

## Challenges in Economic Capital Modeling

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Financial institutions are increasingly using economic capital models to help determine the amount of capital they need to absorb unexpected losses. These models typically aggregate capital based on business-level analysis. However, important challenges surround this aggregation as well as other aspects of these models. Supervisors could use these capital calculations when they assess capital adequacy, but they need to be aware of these modeling issues.

Financial institutions are in the business of managing and reallocating risk. An important part of risk management is having an appropriate level of capital as a buffer against unexpected losses. A key question is how much capital to hold. Too little would leave an institution exposed to losses that could lead to bankruptcy, while too much is expensive in terms of foregone business opportunities. Since the failure of individual institutions has a large impact on the financial system as a whole, government supervisors have put in place regulatory capital requirements. However, managers still must make their own determination of how much capital their institution should hold, given its current risk exposures and business model.

The general name for this determination is economic capital calculation, which can be viewed as an extension of the capital calculations made for individual business lines based on their risk exposures and potential losses, such as credit losses on a loan portfolio. The idea is to measure all risk exposures using mainly quantitative techniques and decide how much capital to hold in light of potential losses. A recent report by the Basel Committee on Banking Supervision (BCBS 2009) argues that no consensus on how to calculate economic capital has developed. In this *Economic Letter*, I review some of the methods currently used for economic capital calculations and discuss the associated challenges and supervisory concerns.

The question of economic capital calculation has taken on particular urgency in light of the recent domestic financial crisis. During that period, actual and potential bank losses on mortgage loans and mortgage-backed securities led to a sharp decline in bank capital and enhanced systemic concerns about the soundness of the U.S. banking system. Policy responses targeted at the quantity and quality of bank capital, such as the Treasury department's Troubled Asset Relief Program capital injections into large banking organizations in October 2008 and the Federal Reserve's Supervisory Capital Assessment Program stress tests in the spring of 2009, highlight the broader economic importance of this component of bank risk management.

## What is economic capital?

Economic capital is the amount of risk capital, or equity, needed to cover possible *unexpected* losses that might arise from an institution's risk exposures. These exposures are measured on a consistent and ongoing basis as part of an institution's internal capital assessment processes. Note that capital is targeted at unexpected losses since expected losses should be incorporated into the pricing of the institution's products and its loss provisioning.

In theory, economic capital can be calculated at various levels, including for the entire institution. However, since potential losses typically arise from specific business activities or investments, calculations are conducted mostly at the business-line level and then aggregated to determine total needed capital. The amount is calculated for losses over a certain time horizon, such as a year. The amount also depends on the level of confidence the institution seeks in its ability to absorb losses. For example, having sufficient capital and loan loss provisions for covering losses 99% of the time is a 1% confidence level.

Processes for determining economic capital were originally developed as tools for business-line risk management. The use of these tools has expanded to include institution-wide risk management and related analyses. For example, economic capital measures can be used to generate risk-adjusted profitability measures. They can also serve as inputs to decisions regarding whether to expand or contract specific business lines. Financial institutions have increased their use of economic capital models in response to advances in risk quantification techniques, the growing complexity of institutional risk exposures, and supervisory expectations that institutions develop internal capital-adequacy assessments.

## Methods for calculating economic capital

In principle, economic capital should be based on exposures to all forms of risk. In practice, the notion of which risks should be considered and how they should be measured has evolved over time and varies across institutions. Typically, economic capital models encompass possible losses arising from defaulted loans (credit risk), financial market fluctuations (market risk), and business operations (operational risk). Quantitative approaches are available for measuring and managing these risks. In practice, a wide variety of methods are used. Certain other types of risk, such as concentration risk or legal risk, are assessed using more qualitative methods due to a lack of appropriate data and modeling techniques.

Quantitative approaches attempt to characterize the entire distribution of potential losses and can generate several risk measures. The most common are value-at-risk (VaR) and expected shortfall (ES). VaR provides a measure of potential losses at a chosen confidence level, say, 1%, or the second largest daily loss expected over a one-year horizon. ES is a measure of expected losses at or beyond, say, the 1% level and better characterizes the distribution of extreme losses beyond that level. Both measures have advantages for business-line risk analysis, but neither measure facilitates aggregation across business lines.

Financial institutions use a variety of assumptions and aggregation methods for institution-wide economic capital calculations. In simple summation, they add individual risk measures. This approach is perceived as conservative since it ignores potential diversification benefits and effectively produces an upper bound for total economic capital. A related approach is to apply a fixed diversification percentage to the summation and thereby impose a diversification benefit. According to the BCBS report, the range of diversification percentages was reported to reduce the summed exposure by 10 to 30%. Although often ad hoc, these methodologies are easy to calculate and to communicate to senior management,

government supervisors, security analysts, and shareholders. However, neither method allows for meaningful interactions between risk types or detailed analysis of possible diversification benefits.

Aggregation using weights derived from a correlation matrix of the various risk types provides greater flexibility for measuring diversification benefits. Yet, by focusing on the average correlation between risks, this approach will tend to underestimate the correlations between risk types in periods of especially large losses, or, in other words, the tails of the loss distributions. Academic studies indicate that the degree of diversification in this aggregation technique varies substantially depending on risk types and the weights applied to them. No one risk aggregation method has been established as best practice, but more than 60% of surveyed institutions used a variant of the correlation approach, according to the BCBS report.

### **Challenges to implementation**

Several other challenges need to be addressed in implementing economic capital models. A key question is whether all of an institution's relevant risk exposures are accounted for. If relevant risks are not captured, an economic capital calculation cannot provide a reliable measure of risk exposures and potential losses. According to the BCBS survey, larger institutions appear to use economic capital models for quantifiable risks and rely on more qualitative assessments, such as expert judgment or stress scenarios, for less quantifiable risks.

A related implementation challenge is data quality. For some institutions, data regarding specific risk types are not available or are of poor quality. The institution must either make internal judgments or rely on external sources, such as consultants or industry benchmarks.

Economic capital calculations must also correctly align the measurement horizon across risk types. For example, aggregating the daily risk measures for an institution's trading operations and the annual measures for loan default risk requires assumptions that may not be appropriate in practice. Simple mathematical adjustments are often used, but their underlying assumptions can be quite strong and may not be suitable for a given institution.

Once economic capital calculations have been completed, it is necessary to validate them, that is, to gauge their appropriateness and reliability. Like implementation, validation can be challenging. Several procedures have been constructed, but these techniques commonly provide evidence only for or against specific desirable properties of an economic capital model. No standard validation procedure provides a comprehensive measure of model performance. In addition, these procedures are limited in their ability to confirm the accuracy of a model's forecasted tail losses. As a result of these limitations and the dearth of relevant data, the ability to validate an economic capital model in relation to an institution's historical experience remains at a very preliminary stage.

### **Supervisory concerns**

Economic capital calculations can be useful not only for an institution's own capital adequacy assessment, but also for supervisory purposes. But important concerns must be addressed here as well. Supervisors need to have confidence that an institution's management is devoting necessary resources to resolving operational issues. Supervisors will have no obvious preferences for VaR, ES, or any other specific risk measure but should consider the design and appropriateness of measures on an institution-by-institution basis. They will want assurances that managers are able to document economic capital calculations and understand their limitations. The credibility of economic capital calculations depends

on the willingness and ability of senior management to ensure the integrity of the process and show a commitment to actually using the calculations when making important decisions.

Robust internal validation is a key supervisory concern. Several qualitative and quantitative techniques are available. Examples of more qualitative methods are use tests, which examine whether institutions are properly using their economic capital calculations, and qualitative reviews, which look at an institution's documentation of its models and internal validation efforts. Supervisors may also see value in internal audits by institutional staff not involved in design and implementation of economic capital models.

Quantitative validation methods include comparison of model inputs, such as correlations, with historical data or industry benchmarks. Another common quantitative approach is benchmarking, which requires comparisons of an institution's economic capital calculations with industry survey results, academic studies, alternative models by outside vendors, and regulatory capital outcomes. Benchmarking has limitations though, including an emphasis on relative model comparisons as opposed to absolute accuracy comparisons with observed data. Overall, these methods are only able to confirm that input parameters or model outputs are broadly in sync with other sources. They do not assess a model's actual performance.

In theory, backtesting could address this concern by comparing observed losses with an economic capital model's forecasts of potential losses. Backtesting is useful primarily for risk types that can be characterized by a quantifiable metric that can be compared with an outcome. That places limits on this method's usefulness for aggregate economic capital calculations. Thus, backtesting is not yet a standard economic capital validation component among the institutions surveyed by the BCBS. Stress testing, increasingly used by financial institutions and regulators, is another validation technique that examines a model under difficult financial scenarios. Model inputs assume stressed conditions and model outputs are compared with more typical conditions. Such testing can reveal model limitations that might only become apparent under unusually adverse conditions. However, stress tests are still limited in their applicability, especially for aggregated economic capital calculations.

Economic capital models can provide supervisors with information that complements their own assessments of institutional risk exposures and capital adequacy, although validation issues need to be addressed. Given the wide range of techniques available, creating a layered validation approach could provide supervisors with greater comfort. However, the BCBS report suggests that, while supervisors might benefit from considering an institution's economic capital calculations, they should not rely on them to assess capital adequacy.

## Conclusion

Significant methodological, implementation, and business challenges remain concerning the application of economic capital models to financial institutions' internal assessments of capital adequacy. However, the trend is toward refinement of and greater reliance on these models. Supervisors should encourage this trend and make use of economic capital models to the extent prudent.

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## References

Basel Committee on Banking Supervision. 2009. "Range of Practices and Issues in Economic Capital Frameworks." Bank for International Settlements (March). <http://www.bis.org/publ/bcbs152.htm>

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