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Abstract

This paper examines risk-adjusted performance measures in banking, which are used as a guide for efficient asset allocation, performance evaluation, and capital structure decisions in complex, multidivisional financial institutions. Traditional measures of performance are contrasted with the portfolio-based risk-adjusted measures using a unique detailed micro data set for a sample of domestic bank holding companies (BHCs) that engaged in both commercial banking and investment banking activities between 1990 and 1999. This paper finds evidence that traditional stand-alone performance measures can lead to results substantially different from those of the portfolio models. This study also examines BHCs' optimal portfolios consisting of traditional and nontraditional banking activities derived from the efficient frontiers. These results show that there are gains from diversification as indicated by the composition of optimal portfolios.

Keywords: Risk-adjusted return on capital (RAROC), Value at Risk (VaR), bank portfolio analysis

JEL classification: G21, G24, G28

RISK-ADJUSTED PERFORMANCE MEASURES AT BANK HOLDING COMPANIES WITH SECTION 20 SUBSIDIARIES

1. Introduction

One of bank management's main objectives is to maximize risk-adjusted profitability subject to the regulatory constraint on bank total capital. One way to accomplish this objective is to minimize the risk of each activity in which a bank participates (for example, commercial banking, insurance, securities underwriting, mortgage banking, etc.) and then sum these risks over the entire organization. This approach, however, is problematic because it ignores the interdependent nature of risks within a company. During recent years, financial market practitioners and regulators have made great strides in the design, calibration, and implementation of portfolio models of credit risk. Portfolio (or consolidated) models of risk allow bank management to identify concentrations of risk and opportunities for diversification on a company-wide basis. To measure the risk contribution of a unit to the entire organization, these models take into account the "stand-alone" volatility of a business line as well as the correlation between an individual business line and other units within the organization. Thus, adding a business line with lower correlation to an existing portfolio can bring diversification benefits, contributing little to the volatility (risk) of the portfolio.

Serious work on the portfolio-based credit risk models has been fueled by the proposed new Capital Accord (Basel II), which is intended to ameliorate an increasingly urgent problem of regulatory arbitrage. Specifically, the current regulatory framework for required capital on commercial bank lending is based on the 1988 Basel Accord (Basel I), which fails to distinguish among loans of different degrees of credit risk. This creates an incentive for banks to move low-risk instruments off balance sheet and retain only relatively high-risk instruments (Gordy, 2002). Portfolio-based models provide a reliable way to determine the amount of capital necessary to support various business lines and the overall leverage for the bank and closely link capital charges to the organization's credit risk exposures, resulting in a more efficient allocation of capital (Cumming and Hirtle, 2001).

Despite the high level of interest in internal risk-adjusted capital allocation models, so far only the largest banks are known to have successfully implemented them.[1] There are computational and information systems barriers to implementing these models. One of the biggest challenges arises from the need to assess measures of performance that are comparable across business units, especially when organizations are involved in a wide range of financial activities. This is particularly relevant in light of the recent passage of the Financial Services Modernization Act of 1999, which allowed BHCs to engage in a greater scope of activities, such as insurance, investment banking, and merchant banking. This presents challenges to consolidated risk, since diversity often means that models must consider a variety of risk types to construct meaningful measures of performance. Risk-adjusted performance measures (RAPM), discussed in greater detail below, use the concept of Value at Risk to derive the risk-adjusted return on capital, which is used as a guide for active portfolio management and performance evaluation.

The goal of this paper is to examine risk-adjusted performance measures in banking, which are used as a guide for efficient asset allocation, performance evaluation, and capital structure decisions in complex, multidivisional financial

[1] See Treacy and Carey (1998) for the analysis of internal credit risk modeling at the 50 largest consolidated domestic BHCs. The scarcity of the data required to estimate credit risk models stems from the infrequent nature of default events, nonmarketability of some bank products and services, and longer-term time horizons used in measuring credit risk. Larger

institutions. In this paper, traditional measures of performance are contrasted with the portfolio-based risk-adjusted measures of performance for the sample of domestic bank holding companies (BHCs) that engaged in both commercial banking and investment banking activities from 1990 through 1999. Unlike previous studies that relied on the hypothetical-merger analysis to examine potential benefits of diversification arising from bank expansion into investment banking activities (Wall and Eisenbeis, 1984; Boyd and Graham, 1986; Boyd and Graham, 1988; Boyd, Hanweck, and Hewitt, 1993; Allen and Jagtiani, 1996; Saunders and Walter, 1996), this study uses a fundamentally different approach based on a unique detailed micro data set for BHCs with securities affiliates (also known as Section 20 affiliates) operating in the U.S. from 1990 through 1999.[2] This approach allows me to capture potentially important synergies within established, integrated production processes that studies of unrelated firms cannot capture. To my knowledge, only two studies used such data: an unpublished study by Boyd and Pithyachariyakul (1981) and Kwan (1998). However, these studies conducted separate analyses of risk and return without deriving risk-adjusted performance measures (RAPM). Landskroner, Ruthenberg, and Zaken (2005) estimate RAPM using actual banking financial statements, but the study is conducted using a small number of "universal" banks in Israel. No similar studies were conducted for the U.S. market.

The present paper describes and estimates alternative forms of RAPM and discusses the appropriateness of each measure in the context of assessing the

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banks are usually better positioned to use internal risk models because they have longer-term data and the statistical sophistication to implement these models.

[2] Section 20 subsidiaries are subsidiaries of bank holding companies that were authorized by the Federal Reserve to conduct bank-ineligible securities activities. Historically, Section 20 of the Glass-Steagall Act of 1933 expressly prohibited banks from any affiliations with organizations engaged in the underwriting, sale, or distribution of stocks, bonds, debentures, notes, or other securities.

consistency of BHCs' portfolio performance. One of the main findings of this paper illustrates that traditional "stand-alone" performance measures can lead to results substantially different from those of the portfolio models. When the true correlation between a prospective investment and an existing portfolio is nonzero, the traditional performance measures may lead to incorrect management assessment of prospective or past investment decisions. This study also examines BHCs' optimal portfolios, consisting of commercial banking and investment banking components derived from the efficient frontiers. Similar to Landskroner et al. (2005), I find evidence of gains from diversification as indicated by the composition of optimal portfolios. The evidence presented in this paper has important implications for bank regulators. Reliable measures of performance and diversification gains help regulators to evaluate the appropriateness of allowing banks to engage in nontraditional bank activities.

The remainder of the paper is organized as follows. Section 2 describes the types of risk-adjusted performance measures used in portfolio models of credit risk and discusses the relationship between them. Section 3 describes the sample of BHCs involved in securities underwriting activities between 1990 and 1999. Section 4 follows with an empirical implementation of RAPM for the sample of domestic BHCs and discusses main findings. Section 5 compares predictions of the risk-adjusted models with optimal allocations based on the efficient-frontier methodology and actual BHCs' portfolios, and Section 6 concludes.

2. Risk-Adjusted Performance Measures

Risk-adjusted performance measures, or RAPM, have been one of the catchphrases of the banking industry over the last decade or so. The term embraces a number of concepts and has been given different definitions, but all RAPM techniques have one thing in common: they compare risk-adjusted return against an appropriate hurdle rate that reflects the bank's cost of capital or the opportunity cost to stockholders in holding equity in the bank.[3] Risk-adjusted return on capital (RAROC) is usually derived by dividing excess return by the total amount of economic capital, where economic capital is measured on the basis of the potential loss of value over a given period of time at a certain confidence level, or the Value at Risk (VaR).

Excess return is measured relative to the required rate of return, or the hurdle rate. Some models define the hurdle rate as ROE, while others define it as the risk-free rate or as some measure of the weighted-average cost of capital (Saunders and Allen, 2002). By incorporating the opportunity cost into the managers' decision-making and using economic rather than accounting profits, banks hope to align managerial behavior more closely with shareholders' interests. In terms of performance, we hypothesize that when banks allocate scarce resources, business units earning a return in excess of a risk-adjusted opportunity cost of equity are candidates to receive additional resources, while those earning less than the opportunity cost of equity are candidates for corrective action (Kimball, 1998). In

[3] Landskroner et al. (2005) describes the four most commonly cited RAPM models: RORAA (return on risk-adjusted assets), RAROA (risk-adjusted return on assets), RORAC (return on risk-adjusted capital), and RAROC (risk-adjusted return on capital). The differences between the last two measures are often blurred; both are aggregated under the acronym RAROC, which I use in this study.

other words, those business units that earn higher risk-adjusted return should be allocated higher investment.

2.1. Risk-Adjusted Performance Measures in Banking

There are several approaches to measure risk-adjusted performance: the stand-alone and the portfolio approaches. These measures are commonly used in the literature on equity investment, and they are the Sharpe, Treynor, and Jensen performance measures (Bodie, Kane, and Marcus, 2005).

Under the stand-alone methodology, the risk of each activity in which a bank participates is expressed in terms of the volatility of its returns (i.e., the standard deviation) without accounting for correlation between banks' activities. The theoretical risk-adjusted return is derived from the one-factor capital asset pricing model (CAPM), which assumes that all assets are tradable and the opportunity cost of holding capital in the bank is the return on the market portfolio (James, 1996; Crouhy, Turnbull, and Wakeman, 1998).[4] Following Matten (2000), Landskroner, Ruthenberg, and Zaken (2005), and Bodie, Kane, and Marcus (2005), the stand-alone risk-adjusted return on each activity *i* is based on total economic capital or Value at Risk (VaR), σ_i. This measure is the simple Sharpe ratio or the reward to variability ratio (RVAR), which can be expressed as:

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[4] From the one-factor CAPM, the theoretical RAROC is equal to the excess return on the market per unit of market risk (the market price of risk) and is equal to the hurdle rate,

$$\frac{R_i - R_f}{\rho_{im}\sigma_i} = \frac{R_m - R_f}{\sigma_m},$$

where R_m, R_i, and R_f are the market return, return on a risky asset *i*, and the risk-free rate of return, respectively; σ_m = the standard deviation of the market return; σ_{im} = covariance between the returns on asset *i* and the market portfolio m; ρ_{im} = correlation between the

Equation 1

$$RVAR_i = \frac{NI_i - NI_{fi}}{\sigma_i},$$

where

$$NI_i - NI_{fi} = \frac{1}{T}\sum_t^T (NI_{it} - R_f E_{it})$$

where NI_i and σ_i are the average earnings and the standard deviation of earnings from the activity *i,* respectively;[5] E_{it} is the average equity investment in activity *i,* measured as the total equity capital from the call reports, consolidated BHC reports, and Section 20 subsidiaries' reports; R_f is the risk-free rate of return on U.S. Treasury bills; NI_{fi} is average earnings in the risk-free activity derived from activity *i*, defined as R_f*E_{it}, and can be thought of as an opportunity cost of capital invested in *i*.

CAPM assumes that all tradable risks (risks that can be hedged at little cost in the capital market) are diversified away. Applied to banks, this would mean that a bank can frictionlessly hedge *all* risk in the capital market and thus should have no reason for risk management. However, this may not be the case because bank divisions do not usually have market-determined valuations. The RAROC methodology was first developed in the late 1970s by a group at Bankers Trust to deal with individual bank products or divisions, some of which may be nontradable.[6]

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returns on *i* and the market portfolio; β_i is the market risk of the risky asset *i* (Saunders and Allen, 2002).

[5] It is common in the banking literature to use earnings instead of rates of return to evaluate RAROC (Landskroner, et al., 2005). Income comprises net interest income (the difference between interest income and interest expense), noninterest income, realized gains (losses) on held-to-maturity and available-for-sale securities, minus provision for loan and lease losses, and minus noninterest expense.

[6] See James (1996) for the discussion of this model. Froot and Stein (1998) developed a framework for capital budgeting that is based on the objective of profit maximization but also incorporates risk management and the fact that some risks cannot be hedged away. They derived a two-factor CAPM, in which they decomposed total risk into a tradable (market) risk component, *m*, such as currency and interest rate risk, and a nontradable (illiquid) risk component, *p*.

Another problem with using the stand-alone measurements is that they do not take into consideration the effects of diversification that arise in situations when the returns on the individual business activities are less than perfectly correlated. Such activities will tend to dampen the fluctuations in returns for the bank as a whole, so that the total risk of the bank will be less than the sum of the risks of the individual stand-alone business components. In effect, the business units will tend to act as partial natural hedges for each other, reducing the need for equity capital (Kimball, 1998). The theoretical RAROC measure that incorporates the effect of diversification is referred to as the reward to volatility (RVOL) or the Treynor ratio. It is measured by the excess return evaluated against the portfolio's internal systematic risk. Unlike the Sharpe ratio, the Treynor ratio is a portfolio-type measure and considers the correlation between various BHCs' activities. Activity's contribution to the overall portfolio performance is evaluated against its systematic risk rather than against total risk.

Equation 2

$$RVOL_i = \frac{NI_i - NI_f}{IVaR_i},$$

where

$$IVaR_i = \frac{\partial VaR_p}{\partial \sigma_i} * \sigma_i = \frac{\sigma_{i,p}}{\sigma_p} = \beta_{ip}\sigma_p$$

where *IVaR* is the incremental Value at Risk, defined as the marginal effect on *VaR* of adding a new instrument or business unit to an existing portfolio.[7]

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[7] VaR=$\alpha\sigma_p$, where α is a factor defined by the probability with which the actual loss may not exceed the VaR and σ_p is the standard deviation of earnings on the institution's portfolio over a specified period. IVaR for each business division can be written as a semi-elasticity $\frac{\partial \alpha\sigma_p(\sigma_i,\sigma_j)}{\partial \sigma_i} * \sigma_i$ for business units $i \neq j$, which represents a change in VaR of the bank's overall portfolio due to an additional instrument *i*.

$IVaR_i = \beta_{ip} VaR_p$,, where the coefficient β_{ip} is the systematic risk of asset *i* in the portfolio *p*. Given that some assets of BHCs or business units are nontradable, the relative risk contribution of each line of business is calculated as an internal beta, defined as the ratio of the covariance between the business unit's and bank's (portfolio) returns to the variance of the bank's returns.[8] Those business lines with relatively low correlation in returns are allocated less equity capital than the business lines with relatively high correlation in returns.

Another portfolio-type risk measure is an application of the Jensen's alpha (α_i) or economic value added, EVA. This measure indicates if the earnings of activity *i* are above the "benchmark" BHC (rather than the market) portfolio, based on an "internal" CAPM.[9] Applied to BHCs' activities, EVA – also referred to in the finance literature as Jensen's alpha – can be expressed in the following equation:

Equation 3

$$A_i = NI_i - [NI_{fi} + \beta_{ip}(NI_p - NI_{fi})]$$

and Jensen's $\alpha_i = \frac{A_i}{E_i}$, where E_i is the average equity investment in the activity *i*, defined above; NI_p are the average earnings of the "benchmark" BHC portfolio calculated as the earnings of activity *i* assuming a rate of return equal to BHCs' ROE, i.e., $NI_p = \frac{1}{T}\sum_t E_{it} * ROE_{BHC}$ and $\beta_{ip} = \frac{\sigma_{ip}}{\sigma_p^2}$.

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[8] This constitutes an important difference between the performance measures in finance and their applications in the banking literature.

[9] Expressed in terms of rates of returns, $R_i - R_{fi} = \alpha_i + \beta_{ip}(R_p - R_f)$,where R_i is the ROE on the activity *i*; R_f is the risk-free rate of return; and $\beta_{ip} = \frac{\sigma_{ip}}{\sigma_p^2}$; R_p is the return on equity for a BHC ("benchmark") portfolio or a hurdle rate of return for $RAROC_i$.

In its applications in banking, EVA is a performance measure of the amount by which adjusted earnings exceed or fall short of the opportunity cost of the capital involved. The decision rule is the following: if α_i is positive and significantly different from zero, then an activity should be undertaken because it has a superior risk-adjusted performance compared to that of the BHC's portfolio. EVA is an increasingly popular performance metric. Researchers have argued that among many measures of performance, including ROA, ROE, and EPS, EVA is the most relevant measure of the success of the management team's effort (Uyemura, Kantor, and Pettit, 1996). Proponents of this measure contend that by incorporating the opportunity cost of equity capital into performance measurement and incentive systems, an EVA-based system makes explicit each bank manager's increased focus and commitment.

Both the reward to variability (the Sharpe measure) and the reward to volatility (the Treynor measure) are modifications of RAROC and provide a comparable index by which several portfolios can be assessed and ranked. The higher the risk-adjusted return, the better is the portfolio's performance and the more likely is its inclusion in an investment portfolio. Table 1 illustrates the relationship between these performance measures, and they are empirically estimated below.[10]

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[10] It is important to note that for a *well-diversified portfolio*, the Sharpe, the Treynor, and the Jensen performance measures yield the same rankings (Table 1). To prove equality of rankings for well-diversified portfolios, assume that there exist two well-diversified portfolios, *i* and *j*, with rates of return of R_i and R_j, respectively (note that for a well-diversified portfolio, $\beta_i = \frac{\sigma_i}{\sigma_m}$). Also assume that $R_m > R_f$. It is simple to show that the portfolio ranking according to the Sharpe ratio (SR) and the Treynor ratio (TR) will be the same (SR_i can be expressed as the ratio of TR_i to σ_m; thus, if $SR_i > SR_j$ then $TR_i > TR_j$). Next, consider the rankings according to the Treynor and the Jensen measures. If, for example, $R_i \leq R_j$ and $\beta_i \leq \beta_j$ with at least one strict inequality, we can show that $TR_i > TR_j$. Because $\alpha_i - \alpha_j = (R_i - R_j) - (\beta_i - \beta_j)(R_m - R_f)$, at least one term on the right-hand side will be

3. Sample Selection

This study estimates risk-adjusted performance measures for the sample of BHCs that were authorized by the Federal Reserve to conduct bank-ineligible securities activities (Section 20 activities) from 1990 through 1999. Accounting data for BHCs' subsidiaries consist of annualized financial statements for domestic BHC subsidiaries engaged in ineligible securities underwriting and dealing (FR Y-20 reports[11]) and annualized FDIC Call and Income Reports for commercial bank subsidiaries controlled by the same holding companies.[12] The sample period is from 1990 – the first year FR Y-20 data were collected – through the end of 1999, when passage of the Gramm-Leach-Bliley Act allowed a qualified BHC to convert into a financial holding company and not file the FR Y-20 reports. As a result, the companies that remained after 1999 were no longer representative of companies involved in securities activities.

Balance-sheet data were averaged over the quarters in which Section 20 subsidiaries reported, to derive an annual figure for Section 20 firms and their

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positive. Thus, $\alpha_i > \alpha_j$ and we conclude that for well-diversified portfolios, the Sharpe, the Treynor, and the Jensen performance measures yield the same rankings.

[11] Financial Statements for a Bank Holding Company Subsidiary Engaged in Bank-Ineligible Securities Underwriting and Dealing are filed with the Federal Reserve. This report is filed by all bank holding companies for each subsidiary that engages in bank-ineligible securities underwriting and dealing, and it is not available to the public. *Confidentiality of individual reports is preserved by data aggregation.*

[12] Activities of lead banks are used as a proxy for BHCs' commercial bank subsidiaries. Lead commercial banks are defined as the largest bank in a multibank holding company. One caveat about representing commercial banking activity by lead bank is that there might be other, albeit smaller, commercial banks under the same BHC structure that are omitted from the calculations. One possible solution is to aggregate across all commercial banks that are controlled by the same holding company. This, however, presents a problem, since the majority of BHCs involved in securities activities are very complex financial organizations with 50 or more subsidiaries. This would be of particular concern if the share of lead banks' assets to the total BHC assets were low. However, in this sample, the total assets of lead banks comprise a large portion of the consolidated assets of BHCs. The mean (median) ratio of lead banks' assets to total BHC assets is 67 percent (73 percent). Thus, limiting the analysis to lead banks should not significantly distort the results for commercial banking activities. I

consolidated top-tier parent companies. For example, if for any reason (such as later establishment date or an earlier exit) a Section 20 affiliate did not report for a full year, the averages for Section 20 *as well as* for their consolidated bank holding companies were adjusted to reflect this. Income information was matched to Section 20 data by the date reported on the Y-20. For each BHC, the Y-9C reports have a unique code that identifies a BHC over time and allows firm-level calculations. In cases of mergers and acquisitions, the acquiring BHC's code was maintained and the target was dropped from the sample.

4. The Main Findings

Tables 2 through 4 calculate various risk-adjusted measures described above to compare the performance of the consolidated BHCs and their business components during the period between 1990 and 1999. The main interest of the analysis of performance is the rankings of BHC portfolios, how a specific activity performed relative to a BHC portfolio, as well as how a specific activity performed relative to other activities in which a BHC is involved.

It should be noted that the Treynor (RVOL) measure and the EVA measure are reported only on an activity basis because these measures are based on internal systematic risk, which cannot be compared across companies. Inter-company comparisons and rankings of the individual activities should be performed using total risk measures, such as the Sharpe ratio (Landskroner et al., 2005). The Sharpe measure (RVAR) and the Treynor measure (RVOL) for entire BHCs are identical because of the property that the sum of individual divisions' incremental Value at

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also find that excluding observations with a small share (less than 50 percent) of lead banks'

Risk, *IVaR,* equals the overall BHC's Value at Risk, or σ_p. Jensen's alpha, which uses an internal risk approach to measure earnings above the benchmark portfolio, is by definition equal to zero in the case of the entire BHC portfolio and, therefore, not reported in the table.

First, we compare the performance of BHCs, or total investment, during the sample period 1990-1999. The risk-adjusted RVAR rankings are different from the traditional ROE rankings (column 1 and column 2).[13] The performance of the overall BHC is affected by the performance of its components and how heavily the company is involved in these various activities. For example, a company that ranked first according to the traditional ROE measure invested more than 90 percent of its assets in commercial banking (compared to the average of 62 percent for the whole sample). This company's auspicious performance can be attributed to its relatively good performance in both banking and Section 20 activities. On the other hand, the company that ranked last according to the RVAR measure performed poorly compared to the average for all BHCs in both the commercial banking and securities underwriting activities. Five securities subsidiaries had negative RVAR measures, suggesting that these activities generated an average rate of return below the risk-free rate. A closer examination reveals that these companies were newer entrants in the securities underwriting business, which may explain their lackluster performance.

Because the majority of companies invested heavily in traditional banking, the RVAR rankings of BHCs and commercial banking – columns 5 and 3, respectively, in Table 2 – yield similar results. The Spearman rank correlation

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assets to the total BHC assets had little impact on the results of the analysis.

between these RVAR measures is 0.88. In contrast, the rank correlation between RVAR of BHCs (column 5) and RVAR of Section 20 activities (in column 4) is only 0.1, suggesting only a weak relationship between these measures. This occurs because the correlation between the earnings of the securities activities and BHCs is low. Hence, it is important not to ignore the effects of diversification and to take them into consideration in the risk-adjusted performance calculations.

As mentioned in the above discussion, the Treynor and the EVA performance measures are based on the systematic risk, which depends on the internal correlations. Thus, it is useful to examine the intrabank correlations among activities that determine the internal systematic risk. Specifically, the correlation between earnings of commercial banking units and earnings of the consolidated BHCs is high, approximately 0.7 for the group as a whole. In contrast, the correlation between securities activities and commercial banking is negative but not statistically different from zero. The relatively low correlation coefficient between securities and commercial banking activities serves as evidence of diversification opportunities across the BHC's activities.

Table 3 and Table 4 compare the performance of the component activities of BHCs, taking into consideration systematic risk, where systematic risk is evaluated in reference to each portfolio. According to the system averages, performance of securities subsidiaries was superior to that of commercial banking subsidiaries, measured by both the Treynor (RVOL) and the Jensen (EVA) metrics.[14] These findings contradict results based on the Sharpe ratios that suggested that performance

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[13] The distribution-free Spearman rank correlation coefficient between nontraditional (column 1 in Table 2) and traditional (column 2) rankings for BHCs is 0.5. The correlation coefficient of zero is rejected at the 0.05 level, but not at the 0.01 level.

of commercial banking activities was superior to that of securities underwriting. This example shows a problem with using the traditional stand-alone measures in management decision-making because they ignore correlations between a prospective asset acquisition (an activity expansion) and an existing portfolio. The higher the correlation, the more activities expansion would add to overall portfolio risk and the higher the expected (required) return needed to make the expansion attractive. Note that the required return for expansions that reduce risk (activities that are less than perfectly correlated) is less than the existing expected portfolio returns. In the case where the correlation between activities is low or negative, the traditional performance measures overestimate the required return and may lead to *incorrect* decisions not to expand into new activities. Recognizing the omission of traditional ratios, EVA is increasingly becoming a key measure of bank performance.

5. Implications of the RAROC Performance Measures

5.1. Implications for Investment Allocation

This section compares predictions of the RAROC-based models with predictions of the optimal structure of BHC investments based on the efficient-frontier methodology. The optimal allocation of BHCs' activities is determined by deriving efficient frontiers and solving for optimal portfolios for each BHC separately and for the group as a whole. I compare optimal asset allocations with the actual asset allocations in commercial banking, investment banking (Section 20 activities), and other activities (defined below). The optimization problem can be written as:

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[14] EVA measures for banking and securities activities were not statistically different from

Equation 1

$$\underset{w}{Min}\,\sigma^2_{BHC} = \mathbf{w'\Omega w}$$

subject to

Equation 2

$$\mathbf{1'w} = \mathbf{1}$$
$$\mathbf{w'\mu} = \mu_{BHC}$$

Equation 3

$$w \geq 0$$

where $\mathbf{\mu}$ is a vector of returns; $\mathbf{\Omega}$ is a covariance matrix; and $\mathbf{w}$ is a vector of portfolio weights allocated to banking, securities, and other activities. When one of the assets is risk-free, the constraint becomes $\mathbf{w'\mu+(1\text{-}w'1)R_f} = \mu_{BHC}$. The optimization is performed using the average risk-free return, R_f, over the 1990-1999 period, to maximize the Sharpe ratio.[15] Given the expected returns, variances, and covariances of assets in the portfolio, the efficient frontier can be derived by changing the target expected return on the portfolio. The objective is to maximize the slope of the tangent (capital allocation) line from the risk-free return to the efficient frontier.[16]

Before we proceed, it is important to define "other" activities. In the context of this study, "other" is defined as the residual of BHC total assets and the sum of

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zero, suggesting that neither of these activities significantly outperformed the BHC portfolio.

[15] Monthly averages for the three-month Treasury bills are computed on an issue-date basis. The rates are annualized, using a 360-day year or bank interest (source: Haver). The average for this period was 4.8 percent.

[16] I used Mathematica to find optimal portfolio allocations that satisfy the Kuhn-Tucker necessary conditions for the optimization problem in Equations 8-10 (for methodology, see Huang and Crooke, 1997).

commercial banking and Section 20 activities.[17] The category "other" may include insurance; data processing and information services; asset and capital management; business, sales, and consumer finance activities; mortgage banking, and so forth.

The optimization was performed in two parts: for long-term and short-term horizons. In the long-term problem, I assume that the bank is permitted unlimited changes in its portfolio mix. For the short-term optimization problem, the possibilities for portfolio changes are limited. I specify 20 percent as the maximum permissible change in investment relative to the existing positions because it approximately equals the calculated actual change in commercial banking activity between 1990 and 1999. In both cases, optimization is performed subject to the no-short-sales constraint (the weight of each activity in the overall portfolio, w_i, is greater than or equal to zero).[18]

The results of calculations of optimal and actual portfolio allocations for the short-term and long-term horizons are presented in Table 5 and Table 6, respectively. Table 5 also reports actual changes in the portfolio composition between the two sub-periods: 1990 through 1994 and 1995 through 1999. The analysis is limited to BHCs that reported continuously during the entire period to ensure that there are enough time-series observations to perform long-term optimization even though it can potentially introduce survivorship bias. I also exclude BHCs with the proportion of "other" activities greater than 50 percent of consolidated BHCs' assets to focus the analysis on BHCs with significant investment in traditional banking activities. The

[17] Recall that commercial banking was proxied by activities of the lead banks–the largest or dominant banks in a multibank holding company. The category "other" includes all activities, besides those of the lead bank and Section 20 affiliates, conducted by the consolidated BHCs (refer to the discussion in note 12).
[18] The original problem was also subject to the constraint that limited securities activities to 20 percent of the total BHC assets. However, this constraint did not bind, since the actual investment in Section 20 activities was, on average, about 4 percent.

final data set is a balanced panel of 12 BHCs that participated in all three types of activities between 1990 and 1999 and that had more than half of their assets invested in traditional banking activities.

First, Table 5 shows that in the short run, with limited possibilities for changes in the portfolio mix, in order to maximize the ratio of excess return to the volatility of return, BHCs in this sample should slightly reduce their commercial banking activities, by 2.3 percentage points, and basically leave the securities activities at the current level. In the long run, however, as depicted by Table 6, BHCs should reduce their commercial banking activities from the average of 74 percent of the total BHCs' assets to approximately 61 percent. At the same time, they should increase their investment in securities activities from 4.4 percent of total assets to 22.4 percent (the long-run figures are reported in parenthesis). Despite the fact that commercial banking was a major and, in general, profitable activity during the 1990s, the recommendation for a long-term horizon may be indicative of overinvestment in this business area. Similar results were reported by Landskroner, Ruthenberg, and Zaken (2005) for the sample of Israeli banks.

The discrepancy between short-term and long-term optimal allocations may exist because of the possible slow and costly adjustment in the banks' portfolio allocation. Researchers have documented costs that banks incur from excessive shrinking or expansion of their portfolios, particularly in loan markets. Sharpe (1990) uses an information asymmetry explanation to show that severing long-term customer relationships in lending markets is costly for banks.[19] On the other hand,

[19] According to that theory, a bank may incur initial losses as it lends to new firms. But in the process of lending, a bank becomes privy to information not available to others, which allows it to capture rents generated by older customers.

an excessive growth of a (loan) portfolio may also be costly, since banks may be forced to lower their credit standards to accept more borrowers.

Second, as evident from the table, there are gains from diversification as manifested in the nonzero optimal allocation in all feasible activities. In the long run, an average BHC in the sample should allocate 61 percent of its investments to commercial banking activities, 22 percent to securities activities, and 17 percent to the remaining nonbank activities. In the short run in Table 5, such large fluctuations are difficult to achieve; therefore, the corresponding allocations are 71 percent, 4 percent, and 25 percent, respectively. Third, with only a few exceptions, the optimal direction of change for the long-term allocations to securities activities is consistent with that based on RAROC measures. Recall from Table 4 that the EVA performance measure, which adjusts for the correlation between activities, suggests that the performance of Section 20 subsidiaries was superior to that of traditional commercial banking activities. Thus, companies should channel their investments toward better-performing business divisions.

Fourth, in the majority of cases, the actual change in BHCs' portfolios between the first and second halves of the 1990s was consistent with the changes needed to optimize the Sharpe ratio. Banks took advantage of diversification by investing in all activities. In terms of the actual changes in allocations, BHCs increased their portfolio allocation to commercial banking and securities activities during the 1990s. All but one company followed the long-run optimization path for securities activities. Four BHCs followed the optimization path and reduced allocation to commercial banking between 1990 and 1999. Of those, three BHCs experienced a significant increase in return on equity between the two sub-periods. In contrast, a company that ranked fifth among all BHCs followed the optimization path for the commercial banking activity, but not for the securities activities. That company was the only BHC to experience a decline in performance between the two sub-periods.

In sum, both the short-term and long-term optimization results indicate that BHCs in this sample should reduce their investment in commercial banking, and they should increase their investment in securities underwriting in the long term. The discrepancy in the magnitude of change between short-term and long-term horizons probably arises owing to the costly adjustment in the banks' portfolio composition.

5.2. Implications for Capital Allocation

As discussed in the introduction, many banks use risk-adjusted performance measures (RAPM) to actively manage their portfolios of investments or activities and for performance evaluation. An active approach to capital allocation uses RAPM processes to influence business results by adjusting the capital allocated to particular business units and encourages managers to maximize returns on this allocated capital. After determining the amount of capital available, the active approach involves setting the targets for expected returns. Once the targets are set, management allocates capital to business units, based on their "contribution" to the overall volatility of the bank's earnings, so that the effect of individual investment decisions on the overall level of risk is internalized. Because in this model the capital allocation depends both on the standard deviation of earnings of each division and on the covariance with the other divisions, the decisions of one division or business unit affect the decisions of other units. In this way, the price of risk internalizes the externality across business divisions (James, 1996; Stoughton and Zechner, 1999).

The internal models approach is designed to fully capture portfolio diversification effects that occur when assets that are less than perfectly correlated are combined in a portfolio. The goal is to more closely align the regulatory assessment of risk capital with the risks actually faced by the bank. General market risk is a direct function of the output from the internal Value at Risk model. Under the normality assumption, VaR (or earnings at risk, EAR) is set to equal economic capital, defined as $\alpha * \sigma$, where σ is the standard deviation of earnings and α is a factor defined by the probability with which the actual loss may not exceed VaR. α is determined by management's appetite for risk and is set to equal three in this study (the specific risk charge is explained in more detail in the Basel Amendment, 1996).[20]

Table 7 presents average values of actual, regulatory, and economic capital – defined as VaR above – for the sample of BHCs that participated in all three types of activities. The table shows that between 1990 and 1999, allocated regulatory capital of BHCs was above economic capital, suggesting that regulatory capital was not a good guide for efficient allocation of capital for these financial institutions. Economic capital of individual business divisions was below actual allocations. This indicates that if bank management conducted internal risk calculations, their assessment of capital would be lower than what was actually allocated. This is a

[20] When earnings are normally distributed, one standard deviation implies a confidence interval of around two-thirds: that is to say that annual earnings will be no more than one standard deviation either side of the average earnings two-thirds of the time. Because this level of confidence is probably too low, managers tend to use a higher level of two (95 percent confidence interval) or even three standard deviations (99 percent confidence interval) around the mean to calculate EAR. Management's choice of the confidence interval is usually determined by evaluating implicit risks and default rates of an asset over a certain period of time, usually one year.
An alternative definition of economic capital is the ratio of earnings at risk to the required return. One difficulty in calculating economic capital is the choice of the required return. Available options include the risk-free rate, the cost of capital, or a target rate of return.

particularly important finding in light of the impending new bank capital regulations under Basel II that will require banks to make their own assessment of the various risks they face and decide on the appropriate allocations of capital to cushion those risks. The Basel Committee on Bank Supervision undertook several detailed impact studies of how banks' internal portfolio-based models will change the capital levels required to cover credit and operational risks (Basel Committee on Banking Supervision, 2003). The committee's findings indicate that banks using the internal ratings-based approach will be likely to register an overall decrease in their minimum capital requirements.[21] It appears that BHCs in this sample are also likely to experience downward calibration of the capital levels when they move toward new capital requirements.

The evidence on excess capital is consistent with the literature that reports that banks may hold excess capital for reasons not necessarily related to internal risk (see, for example, Matten, 2000; Furfine, 2001).[22] What are the reasons for banks to hold excess (buffer) capital? One reason is to avoid costs related to market discipline and regulatory intervention if their capital is approaching or falling below the minimum capital ratio. A poorly capitalized bank runs the risk of losing market confidence and reputation. Thus, excess capital acts as an insurance against costs that

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[21] These are group results. There is a significant variation in outcomes across banks (Basel Committee on Banking Supervision, 2003).

[22] In his remarks about the new Basel Accord in November 2003, Federal Reserve Vice Chairman Roger Ferguson mentioned that "the overwhelming majority of U.S. banks maintain capital above the well-capitalized criteria of 10 percent of risk-weighted assets under the U.S. prompt corrective action rules, and generally the smaller the bank, the larger the proportionate capital cushion. Nearly 95 percent of all small and medium-sized banks have regulatory capital ratios of at least 10 percent, and thus it is likely that their current ratios would essentially meet or surpass proposed requirements under Basel II." ("The Changing Regulatory Capital Regime in Europe: A Challenging New Business Concept," Brussels, Belgium, November 2003)

a bank may incur because of unexpected loan losses and difficulties in raising new capital.

Other reasons to hold excess capital include portfolio risk (the riskier the portfolio, the higher the capital buffer); market discipline (the bank's capital buffer should depend positively on the capital buffer of its rivals); regulatory discipline (increased regulatory scrutiny should increase the buffer capital (Lindquist, 2003)); the potential business opportunities (Berger, et al., 1995, refer to it as the "franchise value"); and economic cycle (the capital buffer is generally thought to be pro-cyclical).[23]

Leading financial firms maintain levels of eligible regulatory capital far in excess of the regulatory minimums (Herring and Schuermann, 2003), in part, because of regulatory inducements. In the United States, for example, banks must have a Tier 1 risk-based capital ratio of 6 percent or more (rather than the minimum of 4 percent) and a Tier 1 to total asset (leverage) capital ratio of 5 percent or more (rather than the 4 percent minimum) to be considered "well capitalized" (US GAO, 1998). Well-capitalized banks have lower risk-based deposit insurance premiums and are more likely to receive regulatory permission to expand activities. Herring and Schuermann (2003) assert that for leading firms, market forces, not minimum regulatory capital requirements, appear to play an important role in firms' capital decisions. These authors point out that these firms target ratings for their long-term debt that exceed the degree of protection from insolvency that the regulators require.

For the sample of BHCs that participated in both banking and Section 20 activities between 1990 and 1999, Table 7 demonstrates that the risk-adjusted capital ratio was 12 percent, whereas the bank is considered adequately capitalized with the standard risk-based ratio of 8 percent (and well capitalized with the ratio of 10 percent). This is in line with the evidence presented above that the majority of banks in this country hold regulatory capital above the required levels. What is the cost of this misallocation? The level of capital that the bank's management decides is appropriate should be supported by an internal assessment of the capital at risk. Excessive amounts of equity can reduce the value of the bank and increase its weighted average cost of financing as explained below. In competitive markets in the long run, higher costs are likely to be passed on to bank customers in the form of the reduced size of the banking industry and the quantity of financial intermediation. Santomero and Watson (1977) stress that the opportunity costs generated when banks hold excessive amounts of capital are borne by the banking community and the society at large. First, the funds used by banks become more expensive on the margin, translating into a higher weighted average cost of capital. Second, misallocation of capital may divert funds from more productive loans and decrease the existing stock of physical capital in the economy. Third, the larger the capital allocation, the more difficult it is for a line of business to earn an economic profit. Theoretically, it would be possible for each line of business to fail to earn its required opportunity cost of stand-alone equity, while the bank as a whole surpassed its required opportunity cost of equity based on actual equity capital, which includes the effects of diversification (Kimball, 1998). In extreme cases, a bank might choose to exit a business based on an insufficient return to equity earned on allocated capital, when the return on equity on actual capital might be quite satisfactory.

Once risk calculations for individual business units are compiled, the risk-adjusted return is derived by dividing adjusted income by the total amount of

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[23] The latter was a topic of the Basel Committee on Banking Supervision Conference in 2001:

economic capital. According to Table 7, the level of earnings at risk (EAR) at commercial banking units is higher than at securities affiliates, and therefore, in an active approach to capital allocation, bank management should allocate higher levels of capital to those units to account for higher risk. In terms of performance, RAROC of securities affiliates is greater than RAROC of commercial banking. This is in accord with the EVA rankings presented in the previous section. The table also shows that RAROC of consolidated BHCs is superior to that of both the Section 20 subsidiaries and commercial banking alone. This serves as evidence of benefits from bank diversification into securities activities.

A large number of U.S. banks have invested heavily in models designed to measure the risks associated with their different lines of business. The immediate purpose of such risk-measurement models 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. However, as discussed above, there are still unresolved issues that need to be addressed in order to fully implement risk-adjusted techniques for consolidated risk-management models.[24] First, there is the problem of numerous definitions of return

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Review of Pro-cyclicality, Research Task Force. See www.bis.org for more details.

[24] In January 2005, the Committee on the Global Financial System (CGFS) concluded that while improvements have been made in using stress testing as a practical risk management tool, a number of challenges still remain. Stress testing is used to see how banks would cope under adverse financial situations, such as the 1997 Asian financial crisis, and the failure of the financial house Long Term Capital Management in 1998, and what measures may be necessary to minimize the adversity. One area of difficulty pointed out by the CGFS was the need to incorporate loan portfolios, owing partly to the difficulty in marking to market loan portfolios and insufficient data accumulation. "Efforts to develop firm-wide credit stress tests for both trading and loan books have also been hindered by differences in accounting treatment, regulatory environments, a lack of trading markets for certain products, and/or the organizational structure of firms," the CGFS said. Another problem is that "although firms recognize the potential for feedback effects--which measure the second-round impact of firms' own activities on prices--these effects are rarely incorporated in stress tests because they are difficult to measure." (The CGFS report, "Stress Testing at Major Financial Institutions:

(profit, contribution, revenue, etc.) and capital (regulatory capital, risk capital, etc.) that needs to be resolved in order to correctly assess the risk-adjusted performance measures. Second, difficulties arise out of the need to align and compare risk and returns across various business lines. In particular, to cover all possible combinations of subsidiary investments, this implies the need for a framework that would include credit, market, technical, and operational risks. Finally, risk-based models require the use of the bank's actual default history and more sophisticated statistical techniques. Therefore, it is more likely that large, more diversified, internationally active banks will opt for the most advanced internal ratings-based approach under the proposed BIS capital accord, which more closely links capital charges to the risk exposures.

6. Conclusions

Current capital regulation sets the minimum capital requirements uniformly across banks, regardless of diversification benefits achieved from combining less than perfectly correlated business activities. This study investigated the issue of risk-adjusted performance models, which allow financial institutions to build internal portfolio-based measures of risk. Researchers have argued that this approach should lead to capital charges that more accurately reflect individual banks' true risk exposures (Hendricks and Hirtle, 1997). These concerns are relevant in light of the current review of bank capital requirements. The new Basel rules will recognize correlations between risk factors and will make use of VaR models that yield a much more accurate assessment of the likely loss in value and necessary levels of capital buffer.

Survey Results and Practice," is available on the Bank for International Settlements' web site

Empirical evidence on risk-adjusted performance presented in this paper is based on the sample of domestic BHCs that combined traditional commercial banking with investment banking activities from 1990 through 1999. Results indicate that risk-adjusted performance measures for these entities: 1) are different from the traditional performance metrics, such as ROE, particularly when the correlations between banks' activities are nonzero; 2) they are consistent with optimal allocation of capital derived from the optimal portfolio theory, especially in business units in which economies are not exhausted; and 3) the derived composition of the optimal portfolios shows that BHCs can take advantage of potential gains from diversification by allocating their resources to nontraditional banking activities, such as securities underwriting. In view of recent bank deregulation and growing consolidation in the banking industry, the results of this study are of particular relevance to bank management and regulators.

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at http://www.bis.org/publ/cgfs24.pdf)

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Table 1 Relationship Between RVAR, RVOL, and EVA Measures

Performance Measure	Definition	Relationship to Jensen's Alpha	Relationship to Sharpe Ratio in a Well-Diversified Portfolio $\beta_i = \frac{\sigma_i}{\sigma_m}$
Jensen's Alpha (EVA)	$\alpha_i = R_i - [R_f + \beta_m (R_m - R_f)]$		$(SR_i - SR_m)\sigma_i$
Sharpe Ratio (RVAR or reward to variability ratio)	$SR_i = \frac{R_i - R_f}{\sigma_i} = \frac{(R_i - R_f) - \beta_m (R_m - R_f)}{\sigma_i} + \frac{\rho_{im}}{\sigma_m}(R_m - R_f)$	$\frac{\alpha_i}{\sigma_i} + \rho_{im} SR_m$	
Treynor Ratio (RVOL or reward to volatility ratio)	$TR_i = \frac{R_i - R_f}{\beta_i} = \frac{(R_i - R_f) - \beta_m (R_m - R_f)}{\beta_i} + \frac{(R_m - R_f)}{\beta_m}$	$\frac{\alpha_i}{\beta_i} + TR_m$	$SR_i \sigma_m$

This table describes the relationship between active performance measures for banks: the standard Sharpe ratio, SR (RVAR=reward to variability), Treynor ratio, TR (RVOL=reward to volatility), and Jensen's measure, α (EVA=Economic Value Added). R_i and t_i are the average rate of return and the standard deviation of return on the activity *i,* respectively; R_m is the return on the reference market portfolio (the reference portfolio has the standard deviation of t_m); R_f is the risk-free rate of return (such as the Treasury bill rate); s_{im} is the correlation coefficient between portfolio *i* and the market. $\beta_i = \frac{\sigma_{im}}{\sigma_m^2} = \frac{\rho_{im}\sigma_i}{\sigma_m}$ is the internal beta. The decision rule: superior performance requires a positive α_i in all three measures. The ratio of α_i to σ_i shows how much a portfolio outperforms the benchmark market portfolio. The ratio of α_i to c_i for portfolio *i* gives an improvement in the Treynor's measure relative to the passive market portfolio.
Source: similar table appears in Bodie, Kane, and Marcus (2005).

Table 2 Reward to Variability (RVAR) Measure for BHCs with Section 20 Subsidiaries, 1990-1999

RVAR (Sharpe Ratio) Rank	ROE Rank	RVAR (Sharpe Ratio) Banking	RVAR (Sharpe Ratio) Section 20	RVAR (Sharpe Ratio) BHC
(1)	(2)	(3)	(4)	(5)
1	2	5.315	0.302	5.485
2	7	2.289	0.305	4.188
3	1	2.383	1.708	3.432
4	15	2.591	1.086	3.319
5	10	1.950	0.170	2.870
6	4	3.454	-0.430	2.799
7	16	2.438	-0.118	2.215
8	6	1.455	0.935	1.984
9	5	1.270	0.522	1.651
10	14	2.184	-1.176	1.614
11	8	1.235	0.715	1.501
12	12	0.813	0.949	1.213
13	9	0.591	0.067	0.999
14	20	1.898	-1.146	0.966
15	13	1.053	0.462	0.966
16	19	0.633	0.417	0.912
17	3	0.720	0.829	0.867
18	18	0.165	0.279	0.860
19	17	0.789	0.577	0.785
20	11	0.487	-0.006	0.748
Average		**1.68**	**0.32**	**1.97**

The first two columns present rankings based on RVAR and the traditional ROE measures.

$$RVAR_i = \frac{NI_i - NI_{fi}}{\sigma_i}$$

where NI_i is the average earnings from activity *i*; σ_i =standard deviation of earnings in *i; NI_{fi}* is average earnings in the risk-free activity attributed to activity *i* and is equal to $R_f * E_{it,}$ where R_f is the risk-free return on a Treasury bill and E_{it} the average equity investment in activity *i.* The rank correlation between column 1 and column 2 is 0.5 and equals zero at the 1% significance level. The rank correlation between column 3 (RVAR of banking units) and column 5 (RVAR of BHCs) is 0.9 and significant, while the correlation between column 4 (RVAR of Section 20) and column 5 (RVAR of BHCs) is 0.1 and insignificant. Several outliers were deleted from the sample because of either large deviation from the mean or a small number of observations.

Table 3 Reward to Volatility (RVOL) Measure for BHCs with Section 20 Subsidiaries, 1990-1999

RVAR (Sharpe Ratio) Rank (1)	ROE Rank (2)	RVOL (Treynor Ratio) Banking (3)	RVOL (Treynor Ratio) Section 20 (4)
1	2	-15.958	0.303
2	7	2.982	0.386
3	1	2.522	2.855
4	15	3.236	1.279
5	10	2.347	0.430
6	4	3.530	1.066
7	16	2.438	-0.148
8	6	1.548	1.297
9	5	1.347	0.683
10	14	2.507	1.783
11	8	1.299	1.077
12	12	0.839	1.373
13	9	0.618	0.106
14	20	1.995	50.628
15	13	1.340	0.579
16	19	0.643	1.930
17	3	2.275	1.233
18	18	0.220	0.683
19	17	0.792	0.882
20	11	0.497	-0.019
Average		**0.851**	**0.936***

The first two columns present rankings based on the reward to variability (RVAR) and the traditional ROE measures.

$$RVOL_i = \frac{NI_i - NI_{fi}}{IVaR_i} = \frac{NI_i - NI_{fi}}{(\sigma_{ip} / \sigma_p)}$$

where NI_i is the average earnings from activity *i*; σ_i =standard deviation of earnings in *i; NI_{fi}* is average earnings in the risk-free activity attributed to activity *i* and is equal to $R_f*E_{it,}$ where R_f is the risk-free return on a Treasury bill and E_{it} the average equity investment in activity *i.* Several outliers were deleted from the sample because of either large deviation from the mean or a small number of observations.

Table 4 Economic Value Added (EVA) Measure for BHCs with Section 20 Subsidiaries, 1990-1999

RVAR (Sharpe Ratio) Rank (1)	ROE Rank (2)	EVA (Jensen's Alpha) Banking (3)	EVA (Jensen's Alpha) Section 20 (4)
1	2	0.158	0.016
2	7	-0.027	0.022
3	1	-0.054	0.159
4	15	0.030	0.122
5	10	0.004	0.021
6	4	0.110	-0.081
7	16	0.051	-0.002
8	6	-0.003	0.224
9	5	0.110	0.149
10	14	0.034	-0.081
11	8	0.002	0.074
12	12	-0.005	0.149
13	9	-0.019	0.003
14	20	0.105	-0.059
15	13	0.059	0.201
16	19	-0.007	0.050
17	3	0.055	0.076
18	18	-0.004	0.076
19	17	0.024	0.077
20	11	0.018	-0.002
Average		**0.032**	**0.06**

The first two columns present rankings based on the reward to variability (RVAR) and the traditional ROE measures.

$$EVA_i \equiv A_i = NI_i - [NI_{fi} + \beta_{ip}(NI_p - NI_{fi})]$$

where NI_i is the average earnings from activity *i*; σ_i =standard deviation of earnings in *i; NI_{fi}* is average earnings in the risk-free activity attributed to activity *i* and is equal to R_f*$E_{it,}$ where R_f is the risk-free return on a Treasury bill and E_{it} the average equity investment in activity *i; NI_p* is the average earnings of the BHC (benchmark) portfolio. Superior performance over the benchmark requires a positive value of Jensens's alpha or the EVA measure.
Several outliers were deleted from the sample because of either large deviation from the mean or a small number of observations.

Table 5 Optimal and Existing Composition of the BHC Portfolios, Short Term

Rank	Optimal Investment			Actual Investment			Change in Portfolio Composition that Optimizes Sharpe Ratio		Actual Change Between 1990-1994 and 1995-1999	
	CB	Sec 20	Other	CB	Sec 20	Other	CB	Sec 20	CB	Sec 20
4	70.0	2.3	27.7	74.9	2.0	23.1	-4.9	0.3	5.2	2.1
5	59.0	20	20.0	75.0	25.0	0.0	-16.0	-5.0	-4.5	4.0
8	83.9	0.1	16.0	79.0	0.1	20.0	4.9	0.0	15.6	0.0
11	74.3	1.0	24.7	78.6	0.8	20.6	-4.3	0.2	31.0	0.6
12	78.8	0.2	21.0	82.0	0.2	17.8	-3.2	0.0	41.0	0.0
13	81.5	6.5	12.0	84.5	5.0	10.0	-3.0	1.5	29.0	4.0
15	56.2	1.8	42.0	62.9	1.5	35.0	-6.7	0.3	-6.0	2.1
16	76.8	3.8	19.4	80.0	3.0	16.0	-3.2	0.8	8.0	0.5
17	65.8	0.9	33.3	71.8	0.8	27.0	-5.9	0.1	-28.0	0.1
18	68.3	1.6	30.0	60.0	1.0	39.0	8.3	0.6	-25.0	0.6
19	74.7	8.5	16.8	71.9	7.1	21.0	2.8	1.4	5.0	-0.7
20	67.0	0.0	33.0	64.1	6.7	29.2	2.9	-6.7	32.0	4.1
Average	**71.4**	**3.9**	**24.7**	**73.7**	**4.4**	**22.4**	**-2.3**	**-0.5**	**8.6**	**1.4**

This table compares the estimated optimal and actual portfolio composition of BHCs that operated commercial banking units (CB) and Section 20 affiliates (Sec 20) from 1990 through 1999 and reports changes in the portfolio mix needed to achieve the optimal allocation for the short-term horizon. The optimal allocation of BHCs' activities is determined by deriving efficient frontiers and solving for optimal portfolios for each BHC separately and for the group as a whole. In the short run, the possibilities of change in banks' positions are limited to 20% from the original portfolio composition. The table also reports actual changes in the portfolio composition between the two sub-periods: 1990-1994 and 1995-1999. The rankings are based on the Sharpe ratio (RVAR=the reward to variability). Calculations were performed for BHCs that reported continuously during the sample period and whose "other" activities (those besides commercial banking and investment banking) constituted less than 50% of consolidated BHCs' assets (12 BHCs).

Table 6 Optimal and Existing Composition of the BHC Portfolios, Long Term

Rank	Optimal Investment			Actual Investment			Change in Portfolio Composition that Optimizes Sharpe Ratio	
	CB	Sec 20	Other	CB	Sec 20	Other	CB	Sec 20
4	65.3	15.4	19.3	74.9	2.0	23.1	-9.6	13.4
5	67.6	0.0	32.4	75.0	25.0	0.0	-7.4	-25.0
8	92.3	0.0	7.8	79.0	0.1	20.0	13.3	-0.1
11	64.8	32.6	2.6	78.6	0.8	20.6	-31.0	31.8
12	33.2	44.0	22.8	82.0	0.2	17.8	-48.8	43.9
13	52.5	47.9	0.0	84.5	5.0	10.0	-32.4	42.9
15	38.1	36.0	25.9	62.9	1.5	35.0	-24.8	34.5
16	56.9	21.4	21.6	80.0	3.0	16.0	-23.1	18.4
17	48.3	46.9	4.8	71.8	0.8	27.0	-23.5	46.1
18	60.0	9.7	30.4	60.0	1.0	39.0	0.0	8.7
19	80.8	15.1	4.1	71.9	7.1	21.0	8.9	8.0
20	64	0.0	36.0	64.1	6.7	29.2	0.0	-6.7
Average	**60.9**	**22.4**	**16.7**	**73.7**	**4.4**	**22.4**	**-12.8**	**18.0**

This table compares the estimated optimal and actual portfolio composition of BHCs that operated commercial banking units (CB) and Section 20 affiliates (Sec 20) from 1990 through 1999 and reports changes in the portfolio mix needed to achieve the optimal allocation for both long-term and short-term horizons. The optimal allocation of BHCs' activities is determined by deriving efficient frontiers and solving for optimal portfolios for each BHC separately and for the group as a whole. In the short run, the possibilities of change in banks' positions are limited to 20% from the original portfolio composition. In the long run, unlimited changes in the composition of a bank portfolio are allowed. The long-term changes are reported in parenthesis. The table also reports actual changes in the portfolio composition between the two sub-periods: 1990-1994 and 1995-1999. The rankings are based on the Sharpe ratio (RVAR=the reward to variability). Calculations were performed for BHCs that reported continuously during the sample period and whose "other" activities constituted less than 50% of consolidated BHCs' assets (12 BHCs). The discrepancy between short-term (in Table 5) and long-term optimal allocations may exist because of the possible slow and costly adjustment in the banks' portfolio allocation (see text).

Table 7 Economic, Available, and Regulatory Capital

Variable	Average ($, mil.)	Standard Deviation ($, mil.)
Economic Capital of Commercial Banking Units	$249.8	$1713.5
Economic Capital of Section 20 Subs	36.9	51.1
Economic Capital of BHCs	3,300.8	2,362.9
Total Equity Capital of Banking Units	4,663.9	3,946.9
Total Equity Capital of Section 20 Subs	157.4	190.2
Total Equity Capital of BHCs	7,250.9	5,585.8
Regulatory Capital of BHCs	10,148	8,079.8
RBC Ratio of BHCs	12%	
Leverage Capital Ratio of Banking Units (vs. Economic Capital Ratio of Banking Units)	7.8% (1.7%)	
Leverage Capital Ratio of Section 20 Subs (Economic Capital Ratio of Section 20 Subs)	19.2% (2.2%)	
Leverage Capital Ratio of BHCs (Economic Capital Ratio of BHCs)	7.5% (3.5%)	
Risk-Adjusted Return on Commercial Banking	2.16%	
Risk-Adjusted Return on Section 20	3.19%	
Risk-Adjusted Return on BHCs	4.41%	

This table uses the same sample as Table 2. The table compares leverage (actual) capital ratios – defined as the ratio of total equity capital over the entity's total assets – to economic capital ratios (defined as the ratio of economic capital to entity's total assets). Risk-adjusted return is derived by dividing adjusted income by the total amount of economic capital. Economic capital, or earnings at risk (EAR), is defined as $\alpha * \sigma$, where α is a constant (here, α =3), and σ is the standard deviation of earnings for an activity between 1990 and 1999. Total equity capital of banks, securities affiliates, and BHCs come from Call Reports, FR Y-20, and BHC reports.