

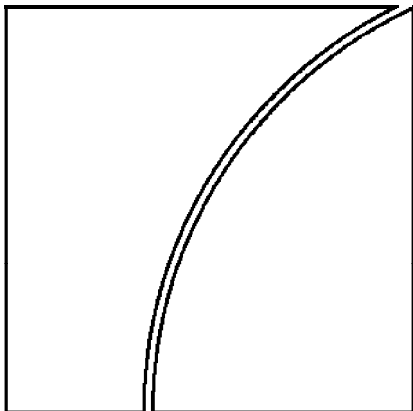
Basel Committee
on Banking Supervision

Consultative Document

**Range of practices and
issues in economic capital
modelling**

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Executive Summary

Economic capital can be defined as the methods or practices that allow banks to attribute capital to cover the economic effects of risk-taking activities. Economic capital was originally developed by banks as a tool for capital allocation and performance assessment. For these purposes, economic capital measures mostly need to reliably and accurately measure risks in a relative sense, with less importance attached to the measurement of the overall level of risk or capital. Over time, the use of economic capital has been extended to applications that require accuracy in estimation of the level of capital (or risk), such as the quantification of the absolute level of internal capital needed by a bank. This evolution in the use of economic capital has been driven by both internal capital management needs of banks and regulatory initiatives, and has been facilitated by advances in risk quantification methodologies and the supporting technological infrastructure.

While there has been some convergence in the understanding of key concepts of economic capital across banks with such frameworks in place, the notion of economic capital has broadened over time. This has occurred in terms of the underlying risks (or building blocks) that are combined into an overall economic capital framework and also in terms of the relative acceptance and use of economic capital across banks.

Economic capital can be analysed and used at various levels – ranging from firm-wide aggregation, to risk-type or business-line level, and down further still to the individual portfolio or exposure level. Many building blocks of economic capital, therefore, are complex and raise challenges for banks and supervisors. In particular, Pillar 2 (supervisory review process) of the Basel II Framework may involve an assessment of a banks' economic capital framework.

In this paper we emphasise the importance of understanding the relationship between overall economic capital and its building blocks, as well as ensuring that the underlying building blocks (individual risk assessments) are measured in a consistent and coherent fashion. In the main body of the paper we focus on issues associated with the overall economic capital process, rather than on the components of economic capital. Therefore we focus on the use and governance of economic capital, issues related to the choice of risk measures, aggregation of risk, and validation of economic capital. In addition, three important building blocks of economic capital (dependency modelling in credit risk, counterparty credit risk and interest rate risk in the banking book) are examined in separate, stand-alone annexes. This list of building blocks is chosen due to the significance and complexity of the topics, and (with the exception of counterparty credit risk) partly because the topics are not covered in Pillar 1 of the Basel II Framework. This list is by no means exhaustive.

Use of economic capital and governance

The robustness of economic capital and the governance and controls surrounding the process have become more critical as the use of economic capital has extended beyond relative risk measurement and performance to the determination of the adequacy of a bank's absolute level of capital.

The viability and usefulness of a bank's economic capital processes depend critically on the existence of a credible commitment or "buy-in" on the part of senior management to the process. In order for this to occur, it is necessary for senior management to recognise the importance of using economic capital measures in conducting the bank's business. In

addition, adequate resources are required to ensure the existence of a strong, credible infrastructure to support the economic capital process. Economic capital model results should be transparent and taken seriously in order to be useful for business decisions and risk management. At the same time, management should fully understand the limitations of economic capital measures. Moreover, senior management needs to take measures to help ensure the meaningfulness and integrity of economic capital measures. It should also seek to ensure that the measures comprehensively capture all risks and implicit and/or explicit management actions embedded in measurement processes are both realistic and actionable.

Risk measures

Banks use a variety of risk measures for economic capital purposes with the choice of risk measure dependent on a number of factors. These include the properties of the risk measure, the risk- or product-type being measured, data availability, trade-offs between the complexity and usability of the measure, and the intended use of the risk measure. While there is general agreement on the desirable properties a risk measure should have, there is no singularly preferred risk measure for economic capital purposes. All risk measures observed in use have advantages and disadvantages which need to be understood within the context of their intended application.

Risk aggregation

One of the more challenging aspects of developing an economic capital framework relates to risk aggregation.

Practices and techniques in risk aggregation are generally less sophisticated than the methodologies that are used in measuring individual risk components. They rely heavily on ad-hoc solutions and judgment without always being theoretically consistent with the measurement of the components. Most banks rely on the summation of individual risk components either equally-weighted (ie assuming no diversification or a fixed percentage of diversification gains across all components) or weighted by an estimated variance-covariance matrix that represents the co-movement between risks. Few banks attempt technically more sophisticated aggregation methods such as copulas or even bottom-up approaches that build overall economic estimates from the common relationship of individual risk components to underlying factors.

Validation is a general problem with aggregation techniques. Diversification benefits embedded in inter-risk aggregation processes (including in the estimation of entries in the variance-covariance matrix) are often based on (internal or external) “expert judgment” or average industry benchmarks. These have not been (and very often cannot be) compared to the actual historical or expected future experience of a bank, due to lack of relevant data.

Since individual risk components are typically estimated without much regard to the interactions between risks (eg between market and credit risk), the aggregation methodologies used may underestimate overall risk even if “no diversification” assumptions are used. Moreover, harmonisation of the measurement horizon is a difficult issue. For example, extending the shorter horizon applied to market risk to match the typically-used annual horizon of economic capital assessments for other types of risk is often performed by using a square root of time rule on the economic capital measure. This simplification can

distort the calculation. Similar issues arise when risk measured at one confidence level is then scaled to become (nominally) comparable with other risk components measured at a different confidence level.

Validation

Economic capital models can be complex, embodying many component parts and it may not be immediately obvious that a complex model works satisfactorily. Moreover, a model may embody assumptions about relationships between variables or about their behaviour that may not hold in all circumstances (eg under periods of stress). Validation can provide a degree of confidence that the assumptions are appropriate, increasing the confidence of users (internal and external to the bank) in the outputs of the model.

The validation of economic capital models is at a very preliminary stage. There exists a wide range of validation techniques, each of which provides evidence for (or against) only some of the desirable properties of a model. Moreover, validation techniques are powerful in some areas such as risk sensitivity but not in other areas such as overall absolute accuracy or accuracy in the tail of the loss distribution. Used in combination, particularly in combination with good controls and governance, a range of validation techniques can provide more substantial evidence for or against the performance of the model. There appears to be scope for the industry to improve the validation practices that shed light on the overall calibration of models, particularly in cases where assessment of overall capital is an important application of the model.

Dependency modelling in credit risk

Portfolio credit risk models form a significant component of most economic capital frameworks. A particularly important and difficult aspect of portfolio credit risk modelling is the modelling of the dependency structure, including both linear relationships and non-linear relationships, between obligors. Dependency modelling is an important link between the Basel II risk weight function (with supervisory imposed correlations) and portfolio credit risk models which rely on internal bank modelling of dependencies. Understanding the way dependencies are modelled is important for supervisors when they examine a bank's internal capital adequacy assessment process (ICAAP) under Pillar 2, since these dependency structures are not captured in regulatory capital measures.

The underlying methodologies applied by banks in the area of dependency modelling in credit risk portfolios have not changed much over the past ten years. Rather, improvements have been made in the infrastructure supporting the methodologies (eg improved databases) and better integration with internal risk measurement and risk management. The main concern in this area of economic capital continues to centre on the accuracy and stability of correlation estimates, particularly during times of stress. The estimates provided by current models still depend heavily on explicit or implicit model assumptions.

Counterparty credit risk

The measurement and management of counterparty credit risk creates unique challenges for banks. Measurement of counterparty credit risk represents a complex exercise, as it involves

gathering data from multiple systems; measuring exposures from potentially millions of transactions (including an increasingly significant percentage that exhibit optionality) spanning variable time horizons ranging from overnight to thirty or more years; tracking collateral and netting arrangements; and categorising exposures across thousands of counterparties.

This complexity creates unique market-risk-related challenges (requiring calculations at the counterparty level and over multiple and extended holding periods) and credit risk-related challenges (estimation of credit risk parameters for which the institution may not have any other exposures). In addition, wrong-way risk, operational risk-related challenges, differences in treatment between margined and non-margined counterparties, and a range of aggregation challenges need to be overcome before a firm can have a bank-wide view of counterparty credit risk for economic capital purposes. Banks usually employ one of two general modelling approaches to quantify counterparty credit risk exposures, a Value at Risk (VaR)-type model or a Monte Carlo Simulation approach. The decision of which approach to use involves a variety of trade-offs. The VaR-type model cannot produce a profile of exposures over time, which is necessary for counterparties that are not subject to daily margining agreements, whereas the simulation approach uses a simplified risk factor representation and may therefore be less accurate. While these models may be supplemented with complementary measurement processes such as stress testing, such diagnostics are frequently not fully comprehensive of all counterparty credit risk exposures.

Interest rate risk in the banking book

The main challenges in the calculation of economic capital for interest rate risk in the banking book relate to the long holding period for balance sheet assets and liabilities and the need to model indeterminate cash flows on both the asset and liability side due to embedded optionality in many banking book items. If not adequately measured and managed, the asymmetrical payoff characteristics of instruments with embedded option features can present risks that are significantly greater than the risk measures suggest.

The two main techniques for assessing interest rate risk in the banking book are repricing schedules (gap and duration analyses) and simulation approaches. Although commonly used, the simple structure and restrictive assumptions make repricing schedules less suitable for the calculation of economic capital. Most banks use simulation approaches for determining their economic capital, based on losses that would occur given a set of worst case scenarios. The magnitude of such losses and their probability of occurrence determine the amount of economic capital. The choice of the techniques depends on the bank's preference towards either economic value or earnings, and also on the type of business. Some businesses, such as commercial lending or residential mortgage lending, are managed on a present value basis, while others such as credit cards are managed on an earnings basis. The use of an earnings based measure creates aggregation challenges when other risks are measured on the basis of economic capital. Conversely, the use of an economic value based approach may create inconsistencies with business practices.

Summary

Economic capital modelling and measurement practices continue to evolve. In some aspects, practices have converged and become more consistent over time, however the notion of economic capital has broadened as its use has expanded. There remain significant

methodological, implementation and business challenges associated with the application of economic capital in banks, particularly if economic capital measures are to be used for internal assessments of capital adequacy. These challenges relate to the overall architecture of economic capital modelling and to the underlying building blocks.

Recommendations

- 1. Use of economic capital models in assessing capital adequacy.** A bank wishing to use an economic capital model should, in its dialogue with supervisors, be able to demonstrate how the economic capital model has been integrated into the business decision making process in order to assess its potential impact on the incentives affecting the bank's strategic decisions about the mix and direction of inherent risks. The bank's board of directors should also be able to demonstrate awareness of the gap between gross (stand alone) and net enterprise wide (diversified) risk when they define and communicate measures of the bank's risk appetite on a net basis.

Economic capital models and the overall frameworks for their internal use can provide supervisors with information that is complementary to other assessments of bank risk and capital adequacy. Supervisors should understand the challenges inherent in calibrating and validating economic capital models. While there is benefit from engaging with banks on the design and use of the models, supervisors should guard against placing undue reliance on the overall level of capital implied by the models in assessing capital adequacy.

- 2. Senior management.** The viability, usefulness, and ongoing refinement of a bank's economic capital processes depend critically on the existence of credible commitment or "buy-in" on the part of senior management to the process. In order for this to occur, senior management should recognise the importance of using economic capital measures in conducting the bank's business and capital planning, and should take measures to ensure the meaningfulness and integrity of economic capital measures. In addition, adequate resources should be committed to ensure the existence of a strong, credible infrastructure to support the economic capital process.
- 3. Transparency and integration into decision-making.** A bank should effectively integrate economic capital models in a transparent and auditable way into decision making. Economic capital model results should be transparent and taken seriously in order to be useful to senior management for making business decisions and for risk management.

A bank should take a cautious approach to its use of economic capital in internal assessments of capital adequacy. For this purpose, greater emphasis should be placed on achieving estimates of stand alone risks that are robust on an absolute basis, as well as developing the flexible capacity for enterprise wide stress testing.

- 4. Risk identification.** Risk measurement begins with a robust, comprehensive and rigorous risk identification process. If relevant risk drivers, positions or exposures are not captured by the quantification engine for economic capital, there is great room for slippage between inherent risk and measured risk.

Not all risks can be directly quantified. Material risks that are difficult to quantify in an economic capital framework (eg funding liquidity risk or reputational risk) should be captured in some form of compensating controls (sensitivity analysis, stress testing, scenario analysis or similar risk control processes).

- 5. Risk measures.** All risk measures observed in use have advantages and disadvantages which need to be understood within the context of their intended application. There is no singularly preferred risk measure for economic capital

purposes. A bank should understand the limitations of the risk measures it uses, and the implications associated with its choice of risk measures.

6. **Risk aggregation.** A bank's aggregation methods should address the implications stemming from the definition and measurement of individual risk components. The accuracy of the aggregation process depends on the quality of the measurement of individual risk components, as well as on the interactions between risks embedded in the measurement process. Aggregation of individual risk components often requires the harmonisation of risk measurement parameters such as the confidence level or measurement horizon.

Care must be taken to ensure that the aggregation methodologies used (eg variance-covariance matrices, use of broad market proxies, and simple industry averages of correlations) are as much as possible, representative of the bank's business profile.

7. **Validation.** Economic capital model validation should be conducted rigorously and comprehensively. Validation of economic capital models should be aimed at demonstrating that the model is fit for purpose. Evidence is likely to come from multiple techniques and tests. To the extent that a bank uses models to determine an overall level of economic capital, validation tools should demonstrate to a reasonable degree that the capital level generated by the model is sufficient to absorb losses over the chosen horizon up to the desired confidence level.
8. **Dependency modelling in credit risk.** A bank should assess the extent to which the dependency structures are appropriate for its credit portfolio, under normal circumstances as well as under stress circumstances. The dependency structures embedded in credit risk models have an important impact on the determination of economic capital needs for credit risk.
9. **Counterparty credit risk.** A bank should understand the trade-offs involved in choosing between the currently used methodologies for measuring counterparty credit risk. Complementary measurement processes such as stress testing should also be used, though it should be recognised that such approaches may still not fully cover all counterparty credit risk exposures. The measurement of counterparty credit risk is complex and entails unique market and credit risk related challenges. A range of aggregation challenges need to be overcome before a firm can have a bank-wide view of counterparty credit risk for economic capital purposes.
10. **Interest rate risk in the banking book.** Close attention should be paid to measuring and managing instruments with embedded option features, which if not adequately performed can present risks that are significantly greater than suggested by the risk measure. Trade-offs between using an earnings-based or economic value based approach to measuring interest rate risk in the banking book need to be recognised. The use of an earnings based measure creates aggregation challenges when other risks are measured on the basis of economic value. Conversely, the use of an economic value based approach may create inconsistencies with business practices.