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RAROC Based Capital Budgeting and Performance Evaluation: A Case Study of Bank Capital Allocation

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RAROC Based Capital Budgeting and Performance Evaluation: A Case Study of Bank Capital Allocation [1]

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Abstract: This paper describes the RAROC system developed at Bank of America (B of A) in order to examine how risk-based capital allocation models work. I begin by discussing the economic rational for allocating capital in a diversified organization like the B of A. Drawing on recent work by Froot and Stein (1995) and Stein (1996), I argue that the capital budgeting process used by the B of A resembles the operation of an internal capital market in which businesses are allocated capital with the objective of mitigating the costs of external financing. Viewing the capital budgeting process in this way is useful because it suggests that a businesses contribution to the overall variability of the cash flows of the bank will be an important factor in evaluating the risk of (and the capital allocated to) a specific business unit. In addition, since RAROC systems are used both for capital budgeting and management compensation, the measures of risk are designed to limit rent seeking and influence activities by division managers,

Next, given the theoretical background, I provide a detailed look at how the RAROC capital allocation and performance evaluation system works at B of A. The primary objective of B of A's system is to assign equity capital to business units (and ultimately to individual credits) so each business unit has the same cost of equity capital. This process implies that investments in riskier projects or business units (measured by the projects contribution to the overall volatility of the market value of the bank) will be required to use less leverage than investments in less risky
business units.

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Since the late 1980s, a number of large U.S. banks have invested heavily in systems designed to measure the risks associated with their different lines of business. The immediate purpose of such risk-measurement systems is to provide bank managements with a more reliable way to determine the amount of capital necessary to support each of their major activities and, thus, to determine the overall leverage for the bank as a whole.

This recent interest in measuring risk is partly a response to the greater regulatory emphasis on capital adequacy that has come with both the implementation of the Basel risk-based capital requirements issued in 1988 and the passage of FDICIA in 1991. Even more important, however, than such regulatory changes are fundamental changes in the business of banking. As the progressive deregulation (capital requirements aside) of the industry continues, banks are choosing to provide an increasingly diverse set of products and services. The real innovation in these new performance-evaluation methods lies in their ability to allocate banks' capital among their expanding array of nontraditional, fee-based activities -- many of which do not involve any use of capital for finding purposes but create a contingent liability for the bank. The ultimate goal of these risk-based capital allocation systems, which are often lumped together under the acronym RAROC (risk-adjusted return on capital), is to provide a uniform measure of performance. Management can, in turn use this measure to evaluate performance for capital budgeting and as an input to the compensation system used for senior managers,

In this paper I describe the RAROC system developed at Bank of America (B of A) in order to examine how risk-based capital allocation models work. In 1993, B of A's Risk and Capital Analysis Group was charged with the task of developing and instituting a single corporate-wide system to allocate capital to all the bank's activities. Since 1994, that system has been providing quarterly reports of risk-adjusted returns on capital for each of the bank's 45 business units. By 1995, B of A had also developed the capability to calculate RAROC down to the level of individual products, transactions and customer relationships. This three-year process of developing and implementing a system to measure economic returns provides an interesting case study in the application of financial theory to real business problems.

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What Is RAROC?

Development of the RAROC methodology began in the late 1970s, initiated by a group at Bankers Trust. Their original interest was to measure the risk of the bank's credit portfolio, as well as the amount of equity capital necessary to limit the exposure of the bank's depositors and other debtholders to a specified probability of loss. Since then, a number of other large banks have developed RAROC or (RAROC-like systems) with the aim, in most cases, of quantifying the amount of equity capital necessary to support all of their operating activities -- fee-based and trading activities, as well as traditional lending.

Bank of America's policy is to capitalize each of its business units in a manner consistent with an AA credit rating, based on the unit's "stand-alone" risk, but also including an adjustment for any internal diversification benefits provided by the unit. (As I will discuss in more detail later, the stand-alone risk of a business unit is measured by the expected, or forward-looking volatility

of its operating value.) Each of these individual capital allocations are then aggregated to arrive at the optimal level of equity capital for the entire bank.

RAROC systems allocate capital for two basic reasons: (1) risk management and (2) performance evaluation. For risk-management purposes, the overriding goal of allocating capital to individual business units is to determine the bank's optimal capital structure. This process involves estimating how much the risk (volatility) of each business unit contributes to the total risk of the bank and, hence, to the bank's overall capital requirements.

For performance-evaluation purposes, RAROC systems assign capital to business units as part of a process of determining the risk-adjusted rate of return and, ultimately, the economic value added of each business unit. The economic value added of each business unit, defined in detail below, is simply the unit's adjusted net income less a capital charge (the amount of equity capital allocated to the unit times the required return on equity). The objective in this case is to measure a business unit's contribution to shareholder value and, thus, to provide a basis for effective capital budgeting and incentive compensation at the business-unit level.

RAROC and Financial Theory

Allocating equity capital on the basis of the risk of individual business units seems pointless in the classical theoretical paradigm of "frictionless" capital markets (one with perfect information and without taxes, bankruptcy costs or conflicts between managers and shareholders). If markets operated in this manner, the pricing of specific risks would be the same for all banks and would not depend on the characteristics of an individual bank's portfolio. Moreover, given

market prices of risk, whether a bank varied leverage on the basis of risk or varied the cost of capital with the risk of the project would result in the same capital budgeting decisions and investment activity for the bank.

Of course, no self-respecting banker would accept the proposition that capital markets operate without frictions. Indeed, banks and other financial intermediaries add value precisely through their ability to reduce market frictions -- frictions such as limited public information and the possibility of costly renegotiations of troubled credits. This role implies that a large portion of bank assets are likely to be difficult for outside investors to value, which in turn may create information and agency problems for banks themselves when they have to raise capital externally. As Froot and Stein (1995) point out, faced with an increasing cost of raising external funds banks will behave in a risk-averse fashion. Specifically, a business unit's contribution to the overall cash flow volatility of the bank will be an important factor in the capital budgeting decision. Moreover, in this environment capital structure, risk management and capital budgeting are inextricably linked together.

Finance theory suggests that, in designing a capital allocation system, the first step is to identify the costs and benefits of holding equity capital in the context of these market frictions. In banking, as in most industries, the tax shield provided by tax-deductible interest payments (as opposed to non-deductible dividends) creates an incentive to make extensive use of debt financing. Banks' access to fixed-rate deposit insurance also makes debt in the form of deposits a low-cost source of finding. When combined with this federal insurance subsidy, depositors'

further reduction of their required interest rates for the liquidity and convenience of demand and time deposits is an added incentive for banks to use this form of leverage. The advantages of debt financing for commercial banks suggests that holding a large capital buffer will be costly.

The benefits of increasing financial leverage must, of course, be weighed against the costs. In the extreme case, high leverage can lead to default and a costly reorganization. But there are also significant costs to banks that can arise in cases of financial distress that are much less extreme. For one thing, FDICIA imposes heavy costs (in the form of increased regulatory oversight) on banks that violate the minimum capital standards. But the most serious deterrent to high leverage in banking is the possibility for liquidity constraints to cause major disruptions on a bank's operating activities. As Merton and Perold (1993) pointed out, banks and other financial firms can be distinguished from industrial companies by the fact that their customers are often also their largest liability holders. For example, a banks' depositors, swap counter parties and letter-of-credit beneficiaries all have liability claims on the bank. And because these customers place a premium value on assurances of performance on their contracts, they show a strong preference for banks with a high credit quality. As a consequence, a high credit rating is generally held to be essential for a bank to be a major swaps dealer, to underwrite securities or to compete effectively in the corporate banking market. [1]

[1]This argument also suggests that if the importance of a high credit rating varies with the type of business, the capital requirements will vary. Requiring all businesses to be capitalized at a particular level may create an additional burden for those businesses that require a lower credit rating.

In sum, the benefits of debt financing for banks suggests that there are costs associated with holding a lot of capital. This implies that risk-management concerns will enter into capital budgeting decisions. This has two important implication for the design of a capital allocation system. First, when evaluating the risk of a new project or business unit the project's contribution to the overall variability will affect the project's hurdle rate or cost of capital. In particular, Froot and Stein show that assuming a simple one factor pricing model (for tradable risk) the hurdle rate the bank for an investment project will take the following form:

$$(1) \quad \mu_i = \gamma \, cov(\mu_i, R_m) + \lambda \, cov(\mu_i, R_p)$$

Where:

γ = *market unit price of risk for the priced factor*

R_m = *Return on the priced factor*

λ = *Unit cost for volatility of the bank's cash flows*

R_p = *Return on the bank's existing portfolio*

μ_i = *hurdle rate or required return for project i*

Intuitively, the hurdle rate reflects the business unit's priced risk plus the contribution of the project to the overall volatility of the bank's cash flows. The price for the bank specific risk will vary directly with the cost of external financing and the cost of capital short falls. The

important insight of this model is that given the market frictions that make risk management and capital structure matter, bank-specific risk factors are an important element of the capital budgeting process.

A second implication of these market frictions is that the bank should hedge all tradable risks-- risk that can be hedged at little cost in the capital market. This implication follows directly from the fact that the bank's required price for bearing tradable risk will exceed the market price for the risk by the contribution of a hedgable risk to the overall variability of the bank's portfolio. The only risk the bank should assume are illiquid or nontradable risk in which it has a comparative advantage in bearing (perhaps as a result of it's information producing activities in the capital markets). Currency and interest rate risk would appear to fall into the tradable risk category, while credit risk (particularly arising from lending to nontraded entities) would fall into the nontradable category.

Agency and information problems that make external financing costly, also provide incentives for diversification and the creation of an internal capital market in which capital is allocated by a centralized headquarters. Specifically, as discussed in Stein (1996) an internal capital market can improve investment efficiency when agency problems between managers and outside investors create credit constraints. The basic idea is that unlike private lenders, headquarters has control rights over projects that provide incentives for "winner picking"-- the practice of shifting funds from one business unit or project to another. The improvement in efficiency arises from headquarters' ability to derive private benefits from several projects

simultaneously, but unit managers can only derive benefits from a single business unit. This implies that headquarters will sometimes be willing to take finds from weaker projects and allocate these finds to relatively strong projects. Moreover, in allocating capital within an internal capital market, the relative rankings of projects is important. Thus, an ordinal measure of the value added associated with the bank's business unit will be need to allocate capital among competing business units.

In summary, capital market frictions provide an economic rational for risk management and the allocation of capital based, in part, on the contribution of an individual project to the overall volatility of the cash flows of the bank. Moreover, to the extent that these frictions lead to credit constraints, allocating capital to a diverse set of projects based on an ordinal measure of the value of the project can increase investment inefficiency. Before discussing the implications of this analysis for the design of RAROC systems, I briefly discuss recent empirical evidence on effect of capital market fictions on bank investment and the operation of internal capital markets in banking.

Empirical Evidence Concerning Capital Constraints

The preceding discussion suggests that rationale for risk management and how capital is allocated will depend on the importance of external financing constraints that banks face. How important are these constraints? A recent study by Houston James and Marcus (1996) , provides empirical evidence on the importance of external financing costs in banking. Specifically they examine the relationship between loan growth (the equivalent in banking to investment activity)

and internally generated finds for a sample of 281 bank holding companies and approximately 2,000 of their subsidiaries over the period 1981 through 1989. Following Frazzari, Petersen, and Hubbard (1988), capital market imperfections are assumed to create a wedge between the cost of internal and external financing that is reflected in a sensitivity of loan growth to bank earnings. Their results are reported in Table 1. Notice that loan growth is significantly related to internally generated additions to capital after controlling differences in the ratio of the market to book value of equity (a measure of growth opportunities). Moreover, the sensitivity of loan growth to internally generated finds is significantly higher for holding companies at or below the regulatory minimum capital ratio.

Further evidence on the importance of financing constraints is provided by examining the relationship between loan growth of individual subsidiaries of bank holding companies and the subsidiaries own cash flows as well as the cash flows of other subsidiaries with in the same holding company. Specifically, following an approach similar to Lament (1996) we examine whether loan growth at relatively small (less that 15 percent of the holding company assets) subsidiaries of bank holding companies depends on the capitalization of the holding company and the earnings of other subsidiaries within the holding company. If bank holding companies are capital constrained and allocate capital according to the relative value of projects then one would expect a negative relationship between loan growth at a subsidiary and loan growth of other subsidiaries of the holding company.

The results of the analysis are presented in Table 2. Notice that loan growth of the subsidiary is positively related to the both the subsidiaries own cash flows and the cash flows of the other subsidiaries within the holding company. Moreover, the coefficient estimate on the cash flows of other subsidiaries is significantly greater that the coefficient on the subsidiaries own cash flows. More importantly, we find a negative and statistically significant coefficient on the loan growth of other subsidiaries within the holding company. This is evidence consistent with the operation of an internal capital market, in which the holding company "picks winners" (and "sticks loser"),

Implications For the Design of Capital Budgeting Systems

At Bank of America, the capital charge for each business is obtained by multiplying economic capital by the *same, corporate-wide* cost of equity capital -- the so-called "hurdle rate.". A project or business unit is then evaluated according to its expected "residual income" -- or what B of A calls the "economic profit ." Economic profit is calculated as earnings (net of taxes, interest payments and expected credit losses) less a charge for the cost of equity capital. The amount of capital allocated varies with the contribution of the project to the overall volatility of the earnings of B of A (the project's so called internal beta).

How well does this methodology conform with the capital budgeting framework discussed above? First note that the capital allocation system is designed so that an equity investment in each project will have the same risk. This is accomplished by assigning more capital to riskier projects. Assuming for the moment that the right measure of risk is used to allocate

capital, this procedure implies that the same cost of equity capital should be used to evaluate all of the projects in the bank. In particular, allocating capital in this way ensures that even though risk on an "unlevered" basis may vary widely across the various activities of the bank, on a levered basis, the risk of various activities are the same. Second, notice that capital is allocated according to the project's internal beta and not the project's systematic or priced risk. One reason for this is the difficulty of estimating betas for individual lines of business with few stand-alone competitors. And given the lack of objective data, the "influence costs" due to disputes among managers assessed different costs of capital were likely to be significant.

More importantly, if the bank's main concern is with providing a relative ranking of competing projects, (consistent with operating an internal capital market), and the bank lays off "hedgable" risks, allocating capital based on internal betas will, in general, accomplish this goal. To see this, suppose that the proper method of allocating capital involves allocations based on a two factor model similar to the one described in equation (1). In particular, the true cost of capital (or alternatively the amount of equity capital allocated to a project) is determined by the projects "market beta" and the projects internal beta. Instead of using this model, the bank allocates capital according to estimates of each projects internal beta (i.e the covariablity of the project's returns with the banks existing portfolio of projects). The resulting estimates of project risk will suffer from omitted variable bias (since the market return is omitted).

While the resulting risk estimates are biased and inconsistent, the bias is likely to be small if the bank lays off the unit's hedgable risk.[2] A number of banks allocate capital based on either total project risk (variance) or a project's systematic risk. But neither of these methods will preserve relative rankings. However, if equation (1) reflects the cost of capital, these alternative

[2] Formally, suppose that the true model is

$$(2) \quad R_i = \alpha_i + \beta_{im} R_m + \beta_{ip} R_p + \epsilon_i$$

Where R_m= market return and R_p= Return on the bank's existing portfolio.

Instead of estimating (2), the bank estimates a single factor model:

$$R_i = \lambda + \beta_{ip} R_p + \theta_i$$

The resulting estimate of the internal beta is biased since,

$$E(\hat{\beta}_{ip}) = \beta_{ip} + \beta_{im} \beta_{pm}$$

However, to the extent that the bank lays off hedgable risks associated with the projects (or that risk is attributed to another business' unit) β_{im} will be relatively small. Moreover, for credit risk, B_{im} is likely to be quite small.

allocation schemes do not preserve relative rankings.[3]

RAROC, Economic Profit and Performance Measurement

In addition to capital structure planning, RAROC systems are used to evaluate the performance of business units for purposes of compensating line managers. At many banks, including B of A performance is evaluated according to the "residual income" -- or what B of A calls the "economic profit" -- of the activity. The objective of this calculation, again, is to provide an ex-post measure of the value added by a particular activity -- one that allows the economic profit of "off-balance-sheet" activities to be compared to that of traditional asset-based activities, The value added associated with each activity can then be used as a basis for determining incentive based compensation for line managers.

Using capital allocations for both capital budgeting and management performance evaluations raises the question of what is the appropriate measure for measuring risk. Bank of America allocates capital according to the nonhedgable risk that originates in a business unit, For example, in lending activities, the net income of loans is calculated assuming "matched duration" finding, i.e., the loan is funded in a way that removes the interest-rate risk associated with the loan. This process also removes from the capital calculation volatility arising from risks that can

[3] See Uyemura, Kantor and Pettit (1996) for a description of industry practices. It is interesting to note that even if only systematic risk affects the cost of capital, using internal betas still results in the correct relative rankings. This follows from the fact that the return on the bank's portfolio can be thought as a the return on the market portfolio measured with error. As a result estimates of internal betas are biased and inconsistent estimates of market betas. However, the bias is the same for all new projects and as a result relative rankings are preserved.

be easily hedged. The Treasury unit is responsibility for hedging interest rate and currency risk[4]. This process reduces the risk assumed by line managers (through variability in their compensation) and focuses their attention on risk that they can potentially influence. As a result of this process, most business units are allocated capital based on credit risk and business risk (volatility arising from operational errors) and not based on volatility arising from hedgable risk.

A second and more subtle reason for basing compensation (through the capital allocation process) on nonhedgable risks in the business unit is that these risk are likely to result from rent seeking behavior of business unit managers. In particular, suppose that division managers derive private benefits from growth in the size of their division. To the extent that riskier divisions are allocated more capital and therefore face a higher capital charge, division managers can increase their size by understating the risk of their division. Since division managers are likely to have better information about the unique (nonhedgable) risk that arise in their department, rent seeking behavior is likely to take the form of obscuring this risk. By evaluating performance based on the realized outcomes of a position (net of hedgable risk) relative to management forecasts, this type of rent-seeking behavior can be mitigated.

Given the discussion concerning why banks allocate capital, I turn next to a discussion of the system used by Bank of America for allocating capital and evaluating the performance of its business units.

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[4] To the extent that the Treasury does not hedge interest rate and currency risk, then it is allocated capital in proportion to these hedgable risk.

II. RAROC at Bank of America

Until late 1993, the primary profitability measure in management reports at B of A was return on assets -- net income divided by total assets. For several years, the Bank had struggled with little success to measure performance on a risk-adjusted basis. Like many other banks, B of A had attempted to apply Risk Based Capital Guidelines to profitability measurement. Using regulatory requirements to determine the equity levels of each business, the bank had developed for purposes of capital budgeting and performance evaluation a complicated process for assigning different risk-based hurdle rates to each business. But, because of the difficulty of reconciling regulatory equity requirements with a portfolio-based risk framework, this approach met with considerable internal resistance.

In November 1993, efforts to redefine performance measurement were given high priority. A Risk & Capital Analysis Department was formed at the Bank and given the responsibility of developing the overall framework for risk-adjusted profitability measurement, Senior management pressed for quick implementation. The overall development process was allotted just four months. The initial staffing of the department included a manager and four financial analysts.

The short-term objective of the RAROC project was to develop a comprehensive and consistent methodology for attributing capital to the bank's "first-tier" business units. Following a pilot test in the Bank's U.S. Corporate Group, an initial set of RAROC calculations were performed for 45 different lines of business. Since successful completion of this first pass in

March of 1994, the Bank has been progressively integrating RAROC concepts into existing management and reporting systems.

The Framework

Risk is defined by Bank of America as any phenomenon that creates potential volatility in the economic cash flows of the bank. The purpose of risk capital is to provide comprehensive coverage of losses for the organization as a whole. By "comprehensive," they mean coverage of *all* sources of risk with a very high degree of confidence.

Bank of America has identified four major categories of risk associated with its various activities:

- ***Credit risk*** is the risk of loss due to borrower default. In addition to default risk on loans, credit risk also includes a trading counterpart's failure to pay on a contractual obligation.
- *Country risk* is defined as the risk of loss on cross-border and sovereign exposures due to governmental actions. Suspension of hard currency payments, radical devaluation of the currency and nationalization of assets held as investments are some examples of such government actions.
- ***Market risk*** is the risk of loss due to changes I the market price of the Bank's assets and obligations. Examples of market risk are foreign exchange risk, interest-rate risk and options risk on mortgages and deposits.
- ***Business risk is*** the uncertainty of the revenues and expenses associated with non-portfolio activities, such as origination, servicing and data processing. Business risk is a function of

general industry factors, company-specific factors and external factor, such as technological advances and regulatory changes.

Risk can be measured along two dimensions -- ***expected loss*** and ***unexpected loss.*** Expected loss is the *average* rate of loss expected from a portfolio. In the case of credit risk, expected losses are reflected in loan rates and fees. Because such losses are intended to be covered by operating earnings, they are reported in required loan-loss provisions on a bank's P&L. It is unexpected loss that creates the need for economic capital. And, for each of the four sources of risk associated with a given business unit, it is unexpected loss that determines economic capital.

Capitalization and Confidence

How much protection is sufficient against unexpected losses? At Bank of America, the total amount of economic capital attributed to all of the business units is the amount that is estimated to guarantee the solvency of the bank at a 99. 97°/0 confidence level.

Senior management's choice of the 99.97% coverage level -- alternatively, a .03 °/0 probability of default -- was determined by evaluating the implicit risks and default rates of public debt projected over a one-year horizon. As shown in Table 3 the 99. 97°/0 coverage level was sufficient to reduce the risk of the bank to the average levels for AA-rated companies.

Time Horizon for Measuring Risk

Over what time period should risks be measured? In theory, the choice of time horizon for measuring risk is arbitrary. One could use volatility measured over five-year or even 10-year intervals, with the aim of capturing "full cycles" in risk. On the other hand, it is hard to get reliable data for such long periods, particularly on unfamiliar businesses. And one may be able to get reasonably precise measurements using volatility over much shorter periods of time.

B of A has chosen to calculate both expected and unexpected loss using a common one-year time horizon to ensure consistency across the organization. This choice of time horizon is somewhat of a compromise between a credit-risk and a market-risk perspective. If the time horizon is not consistent, then comparability of return measures is lost.[5]

Another key consideration was to ensure the measures of risk are both as current and as forward-looking as possible. Both risk measures and capital assignments are updated quarterly. By assigning levels of capital based on anticipated future risks, rather than on historical volatility, the system is designed to encourage managers to make changes in the business mix of their unit or in the composition of the credit portfolio -- changes that will improve the risk-reward profile of the bank while increasing their own RAROC and economic profit.

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[5] As noted, the average default rate for AA firms was approximately .03% over that horizon. Measured over a 10-year-horizon, the default probability for AA loans would be 1.00% or more. But, in that case, our required confidence level would fall from 99, 97°/0 to 99. 00°/0 or less, and, thus, the amount of capital required would not necessarily increase as a consequence of lengthening the horizon.

Capital and Probability Distributions

To achieve the targeted confidence level for the capitalization of any business, it is necessary to consider not only the volatility of that business' results, but also the probability distribution of potential outcomes. Is the distribution a "normal," bell-shaped curve, in which high and low outcomes are roughly symmetrical? Or is the distribution highly "skewed," with losses tending to become very large at the extreme end of the distribution? The probability distribution is important because it will determine the number of standard deviations of unexpected losses to achieve the 99. 97°/0 confidence interval.

For example, for risks that can be characterized as having normal distributions (such as interest rate, foreign exchange and other "market risks), capital coverage of 3.4 standard deviations is consistent with a 99.97% confidence interval. For credit losses, by contrast, the empirical data suggest that the distribution is not normal, but is highly skewed. And the very small possibility of very large losses require capital coverage of credit risks of six standard deviations to achieve the same 99. 97% confidence interval.

Defining Risk: Volatility of Book Capital or Market Value?

But this system raises a theoretical issue that has considerable practical import: In setting a capital structure target for a bank, how does one measure the volatility of its value or the value of its individual units? Is the value that of the bank's stock price or of some proxy for market value, such as a business unit's economic cash flows? Or is it the volatility of the bank's reported

earnings and book capital -- the main focus of the regulators -- that is critical in determining capital adequacy.

Given the rationale for managing the capital position of a bank presented earlier -- the relevant measure of risk for determining capital adequacy is the volatility of a bank's cash flows, not the volatility of its book or regulatory capital.

And just as a bank's overall capital should depend upon the volatility of its cash flows, capital allocations to individual business units of the bank should be made on the basis of the "contribution" of each business unit to the overall volatility of the bank's cash flows. For many of the fee-based activities of banks, this arrangement will likely mean assigning considerably more capital than such operations require in their day-to-day execution. Take the cases of securities underwriting and the issuance of commitments. Although neither requires much capital for day-to-day finding of operations (what Merton and Perold (1993) refer to as "cash capital"), both require the implicit backing of significant amounts of the bank's capital ("risk capital,")

Measuring and Capitalizing the Four Sources of Risk

The risk measurement and capital assignments for each of the four sources of risk are made at the lowest level of the organization that the data will support -- in some cases, down to the level of the individual facility or transaction. Such a bottom-up, or building-block approach allows capital to be aggregated or desegregated at various levels and in various ways without distorting the results. For example, capital can be assigned not only to lines of business, but also, in many cases, to individual products that cut across the different business units.

Credit risk, or the risk of loss due to borrower defaults, is attributed to all units with borrower counterpart exposure (commercial borrowers, consumer borrowers and trading counterparties). For commercial portfolios, both credit and country risk capital are calculated at the individual loan level. This method of calculation allows for the finest possible gradation of risk. In the case of consumer loans, the sheer volume of such loans makes it cost-effective to perform credit-risk calculations only down to the "sub-portfolio" level. Sub-portfolios are defined to be relatively homogeneous groups of loans with the primary stratification based upon the product and risk classification.

The total amount of credit capital depends on a number of factors. The most important are the internal credit rating of the borrower and the dollar amount of exposure. Other factors that some into consideration are the amount of unutilized commitment, the type of collateral supporting the credit, the instrument type, the size of the exposure relative to the total portfolio and the industry of the borrower.

Country risk is the risk of loss -- independent of the borrower's financial condition -- on foreign exposures arising from government actions. Country risk is attributed to all business units with cross-border and sovereign exposures. Because country and credit risk are close related, B of A's country-risk approach closely parallels its credit risk methodology. The key difference is that the risk rating of the country is used in place of the customer's internal risk rating. The country risk of a cross-border exposure is treated as equivalent to a direct loan to the government where the loan is domiciled.

Market risk is the risk of loss due to changes in the market prices of traded assets and obligations of the bank. It arises most obviously from an outright position or from an explicit derivative. At B of A two general processes are used to measure market risk. For most trading activity, market risk is measured using a "value at risk" or (VAR) framework. For products with options risk exposure, such as mortgages and home equity loans, the market risk is estimated using Monte Carlo simulation. Market risk capital is calculated at the trading unit or portfolio level, with adjustments made to account for diversification associated with the correlation between trading rooms.

Business risk includes all the risks that the bank is subject to as a result of operating as a going concern business, but excluding the three portfolio risks listed above. B of A's current method for measuring business risk is based on average capitalization rations for non-financial firms in retail and wholesale industries. Also, now being considered, however, are alternative approaches, notably, use of performance volatility measures or "pure plays" for possible implementation by the end of 1996. It is interesting to note that the majority (over 75 percent) of the capital B of A holds is for credit risk and business risk. This allocation is consistent with a strategy of hedging most market risk.

A Closer Look at Credit Risk

Measurement of credit risk at B of A involves a six step process. The first step is the loan officer in conjunction with internal credit analysis group to estimate the likelihood of default. This estimation process for commercial credits is based on a proprietary credit rating model in which a loan is assigned one of six credit ratings. The default probability associated with each of the credit ratings is provided in Table 4. The second step in the process is to estimate the bank's exposure given default. This involves estimating the outstandings associated with a line of credit given a default (useage tends to increase immediately prior to a default). Exposure estimates vary with the type of credit and initial credit rating and are based on historical data. The next step in the process is to estimate the severity of loss given default. This estimate is based on the collateral type and is again based on historical data. Given this information the expected loss is simple the default probability times the exposure and the severity of loss. An estimate of the volatility of loss is based on a binomial standard deviation formula:

$$Volatility = EXP \times \sqrt{LGD^2 \times DP \times (1-DP) + DP \times VOL^2} \times \sqrt{[S + (1-S) \times C]}$$

Where: EXP = Exposure LGD = Loss Given Default DP = Default Probability

VOL = Volatility of Severity S = Relative Size Factor C = Correlation

Business Unit Calculations

The risk measures described above provide the basis for assigning capital to each of the bank's 45 business units. Such capital assignments in turn allow for periodic calculations of RAROC and economic profit. Every quarter a management briefing book of RAROC and economic profit performance is distributed to senior management, business managers and senior finance officers. This book shows results for the current quarter, an eight-quarter trend, and a projection of the plan for the entire bank and its 45 business groups. Reports and graphics are presented that allow comparisons of RAROC, economic profit and capital invested across all business groups.

Calculating RAROC

The calculation of RAROC is relatively simple once all the risk calculations have been completed. RAROC is computed by dividing risk-adjusted net income by the total amount of economic capital assigned based on the risk calculation.

The starting point for the numerator is B of A's management-reporting system. The existing system allocates income and expense items down to the unit level. This system reports not only direct revenues and expenses, but also transfer pricing allocations, charges for internal services and overhead and tax allocations.

Risk-adjusted net income is then determined by taking the financial data allocation to the businesses and adjusting the income statement for expected loss. A second adjustment is also

required to take into consideration the effects on the net interest margin of the change in the capital accounts as the focus is shifted from book profitability to economic profitability.

Conclusion

This paper describes the capital allocation process used by Bank of America. The way in which B of A allocates capital is consistent with the existence of market frictions that create a wedge between the cost of internal and external funds. Moreover, the capital allocation process is an integral part of not only the capital budgeting process of the bank but also of the performance evaluation system of senior management. This dual purpose implies that

Table 1
Loan Growth and Internally Generated Additions to Capital

Fixed effects regressions relating loan growth to internal additions to capital, capital requirements and firm financial characteristics. The sample consists of bank holding companies over the period 1981-1989 (t-statistics in parentheses).

Dependent Variable = $(Loan_t - Loan_{t-1}) / Loans_{t-1}$

Coefficient	(1)	(2)
(Additions to Capital)/$Loan_{t-1}$ [a]	4.53 (13.96)	3.55 (13.395)
Surplus Capital/Total $Assets_{t-1}$ [b]	.708 (2.62)	
Bind[c]		-0.026 (-2.752)
Surplus Capital*(Additions to Capital)/$Loans_{t-1}$	-34.95 (-2.92)	
Bind *(Additions to Capital)/$Loans_{t-1}$		1.49 (3.138)
Market/Book	0.262 (3.64)	0.263 (3.658)
$Securities/Assets_{t-1}$	.226 (3.57)	0.242 (3.90)
log (Assets)	-0.018 (-2.76)	-0.019 (-2.744)
R^2	0.24	0.245
N (Categories)	1366 (278)	1373 (278)

a Additions to capital equal net income (before extraordinary items) plus additions to loan loss reserves
b Surplus capital equals actual capital less capital required to meet minimum capital requirements.
c Bind = 1 if surplus capital is less than or equal to zero

Table 2

Subsidiary Loan Growth, Holding Company Internal Additions to Capital and Loan Growth in Related Subsidiaries
Regressions relating subsidiary loan growth to internal additions to capital, capital requirements and subsidiary and bank holding companies financial characteristics. The sample consists of 2000 subsidiaries of 178 multiple bank holding companies from 1986-1990 (t-statistics in parentheses). *

Dependent Variable = $(Loan - Loan_{t-1}) / Loan_{t-1}$

Coefficient	Overall Sample	Small Bank Subsidiaries	Lead Banks
$(IAC_H - IAC_B)/Loan_H - Loan_B$ [a]	3.20 (11.24)	3.58 (11.09)	1.19 (1.62)
$IAC_B/Loan_B$	0.182 (3.040)	0.166 (2.660)	1.271 (2.163)
$Bind_H$ [b]	-0.063 (-2.752)	-0.067 (-2.765)	-0.168 (-2.659)
$Bind_B$	0.022 (1.160)	0.020 (1.006)	-0.168 (-2.159)
Loan $Growth_H$ [c]	-0.138 (-4.884)	-0.171 (-5.540)	-0.045 (-0.0488)
$Market/Book_H$	0.600 (-5.814)	0.660 (5.777)	0.326 (1.526)
$Securities/Assets_B$	0.0234 (0.845)	0.0015 (0.959)	0.018 (0.170)
R^2	0.06	0.06	0.08
N (Categories)	4307 (2001)	3901 (1839)	404 (237)

a IAC_i = internal additions to capital (I=H for holding company and B for bank subsidiary).

b $Bind_i$ = 1 if bank capital ratio is less than or equal to the regulatory minimum.

c Loan $Growth_H$ equals loan growth of other subsidiaries in the holding company divided by their beginning of the period loans outstanding.

* Estimated using between effects regressions for individual bank subsidiaries. Results are similar using O.L.S. techniques.

Table 3
Estimated Default Probabilities
By Rating Class

S&P Rating	Moody's Equivalent	Default Probability (Subsequent year)	Coverage Level
AAA	Aaa	0.01%	99.99%
AA	Aa3/A1	0.03%	99.97%
A	A2/A3	0.11%	99.89%
BBB	Baa2	0.30%	99.70%
BB	Ba1/Ba2	0.81%	99.19%
B	Ba3/B1	2.21%	97.79%
CCC	B2/B3	6.00%	94.00%
CC	B3/Caa	11.68%	88.32%
C	Caa/Ca	16.29%	83.71%

Source: Bank of America

Table 4
Commercial Credit Capital Allocation by BACRR
First Quarter 1996
(Dollars in Millions)

Summary Results

Domestic Private Bank

BACRR	Commitments	Outstandings	Commercial & Standby LCs	Weighted Exposure	Expected Loss	Expected Loss (% of Outstdgs)	Unexpected Loss	Credit Capital	Credit Capital (% of Outstdgs)
1	62.7	38.7	14.2	51.6	0	0.01%	0	0.2	0.56%
2	996.4	650.4	24.9	812.9	0.1	0.02%	1.5	8.9	1.37%
3	867.7	569.4	22.8	711.3	0.4	0.07%	2.6	15.7	2.75%
4	793.4	402.7	48	601.5	0.9	0.23%	3.6	21.8	5.42%
5	16.5	16.3	0	16.4	0.1	0.64%	0.2	1.5	9.08%
6	29.6	28.9	0	29.6	0.4	1.54%	0.6	3.5	11.95%
7	3.4	2.6	0.8	3.4	0	0.00%	0.3	1.8	69.47%
Sovereign	0.1	0.1	0	0	0	0.00%	0	0	0.00%
Missing	0	0	0	0	0	NA	0	0	NA
Total	**2769.8**	**1709.2**	**110.7**	**2226.8**	**2**	**0.12%**	**8.9**	**53.4**	**3.13%**

Source: Bank of America

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