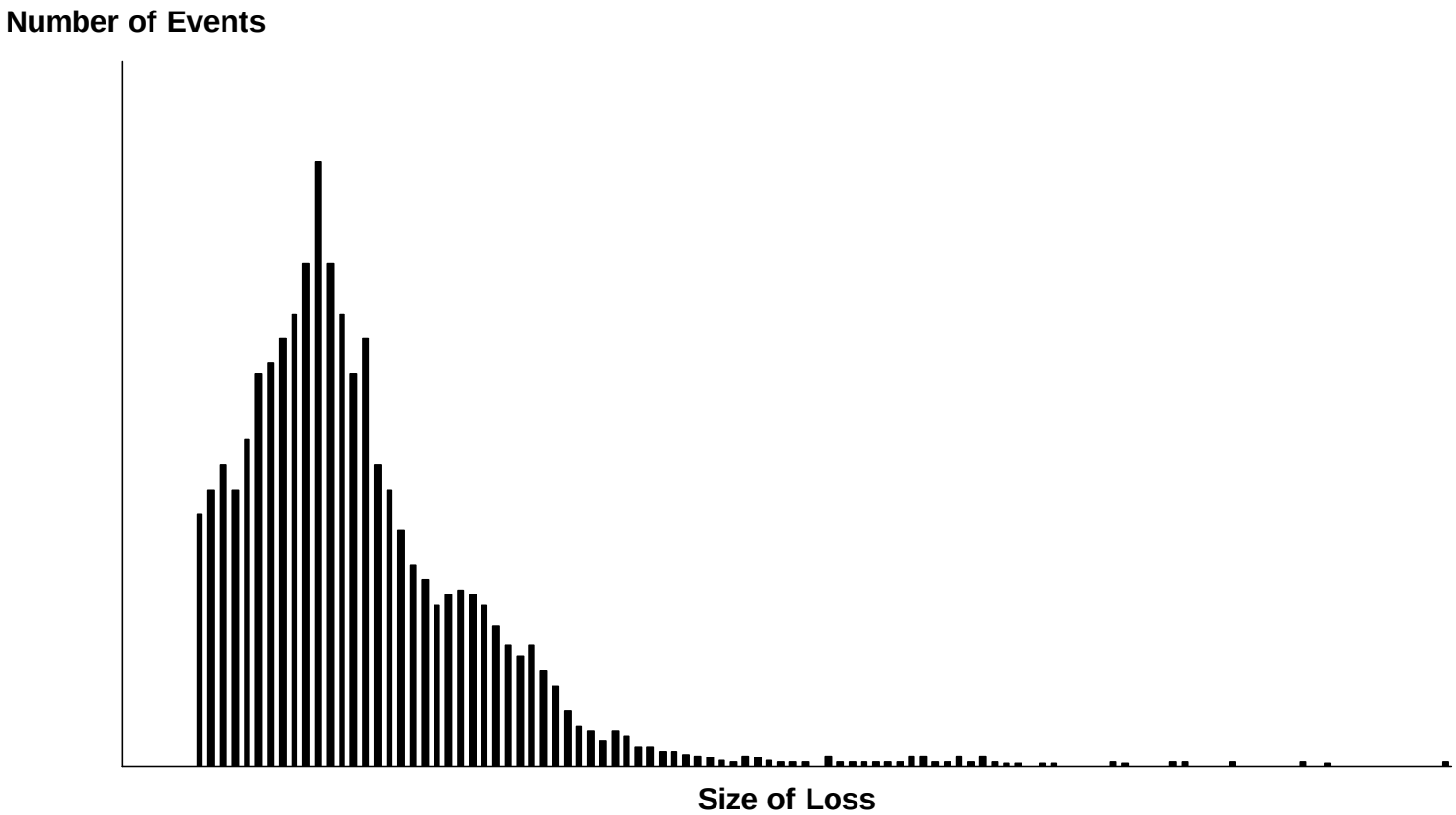
Basel II requirements for scenario analysis.

Scenario analysis

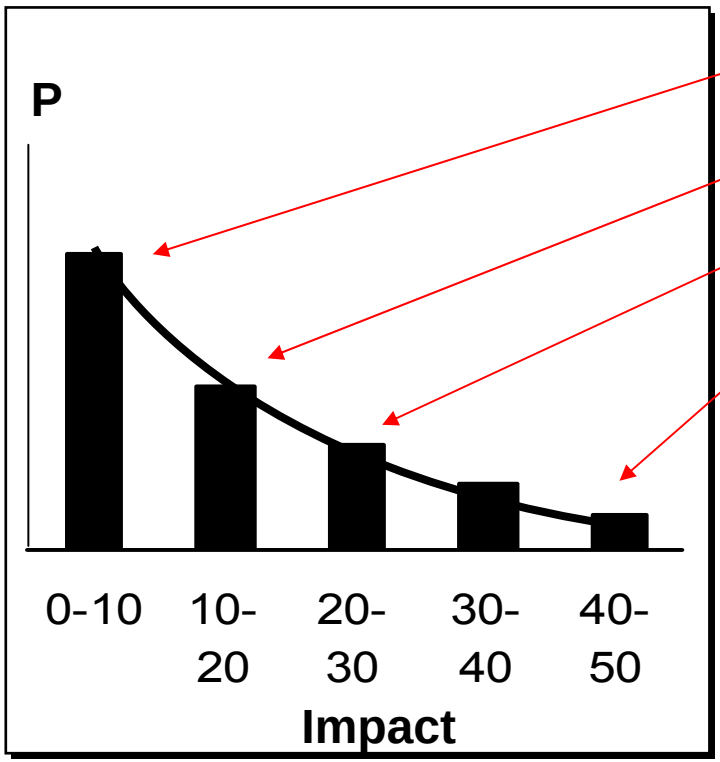
675. A bank must use scenario analysis of expert opinion in conjunction with external data to evaluate its exposure to high-severity events. This approach draws on the knowledge of experienced business managers and risk management experts to derive reasoned assessments of plausible severe losses. For instance, these expert assessments could be expressed as parameters of an assumed statistical loss distribution. In addition, scenario analysis should be used to assess the impact of deviations from the correlation assumptions embedded in the bank's operational risk measurement framework, in particular, to evaluate potential losses arising from multiple simultaneous operational risk loss events. Over time, such assessments need to be validated and re-assessed through comparison to actual loss experience to ensure their reasonableness.

Source: BIS – International Convergence of Capital Measurement and Capital Standards

Even with significant amounts of historical loss data it is virtually impossible to reliably estimate severity parameters, particularly for a three parameter severity distribution.



It is also very difficult to reliably estimate severity probabilities at different quantiles. Multiple estimates often create internal inconsistency



1 in 1 years = $1,000

1 in 10 years = $10,000

1 in 20 years = $25,000

1 in 100 years = $50,000

What are the key challenges in scenario analysis?

- How to incorporate external data into the process
- How to incorporate both frequency and severity into the analysis
- How to assess risk at different confidence levels
- How to ensure the absolute rankings are accurate
  - Is a $100 million sales practices loss a 90%, 99% a 99.9% level event?
- How to determine whether the relative rankings are accurate
  - Is computer fraud more likely to cause $10 million in aggregate losses than transaction processing errors?

Disciplined scenario analysis has been found to be moderately reliable and has produced valuable business benefits.

- The analysis is based on factual, historical (external) loss data
- Risk magnitude is clearly defined as potential loss at a specified confidence level, such as 99%
- A 99% level event is defined to mean the second highest loss in one hundred years
- This is further clarified – put into practical terms – based on loss experiences of ten peer banks; (similar size, similar controls), the second highest loss in the last ten years for the peer group

The whole purpose of this analysis is to allow the bank to compare the magnitude of loss at the same probability level:
50 foot tidal wave vs. 100 tidal wave
$10 million money transfer loss vs. $100 million sales practices loss

Scenario analysis can be very useful in contingency planning.

- Johnson and Johnson conducted scenario analysis with respect to potential product defects; when it was discovered that certain Tylenol containers had been tampered with the firm immediately recalled all product as part of a fully rehearsed contingency plan.
- In the late 1990's Bankers Trust conducted scenario analysis with respect to physical damage to its headquarters building. As a result the bank decided to invest in a huge back up facility, capable of housing every business activity. After the September 11th event, Bankers Trust (then part of Deutsche Bank) was one of the few organizations fully up and running in hours as part of a fully rehearsed contingency plan.

MANAGEMENT APPLICATIONS

This approach can be used to help justify investments that may reduce operational risk

The Trading and Sales Department considers purchasing a new back office processing system. Cost = $23.0 million

CSA SCORE	CURRENT	NEW ESTIMATE
Criminal	59	61
External	62	62
Employee Practices	61	61
Business Practices	64	64
Sales Practices	58	59
Systems	70	78
Transaction Processing	63	74
Unauthorized Activities	75	80

COST BENEFIT ANALYSIS

Capital Savings		$35 MM
Hurdle Rate		15%
Annual Benefit		$5.25 MM
Capital Cost Savings		Cost Of New System Over 5 Year
$26 MM	>	$23 MM

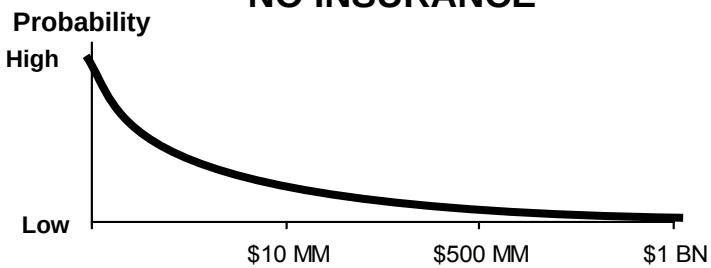
			Change
Capital	$345	$310	-$35

Simulation can be used to determine whether to purchase certain types of insurance coverage

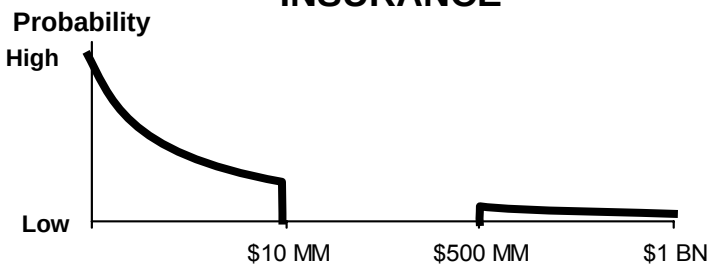
ISSUE

Whether to purchase an unauthorized activities insurance policy:
500 million limit; 10 million deductible; cost $6.5 million

NO INSURANCE



INSURANCE



COST BENEFIT ANALYSIS

VaR Savings		$50.0 MM
Hurdle Rate		20%
Annual Benefit		$10 MM
Cost Savings		Cost Of Insurance
$10 MM	>	$6.5 MM

Capital	No INS	INS	Difference
VaR Estimate	$150	$100	$-50

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SUMMARY & CONCLUSIONS

How will an effective operational risk management program improve the way operational risk is managed?

- Providing business managers with reliable information about their most significant risks as well as the quality of their corresponding internal controls, will allow these managers to make more educated decisions when developing risk mitigation and risk transfer strategies
- An equitable and transparent RAROC process, which is sensitive to real changes in a businesses' risk and control profile, will facilitate desired behavioral change as it will provide a financial incentive for business managers to improve controls in areas where such improvements are warranted.

Past experience indicates that if such a program does not provide reliable and accurate information it is likely to do more harm than good

Where do things stand today?

- There is still much confusion throughout the industry about fundamental operational risk management concepts.
- Many “experts” are recklessly propagating these falsehoods.
- Many banks have developed frameworks based on fundamentally flawed methodologies.
- Many such programs are hugely resource intensive, obfuscate the risk and control assessment process, create the wrong incentives and generally do more harm than good.
- Some auditors are “validating” these flawed methodologies. As this happens, these “approved” methodologies will become the standard for industry best practices.
- **More people who understand risk, i.e., actuaries, need to enter the fray.**

Where do things stand today?

- Many business managers have been able to discern that their firm's operational risk management program is based on a "half-baked" methodology which produce spurious and misleading results.
- Many business managers think this is as good as it gets and have erroneously concluded that operational risk management is *"a false science and a meaningless compliance exercise."*
- Where operational risk management is considered to be a waste of effort it is not likely to receive much additional funding.
- A cultural shift is necessary for organizations to evolve their operational risk management programs to the next level; the regulators must lead this initiative.
- If regulators don't take action soon, the window of opportunity will close and many banks will stop investing in their operational risk management programs – for good!

Biographical Information – Ali Samad-Khan

Ali Samad-Khan is *President of OpRisk Advisory LLC*. He has over nine years experience in operational risk measurement and management and more than twenty years experience in financial services. His areas of expertise include: establishing an integrated operational risk measurement and management framework, developing policies and procedures, internal loss event database design and implementation; data quality assessment, data sufficiency, risk indicator identification, risk and control self assessment, disciplined scenario analysis, causal/predictive modeling, advanced VaR measurement techniques and economic capital allocation.

Mr. Samad-Khan has advised dozens of the world's leading banks on operational risk measurement and management issues. His significant practical experience in this field comes from managing the implementation of more than ten major operational risk consulting engagements at leading institutions in North America, Europe and Australia. Key elements of the ORA framework and methodology have been adopted by dozens of leading financial institutions worldwide and have also been incorporated into the Basel II regulations.

Mr. Samad-Khan has frequently advised the major bank regulatory authorities, including the Risk Management Group of Basel Committee on Banking Supervision, the Board of Governors of the Federal Reserve System, the Federal Reserve Bank of New York, the Financial Services Authority (UK) and the Australian Prudential Regulation Authority. He also holds seminars and workshops in North America, Europe and Asia for the national and international regulators.

Prior to founding OpRisk Advisory, Mr. Samad-Khan was CEO of OpRisk Analytics LLC, which was acquired by SAS in 2003. (From June 2003 to September 2004 Mr. Samad-Khan provided transitional support for the acquisition of OpRisk Analytics, serving as SAS' Head of Global Operational Risk Strategy.) He has also worked at PricewaterhouseCoopers (PwC) in New York, where for three years he headed the Operational Risk Group within the Financial Risk Management Practice, in the Operational Risk Management Department at Bankers Trust as well as the Federal Reserve Bank of New York and the World Bank.

Mr. Samad-Khan holds a B.A. in Quantitative Economics from Stanford University and an M.B.A. in Finance from Yale University.

Articles include: "Why COSO is Flawed," *Operational Risk Magazine*, January 2005; "Is the Size of an Operational Loss Related to Firm Size," with Jimmy Shih and Pat Medapa, *Operational Risk Magazine*, January 2000; "Measuring Operational Risk," with David Gittleson, *Global Trading*, Fourth Quarter, 1998.
Working papers include: *"How to Categorize Operational Losses – Applying Principals as Opposed to Rules"* March 2002 and *"Categorization Analysis"* January 2003.

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