should a bank expand its ATM network or open a new chain of branches? Securitize its loan portfolio or acquire someone else’s? The importance of the effective use of economic capital is in direct proportion to pressures to reduce margins. And the intensity of competition today brings the level of importance to an all-time high.

Since Bankers Trust publicly introduced risk-adjusted capital allocation to the banking community in the 1970s, virtually all bankers have become well acquainted with “RAROC”—risk-adjusted return on capital—as a tool for answering these sorts of questions. But despite this familiarity, surprisingly few banks actually use a comprehensive RAROC approach to manage their capital, and the gulf between the theory and practice of RAROC remains disturbingly wide.

One source of significant confusion in the application of RAROC to the allocation of risk capital is confusion between what can be called ex ante and ex post RAROC. The actual RAROC measure itself can, after all, be used either for ex ante capital allocation or for the evaluation of a business unit’s actual performance ex post. However, the measurement and implementation of these two versions of RAROC is significantly different. Allocating capital based on an ex post measure of risk-adjusted return...
can lead to serious problems.

The Importance of Risk Capital Allocation

Many people equate “capital allocation” to the apportionment of funds for investments. In banking, however, “capital” has many different meanings, only one of which is the funding capital required to finance asset acquisitions and other transactions. Economic capital is the broadest form of banking capital and includes equity and other long-term liabilities of the bank. Regulatory capital, by contrast, includes the three tiers of capital defined in the Basel Accord of 1988 that all banks must allocate to assets with credit risk (and, since 1996, market risk).

When the need for capital allocation by banks is considered, however, capital does not usually refer to funding or regulatory or even economic capital, but rather to capital at risk (CaR). CaR is the smallest amount of economic capital that a bank must set aside to prevent the net asset value or earnings of a business unit from falling below some “catastrophic loss” level. Because this economic capital is never actually invested, CaR is an imputed buffer against unexpected and intolerable losses.

All banks must allocate risk capital. The issue is not whether they do, but how. The simplest capital allocation scheme, still followed by a surprisingly large number of banks, relies solely on the Basel Accord of 1988. Such banks essentially equate risk capital to regulatory capital as defined in the Accord. Because the asset risk weights defined in the Accord are woefully imprecise and increasingly outdat-
period average or period-ending) or marginal basis. Net income may also be adjusted to reflect the opportunity cost of regulatory capital tied up in a business line.

Net income may be either expected or actual. The importance of distinguishing between expected and actual net income is nowhere better illustrated than in the treatment of losses, such as loan losses in excess of recoveries. At some banks, the loan desk is debited for expected losses at the time of loan origination. In exchange for that debit, resem- bling a payment by the desk of an insurance premium, actual losses relative to expected losses are managed in another part of the bank. At other banks, however, the loan desk may be accountable for actual losses.

For CaR allocation decisions, banks should use expected net income in RAROC inclusive of expected losses. If a bank treats expected loss as an explicit cost, it should be subtracted from revenues as just another cost of doing business. If a bank allocates actual losses to the desk, expected loss is still an expected cost of doing business—namely, it is the best-estimate ex ante of future actual losses. In either case, expected losses should be subtracted from expected revenues in the RAROC used for capital allocation.

RAROC calculated to measure actual desk performance ex post, however, should attribute losses in a manner that is consistent with the internal loss allocation mechanism of the bank. If a bank books expected losses as a debit to the desk at loan origination and never goes back to credit or debit the difference between actual and expected losses, RAROC should treat expected loss as a known operating cost. If a bank attributes actual losses to the loan desk, however, RAROC net income measured ex post should reflect actual losses, even though the RAROC for the same desk used to determine its CaR allocation ex ante would treat losses on an expected value basis.

Depending on the compensation scheme, a lending officer compensat-ed based on revenues less actual loss-es could have an incentive to take greater risks because of a finite down-side in income and a potentially unlimited upside. Yet, the risk capital allocated to that manager ex ante will reflect the unexpected loss potential, unlike the risk capital allocated to the manager whose performance is independent of actual losses. As is desired, the manager of the desk that reaps the rewards of riskier lending is allocated less capital. This might not be true if the bank is inattentive to the distinction between ex ante and ex post RAROC.

Capital at Risk. The other com-ponent of RAROC is CaR, or the capital a bank allocates to a business unit to cover all losses the bank desires to avoid over its risk horizon. The simplest measure of CaR, originally used by Bankers Trust in its early formulation of RAROC in the 1970s, is a duration gap-like measure. The duration gap of a business line is the duration of the line’s assets less its liabilities weighted by the proportion of assets funded by liabilities. In the simple case where the net asset value (NAV) of a business unit is affected only by a single interest rate y, the CaR of the business unit is

\[ \text{CaR} = \text{NAV} \times \text{Modified Duration} \times \text{Dy} \]

where Modified Duration is duration (that is, Macaulay duration) divided by 1+y, and Dy is a small change in the interest rate. The calculation can be generalized to reflect the impact of multiple risk factors.

Duration gap measures of risk are far from perfect proxies of CaR. One major limitation is the artifact of duration that only small changes in risk factors are considered. Another drawback is the inability for management to associate a likelihood of occurrence with this measure of risk—namely, a CaR that reflects 50% of all market movements has a different interpretation than one which is virtually never expected to occur.

Value at risk (VaR) is a measure of CaR that addresses these limitations. VaR enables bankers to make statements like the following: “With 95% confidence, losses in excess of SX are not expected to occur over the next day/month/quarter” where SX is the VaR. The banker chooses the confidence level and the time period. The confidence level depends on the desired degree of conservat-ism in the definition of “cata-strophic” loss. A 99% confidence level, for example, measures VaR as the loss expected to occur no more than one percent of the time. The time period should correspond to the period over which net income is calculated for RAROC.

If returns on all assets and liabilities are distributed “normally” with a zero mean, the VaR of business unit is

\[ \text{VaR} = \text{NAV} \times \text{Modified Duration} \times \text{a} \]

where a is the standard deviation of interest rate changes and a is a constant that allows the banker to make probabilistic statements about VaR based on the properties of the normal distribution. Five percent of the normal distribution, for example, lies 1.65 standard deviations below the mean, so that a=1.65 yields a VaR at
of CaR considered the impact of changes in both market prices and credit spreads. More rigorous credit models thus can—and should—be incorporated into risk measures such as VaR and EaR whenever possible.

**Forward- versus Backward-Looking CaR.** Regardless of whether a banker uses a VaR- or EaR-based CaR, two fundamentally distinct approaches for calculating those measures, the appropriateness of which depends largely on whether the intended use of RAROC is ex ante or ex post.

The first approach begins with the assets and liabilities of a business unit at the time risk is measured. The individual risks of these positions are calculated and then aggregated up to the business unit level using appropriate within-desk correlations to get a business-unit-level CaR. This CaR estimate is both forward-looking and independent of past management style.

The second approach requires no knowledge of the business line’s assets and liabilities at the time of RAROC measurement. Instead, *historical* earnings or changes in NAV serve as the sole basis for the VaR or EaR estimate. Because the future is assumed to behave just like the past, this measure of CaR is backward-looking and depends critically on past performance of the business unit; this measure of CaR depends on the style of the manager running the business line over the evaluation period.

If a bank uses RAROC to evaluate performance ex post, capital at risk should also be measured ex post using actual historical performance at the level of the business unit being evaluated. The situation is trickier when the bank uses RAROC to allocate CaR ex ante. On the one hand, the bank should use a forward-looking measure of risk that measures loss based on the particular asset/liability mix in the business unit. On the other hand, if the business unit’s historical returns reflect a penchant for tactically positioning the unit to take certain risks, a forward-looking risk measure might miss those effects whereas a backward-looking measure would not.

The means by which CaR is measured can significantly impact the incentives of business unit managers. If managers are compensated with a RAROC whose CaR is forward-looking, her compensation would be based on the composition of assets and liabilities in the business unit at the time RAROC is calculated. Managers could thus raise their compensation by delaying asset and liability management decisions, resulting in suboptimal investments.

If a business manager is instead compensated using ex post RAROC but is allocated risk capital historically and backward-looking, the manager will receive a risk capital allocation based solely on past performance of the desk rather than the current risk of the business unit. Especially if the tactics or management of the business unit have changed, ex post measures of CaR can badly understate or overstate the true risk of a business line, again resulting in suboptimal investments.

**Defining Bank-Wide “Allocatable” Capital at Risk**

Before a bank can actually define a RAROC allocation rule, the bank must decide what kind of CaR it plans to allocate to business units in the allocation process—specifically, how business unit CaRs are related to the CaR for the whole bank. And the bank’s definition of “allocatable CaR” for
actual capital allocation purposes may well not be the best definition for the bank to use in evaluating historical performance. To see why, some additional discussion of alternative definitions of “allocatable CaR” is appropriate.

**Bank-Wide Capital at Risk.**

The main distinction between different measures of aggregate capital at risk is how correlations are taken into account across business units. If correlations across business units are not taken into account, the business-unit-level CaR is called its stand-alone CaR. The sum of the stand-alone CaRs for all business units is called the bank’s undiversified total CaR.

The aggregate CaR of the bank inclusive of cross-business-line correlations, by contrast, is called the enterprise-wide CaR. Undiversified total CaR is not equal to enterprise-wide CaR unless the returns on different business units are perfectly correlated. Otherwise, enterprise-wide CaR is less than undiversified total CaR.

Undiversified and enterprise-wide CaR are both measures of total capital at risk. Alternatively, a bank can measure the marginal contribution of a business to enterprise-wide VaR. The marginal CaR of a business line is the difference between enterprise-wide CaR with and without that business line. Interactions between business units can impact enterprise-wide CaR differently depending on the specific combination of businesses in the total firm. Consequently, the sum of marginal CaRs is less than enterprise-wide CaR if changes in NAV or earnings are imperfectly correlated across business lines. The following relation thus generally holds:

\[
\text{Sum of Marginal CaRs} < \text{Enterprise-Wide CaR} < \text{Undiversified Total CaR}
\]

**Allocatable Risk Capital Measures.** Banks may define allocatable bank-wide CaR using any of four different methods, each of which define an “allocatable” CaR. Method I for capital allocation allocates undiversified total CaR pro rata across business units. Each unit receives an allocation of undiversified total CaR based on the share of its stand-alone CaR in the total amount. Method I thus evaluates each business in isolation and takes into consideration no interactions between business units.

Method II for capital allocation incorporates cross-business-line correlations by allocating enterprise-wide CaR. Called the “Splitting Method,” this approach allocates each business unit a proportion of its stand-alone CaR, where the proportion is equal to the ratio of enterprise-wide CaR to total undiversified CaR. If enterprise-wide CaR is 20% less than undiversified CaR, for example, Method II will allocate each business unit 20% of its stand-alone CaR. This method thus assumes incorrectly that each business unit contributes equally to enterprise-wide risk diversification.

Because the sum of marginal CaRs does not equal enterprise-wide CaR, Method II allocates risk capital in a manner that does not reflect the true marginal contribution of each business to the total risk of the firm. In extreme cases, the over-investment of risk capital to some businesses—which, as will be discussed later, is costly for the businesses—can cause new investment opportunities to be rejected when they should actually be accepted.

Method III allocates capital based on the marginal CaR of a business unit. This method takes into account the specific contribution of each business unit to firm-wide CaR in the allocation scheme and has the added benefit of being naturally comparable to the standard investment criterion of investing capital up to the point where its marginal benefit equals its marginal cost.

Because the sum of marginal CaRs is less than enterprise-wide CaR, Method III never results in a full allocation of enterprise-wide capital when business line returns are imperfectly correlated. Merton and Perold characterize this implication of Method III as a type of “positive intra-firm externality” in which different businesses de facto insure one another and, in the process, reduce the total economic risk of the firm.

Finally, Method IV allocates enterprise-wide CaR based on the “internal beta” of each business unit. Internal beta is defined for any business line as the covariance of its returns with the returns on the whole firm scaled by the variance of firm-wide returns. Each business line is assigned such a beta and then allocated a fraction of diversified enterprise-wide CaR based on that beta in a manner similar to the capital budgeting rule of thumb in which positive NPV projects competing for scarce funding capital are selected based on their internal beta ranks.

Unlike Method III, Method IV fully allocates enterprise-wide capital. The weighted average of all internal betas is equal to one, which means that the sum of the weighted CaR allocations to each business unit will exactly equal enterprise-wide CaR.

Methods I and II can clearly lead to inappropriate capital allocation decisions, whereas Methods III and IV can both be appropriate. Differentiating between Methods III and IV, however, is no easy task. Both
have economic intuition behind them, as well as practical appeal. For those who believe the Merton and Perold story that risk capital diversification effects create a firm-wide externality, unallocated enterprise-wide CaR should not be a concern. But for those who believe unallocated risk capital is a wasting asset, the internal beta approach likely will be preferred to the marginal CaR allocation rule.

**How Does the Definition of Allocatable CaR Impact Ex Post Performance Evaluation?** How to measure CaR for ex post performance evaluation is a fundamentally different problem from how to allocate risk capital ex ante. The manager of a given business unit, after all, can control only the risks that the activities and investments of that business unit create; the interaction of those risks with the rest of the bank is not under control of the business line manager. Ultimately, whether or not to reward line managers for how their businesses interact with the risks of the whole bank is a decision every bank must make for itself.

A related problem in using RAROC for the basis of ex post performance measurement is whether performance should be evaluated based on *allocated* CaR or *utilized* CaR. Allocated risk capital is the CaR actually assigned to each business unit. Because this capital is intended to provide a buffer against significant losses, however, the risk capital actually used by the desk to generate its realized net income in any period will almost always be less than risk capital allocated.

On the one hand, measuring ex post RAROC with utilized capital is appealing because the risk capital utilized is the risk capital that led to the actual revenue stream. If allocated capital exceeds utilized capital, compensating managers relative to the former would create an incentive for managers to use *all* of their allocation, which might not make sense. On the other hand, if managers are compensated based on ex post RAROC measured with utilized capital, they will have no incentive to use allocated capital efficiently. This is thought to lock up capital — much like regulatory capital requirements — and prevent the bank from re-allocating risk capital toward higher-valued uses.

As a solution, some advocate performance evaluation based on utilized risk capital plus a penalty for unutilized risk capital. The lower the penalty rate, the closer solution to utilized CaR, and the higher the penalty rate, the closer the solution to an allocated CaR regime. This solution has the advantage of giving the bank the flexibility to let its approach evolve over time by changing the penalty rate rather than changing the entire basis for performance evaluation.

**Implementing RAROC-Based Capital Allocation**

RAROC is of limited use unless it can be linked to decisions about whether business units deserve allocations of scarce economic capital. To accomplish this, the bank takes its definition of allocatable capital, measures that allocatable CaR for business units and the bank as a whole, and then allocates capital using a RAROC rule. The mechanics of this process vary widely from bank to bank. In general, two types of allocation rules are utilized. The first is the comparison of RAROC to hurdle rates for unit-by-unit allocation decisions. The second allocation rule treats the problem at a much broader level and allocates CaR using mathematical optimization.

**Hurdle Rates.** The comparison of RAROC to a hurdle rate enables a bank to determine whether a business is viable and thus entitled to new capital (or to keep its existing risk capital). One such hurdle rate is the requirement that risk-adjusted returns on a business be at least as high as the risk-adjusted returns required as compensation for the systematic risk of the business.

One popular hurdle rate is based on economic value added (EVA)\textsuperscript{11}. The traditional formulation for EVA is that a business adds economic value to the firm if

$$\text{Net Income} - \text{CaR} \cdot \text{CC} > 0$$

where CaR is the risk capital allocated to the business, CC is the cost of that risk capital, and net income is realized end-of-period. The EVA criterion can be rewritten in terms of RAROC so that a business line adds value to the bank if

$$\text{RAROC} > \text{CC}$$

Beyond indicating whether a project is viable ex ante, EVA can also serve as the basis for a measure of how much value the business added to the firm ex post. “Economic profit” can be defined using RAROC and EVA as follows:

$$\text{Economic Profit} = \text{RAROC} - \text{CC}$$

This measure of value added is used, for example, by Bank of America in its RAROC implementation. Imputing the proper shadow price to CaR is a tricky business. For ex ante decision making, the marginal cost of capital (or the cost of marginal CaR) should be taken into consideration, whereas ex post performance measurement should account for the all-in cost of capital for the allocated or utilized CaR. One school of thought argues that the marginal cost of risk capital is
the cost of the provision of “insurance” to the business unit. In that sense, option pricing models can provide the basis for calculating the cost of CaR.

Other firms prefer to rely on more traditional measures for the cost of capital. The cost of capital in an EVA framework, for example, is often approximated with the firm’s weighted average cost of capital (WACC). A problem with using such measures for cost of risk capital comparisons to RAROC, however, is that WACC is constant and independent of the business line’s performance.

### Optimizing the RAROC-Based Allocation

Many banks utilize many or all of the pieces of the RAROC puzzle discussed so far in some way. Only a few banks, however, pull all these pieces together to answer systematically the question posed at the beginning of this article: How do banks allocate risk capital across existing and new businesses when all of the prospects have positive expected economic profits? The solution to this problem lies in the application of mathematical programming techniques to RAROC concepts for the purpose of optimizing the bank’s risk-adjusted capital allocation.

Optimization is the process by which a bank chooses the allocation of marginal CaR or internal beta-adjusted enterprise-wide CaR to maximize business unit RAROCs less their costs of risk capital and subject to certain constraints. If regulatory capital has not been included as an opportunity cost in RAROC net income estimates, BIS capital requirements should be represented as a set of constraints on the optimization problem. In addition, allocations of capital to every business unit should satisfy the proper hurdle rate constraints and guarantee that only positive NPV projects are allocated positive CaR.

Treating the RAROC problem as an optimization problem has a number of advantages over using case-by-case hurdle rates or ad hoc economic profit calculations. Chiefly, hurdle rates and economic profits tell a bank specific information about each business unit’s value added, but these measures in the absence of a bank-wide CaR optimization do not tell the bank how to choose among multiple value-added projects all competing for scarce economic CaR. Optimizing the bank-wide allocation of marginal or internal beta-adjusted enterprise-wide CaR with the proper constraints and a well-defined optimization objective can take bankers a long way toward solving that problem.

### Integrating Performance Evaluation and the Allocation Decision

When hurdle rates or mathematical optimization is employed to allocate risk capital, the capital allocation decision is essentially independent of the performance evaluation decision. Because past performance is no guarantee of future performance, allocating capital without biases from past performance is intuitively appealing. But total independence is not always necessary, or even desirable.

One means by which a bank may integrate performance evaluation with the capital allocation process is to incorporate past performance through the constraints to an optimization problem. Capital is allocated based on ex ante RAROC, but the optimization can be “steered” toward desired outcomes through ex post RAROC-based constraints so that particularly bad managers never receive too much capital and particularly good managers receive some minimum amount.

Modeling the constraints in this manner is, of course, completely subjective, and it can lead to problems if the bank relies so heavily on past performance that ex ante measures of risk and return are neglected.

An alternative means by which performance measurement and capital allocation can be integrated would require managers to “pre-commit” to maximum levels of utilized capital. If actual risk capital exceeds their pre-commitment levels, the managers would be penalized in their compensation—and conversely.

### Conclusion

The fundamental question facing bankers is: What is the intended management application of RAROC? If the answer is the allocation of capital across business lines, ex ante RAROC is the proper tool. If evaluations of historical business line performance are desired, then ex post RAROC is the right way to go.

Whether RAROC is intended for ex ante or ex post decisions—or both—is necessarily situational. A banker that considers RAROC to help evaluate an investment in an e-business, for example, is contemplating an ex ante application of RAROC. But five minutes after making that decision the very same banker may wish to use RAROC to determine traders’ bonuses—clearly an ex post application and a different RAROC altogether.

While the situational nature of whether ex ante or ex post RAROC is a decision bankers must make case-by-case, the other specific issues raised in this article about how to measure and implement RAROC are not situational. Indeed, banks can and...
should address these issues well before they are faced with a situation that requires their use. Table 1 summarizes specific questions bankers should answer about ex ante and ex post RAROC applications. The only question in the table that should be addressed on a situation-by-situation basis using managerial judgment is the first. For all the others, the bank should adopt a written policy on whether ex ante or ex post RAROC—or both—will be used when an appropriate situation arises.

Notes


2. The Bank for International Settlements has circulated a proposal to modify the Accord and improve its risk weight system. The new proposal, however, suffers from some significant drawbacks of its own. For a discussion of the problems with the new proposal, see Christopher L. Culp, “Wettbewerbsnachteile für Schweizer Banken?” Neue Zürcher Zeitung (15 Oktober 1999).

3. In this article, risk-adjusted return on capital (RAROC), return on risk-adjusted capital (RORAC), and risk-adjusted return on risk-adjusted capital (RARORAC) are treated as synonymous. As long as risk is adjusted properly, the name of the measure is of secondary importance. RAROC is a specific type of “risk-adjusted performance measure” (RAPM). A discussion of non-RAROC RAPMs can be found in the excellent book by Chris Matten, Managing Bank Capital (New York: John Wiley & Sons, 1996).


6. This and other methods of relating EaR to CaR are discussed in Matten, op. cit.

7. See Matten, op. cit., Chapter 5, and The Practice of Risk Management (London: Euromoney Books, 1998). Both references treat the forward-looking approach as synonymous with VaR measurement and the backward-looking approach as synonymous with EaR measurement. Although this distinction is a common one, it is not accurate. EaR can be measured as forward-looking just as easily as VaR can be measured looking backwards. See Culp, Miller, and Neves, op. cit.


10. Saita, op. cit.

11. EVATM is a registered trademark of Stern Stewart & Co.


Table 1

<table>
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<th>Intended Management Application</th>
<th>Ex Ante Allocations of Capital Across Application</th>
<th>Ex Post Evaluations of Business Line Performance</th>
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<td>(1) Pro rate share of undiversified total CaR (2) Pro rate share of enterprise-wide CaR (3) Marginal business line CaR (4) Internal beta-based</td>
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<td>Should CaR be measured as allocated/allocatable or utilized?</td>
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Risk-Adjusted Return on Capital (RAROC). Dr. Yousef Padganeh Head of Enterprise Risk Management Commercial Bank International. Global Association of Risk Professionals. © 2014 Global Association of Risk Professionals. All rights reserved. Risk-Adjusted Return on Capital (RAROC). (RAROC) is a unique risk adjusted performance/profitability measuring tool that presents risk-oriented view for the revenues in the perspective of magnitude of risks taken to generate those revenues. RAROC Revisited. Journal of Lending & Credit Risk Management. has been cited by the following article: TITLE: The Impact of Credit Risk Management in Financial Market Indicators—Analytical Study in the Iraqi Market for Securities. AUTHORS: Mahdi Attia Jubouri. KEYWORDS: Credit Risk Management, Financial Market Indicators, Private Banks. JOURNAL NAME: Journal of Financial Risk Management, Vol.7 No.3, September 27, 2018. Risk-Adjusted Return on Capital (RAROC). Risk-adjusted return on capital (RAROC) is a modified return on investment (ROI) figure that takes elements of risk into account. The formula used to calculate RAROC is: Where: Income from capital = (capital charges) x (risk-free rate). Expected loss = average loss expected over a specified period of time. In financial analysis, projects and investments with greater risk levels must be evaluated differently; RAROC accounts for changes in an investment’s profile Risk-adjusted return on capital is a useful tool in assessing potential acquisitions. The general underlying assumption of RAROC is investments or projects with higher levels of risk offer substantially higher returns. Companies that need to compare two or more different projects or investments must keep this in mind. RAROC and Bankers Trust. RAROC is also referred to as a