Industry Position Paper

Unit of Measure and Dependence

Introduction

This paper on Unit of Measure and assumptions surrounding the estimation of dependence between losses drawn from different Units of Measure is one in a series of industry position papers by the AMA Group[1] on business practices affecting the implementation of AMA in the United States. It is intended to help progress a dialogue between the industry and regulatory community on this aspect of the implementation of the AMA.

This paper was first developed and released by AMAG in 2008; it has been refreshed and re-released based on the results of a 2010 AMAG Range of Practice survey. AMAG is in the process of conducting a 2011 survey and it is anticipated that this paper may be updated once again upon the conclusion of that exercise.

Background

The Final U. S. Rule defines:

- Unit of Measure as the level at which a bank's operational risk quantification system generates a separate distribution of potential operational losses where "level" means, for example, organizational unit or operational loss event type; and

- Dependence as the measure of the association among operational losses across and within Units of Measure.

The two concepts are important in calculating capital under Pillar I of the Basel Capital Adequacy Standards for operational risk when a bank is using the Advanced Measurement Approaches. The way they are interpreted can have a major impact on the level and quality of a bank's capital estimates and on the time and effort required to derive them.

The two concepts are closely related. As the number of Units of Measure increases, the need to address the diversification effect among Units of Measure increases too. Until data scarcity becomes an issue, a global capital estimate for an entire institution that takes into account diversification across Units of Measure will tend to become better defined. Beyond that point, the available data will be spread too thinly across units and the quality of a global capital estimate will suffer.

[1]The Advanced Measurement Approaches Group (AMAG) was formed in 2005 to share industry views on aspects of Advanced Measurement Approaches (AMA) implementation with the U.S. financial services federal regulatory agencies. The members of AMAG are listed in the Attachment to this Paper. They are listed for identification purposes only. Support for the AMAG is provided by RMA and Operational Risk Advisors LLC (ORA). This paper does not necessarily represent the views of RMA's institutional membership at large, ORA, or the views of the individual institutions whose staff have participated in the AMAG.

Industry Practices

There is a significant range of practice among core and opt-in institutions within the AMA Group regarding the number and definition of Units of Measure. Today, the number of Units of Measure varies from 1 to over 100, with most using 25 or more. The number selected depends to a significant degree on data availability and the maturity of data collection and modeling. Other considerations are the size, uniqueness and diversity of banks' businesses – things that inherently affect internal data availability and homogeneity, as well as external data relevance. Whether an institution is core or opt-in has little or no bearing on the number of its Units of Measure.

There is also a range of practice in how Units of Measure are defined. Some institutions use event type, some use business unit, and some use a matrix of the two. Most banks collect loss and other data at a level that is more granular than their Units of Measure. They use it variously for internal benchmarking across areas of their organizations and as input into various risk and business management processes, including pricing and risk-adjusted performance measurement.

The determination of Units of Measure is dependent to a substantial degree on the sufficiency of sample, in consideration of the body of the loss distribution, and to an even greater degree the tail of the distribution. It is a common industry practice to use either the primary Basel event type or Basel-defined business types as the basis for Units of Measure. Some financial institutions are exploring the combinations of event types and business lines as their Units of Measure; however the size of the sample is even more of a challenge for these more granular Units of Measure. Without sufficient sample in the body or the tail of the loss distribution it is very difficult to determine if sufficient homogeneity is present.

With regard to dependence between losses in different Units of Measure, many firms have now addressed it. Some have applied statistical methods, and some are using a hybrid involving statistical analysis and judgment. Among those using statistical methods in part or in whole, the most common way to analyze dependence is copulas, particularly Gaussian copulas. A majority of core banks take dependence into account between both business lines and event types while some do so only for business lines. Some estimate dependency for frequency and severity separately but most calculate it directly for the underlying loss distributions.

Responses on correlation factors applied indicated a wide range of practice and application. Some are finding no correlation; nearly half of those responding indicated a factor of between 25-50%, whereas others indicated even higher percentages. These findings must be tempered, however, with the recognition that differing methodologies are represented, ranging from discrete correlations across units of measure, frequency, severity, and / or business divisions.

The diversification effect indicated by those firms that have developed estimates also represents a wide range of results (i.e., diversified capital estimates that have taken dependency into account are between 50% and 75% less than the sum of the unit of measure capital estimates).

Both correlation and diversification practices remain the subject of review and discussion by AMAG and, specifically, are being addressed in the Group's 2011 Range of Practice survey.

Industry Positions

Position 1 -- Unit of Measure:

A firm's choice of Unit of Measure should be based on key considerations such as data availability, data homogeneity, the way the firm is organized and how it uses its capital estimates, and should incorporate practical judgment at appropriate management levels.

Data availability: As a firm increases the number of its Units of Measure, the confidence it can have in its capital estimates may rise at first as it segregates out different underlying loss distributions, but then it will inevitably fall if the decline in the amount of data in each Unit of Measure has a more-than-offsetting effect on the quality of individual loss distribution estimates. Depending on how much data it has collected – their level and rate of losses in different parts of the firm and the maturity of its data collection process – and depending on the confidence with which they feel they can rely on external data – its quality, completeness and applicability – it may well be the case that some large institutions should use only a few Units of Measure.

Data homogeneity: Although a firm will strive to capture similar data in a distribution (i.e., avoid mixing different risks in a single UoM), this is not as simple as avoiding a distribution of heterogeneous risks at all costs. Firms generally seek a level of homogeneity to the extent reasonably supported by data availability and sufficiency.

Organization: Institutions with relatively few business lines and similar risk profiles across many business units and processes will normally have few Units of Measure, even if their approaches are mature and their data abundant.

Use of estimates: The case for spending the resources to divide up an institution into more rather than fewer Units of Measure is strengthened when the estimates derived for each of those units are used for more than one purpose. In some institutions, they are used not only for estimating a minimum capital requirement, but also as an input into economic capital allocation for management purposes such as product pricing and performance measurement. In others, risk is taken into account in product pricing in different ways; and how well managers trade off risk and return is measured in different ways. For this second class of institutions the case for greater granularity of Units of Measure is reduced.

Position 2 -- Diversification:

Estimates of dependence and independence between losses in different Units of Measure should be well-supported logically and/or statistically.

Firms should be able to demonstrate how dependence between units of measure is incorporated into exposure estimates; given the short time horizon of loss collection and data scarcity in general, however, it would be premature and unreasonable to expect firms to validate these methodologies and assumptions with statistical analysis rigorously, supported by sufficient data sample sizes. Data sufficiency is a challenge for most firms, and it is relevant that the empirical evidence represented by the Operational Riskdata Exchange Association (ORX), which in the aggregate represents a substantial depth of data, does not support strong correlation. So, one should not assume that data sufficiency is the barrier to correlation proof.

Flexibility is key for firms' choice of methodologies and assumptions that support their dependence structure (e.g. whether to use a standard matrix transformation or a copula, if a copula is used which type of copula, and the values applied for correlation coefficients). Firms' dependence structures should be assessed based on the combined or aggregate effect of the methodologies and assumptions and not on any one element of the structure in isolation. There are multiple factors that affect the level of dependence between units of measure including

the number of units of measure, whether the dependence is between frequency, severity or aggregate losses, and the value applied to the correlation coefficient. In the end, the approach selected should be supported by documentation that evidences the thought process that drove decisions about its viability and use.

Logical arguments for independence: Failures in different processes supporting different businesses in different regions serving different customers and supported by different information technology (IT) and human resource (HR) systems, do not seem likely to be dependent on one another, even in extreme situations. This is an example of a strong logical argument for assuming independence between losses within and across different Units of Measure that does not require significant additional statistical support. There will likely never be any dependence between loss event observations in such cases.

Judgment will be supported by data, when and where available. Where the logic for arguing independence is strong and there is no statistical evidence to the contrary, however, firms should be allowed to assume that risks are independent between Units of Measure in estimating minimum capital requirements using the AMA.

Choice of copulas: Where statistical evidence is available and it is analyzed using copulas, the choice of copula depends on data, to the extent that they are available, and on a judgment regarding the behavior of the underlying generator of the joint probability distribution. So, for example, a choice of a Gaussian copula would be supported by a judgment that the tail events are independent or only weakly dependent. (Note: copulas are implemented into operational risk models to incorporate dependence and the correlation coefficient can be any value between 0 and 1). The Gaussian copula is a mainstream and frequently used copula because joint normal (or log-normal) distributions are commonplace in other risk disciplines such as market risk and credit risk. The Gaussian copula has the property of asymptotic tail independence, which means that as you go out further and further into the tail the dependence tends to zero. The Student-t copula has the ability to incorporate higher levels of correlation in the tail, but requires the estimation of a second parameter, degrees of freedom.

There are not enough data to prove statistically how Units of Measure should be correlated so that is probably why firms use the Gaussian copula in an effort to incorporate judgmentally derived levels of correlation but stay away from trying to estimate increased levels in the tail of the distribution.[2] A Student-t copula would be supported by a judgment that this was not the case. Today, there is still very little evidence for one choice or the other: it is truly a matter of judgment.

Position 3 - Conservatism:

Given the uncertainty around dependence, firms should be able to demonstrate where they have been conservative in their implementation of a dependence structure into their operational risk capital models. Reasonable examination and a level of analysis should produce some level of diversification benefit.

An appropriate adjustment might be made for the uncertainty in estimating dependency relative to either a single pair of observations (i.e., cells in the business / loss event matrix), or in a global adjustment (i.e., across all combinations), but not both. Firms should not be expected however, to incorporate high levels of dependence, such as full dependence between Units of Measure, simply because statistical uncertainty exists.

Layering conservatism: If a process involving analytical methods and judgment yields an estimate that is uncertain, it may well be justified to add something to that estimate to ensure the final number is conservative -- say, for example, to add 10 units to a 100 unit estimate.

[2] E. Cope, G. Antonini; "Operational correlations and dependencies among operational losses in the ORX consortium database"; *Journal of Operational Risk*, Vol. 3, No. 4, Winter 2008/09, p. 47-74.

Firms should assess where they have risk class pairs that can be correlated and should incorporate those conditions into their dependence structure. For example, if several business lines were operating off of the same technology platform and the system were to become unavailable, there could be losses sustained in multiple business lines resulting from the same root cause.

Other sources of uncertainty: There are other aspects of uncertainty regarding the estimation of dependence. For example, there are not much data for estimating dependence or independence at the tail. So, aside from the uncertainty regarding method – choice of copula – there is uncertainty attributable to data paucity.

The fallback position of zero capital savings: The capital savings for independence of losses across different Units of Measure – that is, the percent difference between the sum of Unit of Measure capital estimates and the total for the institution after diversification has been taken into account – can theoretically take any value between 0 and 1. Based on a combination of judgment and statistical analysis, best estimates of these savings by AMAG members in instances where dependence is present are centered between 50% and 75%, as noted above. Based on statistical analysis of their large data set, recent Operational Riskdata Exchange Association (ORX) estimates also suggest capital savings of at least this much are generally well justified. While it is reasonable to argue for some conservatism on account of the inherent uncertainties in estimating dependence at this time, it is generally not going to be reasonable to assume that capital savings from diversification should be zero -- or even close to zero.

Attachment

About the AMA Group

The Advanced Measurement Approaches Group (AMAG) was formed in 2005 by the Risk Management Association (RMA) at the suggestion of the U.S. AMA-BQT (formerly the Inter-Agency Working Group on Operational Risk). The RMA is a member-driven professional association whose purpose is to advance the use of sound risk management principles in the financial services industry.

The purpose of the AMAG is to share industry views on aspects of Advanced Measurement Approaches (AMA) implementation with the U.S. financial services federal regulatory agencies. The Group consists of senior operational risk management professionals working at financial service organizations throughout the United States. The AMAG is open to any financial institution regulated in the U.S. that is either mandated, opting in, or considering opting in to AMA. A senior officer responsible for operational risk management represents each member institution on the AMAG. Of the twenty or so U.S. financial service institutions that are currently viewed as mandatory or opt-in AMA institutions; eighteen were members of the AMAG at the time of this writing.

The members of AMAG are listed below. They are provided for identification purposes only. This Paper does not necessarily represent the views of RMA's institutional membership at large, or the views of the individual institutions whose staff have participated in the AMAG.

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