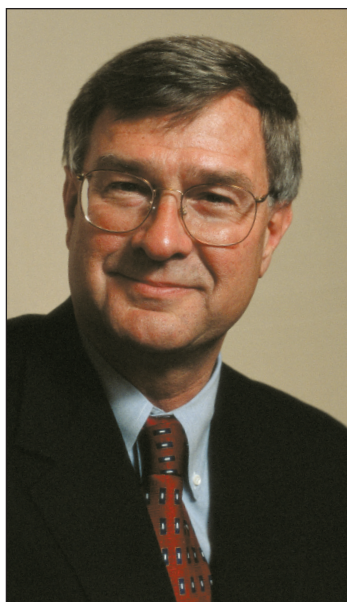


Quantifying operational risk

By Charles Smithson and Paul Song



This is the fifth of Charles Smithson's latest series of Class Notes, which will run in alternate issues of *Risk* through to the end of 2004. Class Notes is an educational series, designed to pull together the threads of recent developments and thinking about issues in risk management.

This month, writing with Paul Song, he looks at how much has changed with regard to operational risk in the past four years.

For this column, we have repeated the title originally used for the Class Notes column in the March 2000 issue of *Risk*. Given the attention devoted to operational risk – particularly in Basel II – we wanted to see how much has changed in the four years since that last column.

Frequency and magnitude of losses

As was the norm at that time, the March 2000 column contained only some high-level, anecdotal data (that is, a PricewaterhouseCoopers estimate based on press reports and an estimate by Operational Risk, Inc). Today, not only is there a lot more data on losses associated with operational risk available, but also the data is more granular.

Not surprisingly, the Basel Committee on Banking Supervision is a primary source of public operational risk loss data. The 2002 Loss Data Collection Exercise for

Operational Risk (LDCE) produced by the Risk Management Group (RMG) of the Basel Committee comprises more than 47,000 individual loss events collected from 89 banks.¹ As illustrated in table A, the RMG examined the number of loss events and the loss amounts by line of business. Not surprisingly, the largest percentage of loss events occurred in retail banking, but the percentage of gross loss amount for commercial banking was the same as that for retail banking.

The RMG also examined the number of loss events and gross losses by type of operational risk. As shown in the first column of table B, the largest percentage of the loss events was associated with 'external fraud' (EF), followed by 'execution, delivery and process management' (EDPM) and – distantly – by 'employment practices and workplace safety' (EPWS). As shown in the second column of table B, the largest percentage of gross losses was associated with EDPM, followed by 'damage to physical assets' (DPA) and EF.²

The RMG also looked at recoveries. We created the third column of table B by using the recoveries reported by the RMG to calculate 'net loss' and then calculating the percentages attributable to the seven types of operational risk.

Quantifying operational risk

There seems to be general agreement that the goal of this exercise is to estimate a loss distribution. Of the articles we reviewed in preparing this column, one quarter to one third included a loss distribution diagram. The supervisors also seem to be focusing on loss distribution. For example, in its description of its 'advanced measurement approaches' (AMA), the Basel Committee says "the bank [must be able] to calculate its regulatory capital requirement as the sum of expected loss and unexpected loss", and goes on to say that "a bank must be able to demonstrate that its approach captures potentially severe 'tail' loss events" and that "a bank must demonstrate that its operational risk measure meets a soundness standard comparable to that of the internal ratings-based approach for credit risk (that is, comparable to a one-year holding period and a 99.9% confidence interval)".³

The question is how to observe or estimate the loss distribution associated with operational risk.

□ **A taxonomy of approaches to quantifying operational risk.** The March 2000 column described nine techniques for quantifying operational risk. In our review in preparation for this column, we encountered discussions of three additional techniques (or extensions of some of the nine techniques) – shown in italics in table C.

A *process* approach is one that focuses on the chain of activities that comprise an operation or transaction (in much the same way that an industrial engineer examines a manufacturing process by looking at the individual work stations). Examples of this approach that were discussed in the March 2000 column included:

■ 'Causal models' that look at a specific outcome (for example, a settlement payment) in terms of the probabilistic impact of the activities that are in the chain (for example, recognition that a payment date has occurred, calculation of the settlement amount, notification of the counterparty, and paying or receiving). The success of each activity in the chain might be modelled as a function of inputs. Each of the inputs and implied outcomes is given a probabilities description, and, using conditional probabilities, the probability of a failure further down the chain can be estimated.

■ 'Statistical quality control and reliability analysis'; and

■ 'Connectivity', which requires the analyst to develop a 'connectivity matrix' that can then be used to estimate the likelihood of failure (or potential losses) for the process as a whole.

In preparation for this column, we encountered discussion of other techniques that could be considered 'process' approaches:

■ 'Bayesian belief networks' extend the 'causal model' technique by treating the initial model as the null hypothesis, so, as

¹ The 2002 data collection exercise refined the RMG's previous exercises that were part of Quantitative Impact Study 2 (QIS2).

² Paraphrasing the RMG's discussion in QIS2, the comparatively smaller share of gross losses for 'external fraud' as compared with its share of the number of loss events suggests that gross loss amounts tend to be smaller than average for this event type, while the larger share for 'damage to physical assets' as compared with the number of loss events suggests that individual losses tend to be larger than average for this category.

³ Consultative Document 3 (April 2003), paragraph 627.

data is collected, the model can be tested (that is, trained) to provide a more accurate picture of the process.

■ 'Fuzzy logic' is a branch of mathematics that facilitates decision-making when some of the inputs are vague, or if they are subjective judgements. In a 'causal model', fuzzy logic could provide a way to aggregate the subjective drivers of a process.

■ 'System dynamics' extends 'connectivity' by making the connections between activities dynamic (stochastic). This technique requires the analyst to develop a model to simulate the cause-effect interactions among activities that make up the processes within the firm.

In the *factor* approach, the analyst attempts to identify the significant determinants of operational risk – either at the institution level or at the level of an individual business or individual process. The objective is to obtain an equation that relates the level of operational risk for institution *i* (or business *i* or process *i*) to a set of factors:

$$(\text{Operational risk})_i = \alpha + \beta(\text{Factor 1}) + \gamma(\text{Factor 2})$$

If the analyst is able to identify the appropriate factors and obtain measures of the parameters ($\alpha, \beta, \gamma, \dots$), the analyst can estimate the level of operational risk that will exist in future periods. The March 2000 column described three applications of the factor approach:

■ 'Risk indicators', where the analyst identifies the significant factors using regression techniques.

■ 'CAPM-like models', which would relate the volatility in share returns (and earnings and other components of the institution's valuation) to operational risk factors.

■ 'Predictive models', which use discriminant analysis and similar techniques to identify factors that 'lead' operational losses.

An *actuarial* approach attempts to identify the loss distribution associated with operational risk – either at the level of the institution or at the level of a business or process.

■ 'Empirical loss distribution' is the most straightforward way to estimate the loss distribution, using the institution's own data on losses or both internal data and (properly scaled) external data. However, empirical loss distributions will probably suffer from limited data points (especially in the tail of the distribution).

■ 'Explicit distributions parameterised

⁴ The Basel Committee has proposed that α be set at 15%

A. Frequency and magnitude of losses associated with operational risk – by line of business

	Percentage of number of loss events	Percentage of gross loss amount
Corporate finance	1%	4%
Trading and sales	11%	15%
Retail banking	61%	29%
Commercial banking	7%	29%
Payment and settlement	4%	3%
Agency services	3%	4%
Asset management	2%	3%
Retail brokerage	7%	12%

B. Frequency and magnitude of losses associated with operational risk – by risk type

	Percentage of number of loss events	Percentage of gross loss amount	Percentage of net loss amount
Internal fraud	3%	7%	11%
External fraud	42% (1)	16% (3)	22% (2)
Employment practices and workplace safety	9% (3)	7%	9%
Clients, products and business practices	7%	13%	15% (3)
Damage to physical assets	1%	24% (2)	11%
Business disruption and system failures	1%	3%	–
Execution, delivery and process management	35% (2)	29% (1)	34% (1)

C. Techniques for quantifying operational risk

Process approaches	Factor approaches	Actuarial approaches
Causal	Risk indicators	Empirical loss distributions
Bayesian belief networks		
Fuzzy logic	'CAPM-like models'	Explicit distributions parameterised using historical data
Statistical quality control and reliability analysis		
Connectivity	Predictive models	Extreme value theory
System dynamics		

using historical data' is one way to get around the sparse data problem. The analyst specifies a distributional form for the loss distribution or a distribution for the frequency of occurrence of losses and a different distribution for the severity of the losses.

■ 'Extreme value theory' provides another way of getting around the data sparseness problem. This theory is an area of statistics concerned with modelling the limiting behaviour of sample extremes, which indicates that, for a large class of distributions, losses in excess of a high enough threshold all follow the same distribution (a generalised Pareto distribution).

□ **Approaches permitted under Basel II.** The Basel Committee has proposed three methods for calculating operational risk capital. Two of these could be de-

scribed as implementations of the risk indicator approach described above:

■ **Basic indicator approach.** Banks must hold capital for operational risk equal to a fixed percentage (denoted α) of average annual gross income over the previous three years:

$$K_{BIA} = GI \times \alpha$$

where GI is the average annual gross income and α is the parameter relating the industry-wide level of required capital to the industry-wide level of annual gross income.⁴

■ **Standardised approach.** The banks' activities are divided into the eight business lines shown in table A. The capital charge for each business line is calculated by multiplying the business line's gross income by a factor (denoted β) as-

signed to that business line. The total capital charge is calculated as the simple summation of the regulatory capital charges across each of the business lines:

$$K_{TSA} = \sum (GI_{1-8} \times \beta_{1-8})$$

where GI_{1-8} is the average annual gross income over the past three years for each of the eight business lines and β_{1-8} is a fixed percentage, relating the level of required capital to the level of the gross income for each of the eight business lines.⁵

Notwithstanding the fact that the Basel Committee has made a point of saying that it is "not specifying the approach... used to generate the operational risk measure..."⁶, it appears to us that the third method proposed by the Basel Committee – the AMA – is an implementation of the actuarial approach described above.

■ **AMA.** In addition to a set of qualitative standards a bank must meet, the Basel Committee has specified a set of quantitative standards that internally developed operational risk measures must satisfy. A process, factor or actuarial approach would all be able to satisfy the requirements that the measure (1) provide both expected and unexpected loss and (2) be sufficiently 'granular' to capture the major drivers of operational risk affecting the shape of the tail of the loss estimates. The standard that led us to characterise AMA as an actuarial approach is the data-use requirement.

This means the bank will be required to collect and maintain internal loss data according to the eight business lines and seven operational risk types enumerated above. This data is to be used either as the foundation of empirical risk estimates or as a means of validating the inputs and outputs of the bank's risk measurement system or as the link between loss experience and risk management and control decisions. Relevant external data (either public data and/or pooled industry data) must be used, especially when there is reason to believe the bank is exposed to infrequent, yet potentially severe, losses. The bank must use scenario analysis of expert opinion in conjunction with external data to evaluate its exposure to high-severity events, in particular to evaluate potential losses arising from multiple simultaneous operational risk loss events.

A recent survey by Fitch Ratings of 450 major banks located in Australia, Canada, Europe, Japan, South Africa and the US supports our characterisation of the AMA as an actuarial approach. According to this Fitch survey: "The vast majority of banks hoping to adopt the AMA plan to use a loss distribution approach to generate

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their capital charge.... The distribution is created by using loss data.... The banks tended to try to use internal data to represent the observable portion of losses they have incurred. But due to the scarcity of their own internal data and the desire to understand what the 'tail' of the distribution... might look like [they use or intend to use] external data, scenario analysis and a variety of statistical techniques, including, for example, extreme value theory."

Concluding remarks

Over the past four years, the volume and granularity of data on losses associated with operational risk have increased dramatically. And, from this data, the operational risk picture is starting to come into focus:

■ Looking at loss data by lines of business, retail banking dominates with respect to the number of loss events, but, in terms of gross loss amount, commercial banking's share is the same as that for retail banking.

■ Looking at loss data by type of loss event, we believe the data suggests that the most important types of operational risk are EDPM and EF. In terms of number of loss events, EPWS ranks a distant third to EF and EDPM, but it does not rank in the top three in terms of loss amount. In terms of gross loss amount, DPA ranks higher than EF, but when recoveries are netted in, it does not remain in the top three. In terms of loss amount net of recoveries, clients, products and business practices ranks third to EDPM and EF.

We were hoping that we would get a clearer idea of which technique for estimating the loss distribution would dominate for operational risk. In this, we were disappointed. We found discussions of new techniques (or extensions of previously discussed techniques), but we did not find very much data that helps us get a picture of which techniques are being used by banks and other financial institutions to estimate the loss distribution (and ultimately economic capital for operational risk). ■

Charles Smithson is widely recognised as an expert in risk management. In 1999, he founded Rutter Associates, an education and advisory firm dealing with all aspects of the measurement and management of risk. Rutter Associates' research is currently focused on questions dealing with economic capital and the management of portfolios of credit assets. Paul Song is an associate at Rutter Associates. His current interests include empirical analysis of credit capital models and implementation of Basel II. He is the developer of Rutter Associates' Regulatory Capital Calculator

⁵ The betas proposed by the Basel Committee are: corporate finance – 18%, trading and sales – 18%, retail banking – 12%, commercial banking – 15%, payment and settlement – 18%, agency services – 15%, asset management – 12% and retail brokerage – 12%

⁶ Consultative Document 3 (April 2003), paragraph 627