The Federal Reserve Banks' Imputed Cost of Equity Capital *

Edward J. Green
Federal Reserve Bank of Chicago

Jose A. Lopez
Federal Reserve Bank of San Francisco

Zhenyu Wang
Columbia University, Graduate School of Business

Draft date: December 10, 2000

Abstract

According to the Monetary Control Act of 1980, the Federal Reserve Banks must establish fees for their priced services to recover all operating costs as well as imputed costs of capital and taxes that would be incurred by a profit-making firm. The calculations required to establish these imputed costs are referred to collectively as the Private Sector Adjustment Factor (PSAF). In this paper, we propose a new approach for calculating the cost of equity capital used in the PSAF. The proposed approach is based on a simple average of three methods as applied to a peer group of bank holding companies. The three methods estimate the cost of equity capital from three different perspectives — the historical average of comparable accounting earnings, the discounted value of expected future cashflows, and the equilibrium price of investment risk as per the capital asset pricing model. We show that the proposed approach would have provided stable and sensible estimates of the cost of equity capital for the PSAF from 1981 through 1998.

*The views expressed in the paper are those of the authors and not necessarily those of any Federal Reserve Bank or of the Federal Reserve System. Zhenyu Wang began work on this project as a staff member at the Federal Reserve Bank of New York and is currently a consultant to the Federal Reserve Bank of Boston. The authors are grateful to the members of the 2000 PSAF Fundamental Review Group for valuable comments, to Martin Haugen for providing the historical PSAF numbers, and to Paul Bennett, Eli Brewer, Simon Kwan and Hamid Mehran for helpful discussions. The authors thank Adam Kolasinski and Ryan Stever for carrying out the many calculations needed for this study and for contributing to the technical appendix. The authors also gratefully acknowledge I/B/E/S International Inc. for providing earnings per share forecast data, available through the Institutional Brokers Estimate System.

1 Introduction

The U.S. Federal Reserve System provides services to depository financial institutions through the twelve Federal Reserve Banks. U.S. federal legislation, contained in the Monetary Control Act of 1980, requires the Federal Reserve Banks to price their services at a level that fully recovers their costs. The Act specifically requires imputation of various costs that the Federal Reserve Banks do not actually pay, but that they would pay if they were commercial enterprises. Prominent among these imputed costs is a cost of capital. The Federal Reserve has complied with the Act by adopting an imputation formula for the overall cost of capital that combines separate imputations of costs of debt and equity. This paper provides a survey of the economic and statistical issues in imputing a cost of equity capital to the Reserve Banks and suggests a revised approach for doing so.

Promptly after the Monetary Control Act was passed, the Federal Reserve formulated a Private Sector Adjustment Factor (PSAF) to quantify the costs that must be imputed to comply with the Act. In the PSAF, the cost of capital is determined as an average of the cost of capital to a sample of large U.S. bank holding companies (BHCs). Specifically, the cost of capital is treated as a composite of the costs of debt and equity, and the cost of equity capital is determined according to a comparable accounting earnings (CAE) method.[1] The CAE method has been revised several times, in light of experience with its use. The sample of BHCs has been enlarged to the largest fifty by assets, and a practice of averaging the annual estimates of the cost of equity capital over the preceding five years has been adopted. Both of these measures have been taken largely in order to avoid imputing an unreasonably low — and even negative — cost of equity capital in years when adverse market conditions have impaired bank earnings. The latter measure effectively ameliorates that problem, but it has the drawback that the imputed cost of equity capital lags the actual market cost of capital by about three years and is thus significantly out of phase with the business cycle. This drawback does not result in an over- or under-estimate of the cost of equity capital in the long run, but it can nevertheless lead to setting of prices that do not achieve full economic efficiency.

Currently, the Federal Reserve is again considering possible revision of the PSAF. The goal is to adopt an imputation formula that will:

[1] The Federal Reserve refers to this CAE method for the PSAF as the "bank holding company model."

1. provide a conceptually sound basis for economically efficient pricing;
2. be consistent with actual Reserve Bank financial information;
3. be consistent with economy-wide practice, and particularly with private-sector practice, in accounting and applied financial economics; and
4. be intelligible and justifiable to the public, and replicable from information that is obtainable by the public.

One focus of efforts to meet these criteria is to take account of the substantial changes in academic knowledge and industry practice regarding financial economics that have occurred during the past two decades. Especially, the scientific view that financial asset prices reflect market participants' assessments of future stochastic revenue streams has received strengthened statistical corroboration and general public acceptance. Quantitative models that reflect this view, rather than the backward-looking view of asset-price determination implicit in the CAE method, have come into widespread use in investment banking and also for regulatory rate-setting in utility industries.

In this paper, we survey quantitative models that might be used to impute a cost of equity capital in a way that would conform to theory, evidence, and market practice in financial economics. Such quantitative models compare favorably with the CAE method in terms of the first, third, and fourth criteria framed above.[2] We suggest an imputation formula that would average the estimated costs of equity capital from two such models, a discounted cashflow (DCF) model and a capital asset pricing model (CAPM), together with the estimates from the CAE method. We show that the proposed approach would have provided stable and sensible estimates of the cost of equity capital for the PSAF over the past 18 years from 1981 through 1998.

The paper is structured as follows. Section 2 contains a survey of the models available for estimating the cost of equity capital and their applicability to the PSAF. Section 3 describes our proposed approach and presents supporting empirical results; i.e., the estimated costs of equity capital from the CAE, DCF and CAPM methods as well as their combined average. Section 4 introduces and discusses some conceptual issues regarding the

[2] The second criterion does not bear directly on the cost of capital issue, but is germane to other aspects of the PSAF.

selection of the BHC peer group for our calculations. Although we present some alternative empirical measures of equity capital costs in this section, our recommendation remains as the average of the three aforementioned methods. Section 5 concludes and is followed by an Appendix containing more details regarding our estimation procedures.

2 A Survey of Available Models

Since the cost of equity capital used in the PSAF is unobservable, a model must be used to impute an estimate from available data. Currently, a model of comparable accounting earnings (CAE), which is based purely on publicly available bank holding company (BHC) accounting information, is used. This method can be justified under some restrictive assumptions as a version of the discounted cashflow (DCF) model of stock prices. If actual market equilibrium conformed directly to theory and if data were completely accurate, the DCF model would presumably yield identical results to the Capital Asset Pricing Model (CAPM), which is a standard financial model using stock market data.

Although related, these three models do not yield identical estimates in practice mainly because each suffers from a type of measurement inaccuracy. The accounting data used in the CAE method do not necessarily measure the quantities that are economically relevant in principle; the projected future cashflows used in the DCF model are potentially incorrect; and the overall market portfolio assumed within the CAPM model is a theoretical construct that cannot be approximated accurately with a portfolio of actively traded securities alone. However, in practice, these models are commonly used. The DCF model is widely used to determine the fair value of an asset, while the CAPM is frequently used as the basis for calculating a required rate of return in project evaluation.

In this section, we provide a review of these three models, as well as the multi-beta and dynamic models popular in academic studies on the cost of equity capital. We conclude that, in addition to the CAE method, the DCF and CAPM methods provide useful insights into the cost of equity capital and should be incorporated into the PSAF calculations. However, we do not recommend using the more sophisticated models.

2.1 The Comparable Accounting Earnings Model

The estimate of the cost of equity capital used in the current implementation of the PSAF is based on a comparable accounting earnings (CAE) method. For each BHC in the specified peer group, the estimate is calculated as the return on equity (ROE), defined as

$$\text{ROE} \equiv \frac{\text{Net income}}{\text{Book value of the equity}} \ .$$

The individual ROE estimates are averaged to determine the average BHC peer group ROE for a given year. The CAE estimate actually used in the PSAF is the average of the last five years of the average ROE measures.

When interpreting the past behavior of a firm's ROE or forecasting its future value, we must pay careful attention to the firm's debt-equity mix and the interest rate on its debt. The exact relationship between ROE and leverage is expressed as

$$\text{ROE} = (1 - \text{Tax rate})\left[\text{ROA} + (\text{ROA} - \text{Interest rate})\frac{\text{Debt}}{\text{Equity}}\right],$$

where ROA is the return on assets. The relationship has the following implications. If there is no debt or if the firm's ROA equals the interest rate on its debt, its ROE will simply be equal to $(1-\text{Tax rate})\times\text{ROA}$. If its ROA exceeds the interest rate, then its ROE will exceed $(1 - \text{Tax rate}) \times \text{ROA}$ by an amount that will be greater the higher the debt-to-equity ratio. Intuitively, if ROA exceeds the borrowing rate, the firm earns more on its money than it pays out to creditors. The surplus earnings are available to the firm's equity holders, which raises ROE. Therefore, increased debt will make a positive contribution to a firm's ROE if the firm's ROA exceeds the interest rate on the debt.

To understand the factors affecting a firm's ROE, we can decompose it into a product of ratios as follows:

$$\text{ROE} = \frac{\text{Net profits}}{\text{Pretax profits}} \times \frac{\text{Pretax profits}}{\text{EBIT}} \times \frac{\text{EBIT}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times \frac{\text{Assets}}{\text{Equity}} \ .$$

The first factor is the *tax-burden ratio*, which reflects both the government's tax code and the policies pursued by the firm in trying to minimize its tax burden. The second factor is the *interest-burden ratio*, which will be one when there are no interest payments to be made to debt holders. (EBIT is defined as earnings before interest and tax payments.) The third factor is the *return on sales*, which is known as the firm's operating profit margin.

The fourth factor is the *asset turnover*, which indicates the efficiency of the firm's use of assets. The fifth factor is the *leverage ratio*, which measures the firm's degree of financial leverage. The tax-burden ratio, return on sales and asset turnover do not depend on financial leverage. However, the product of the interest-burden ratio and leverage ratio is known as the *compound leverage factor*, which measures the full impact of the leverage ratio on ROE.

Although the return on sales and asset turnover are independent of financial leverage, they typically fluctuate over the business cycle and cause the ROE to vary over the business cycle. The CAE method has been criticized for being "backward looking" since past earnings may not be a good forecast of expected earnings due to cyclical changes in the economic environment. As a firm makes its way through the business cycle, its earnings will rise above or fall below the trend line that might more accurately reflect sustainable economic earnings. A high ROE in the past does not necessarily imply that a firm's future ROE will remain high. A declining ROE might be evidence that the firm's new investments have offered a lower ROE than its past investments. The best forecast of future ROE in this case may be lower than the most recent ROE.

Another shortcoming of the CAE method is that it is based on the book value of equity. Thus, it cannot incorporate changes in investor expectations of a firm's prospects in the same way that methods based on market values can. Use of book value rather than market value exemplifies the general problem of discrepancy between accounting quantities and actual economic quantities. The discepancy precludes a forward-looking pricing formula for equity in this instance. We propose to incorporate forward-looking pricing methods for equity capital into the PSAF. These methods, to be described below, greatly mitigate the problems of accounting measurement.

2.2 The Discounted Cashflow Model

The theoretical foundation of corporate valuation is the discounted cash flow (DCF) model, in which the stock price equals the discounted value of all expected future dividends. The mathematical form of the model is

$$P_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t} \ ,$$

where P_0 is the current price per share of equity, D_t is the expected dividend in period t and r is the cost of equity capital.[3] Since the current stock price P_0 is observable, the equation can be solved for r, provided that projections of future dividends can be obtained.

It is difficult to project expected dividends for all future periods. To simplify the problem, financial economists often assume that dividends grow at a constant rate, denoted g. The DCF model then reduces to the simple form of

$$P_0 = \frac{D_1}{r-g} \ ,$$

and the cost of equity capital can be expressed as

$$r = \frac{D_1}{P_0} + g \ .$$

If the estimates of the expected dividend D_1, P_0 and g are available, the cost of equity capital can be easily calculated. Finance practitioners often estimate g from accounting statements. They assume that reinvestment of retained earnings generates the same return as the current ROE. Under this assumption, the dividend growth rate is estimated as $(1-\rho) \times \text{ROE}$, where ρ is the dividend payout ratio. The estimate of the cost of equity capital is therefore

$$r = \frac{D_1}{P_0} + (1-\rho) \times \text{ROE} \ .$$

Although the assumption of constant dividend growth is useful, firms typically pass through life cycles with very different dividend profiles in different phases. In early years, when there are ample opportunities for profitable reinvestment in the company, payout ratios are low, and growth is correspondingly rapid. In later years, as the firm matures, production capacity is sufficient to meet market demand as competitors enter the market, and attractive opportunities for reinvestment may become harder to find. In this mature phase, the firm may choose to increase the dividend payout ratio, rather than retain earnings. The dividend level increases, but thereafter it grows at a slower rate because of fewer growth opportunities.

To relax the assumption of constant growth, financial economists often assume multi-stage dividend growth. The dividends in the first T periods are assumed to grow at variable rates, while the dividends after T periods are assumed to grow at the long-term constant rate g. The mathematical formula is stated as

$$P_0 = \sum_{t=1}^{T-1} \frac{D_t}{(1+r)^t} + \frac{D_T}{(1+r)^{T-1}(r-g)} .$$

[3] This model is also commonly known as the Gordon growth model.

Many financial information firms provide projections of dividends and earnings a few years ahead as well as long-term growth rates. For example, the Institutional Brokers Estimate System (I/B/E/S) surveys a large sample of equity analysts and reports their forecasts for major market indexes and individual stocks. Given the forecasts of dividends and the long-term growth rate, we can solve for r as an estimate of a firm's cost of equity capital.

Myers and Boruchi (1994) demonstrate that the assumption of a constant dividend growth may lead financial analysts to unreasonable estimates of the cost of equity capital. They show, however, that the DCF model with multi-stage dividend growth gives an economically meaningful and statistically robust estimate. We therefore recommend the implementation of the DCF model with multi-stage dividend growth rates for the cost of equity capital used in the PSAF.

2.3 The Capital Asset Pricing Model

A widely accepted financial model for estimating the cost of equity capital is the Capital Asset Pricing Model (CAPM). In this model, the cost of equity capital (or the expected return) is determined by the systematic risk affecting the firm. The mathematical formula underlying the model is

$$r = r_f + (r_m - r_f)\beta,$$

where r is the expected return on the firm's equity, r_f is the risk-free rate, r_m is the expected return on the overall market portfolio, and β is the equity beta that measures the sensitivity of the firm's equity return to the market return.

Using the CAPM requires us to choose the appropriate measure of r_f and the expected market risk premium $(r_m - r_f)$ and to calculate the equity beta. The market risk premium can be obtained from a time-series model for market returns. The simplest estimation is the average of historical risk premiums, which is available from various financial services such as Ibbotson Associates. The equity beta is calculated as the slope coefficient in the regression of the equity return on the market return. The equity beta can also be obtained from financial services such as ValueLine or Merrill Lynch.

The classic empirical study of the CAPM was conducted by Black, Jensen and Scholes (1972) and updated by Black (1993). They show that the model has certain shortcomings: the estimated security market line is too flat; the estimated intercept is higher than the risk-free rate; and the risk premium on beta is lower than the market risk premium. To correct this, Black (1972) extended the CAPM to a model that does not rely on the existence of a risk-free rate, and this model seems to fit the data very well for certain portfolios. Fama and French (FF, 1992) argue more broadly that there is no relation between the average return and beta for U.S. stocks traded on the major exchanges. They find that the cross section of average returns can be explained very well by two firm characteristics: firm size and book/market ratio. This study led the business press, such as *Business Week* and *The Economist*, to announce that the CAPM was dead.

However, there are challenges to the FF study. One group of challenges focuses on statistical estimations. Most notably, Kothari, Shanken and Sloan (1994) argue that the FF results are partially driven by survivorship bias in the data. Knez and Ready (1997) argue that extreme samples are the reason for the FF results. Another group of challenges focuses on economic issues. For example, Roll (1977) had argued that the common stock indices do not correctly represent the model's market portfolio. Jagannathan and Wang (1996) demonstrate that missing assets in such proxies for the market portfolio can be a partial reason for the FF results. They also show that the business cycle is partially responsible to the FF results.

Turning to estimates of the cost of equity capital for specific industries using the CAPM, Fama and French (1997) conclude that they are imprecise with standard errors of more than 3% per year. These large standard errors are the result of uncertainty about the true expected risk premiums and imprecise estimates of industry betas. They further argue that these estimates are surely even less precise for individual firms and projects. To overcome these problems, finance practitioners have often adjusted such betas and the market risk premium estimated from historical data. For example, Merrill Lynch provides adjusted betas. Vasicek (1973) provides a method of adjustment for betas, which is more sophisticated than the method used in Merrill Lynch. BARRA uses firm characteristics, such as the variance of earnings, variance of cashflow, growth in earnings per share, firm size, dividend yield and debt-to-asset ratio, to model betas; BARRA's approach was developed by Rosenberg and Guy (1976). These practices can be found in standard MBA textbooks, such as Bodie, Kane and Marcus (1999).

Given this ongoing debate, how much faith can we place in the CAPM model? First, few people quarrel with the idea that equity investors require some extra return for taking on risk. Second, equity investors do appear to be concerned principally with those risks that they cannot eliminate through portfolio diversification. The CAPM captures these ideas in a simple way, which is why finance professionals find it to be the most convenient tool with which to grip the slippery notion of equity risk. The CAPM is still the most widely used model for calculating the cost of capital in MBA classrooms and financial industry. This fact is evident in popular corporate finance textbooks such as Brealey and Myers (1996) and Ross, Westerfield and Jaffe (1996). Given that the CAPM remains the industry standard and is readily accepted in the private sector, we recommend that it be incorporated into the estimation of the cost of equity capital for the PSAF.

2.4 Multi-Beta Models

Empirical evidence suggests that additional factors may be required to adequately characterize the behavior of expected stock returns and naturally leads to the consideration of multi-beta pricing models. Theoretical arguments also suggest that more than one factor is required, since the CAPM will apply period by period only under strong assumptions. Two main theoretical approaches exist. The Arbitrage Pricing Theory (APT) developed by Ross (1976) is based on arbitrage arguments, and the Intertemporal Capital Asset Pricing Model (ICAPM) developed by Merton (1973) is based on equilibrium arguments.

The mathematical formula for these multi-beta models is

$$r = r_f + \gamma_1 \beta_1 + \cdots + \gamma_K \beta_K \ ,$$

where r is the cost of equity capital, β_k measures the sensitivity of the firm's equity return to the k^{th} economic factor, and γ_k measures the risk premium on the k^{th} beta. Given the economic factors, the parameters in the multi-beta model can be estimated from the combination of time-series and cross-sectional regressions. Shanken (1992) and Jagannathan and Wang (1998) both describe this estimation procedure.

The major drawback of the multi-beta models is that economic theory does not specify the factors to be used in the models. The task of identifying the factors is left to empirical research. The first approach is to use economic intuition. Chen, Roll and Ross (1986) selected five economic factors — the market return, industrial production growth, a default premium, a term premium, and inflation. The second approach is to identify factors based on statistical analysis. Connor and Korajczyk (1986) use the asymptotic principal component method to extract factors from a large cross section of stock returns. The third approach is to identify factors based on empirical observation. Fama and French (1993) construct two factors to mimic the risk captured by firm size and the book/market ratio.

In MBA classrooms and industry practice, multi-beta models are sometimes used for estimating the cost of equity capital. For example, Elton, Gruber and Mei (1994), Bower and Schink (1994), Bower, Bower and Logue (1984) and Goldenberg and Robin (1991) use multi-beta models to study the cost of capital for utility stocks. Antoniou, Garrett and Priestley (1998) use the APT model to calculate the cost of equity capital when examining the impact of the European exchange rate mechanism. However, different studies use entirely different factors.

Recent academic studies have comprehensively examined the differences in estimating the cost of equity capital using CAPM and multi-beta models. Fama and French (1997) conclude that when the three-beta model proposed by Fama and French (1993) is used, estimates of the cost of equity capital for industries are still imprecise. Like the CAPM, the three-beta model often produces standard errors of more than 3% per year. Using Bayesian analysis, Pastor and Stambaugh (1999) reach a similar conclusion. They show that uncertainty about which model to use is less important, on average, than within-model parameter uncertainty.

Multi-beta models could be used to calculate the equity cost of capital used in the PSAF. However, since there is no consensus on the factors, adoption of any particular model would attract criticism. Since the academic literature shows that multi-beta models do not substantially improve the needed estimates, the gain in accuracy is likely to be too small to justify the burden of defending a deviation from the CAPM method.[4] We therefore do not recommend using multi-beta models for the cost of equity capital used in the PSAF.

2.5 Dynamic Models

The CAPM and multi-factor models discussed above are static models, which have difficulties in capturing the effects of a changing economic environment. One solution to this problem is to use a short and recent historical data sample to estimate the models. However, this approach is often criticized as being based on inefficient model estimation. In addition,

[4] See section 6.3 of the Appendix for some preliminary empirical results that support this conclusion.

this practice depends on the assumption that the expected returns and risk do not change substantially within the selected data sample.

Another solution is to construct dynamic models. One approach developed in the late 1980s is to use generalized autoregressive conditional heteroscedasticity (GARCH) models to estimate the CAPM with conditional expected return and volatility. This approach was first implemented by Bollerslev, Engle and Wooldridge (1988) for estimating the CAPM with time-varying covariances. In the 1990s, there were many extensions and improvements to the original specification of the GARCH-CAPM. Another approach is to model the conditional expected returns and variances as linear functions of instrument variables, such as various kinds of interest rates. This approach was first implemented by Harvey (1989). Ferson and Harvey (1999) argue that the instrument variables improve the estimates of the expected equity returns in comparison to the CAPM and multi-beta models.

The most rigorous dynamic models consider the consumption-portfolio choice over multiple periods. However, these models rely on aggregate consumption data and perform poorly in explaining the risk premiums on financial assets. The empirical difficulties of the dynamic asset pricing models are convincingly demonstrated by Hansen and Singleton (1982), Mehra and Prescott (1985) and Hansen and Jagannathan (1991). Hansen and Jagannathan (1997) find that the improvements of various sophisticated dynamic models over the static CAPM are not substantial.

Each of these dynamic models has important empirical difficulties. Although widely applied and extended in academic research, none has been used for estimating the cost of equity capital in either industry or MBA classrooms. Therefore, we do not recommend introducing these models into the calculation of the cost of equity capital used in the PSAF.

3 The Proposed Approach

3.1 The Estimates Based on the CAE Method

Currently, the cost of equity capital in the PSAF is estimated using a CAE method. Table 1 reports these estimates on an after-tax basis from 1981 through 1998 in the fourth column. Although the CAE methodology remained relatively constant over this period, a number of minor modifications, described below, were made over the years.

Table 1. The Equity Cost of Capital Estimates Based on the CAE Method

Data Year	# of BHC	After-tax ROE	CAE	GDP growth	NBER business cycle	PSAF Year	One-year T-Bill*
1981	12	12.69	12.69	2.45	Recession begins in July	1983	8.05
1982	12	12.83	12.83	-2.02	Recession ends in Nov.	1984	9.22
1983	25	12.56	12.89	4.33		1985	8.50
1984	25	9.80	11.75	7.26		1986	7.09
1985	25	12.03	11.85	3.85		1987	5.62
1986	25	12.59	11.85	3.42		1988	6.62
1987	25	-0.01	9.49	3.40		1989	8.34
1988	25	18.92	10.54	4.17		1990	7.24
1989	50	7.44	10.11	3.51		1991	6.40
1990	50	-0.01	7.58	1.76	Recession begins in July	1992	3.92
1991	50	5.80	6.11	-0.47	Recession ends in March	1993	3.45
1992	50	13.39	8.85	3.05		1994	3.46
1993	50	16.39	8.43	2.65		1995	6.73
1994	50	14.94	10.06	4.04		1996	4.91
1995	50	15.73	13.00	2.67		1997	5.21
1996	50	16.75	15.22	3.57		1998	5.22
1997	50	16.57	15.95	4.43		1999	4.33
1998	50	15.62	15.93	4.37		2000	5.63

* Note that the Treasury bill rate is aligned with the PSAF year.

The first element of the CAE method is determining the sample of bank holding companies (BHCs) that constitute the peer group of interest. The sample consists of BHCs ranked by their total assets.[5] As shown in the second column of Table 1, the number of BHCs in the peer group has changed over time. For PSAF years 1983 and 1984, the peer group consisted of the top twelve BHCs by assets in the calendar year two years prior; i.e., data years 1981 and 1982.[6] For PSAF years 1985 through 1990, the peer group consisted of the top 25 BHCs by assets, and since PSAF year 1991, the peer group has consisted of the top fifty BHCs. For a given PSAF year, the latest publicly available accounting data is used, which typically is data reported in the annual reports for the calendar year two years prior.

[5] The source typically used for this ranking was the year-end summary published in the *American Banker*. See Appendix Table A at the end of the document for a complete list of the BHCs in the peer group for each year of our sample period.

[6] The timing differences between PSAF years and data years are due to the operational need to calculate the PSAF before year-end in order to announce the new prices for payment services. The PSAF for year x is calculated in calendar year x-1 based on data available as of the end of calendar year x-2. The BHC peer group for PSAF year x is based on the rankings by total assets in calendar year x-2.

For each BHC in the peer group for a given PSAF year, accounting information reported in the BHC's annual report from two years prior is used to calculate a measure of return on equity (ROE). The pre-tax ROE is calculated as the ratio between the BHC's after-tax ROE, defined as the of ratio of its after-tax net income to its average book value of equity, and the appropriate effective tax rate. The variables needed for these calculations are directly reported in or can be imputed from BHC annual reports. The BHC peer group's pre-tax ROE is a simple average of their individual pre-tax ROEs. To compare the CAE results with other methods that are calculated on an after-tax basis, the pre-tax ROE measures are multiplied by the adjustment term (1 - median tax rate), where the median tax rate for a given year is based on the individual tax rates calculated from BHC annual reports over a period of several years. These average after-tax ROEs are reported in the third column of Table 1.[7]

For PSAF years 1983 and 1984, the after-tax CAE estimates used in the PSAF calculations, as reported in the fourth column of Table 1, were simply that year's average of the individual BHCs' pre-tax ROEs multiplied by their median tax adjustment terms. However, for subsequent years, rolling averages of past years' ROE measures were used in the PSAF. The rolling averages were introduced to reduce the volatility of the yearly CAE estimates and to ensure that they remain positive. For PSAF years 1984 through 1988, the after-tax CAE measures were based on a three-year rolling average of annual average pre-tax ROEs multiplied by their median tax adjustment terms. Since PSAF year 1989, a five-year rolling average has been used.[8]

As discussed in Section 2.1, the two factors that link ROE calculations to the business cycle are return on sales and asset turnover (i.e., the ratio of sales to book-value assets). As shown in Table 1, the average ROE measure tends to fluctuate with real GDP growth. Dramatic examples of this correlation are seen for calendar years 1990 and 1991. Due to the recession beginning in July 1990 and the increasing credit problems in the banking sector at

[7] Note that an alternative measure of the average after-tax ROE for the BHC peer group in a given year is simply the average of the individual BHCs' after-tax ROE. This measure could be seen as more appropriate for our purposes since it is based on just two accounting items, i.e., the ratio of reported after-tax net income to average shareholder equity. Since fewer accounting items are used in this measure, it should be less susceptible to mismeasurement due to differences between accounting varaibles and economic concepts. However, this approach is not used currently in the PSAF calculations.

[8] Note that the annual after-tax ROE estimates reported in the third column of Table 1 do not exactly average to the reported after-tax CAE estimates in the fourth column due to minor differences in the tax rates used in the calculations.

that time, the average ROE for the BHC peer group is actually negative. The CAE measure for that year (PSAF year 1992) was positive because of the five-year rolling average. In 1991, the average ROE was again positive, but the CAE measure (used for PSAF year 1993) dipped to its low of 6.11%. This measure was only about 3 percentage points above the one-year Treasury bill rate for that PSAF year (as reported in the last column of Table 1), which is low compared to the CAE measure for PSAF year 2000 that is more than ten percentage points greater than this risk-free rate. Clearly, the influence of the business cycle on the CAE measures are a cause for concern, especially given the two-year lag between the data and PSAF years.

A major deficiency of the CAE measure of equity capital costs is its "backward looking" nature, as previously discussed. This characteristic becomes quite problematic when the economy has just recovered from a recession. For example, as of 1992 when the economy already recovered and experienced a real GDP growth rate of 3.05% (reported in the fifth column of Table 1), the negative average ROE observed in 1990 was still used in the CAE measure. As a result, the CAE measures used for the PSAF were at or below 10% until 1995, even though the after-tax average ROE over this period averaged about 15%.

There two reasons for the backward-looking nature of the CAE measure. The most important reason is its reliance on the book value of equity, which adjusts much more slowly than the market value of equity. Investors directly incorporate their expectations of BHC's performance into the market value of equity, but not into the book value. For example, an interest rate increase should also increase the cost of equity capital, but a capital cost measure based on book values would remain unchanged. As pointed out by Elton, Gruber and Mei (1994), since the cost of equity capital is a market concept, such accounting-based methods are inherently deficient. The other reason for the CAE method to be backward looking is the use of a rolling average of past ROE estimates. This historical average exacerbates the lag of the CAE method in response to the business cycle.

3.2 The Estimates Based on the DCF Method

Using the DCF method, the measure of a BHC's equity cost of capital is calculated by solving for the discount factor in the Gordon growth model, given the BHC's year-end stock price, the available dividend forecasts and a forecast of its long-term dividend growth rate. For our implementation, we used equity analyst forecasts of the BHC peer groups' earnings, which are converted into dividend forecasts by multiplying them by the firm's latest dividend payout ratio. Specifically, we worked with the consensus earnings forecasts provided by the Institutional Brokers Estimate System (I/B/E/S). Although several firms provide aggregations of analysts' earnings forecasts, we use the I/B/E/S forecasts because they have available a long historical record and have been widely used in the academic literature on this topic. I/B/E/S was kind enough to provides us the historical data needed for our study.[9]

An important concern here is the possibility of systematic bias in the analyst forecasts. De Bondt and Thaler (1990) argued that analysts tend to overreact in their earnings forecasts. A recent study by Michaely and Womack (1999) found that analysts with conflicts of interest appear to produce biased forecasts; they find that equity analysts tend to favorably bias their buy recommendations for stocks that were underwritten by their own firms. However, Womack (1996) demonstrated that equity analyst recommendations appear to have investment value. Overall, the academic literature seems to find that consensus (or mean) forecasts tend to be unbiased. Laster, Bennett and Geoum (1999) provide a theoretical model in which the consensus of professional forecasters is unbiased in the Nash equilibrium, while individual analysts may behave strategically in giving forecasts different from the consensus. For macroeconomics forecasts, Zarnowitz and Braun (1993) documented that consensus forecasts are unbiased and more accurate than virtually all individual forecasts. In view of these findings, we chose to use the consensus forecasts produced by I/B/E/S, rather than relying on individual analyst forecasts.

The details of how we calculate the DCF measure of the cost of equity capital are as follows. For a given PSAF year, the BHC peer group is set as the largest fifty BHCs by assets in the calendar year two years prior.[10] For each BHC in the peer group, we collect the available earnings forecasts and the stock price at the end of that calendar year. The nature of the earnings forecasts available varies across the peer group BHCs and over time; that is, the I/B/E/S database contains a variable number of quarterly and annual earnings forecasts, and in some cases, it does not contain a long-term dividend growth forecast. These

[9] For a more detailed discussion of the I/B/E/S forecasts used in this study, please see section 6.1 of the Appendix.

[10] Note that this sample is larger than that used in the CAE approach before PSAF year 1991.

differences are typically due to the number of equity analysts providing these forecasts.[11] Once the available earnings forecast have been converted to dividend forecasts using the firm's latest dividend payout ratio, which is also obtained from I/B/E/S, the discount factor is solved for and converted into an annualized cost of equity capital.

As shown in the second column of Table 2, the number of BHCs for which equity capital costs can be calculated fluctuates slightly due to missing forecasts.[12] To determine the DCF measure for the peer group, we construct a value-weighted average of the individual discount factors using year-end data on BHC market capitalization.[13] The DCF measures are presented in the second column of Table 2; the mean of this series is about 13% with a time-series standard deviation of about 1.5%. Overall, the DCF method generates very stable measures of BHC cost of equity capital. In the fourth column of Table 2, we report the cross-sectional standard deviation of the individual BHC discount factors for each year as a measure of dispersion. The cross-sectional standard deviation is relatively large around the years 1989 and 1990, but otherwise, it has remained in a relatively narrow band around 2%. These estimates of equity capital costs are close to the long-run historical average return of the U.S. equity market, which is about 11%; see Siegel (1998). More importantly, they imply a consistent premium over the risk-free rate, which is an economically sensible result.

---

[11] Analyst earnings forecasts for a firm are included in the I/B/E/S database when two criteria are met. First, at least one analyst is producing forecasts on the firm, and second, sufficient ancillary data, such as actual dividends, are publicly available.

[12] See Appendix Table B at the end of the document for a complete list of the BHCs used in determining the DCF estimate for each year of our sample period.

[13] In Section 4, we examine the impact of weighting methods on the estimated cost of equity capital.

Table 2. The Equity Cost of Capital Estimates Based on the DCF Method

Data year	Number of Banks	DCF Estimate	Standard Deviation	PSAF year	One-year T-Bill*
1981	26	10.52	2.55	1983	8.05
1982	24	9.43	2.15	1984	9.22
1983	27	10.89	1.31	1985	8.80
1984	26	14.93	3.29	1986	7.09
1985	31	13.48	2.31	1987	5.62
1986	34	13.63	1.99	1988	6.62
1987	37	15.38	3.27	1989	8.34
1988	44	14.67	2.56	1990	7.24
1989	44	14.24	5.44	1991	6.40
1990	45	14.54	5.49	1992	3.92
1991	46	11.82	3.80	1993	3.45
1992	45	11.99	2.35	1994	3.46
1993	48	12.47	4.93	1995	6.73
1994	48	13.15	2.41	1996	4.91
1995	48	12.24	2.11	1997	5.21
1996	45	12.47	2.21	1998	5.22
1997	44	13.78	2.18	1999	4.33
1998	43	15.09	2.00	2000	5.63

* Note that the Treasury bill rate is aligned with the PSAF year.

Unlike the CAE estimates, the DCF estimates are mostly "forward looking." In principle, we determine the BHCs' cost of equity capital by comparing their stock prices and expected future cashflows, both of which are market measures. However, some past accounting information is used. For example, the future dividend payout ratio for a BHC is assumed to be constant at the last reported value. Nevertheless, the DCF measure is forward looking since the consensus analyst forecasts will deviate from past forecasts if there is a clear expected change in BHC performance.

3.3 The Estimates Based on the CAPM Method

The CAPM method for measuring BHC equity cost of capital is based on constructing a portfolio of BHC stocks and determining its sensitivity to the overall equity market. As shown in Section 2.3, the relevant equation is $r = r_f + (r_m - r_f)\beta$. Thus, to construct the CAPM measure, we need to determine the appropriate BHC portfolio and its monthly stock returns over the selected sample period, estimate the portfolio's correlation with the overall stock market (i.e., its beta), and construct the CAPM measure using the beta and the appropriate measures of the risk-free rate and the overall market premium.

As in the DCF method, the BHC peer group for a given PSAF year is the top fifty BHCs ranked by asset size for the calendar year two years prior; that is, for PSAF year y', the BHC peer group is the top fifty BHCs in calendar year $y - 2$. However, for the CAPM method, we need to gather additional historical data on stock prices in order to estimate the market regression equation. This need for historical data introduces two additional data questions.

The first question is which sample period should be used for our calculations. The question of the sample period over which to estimate a portfolio's beta has presented academic researchers with an interesting challenge. Much empirical work has shown that portfolio betas exhibit time dependence; see Jagannathan and Wang (1996) and their references. For our purposes, we chose to use a rolling ten-year sample period; that is, for a given PSAF year y, the stock return data used to estimate the peer group portfolio beta is a ten-year period starting with calendar year $y - 11$ and ending with calendar year $y - 2$. The choice of a ten-year period provides a reasonable trade-off between accurate estimation of time-varying betas and computational convenience; see MacKinley and Pastor (2000). Since we chose a monthly frequency, we use 120 observations to estimate the portfolio beta for a given PSAF year.[14]

The second data question is how mergers should be handled in our study. This issue is important in light of the large degree of BHC consolidation that occurred in the 1990s. Our guiding principle was to include all of the BHC assets present in the BHC peer group portfolio at the end of the sample period in our analysis throughout the entire period. In effect, mergers require us to analyze more than a given PSAF year's BHC peer group in the earlier years of the ten-year sample period. For example, the merger between Chase and J.P. Morgan in 2000 will require us to include both stocks in our peer group portfolio for PSAF year 2002, even though one BHC will cease to exist; we must do so over the entire 1991-2000 data window.[15] Clearly, this practice will change the number of firms in the portfolio and the market capitalization weights used to determine the peer group portfolio's return over the 120 months of the sample period.

[14] In Section 4, we examine the theoretical issues and empirical results of using a cumulative sample period to estimate the CAPM measures of equity capital costs.

[15] See section 6.2 of the Appendix for a more complete discussion. Appendix Table C at the end of the document lists the BHCs included in the peer group portfolios for each year of our sample period.

To our knowledge, there does not exist a readily accessible and comprehensive list of publicly-traded BHC mergers from 1970 to the present. We were able to account for all BHC mergers through the 1990s and for large BHC mergers before that. We constructed our sample of mergers between publicly-traded BHCs using the work of Pilloff (1996) and Kwan and Eisenbeis (1999) as well as some additional data work.[16] Thus, the calculations presented in Table 3 do not account for every public BHC merger over the entire sample period. Further work is necessary to compile a complete list and incorporate it into the CAPM estimates. However, since the majority of large BHC mergers occurred in the 1990s, we believe that the results will not change much once the omitted mergers are accounted for.

Once the appropriate elements of the peer group portfolio for the entire ten-year period have been determined, the value-weighted portfolio returns at a monthly frequency are calculated and correspond to r_p in the CAPM equation.[17] The source for the individual stock data is CRSP; the risk-free rate is the yield on one-month Treasury bills; and the source for the monthly risk-free rate and overall equity market premium is the Fama-French series that have been widely used in the academic literature; see section 6.2 of the Appendix for further details.

As reported in the fifth column of Table 3, for the sample period of 1981 through 1998, the average estimated cost of BHC equity capital was 15.04% with a standard deviation of 1.56%. The key empirical result here is that the portfolio betas of the BHC peer group, shown in the second column of the table, rise sharply in 1991 (PSAF year 1993), remain at about 1.15 for several years and rise again in 1998. Up until 1990, we cannot reject the null hypothesis that beta is equal to one, but after then, the hypothesis is strongly rejected, as shown with the p-values of this test in third column. Although beta increased markedly over the sample, the CAPM estimates in the fifth column did not rise as much since the level of the risk-free rate, shown in the seventh column of the table, actually decreased over these years.

[16] We thank Eli Brewer for sharing his database of publicly-traded BHC mergers in the 1990s.

[17] In Section 4, we examine the theoretical issues and empirical impact of equal weighting on the CAPM estimates of equity capital costs.

Table 3. The Equity Cost of Capital Estimates Based on the CAPM Method

Data year	Portfolio beta	p-value for beta = 1	Market premium	CAPM estimate	PSAF year	One-year T-Bill*
1981	0.91	0.29	7.76	18.05	1983	8.05
1982	0.99	0.89	7.82	16.07	1984	9.22
1983	1.02	0.81	7.91	17.18	1985	8.50
1984	1.05	0.56	7.67	15.99	1986	7.09
1985	1.01	0.94	7.92	16.05	1987	5.62
1986	0.98	0.78	7.96	13.82	1988	6.62
1987	0.94	0.41	7.84	12.17	1989	8.34
1988	0.93	0.35	7.90	15.20	1990	7.24
1989	0.94	0.40	8.07	15.14	1991	6.40
1990	1.01	0.89	7.73	15.26	1992	3.92
1991	1.17	0.02	8.02	14.02	1993	3.45
1992	1.20	0.00	7.99	12.98	1994	3.46
1993	1.18	0.01	7.99	12.20	1995	6.73
1994	1.17	0.01	7.81	14.52	1996	4.91
1995	1.17	0.02	8.09	15.47	1997	5.21
1996	1.15	0.04	8.20	15.06	1998	5.22
1997	1.15	0.04	8.43	15.57	1999	4.33
1998	1.32	0.00	8.58	16.02	2000	5.63

* Note that the Treasury bill rate is aligned with the PSAF year.

3.4 The Estimates Based on the Combined Approach

Although clearly related, these three methods for calculating the BHC equity cost of capital are based on different assumptions, models, information sets and datasources. The questions of which method is "correct" or "most correct" are difficult to answer directly. We know that all models are simplifications of reality and hence misspecified; i.e., their results cannot be a perfect measure of reality. In certain cases, the accuracy of competing models can be compared with respect to observable outcomes, such as reported BHC earnings or macroeconomic announcements. However, since equity cost of capital cannot be directly observed, we cannot make clear quality judgements among our three proposed methods.

In light of this, we propose to calculate a simple measure of BHC equity cost of capital that incorporates the three measures. Since one measure may contain some information not included in the others, it might be disadvantageous to ignore any one of them. As surveyed by Granger and Newbold (1986) as well as Diebold and Lopez (1996), the practice of combining different economic forecasts is quite common in the academic and practitioner literature; it is generally seen as a relatively costless way of combining overlapping information sets on an ex-post basis. Focusing specifically on equity cost of capital, Pastor and Stambaugh (1999) use Bayesian methods to examine how to incorporate competing ROE measures and decisionmakers' prior beliefs into a single measure. Wang (2000) demonstrates that the result of decision-maker's prior beliefs over different models can be viewed as a shrinkage estimator, which is the weighted average of the estimates from the individual models; he shows that the weight in the average represents the importance or impact of the model to the result. Following this literature and in the absence of a single method that directly encompasses all three information sets, we propose to combine our three measures within a given PSAF year using a simple average; that is,

$$\text{COE}_{combined} = \tfrac{1}{3}COE_{CAE} + \tfrac{1}{3}COE_{DCF} + \tfrac{1}{3}COE_{CAPM},$$

where COE is the estimated cost of equity capital derived from the subscripted method.

Our recommendation of an equal weighting applied to the three COE measures is based on two priorities. First, we would like to maintain some continuity with current practice, and thus we want to include the CAE method in our proposed measure. Second, in light of our limited experience with the DCF and CAPM methods and of the historical variation observed among the three measures over the 18 year period of analysis summarized in Table 4, we do not have a strong opinion on which of the three measures is best suited to our purposes. Hence, we chose an equally-weighted average as the simplest possible method for combining the three measures. In Bayesian terms, we chose the uninformative prior that summarizes our prior belief on which of the measures is best suited for our purposes.

Of course, this weighting scheme is not the only one possible. For example, for several years, the New York State Public Service Commission used a weighted average of different COE measures in determining its allowed cost of equity capital for the utilities it regulates. As reported by DiValentino (1994), the Commission initially chose a similar set of three COE methods and applied equal weights to them. Recently, the Commission has been reported to have changed its weighting scheme to place a two-thirds weight on the DCF method and a one-third weigh on the CAPM method. Although our current recommendation is of equal weights across the three methods, future reviews of the PSAF framework could potentially change these weights.

As reported in Table 4, the combined measure has a mean value of 13.16% and a standard deviation of 1.32%. As expected, the averaging of the three ROE measures smooths this measure over time and creates a series with less variation than the three individual series. Individual differences between the combined and the individual measures range between ±5% over this historical period; however, the average differences are less than 2% and cannot be said to be statistically different from zero. Note also that the deviations between the DCF and CAPM measures from the one-year risk-free rate are not as large as for the CAE measure due to their greater sensitivity to general market and economic conditions. This property is obviously passed on to the combined ROE measure through the averaging.

Table 4. The Equity Cost of Capital Estimates Based on the Combined Method

Data	Estimated Cost of Equity Capital				PSAF	One-year
year	CAE	DCF	CAPM	Combined	year	T-Bill*
1981	12.69	10.52	18.05	13.75	1983	8.05
1982	12.83	9.43	16.07	12.78	1984	9.22
1983	12.89	10.89	17.18	13.65	1985	8.50
1984	11.75	14.93	15.99	14.23	1986	7.09
1985	11.85	13.48	16.05	13.80	1987	5.62
1986	11.85	13.63	13.82	13.10	1988	6.62
1987	9.49	15.38	12.17	12.35	1989	8.34
1988	10.54	14.67	15.20	13.47	1990	7.24
1989	10.11	14.24	15.14	13.16	1991	6.40
1990	7.58	14.54	15.26	12.46	1992	3.92
1991	6.11	11.82	14.02	10.65	1993	3.45
1992	8.85	11.99	12.98	11.27	1994	3.46
1993	8.43	12.47	12.21	11.04	1995	6.73
1994	10.06	13.15	14.52	12.58	1996	4.91
1995	13.00	12.24	15.47	13.57	1997	5.21
1996	15.22	12.47	15.06	14.25	1998	5.22
1997	15.95	13.78	15.57	15.10	1999	4.33
1998	15.93	15.09	16.02	15.68	2000	5.63

* Note that the Treasury bill rate is aligned with the PSAF year.

4 Some Conceptual Issues

The analysis presented in this paper is based on the assumption that the calculation of the Reserve Banks' cost of capital would be based on data regarding the largest fifty bank holding companies (BHCs) by assets, as currently done. This choice was made, and will likely continue to be made, despite the knowledge that the payments services provided by Federal Reserve Banks are only a segment of the lines of business in which these BHCs engage. Some of these lines of business (such as lending to firms in particularly volatile segments of the economy) intuitively seem riskier than the financial services that the Federal Reserve Banks provide. Moreover, there are differences among the BHCs in the mix of activities in which they engage. These observations raise three, related conceptual issues that we discuss below.

Two preliminary observations will set the stage for this discussion. First, the Monetary Control Act of 1980 (MCA) does not direct the Federal Reserve to use a specific formula, or even indicate that the Reserve Banks' cost of capital should necessarily be computed on the basis of a specific sample of firms rather than on the basis of economy-wide data. What the MCA does require the Federal Reserve to do is to answer, in some reasonable way, the counterfactual question of what the Reserve Banks' cost of capital would be if they were commercial payment intermediaries rather than government-sponsored enterprises. Second, the largest BHCs do not constitute a perfect proxy for the Reserve Banks if that question is to be answered by reference to a sample of individual firms, and indeed no perfect proxy exists. Obviously commercial banks engage in deposit taking and lending businesses (as well as a broad spectrum of other businesses that the Gramm-Leach-Bliley Act of 1999 has further widened) in addition to their payments and related correspondent-banking lines of business. Very few BHCs even report separate financial-accounting data on lines of business that are defined in ways closely comparable to the Reserve Banks' portfolios of financial-service activities. Neither do other classes of firms that do some business comparable to that of the Reserve Banks, such as data-processing firms that provide check-processing services to banks, seem to resemble the Reserve Banks more closely than BHCs do. The upshot is that, unless it were to convert to a radically different PSAF methodology, the Federal Reserve cannot avoid having to determine the Reserve Banks' counterfactual cost of capital from a sample of firms that are not perfectly appropriate to the task.

4.1 Correcting for Debt-Equity Ratio and Business-Line Activities

The first conceptual issue regarding the BHC sample is that the cost of a firm's equity capital should depend on the firm's lines of business and on its debt-equity ratio. A firm engaged in more risky activities (or, more precisely, in activities having risks with higher covariance with the overall risk in the economy) should have a higher cost of capital. There is some indirect, but perhaps suggestive, evidence that the Federal Reserve Banks' priced services may be less risky, on the whole, than some business lines of the largest BHCs. Notably, the Federal Deposit Insurance Corporation (FDIC) has a formula for a risk-weighted capital/asset ratio. According to this formula, the collective risk-weighted capital/asset ratio of the Federal Reserve Banks' priced services would currently be 30.8%.[18] This ratio is substantially above the average ratio in the BHC sample.

The Miller-Modigliani theorem implies that a firm with a higher debt-equity ratio should have a higher cost of equity capital, other things being equal, because there is risk to equity holders in the requirement to make a larger, fixed payment to holders of debt regardless of the random profit level of the firm. For the purposes of this theorem (and of the economic study of firms' capital structure in general), debt encompasses all fixed-claim liabilities on the firm that are contrasted with equity, which is the residual claim. In the case of a bank or BHC, debt thus includes deposits as well as market debt (that is, bonds and related financial instruments that can be traded on secondary markets). The current PSAF methodology sets the ratio of market debt to equity for priced services based on BHC accounting data. The broader debt/equity ratio that an imputation of equity to the Federal Reserve Banks would imply, and that seems most relevant to determining the price of equity, might not precisely equal the average ratio for the sample of BHCs. Moreover, a proposal to base the imputed amount of Federal Reserve Bank equity on bank-regulatory capital requirements rather than directly on the BHC sample average would also affect the comparison between the imputed debt/equity ratio of the Federal Reserve Banks and the average debt-equity ratio of the BHCs.

4.2 Value Weighting versus Equal Weighting

The second conceptual issue is how to weight the fifty BHCs in the peer group sample in defining their average cost of equity capital. Currently, the PSAF is calculated using an equally-weighted average of the BHCs' costs of equity capital according to the CAE method. An obvious alternative would be to take a value-weighted average; that is, to multiply each

[18] Calculation provided by Federal Reserve Board staff.

BHC's cost of equity capital by its stock market valuation, and then to divide the sum of these weighted costs by the total market valuation of the entire sample. Other alternatives, such as weighting the BHCs according to the ratio between their balances due to other banks and their total assets could conceivably be adopted.

How might one operationalize the task of calculating a counterfactually required rate of return set by the MCA? Perhaps the best way would be to imagine how an initial public offering of equity would be priced for a firm engaging in the Reserve Banks' priced service lines of business (and constrained by its corporate charter to limit the scope of its business activities as the Reserve Banks must). What the firm's investment bank ought to do is to calculate jointly the cost-minimizing debt-equity ratio for the firm and the rate of return on equity that the market would require of a firm engaged in that business and having that capital structure.[19] If the investment bank could study a sample of perfectly comparable, incumbent firms with actively traded equity (which, however, we have just concluded that the Federal Reserve cannot do), and if markets were perfectly competitive so that the required return on a dollar of equity were equated across firms, then it would not matter how data regarding the various firms would be weighted. Any weighting scheme, applied to a set of identical observations, results in an average that is also identical to the observations.

How observations are weighted becomes relevant when either (1) competitive imperfections make each firm in the peer group an imperfect indicator of the required rate of equity return in the industry sector where all of the firms operate; (2) as envisioned in the case of Reserve Banks and BHCs, each firm in the comparison sample is a "contaminated observation" because it engages in some activities outside the industry sector for which the appropriate cost of equity capital is being estimated; or (3) for reasons such as discrepancies between accounting definitions and economic concepts, cost data on the sample firms is known to be mismeasured, and the consequences of this mismeasurement can be mitigated by a particular weighting scheme.

Let us consider each of these complications separately. In considering competitive imperfections, it is useful to distinguish between imperfections that affect the implicit value of

[19] The Miller-Modigliani Theorem of financial economics states that, as a benchmark case, a firm's total cost of capital should be independent of its debt-equity ratio. In a theoretical, benchmark case, all capital structures are optimal. Departures from the benchmark case, such as disparate tax treatment of interest income, dividend income, and capital gains, typically imply the existence of a particular debt-equity ratio that minimizes the total cost of capital.

projects within a firm and those that affect the value of a firm as an enterprise. To a large extent, the value of a firm is an aggregate of the values of the various investment projects in which it engages. This is why, in general, the total value of two merged firms is not dramatically different from the sum of their values before the merger; the set of investment projects within the merged firms is just the union of the antecedent firms' sets of projects. If each investment project is implicitly priced with error, and if those errors are statistically independent and identically distributed, then the most accurate estimate of the intrinsic value of a project is the equally weighted average across projects of their market valuations. If large firms and small firms comprise essentially similar types of projects, with a large firm simply being a more numerous set of projects than a small firm, then equal weighting of projects corresponds to value weighting of firms. Thus, in this benchmark case, the investment bank ought to weight the firms in its comparison sample by value, and by implication, the Federal Reserve should weight BHCs by value in computing the cost of equity capital used in the PSAF.

However, some competitive imperfections might apply to firms rather than to projects. Until they were removed by recent legislation, restrictions on interstate branching arguably constituted such an imperfection in banking. More generally, the relative immobility of managerial talent is often regarded as a firm-level imperfection that accounts for the tendency of mergers (some of which are designed to transfer corporate control to more capable managers) to create some increase in the combined value of the merged firms. If such firm-level effects were believed to predominate in causing rates of return to differ between BHCs, then there would be a case for using equal weighting rather than value weighting to estimate most accurately the appropriate rate of return on equity in the sector as a whole. While it would be possible in principle to defend equal weighting on this basis, our impression is that weighting by value is the firmly entrenched practice in investment banking and applied financial economics, and that this situation presumably reflects a judgment that value weighting typically is conceptually the more appropriate procedure.

The second reason why equal weighting of BHCs might be considered appropriate would be that smaller BHCs were regarded more closely comparable than larger ones to Reserve Banks in their business activities. In that case, equal weighting of BHCs would be one way to achieve over-weighting relative to their values, which could be defended if they were less contaminated observations of the true cost of equity to the Reserve Banks. A concern about such a decision would be the difficulty of justifying it to the public. While some persons have a perception that payments and related correspondent-banking services are a relatively insignificant part of the business some of the largest BHCs, this perception appears not to be documentable directly by information in the public domain. In particular, as has been mentioned above, the financial reports of BHCs are seldom usable for this purpose.

It might be possible to make an indirect, but nevertheless convincing, case that the banks owned by some BHCs are more heavily involved than others in activities that are comparable to those of the Reserve Banks. For example, balances due to other banks might be regarded as a fairly accurate indicator of the magnitude of a bank's correspondent and payments business because of the use of these balances for settlement. In that case, the ratio between due-to balances and total assets would be indicative of the prominence of payments-related activities in a bank's business. Of course, if this or another statistic were to be regarded as an appropriate indicator of which BHC observations were "uncontaminated," then following that logic to its conclusion would suggest weighting the BHC data by the statistic itself rather than making an ad hoc decision to use equal weighting.

The third reason why equal weighting of BHCs might be considered appropriate would be that it mitigates some defect of the measurement procedure itself. In fact, this is a plausible explanation of why equal weighting may have been adopted for the CAE method in current use. Equal weighting minimizes the effect of extremes in financial-market performance of a few large BHCs. In particular, when large banks go through difficult periods (as happened in the early 1990s, for example), the estimated required rate of return on equity could become negative if large, poorly performing BHCs received as heavy a weight as their value before their decline would warrant. Because the CAE method is a backward-looking measure, such sensitivity to poor performance would be a serious problem. In contrast, with a forward-looking methods such as the DCF or CAPM methods, poor performance during the immediate past year would not enter the required-return computation in a way that would mechanically force the estimate of required return downward. In fact, particularly in the CAPM method, the poor performance might raise the estimate of risk (that is, market beta) and therefore raise the estimate of required return. Moreover, at least after an initial year, a BHC that had performed disastrously would have a reduced market value and would thus automatically receive less weight in a value-weighted average.

In summary, there are some grounds to use equal weighting to mitigate defective measurement in the CAE method, but those grounds do not apply with much force to the DCF and CAPM methods. If an average of several estimates of equity cost of capital were to be adopted for the PSAF, there would not be any serious problem with continuing to use equal weighting to compute a CAE estimate, where that weighting scheme does some good, while using value weighting to compute DCF and CAPM estimates if value weighting would be preferable on other grounds.

A final issue worthy of attention is the fact, evident in Table 5, that the equity cost of capital estimated via the CAPM method for some of the largest BHCs increased substantially in the early 1990s due to increases in their market betas. The table presents the betas for 1990 and 1991 as well as their differences for a sample of large BHCs sorted by the differences in beta. These increases might be due to artifacts of measurement error, and of course equal weighting would help to minimize them. However, an estimate of equity capital costs will be more credible if it is based on a weighting scheme that was chosen ex ante on grounds of conceptual appropriateness, rather than on one that was chosen with a view toward minimizing the influence of data that has already been observed. The recommendation to average several measurements of equity costs of capital is based on the idea that each method will be subject to some error, and that averaging across methods will diminish its influence. That is exactly what will happen if a value-weighted CAPM measure is averaged with two other measures that do not exhibit such marked differences between large and small BHCs.

To provide insight on the impact that equal weighting could have on the measure of equity capital costs used in the PSAF, Tables 6 through 8 present the DCF, CAPM and combined estimates under this weighting scheme. As shown in Table 6, for the DCF estimates, the differences between the two weighting schemes are not substantial; for this sample period, the mean difference is 30 basis points with a standard deviation of 50 basis points. Clearly, the individual ROE estimates generated by this model are not very sensitive to the size of the BHCs. A possible reason for this result is that equity analysts provide reasonably accurate forecasts of the cashflows from BHC investment projects, which are relatively observable and publicly reported ex-post. As previously discussed, if firm values are roughly the sum of their project values regardless of firm size, then equal weighting and value-weighting of firm ROEs should be roughly similar. This result should hold for projects in competitive product markets, which are generally the ones that contribute the most to BHC earnings and are most closely analyzed by equity analysts.

Table 5. Largest 20 Changes in Individual BHC Betas from 1990 to 1991

BHC	beta for 1990	beta for 1991	Difference
BankAmerica Corp.	0.94	1.28	0.33
Security Pacific Corp.	1.18	1.49	0.30
Shawmut National Corp.	0.84	1.09	0.25
Chase Manhattan Corp.	1.20	1.42	0.22
U.S. Bancorp	0.99	1.21	0.22
First Chicago Corp.	1.24	1.45	0.21
Wells Fargo	1.12	1.32	0.20
Fleet Financial Group	0.95	1.15	0.20
Norwest Corp.	1.11	1.30	0.19
Manufacturers Hanover Corp.	0.89	1.08	0.19
First Interstate Bancorp	1.00	1.17	0.17
NationsBank Corp.	1.19	1.37	0.17
Chemical Banking Corp.	1.02	1.19	0.17
First Bank System Inc.	1.21	1.37	0.17
Bank of New York	1.07	1.23	0.16
J.P. Morgan	0.88	1.04	0.16
Meridian Bancorp	0.67	0.83	0.16
Bank of Boston Corp.	1.19	1.34	0.16
NBD Bancorp	1.02	1.15	0.13
Bankers Trust	1.20	1.32	0.13

Table 6. Differences in the DCF Estimates due to Weighting Scheme

Data	DCF Estimates		
year	Value-weighted	Equally weighted	Difference
1981	10.52	10.39	0.13
1982	9.43	10.31	-0.88
1983	10.89	10.55	0.34
1984	14.93	14.06	0.87
1985	13.48	12.95	0.53
1986	13.63	13.49	0.14
1987	15.38	14.73	0.65
1988	14.67	13.91	0.76
1989	14.24	14.75	-0.51
1990	14.54	13.81	0.73
1991	11.82	11.58	0.24
1992	11.99	11.45	0.54
1993	12.47	12.70	-0.23
1994	13.15	13.19	-0.04
1995	12.24	12.14	0.10
1996	12.47	11.98	0.49
1997	13.78	13.26	0.52
1998	15.09	14.06	1.03

Table 7 presents the results for the two weighting schemes using the CAPM method. With respect to the market betas for the BHC peer group portfolios, the largest change occurred in 1991, when it increased from a value of roughly one to 1.17 under the value-weighting scheme. This measure of BHC risk has remained roughly at that level during the 1990s. However, the market beta under the equally weighted scheme has not deviated far from one. The increase in value-weighted beta in the latter part of the sample period is due to two, related developments in the banking industry. First, as shown in Table 5, the betas of many large BHCs increased in 1991 and have remained high over the period. Second, as shown in Table 9, the market value of the largest BHCs has increased markedly during the 1990s as a share of the market value of the BHC peer group. As of 1998, the top 25 BHCs accounted for about 90% of this market value, and the top five accounted for over 40%. The increase is due to the unprecedented merger consolidations among large BHCs in recent years.

Table 7. CAPM Estimates under the Different Weighting Schemes

Data	Portfolio beta			CAPM estimates		
year	Value-wt.	Equal wt.	Difference	Value-wt.	Equal wt.	Difference
1981	0.91	0.94	-0.03	18.05	18.25	-0.20
1982	0.99	1.00	-0.01	16.07	16.16	-0.09
1983	1.02	1.00	0.01	17.18	17.07	0.11
1984	1.05	1.02	0.03	15.99	15.75	0.24
1985	1.01	1.01	-0.01	16.05	16.12	-0.07
1986	0.98	0.97	0.01	13.82	13.74	0.08
1987	0.94	0.93	0.02	12.17	12.05	0.13
1988	0.93	0.90	0.03	15.20	14.94	0.27
1989	0.94	0.92	0.02	15.14	14.96	0.18
1990	1.01	0.98	0.03	15.26	15.02	0.24
1991	1.17	1.03	0.14	14.02	12.93	1.09
1992	1.20	1.04	0.16	12.98	11.73	1.24
1993	1.18	1.00	0.17	12.20	10.81	1.40
1994	1.17	1.00	0.17	14.52	13.20	1.32
1995	1.17	0.99	0.17	15.47	14.08	1.39
1996	1.15	0.98	0.17	15.06	13.67	1.38
1997	1.15	0.99	0.16	15.57	14.24	1.33
1998	1.32	1.09	0.23	16.02	14.01	2.01

The impact of these developments on the estimates arising from the CAPM method was similar. As shown in Table 7, starting in 1991, the differences between the equity cost of capital estimates based on value-weighted and equally weighted averages have been greater than one percentage point. As shown in Table 8, the impact on the combined measure was less than for the CAPM measure due to the averaging across the methods. However, the differences between the value-weighted and equally weighted measures are still noticeable in the latter half of the 1990s.

In conclusion, the use of equally weighted averages in estimating the cost of equity capital under the DCF and CAPM methods provides reasonable empirical results with some theoretically appealing properties. However, we continue to recommend the use of value-weighted averages since they more closely match current academic and industry practice.

Table 8. Differences in Combined Estimates due to Weighting Scheme

PSAF	Data	Combined estimates		
year	year	Value-weight.	Equal weight.	Difference
1983	1981	13.75	13.78	-0.02
1984	1982	12.78	13.10	-0.32
1985	1983	13.65	13.50	0.15
1986	1984	14.23	13.86	0.37
1987	1985	13.80	13.64	0.15
1988	1986	13.10	13.03	0.07
1989	1987	12.35	12.09	0.26
1990	1988	13.47	13.13	0.34
1991	1989	13.16	13.27	-0.11
1992	1990	12.46	12.14	0.32
1993	1991	10.65	10.21	0.44
1994	1992	11.27	10.68	0.59
1995	1993	11.04	10.65	0.39
1996	1994	12.58	12.15	0.42
1997	1995	13.57	13.07	0.50
1998	1996	14.25	13.63	0.62
1999	1997	15.10	14.49	0.62
2000	1998	15.68	14.66	1.02

Table 9. Percentage Share of the Market Value of the Top 50 BHCs

Data	Percentage Share of Market Value		
year	Top 5 BHCs	Top 10 BHCs	Top 25 BHCs
1981	29	46	70
1982	32	45	67
1983	23	35	59
1984	23	35	57
1985	22	33	55
1986	17	26	47
1987	18	28	50
1988	17	28	49
1989	19	30	53
1990	22	34	58
1991	20	32	56
1992	22	34	58
1993	22	35	61
1994	22	35	61
1995	23	37	65
1996	29	46	75
1997	29	46	76
1998	42	63	88

4.3 Rolling versus Cumulative Beta

A crucial element of the CAPM method is the estimation of a portfolio's market beta. In the academic literature, there are many issues related to this estimation, but the one most important here is the choice between estimating beta using all available years of data or a shorter period of recent data. The first is referred to as a *cumulative beta*, and the second is referred to as a *rolling beta*. In the proposed CAPM method, we estimated a rolling beta based on the past ten years of monthly data, following common industry practice. In this section, we discuss the relative advantages and disadvantages of cumulative and rolling betas.

The main rationale for the use of rolling beta is to capture the time variation of the systematic risk common across firms. There is a large body of academic literature that demonstrates the time-varying nature of this risk. A rolling beta helps to account for this by ignoring data observed more than a certain number of years ago; that is, earlier data are viewed as irrelevant to the estimation of the current beta. However, this modeling method has a basic conceptual difficulty. If we assume that the past ten years of data give an unbiased estimate of the current beta, we are assuming that the current beta was the same during that ten year period. If we do this every year, we implicitly fall into the assumption of a constant beta across all years; in which case, we should use a cumulative beta. To escape this difficulty, we can assume that the systematic risk is changing slowly over time. Under this assumption, both a rolling beta and a cumulative beta are biased, but a rolling beta should have a smaller bias than a cumulative beta.

However, the time variation observed in the rolling beta is not equivalent to the time variation of true systematic risk. The time variation of the rolling beta consists of both the variation due to the changes in the systematic risk, which is what we want to measure, and the variation due to small sample estimation noise, which we want to avoid. We obviously face a trade-off here. Adding more past data in the estimation of rolling beta reduces the estimation noise but also reduces the total variation of the rolling beta, obscuring the variation of the systematic risk that can be captured. Therefore, the time variation of the rolling beta reported in Table 3 cannot simply be viewed as the variation of the systematic risk of BHCs. It is the variation of the average systematic risk during a 10-year period compounded with estimation noise. The actual variation of the true systematic risk in a given year can be larger or smaller than the variation observed in the rolling betas.

Although it is difficult to determine the portion of the time variation of the rolling beta due to changes in the systematic risk, the cyclic behavior of the rolling betas reported in Table 3 suggests there were fundamental changes in BHC risk. The rolling betas were relatively low in the early 1980s and increased during mid-1980s. It was practically one in 1990, but then sharply rose as previously discussed. After staying between 1.15 and 1.20 during 1993–1999, it jumped to 1.32 in 1998.

Why might BHC risk have changed over these years? For the PSAF, it is especially important to understand if these changes were due to changes in the nature of the payments services and traditional banking businesses or due to other non-traditional banking businesses. If the time variation of risk did not arise from the payments services and traditional banking, we would most likely want to avoid incorporating it into the PSAF calculation.

A view that is probably widely held, yet not necessarily unanimous, is that a secular trend of increasing market beta reflects gravitation of BHCs, and particularly of some of the very largest BHCs, toward lines of business that are more risky than traditional banking. If this were so—particularly the asymmetry between the very largest BHCs and the others—then an equal-weighted, rolling-beta estimate of market beta ought to exhibit smaller time variation than the analogous, value-weighted estimate. Table 7 corroborates this conjecture. It thus provides some, albeit far from conclusive, inductive support for the view that secularly increasing beta does not primarily reflect conditions in the payments business.

If this is the case, the varying BHC risk captured by the rolling beta may not be appropriate for the PSAF since we want to measure the risk in BHCs' payments businesses. Evidence from the equal-weighting scheme suggests that the beta of the traditional banking business might be constant. If so, a constant beta would be more accurately estimated with a longer historical period, rather than a series of short ones. Thus, the cumulative beta could minimize the estimation noise and better reveal the risk of the traditional banking business. Table 10 shows the CAPM results using both the rolling and cumulative estimation periods using the value-weighting scheme. As can be seen, the cumulative beta stays very close to one with a mean of 1.00 and a standard deviation of 0.03. It exhibits little variation over time because of the long historical samples used in the estimation. The impact on the estimates of the equity cost of capital are clear; the estimates based on the cumulative beta remain more than one percentage point lower than those based on the rolling beta during the 1990s. A similar impact is seen in Table 11 for the combined estimates.

Table 10. Differences in Value-Weighted CAPM Estimates due to Estimation Period

Data	Portfolio beta			CAPM estimates		
year	Rolling	Cumulative	Difference	Rolling	Cumulative	Difference
1981	0.91	0.92	0.00	18.05	18.06	-0.01
1982	0.99	0.96	0.03	16.07	15.84	0.23
1983	1.02	0.97	0.05	17.18	16.79	0.38
1984	1.05	0.98	0.06	15.99	15.50	0.49
1985	1.01	1.00	0.01	16.05	15.99	0.07
1986	0.98	1.00	-0.03	13.82	14.04	-0.22
1987	0.94	0.99	-0.05	12.17	12.54	-0.37
1988	0.93	0.98	-0.05	15.20	15.58	-0.38
1989	0.94	0.99	-0.05	15.14	15.53	-0.39
1990	1.01	1.03	-0.02	15.26	15.39	-0.13
1991	1.17	1.04	0.13	14.02	13.01	1.01
1992	1.20	1.04	0.16	12.98	11.69	1.29
1993	1.18	1.03	0.15	12.20	11.01	1.20
1994	1.17	1.03	0.14	14.52	13.44	1.08
1995	1.17	1.02	0.15	15.47	14.29	1.18
1996	1.15	1.02	0.13	15.06	14.00	1.06
1997	1.15	1.02	0.12	15.57	14.54	1.04
1998	1.32	1.04	0.28	16.02	13.61	2.41

Table 11. Differences in Value-Weighted Combined Estimates due to Estimation Period

PSAF	Data	Combined estimates		
year	year	Rolling sample	Cumulative sample	Difference
1983	1981	13.75	13.71	0.04
1984	1982	12.78	12.99	-0.22
1985	1983	13.65	13.41	0.24
1986	1984	14.23	13.77	0.45
1987	1985	13.80	13.60	0.20
1988	1986	13.10	13.13	-0.03
1989	1987	12.35	12.26	0.09
1990	1988	13.47	13.35	0.13
1991	1989	13.16	13.46	-0.30
1992	1990	12.46	12.26	0.20
1993	1991	10.65	10.23	0.42
1994	1992	11.27	10.66	0.61
1995	1993	11.04	10.71	0.32
1996	1994	12.58	12.23	0.35
1997	1995	13.57	13.14	0.43
1998	1996	14.25	13.73	0.52
1999	1997	15.10	14.58	0.52
2000	1998	15.68	14.53	1.15

In conclusion, the use of cumulative betas in estimating the equity cost of capital under the CAPM method provides reasonable empirical results with some theoretically appealing properties. However, we continue to recommend the use of rolling betas since they more closely match current academic and industry practice.

5 Conclusion

In this paper, we review the theory and practice of asset pricing models for the cost of equity capital and propose a new approach for estimating the Federal Reserve Banks' cost of equity capital used in the Private Sector Adjustment Factor (PSAF). The proposed approach is based on a simple average of three methods as applied to a peer group of bank holding companies. The three methods estimate the cost of equity capital from three different perspectives – a historical average of comparable accounting earnings, the discounted value of expected future cashflows, and the equilibrium price of investment risk as per the capital asset pricing model. We show that the proposed approach would have provided stable and sensible estimates of the cost of equity capital for the PSAF over the past 18 years.

In addition, we discuss important conceptual issues regarding the construction of the peer group of bank holding companies needed for this exercise. Specifically, we examine the questions of whether to use value-weighted or equally weighted averages in our calculations and whether to use rolling or cumulative sample periods with which to estimate the capital asset pricing model. Although these alternative approaches provide reasonable empirical results with some theoretically appealing properties, we believe that our proposed approach should be adopted since it more closely matches industry practice as well as the academic literature.

6 Appendix

6.1 Implementing the DCF Method

The discounted cashflow (DCF) model of stock prices, also known as the Gordon growth model, assumes that the price of a firm's stock is equal to the present discounted value of all expected future dividends. If the price and expected future dividends are known, the common discount rate, which is the firm's equity cost of capital, can be calculated. If the expected future dividends D_t for T quarters are known, and thereafter the dividend is assumed to perpetually grow at a rate g, the price P_0 of the stock can be expressed as

$$P_0 = \frac{D_1}{1+r} + \frac{D_2}{(1+r)^2} + ... + \frac{D_{T-1}}{(1+r)^{(T-1)}} + \frac{D_T}{(r-g)(1+r)^{(T-1)}}, \quad (1)$$

where r is the discount factor and the firm's cost of equity capital. To implement this model for a given PSAF year, we calculate the discount factor for each BHC in the peer group using year-end stock prices from CRSP and consensus earnings per share (EPS) forecasts for the calendar year two years prior.[20] The firms' EPS forecasts are transformed into the necessary dividend forecasts by multiplying them with the firms' dividend payout ratios.

Our source for the consensus EPS forecasts is I/B/E/S, a firm that collects and summarizes individual equity analysts' forecasts. The equity analyst EPS forecasts for a firm are included in the I/B/E/S database when two conditions are met. First, at least one analyst is producing forecasts on the firm, and second, sufficient ancillary data, such as actual dividends, are publicly available. The consensus forecasts are formed by taking a simple average across all reported analyst forecasts. In addition to I/B/E/S, other such data providers are Thomson/First Call, Zacks and Value Line. We chose to use the I/B/E/S forecasts because they have available a long historical record and have been widely used in the academic literature. I/B/E/S was kind enough to provides us the historical data needed for our study.

For a given PSAF year, we calculate the discount factor for each BHC in the peer group. In every case, we use the last available stock price for the corresponding data year and the last reported set of consensus EPS forecasts (i.e., the forecast set) in that year. We then average these discount rates across the peer group for each year, using either value-weighted

[20] Recall that the PSAF calculations for year y are carried out in calendar year $y-1$ with the data available at the end of calendar year $y-2$.

or equal-weighted schemes.

The forecast set we use in a given data year for a given BHC consists of all the consensus forecasts published in the last month for which data is available. Typically, the last month is December, but it may be an earlier month. Each EPS forecast in the forecast set is for a future fiscal quarter (forecast quarter) or future fiscal year (forecast year); typically, a forecast set includes up to four forecast quarters and five forecast years as well as a long-term EPS growth rate estimate. In order to transform the EPS forecasts into the necessary dividend forecasts, they are multiplied by the BHC's dividend payout ratio for the last quarter available, which is assumed to be constant over time.

Since dividends are typically paid on a quarterly basis and since a maximum of four quarterly forecasts are available, we need to interpolate quarterly EPS forecasts from the annual ones. The procedure we employ is explained below. While there are variations on the procedure depending on what EPS forecasts are available, there are two assumptions that apply in every case. First, we assume that the sum of the quarterly forecasts in a given forecast year equals the annual forecast. Second, we assume that quarterly EPS is a linear function of time. While the general upward trend usually observed in EPS may not be linear, it is plausible and the simplest to implement. These conditions obviously make the interpolation of the annual EPS forecasts beyond the first forecast year into quarterly EPS forecasts straightforward; that is, $Q_1 = A/10; Q_2 = 2Q_1; Q_3 = 3Q_1;$and $Q_4 = 4Q_1$, where A is the annual EPS forecast.

At times, such interpolation is necessary in the first forecast year. In a few cases, the forecast set includes an EPS forecast for some, but not all, forecast quarters in the first forecast year. Given an annual EPS forecast A and n quarterly EPS estimates Q_i (with $n < 4$) for the first forecast year, the interpolated EPS forecast for forecast quarter $n + 1$ is set as

$$Q_{n+1} = Q_n + S_n, \tag{2}$$

where

$$S_n = \frac{A - \sum_{i=1}^{n} Q_i + (4 - n)Q_n}{\sum_{i=0}^{4-n}(4 - n - i)}. \tag{3}$$

The interpolated forecast for Q_{n+2} and later forecast quarters within the first forecast year are simply calculated by adding S_n to the forecast for the previous forecast quarter.

For cases in which there are no quarterly EPS forecasts for the first forecast year, we make use of the EPS forecast for the fourth quarter of prior year (denoted Q_{4b}), regardless of whether it is actual or interpolated. The interpolated EPS forecast for the first quarter of the first forecast year is

$$Q_1 = Q_{4b} + S_{4b}, \tag{4}$$

where

$$S_{4b} = \frac{A - 4Q_{4b}}{10} \tag{5}$$

and A is the annual EPS forecast for the first forecast year. All subsequent quarterly forecasts are estimated by adding S_n to the previous forecast quarter.

On occasion, only annual forecasts are available. In these cases, we estimate the first forecast quarter's EPS as

$$Q_1 = \frac{A_1 - 6S_0}{4}, \tag{6}$$

where

$$S_0 = \frac{A_1 - A_0}{4}, \tag{7}$$

A_0 is the annual EPS forecast for the data year, and A_1 is the annual EPS forecast for the first forecast year (i.e., one year later than the data year). This formula assumes that quarterly EPS is a linear function of time with the slope implied by the change in annual EPS from the data year to the first forecast year.

Once all of the available EPS forecasts are converted to a quarterly frequency, we transform them into dividend forecasts using the BHC's dividend payout ratio for the last historical quarter. We assume this ratio is constant. The final element needed to solve for the BHC's discount rate is the dividend growth rate at a quarterly frequency, denoted g. I/B/E/S provides consensus forecasts of g, when they are available. However, when such forecasts are not available, we then exclude the BHC from the sample. Although a dividend growth rate could be imputed using additional accounting data, we simplify the procedure by limiting ourselves to the data provided in the I/B/E/S database. As shown in the third column of Appendix Table 1, this condition does not exclude many BHCs from our calculations. The most important factor in limiting our BHC peer group calculations for a given year is the number of BHCs without any analyst forecasts, which is most severe in the early 1980s and not much of a factor by the late 1990s; the second column of Appendix Table 2 shows the number of BHCs actually available for use in the DCF calculations for a given year. Appendix Table B at the end of the document contains a complete list of all the BHCs in the peer groups for each year of our sample period.

Appendix Table 1. Characteristics of the DCF Sample for Each Data Year

Data year	# BHCs in sample	# BHCs w/o g forecast	Avg. forecast horizon (months)	Std. error of BHC discount factors
1981	26	2	24.0	2.6%
1982	24	3	24.0	2.2%
1983	27	3	24.0	1.3%
1984	26	1	24.0	3.3%
1985	31	0	25.5	2.3%
1986	34	0	26.3	2.0%
1987	37	0	25.3	3.3%
1988	44	1	26.1	2.6%
1989	44	1	30.1	5.4%
1990	45	1	29.9	5.5%
1991	46	7	22.5	3.8%
1992	45	10	12.7	2.3%
1993	48	10	9.6	4.9%
1994	48	7	13.7	2.4%
1995	48	1	21.2	2.1%
1996	45	0	34.2	2.2%
1997	44	1	30.8	2.2%
1998	43	6	31.0	2.0%

Once the data is in place, we numerically solve for r for each BHC. The average of r across all BHCs in the peer group in a given data year, using either a value-weighted or equally-weighted averaging scheme, is the estimated BHC cost of equity capital for the data year. We use the market capitalization as of the last trading day of the data year. Appendix Table 1 presents a proxy for the standard error of the DCF estimate, which is the standard deviation of r across companies. Note that the yearly standard deviations are roughly 2% with some higher values that push the overall sample average to about 3%.

6.2 Implementing the CAPM Method

All arbitrage pricing models assume that the cost of equity capital for a portfolio of stocks is equal to the risk-free rate plus a risk premium to compensate for the risk associated with holding the portfolio. Since Treasury yields provide ready measures of the risk-free rate, the only controversial aspect of estimating the equity cost of capital is estimating this risk premium.

The CAPM provides the simplest method for estimating this premium. The model assumes that the risk premium for any particular equity portfolio is directly proportional to the risk premium of the entire stock market; that is,

$$r - r_f = \beta(r_m - r_f), \tag{8}$$

where r is the required rate of return on the portfolio in question, r_f is the risk-free rate, and r_m is the rate of return of the entire stock market. The market beta β is typically estimated using the least squares regression

$$r - r_f = \alpha + \beta(r_m - r_f) + \epsilon, \tag{9}$$

where α is a constant term and ϵ is a random error term. In the paper, we use two types of sample periods to estimate the model. For the rolling beta case, we use a rolling ten-year period; that is, for a given PSAF year x, the stock return data used to estimate the peer group market beta is a ten-year period starting with calendar year x-11 and ending with calendar year x-2. The choice of a ten-year period provides a reasonable trade-off between accurate estimation of time-varying betas and computational convenience; see MacKinley and Pastor (2000). Since we chose a monthly frequency, we use 120 observations to estimate the market beta for a given PSAF year. For the cumulative beta case, we use all of the data available starting with January 1972, the first month of the first year of 1981's ten-year sample period, and ending with the last month of the calendar year in question.

For our implementation of the CAPM method, we use the r_m series used by Fama and French (FF, 1992), which they estimate by calculating the monthly total return (including dividends) of all stocks traded on the AMEX, NYSE, and NASDAQ exchanges, weighted by market capitalization. This series is publicly available at the website http://web.mit.edu/kfrench/www/data_library.html. For the r_f series, we also use the appropriate FF series, which they calculate as the monthly total return on one-month Treasury bills. Finally, in order to obtain a time series for r, we need to construct the portfolio returns on the BHC peer group for a given PSAF year.

The BHC peer group for a given PSAF year is the top fifty BHCs ranked by asset size for the calendar year two years prior; that is, for PSAF year x, the BHC peer group is the top fifty BHCs in calendar year x-2. However, an important data issue is how to handle BHC mergers in our study. This issue is important in light of the large degree of BHC consolidation that occurred in the 1990s. Our guiding principle was to include all of the BHC assets present in the BHC peer group portfolio at the end of the sample period in our analysis throughout the entire period. In effect, mergers require us to analyze more than a given PSAF year's BHC peer group in the earlier years of the ten-year sample period. For example, the merger between Chase and J.P. Morgan in 2000 will require us to include both stocks in our peer group portfolio for PSAF year 2002, even though one BHC will cease to exist; we must do so over the entire 1991-2000 data window. See Appendix Table C at the end of the document for a complete list of the publicly-traded BHCs used in this study and every data year for which they are included in the BHC peer group. Clearly, this practice will change the number of firms in the portfolio and the market capitalization weights used to determine the peer group portfolio's return over the 120 months of the sample period.

To our knowledge, there does not exist a readily accessible and comprehensive list of publicly-traded BHC mergers from 1970 to the present. We were able to account for all BHC mergers through the 1990s and for large BHC mergers before that. We constructed our sample of mergers between publicly-traded BHCs using the work of Pilloff (1996) and Kwan and Eisenbeis (1999) as well as some additional data work.[21] Further work is necessary to compile a complete list and incorporate it into the CAPM estimates. However, since the majority of large BHC mergers occurred in the 1990s, we believe that the results will not change much once the omitted mergers are accounted for.

Once the appropriate elements of the peer group portfolio for the entire ten-year period have been determined, the appropriately weighted portfolio returns at a monthly frequency are calculated and correspond to r_p in the CAPM equation. The source for the individual stock data is CRSP.

Since we must estimate the cost of equity capital for each data year between 1981 and 1999, we run 18 separate regressions and estimate 18 portfolio betas. After estimating our betas, we then construct the CAPM estimate of equity capital costs for each year according to the standard equation. The market premium $r_m - r_f$ is constructed as the average of this time series from July 1927, the first month for which equity index data is widely available,

[21] We thank Eli Brewer for sharing his database of publicly-traded BHC mergers in the 1990s.

to the December of the data year. We multiply this average by the estimated beta and add the yield on the one-year Treasury bill yield as of the first trading of that year.

Since the CAPM estimates are derived from a statistical model, we can generate corresponding standard errors for them. The variance of the CAPM estimate from the true but unknown value can be expressed as

$$E[(\hat{r} - r)^2] = E[(\hat{\beta}\hat{f} - \beta f)^2], \tag{10}$$

where r is our portfolio's monthly risk premium $r - r_f$, $f = r_m - r_f$, and $\hat{\beta}$, $\hat{r}$ and $\hat{f}$ are our estimates of β, r and f, respectively. Using a Taylor expansion of $r = \beta f$, we can approximate the above equation as

$$E[(\hat{r} - r)^2] = E[\beta^2(\hat{f} - f)^2 + f^2(\hat{\beta} - \beta)] \tag{11}$$

or, equivalently,

$$Var(\hat{r}) = \beta^2 Var(\hat{f}) + f^2 Var(\hat{\beta}), \tag{12}$$

where $Var(\hat{\beta})$ is the variance of our beta estimate and $Var(\hat{f})$ is the variance of the mean of f. These two variances can be easily estimated from the available data, and $Var(\hat{r})$ can be solved for directly. Thus, an estimate of the standard error of our CAPM estimate $\hat{r}$ is simply the square root of $Var(\hat{r})$.

6.3 Preliminary Analysis of Multi-Beta Models

As discussed in Section 2, a number of multi-beta models have been proposed for estimating the equity capital costs needed for the PSAF. Although our recommendation is that such models not be used in the PSAF, we present here some preliminary results based on the Fama and French (FF, 1992) model. These results indicate that any additional accuracy provided by such models is clearly outweighed by the additional difficulties in specifying and estimating them.

In this section, we present an estimate of the BHC portfolio risk premium using a multi-factor arbitrage pricing model. This model includes the excess market return $r_m - r_f$, as well as four other factors used in the FF model: SMB, which is the spread between the return on stocks with low book-to-market ratios and companies with high ratios; HML, which is the spread between the return on stocks with low market capitalization and stocks with high capitalization; TERM, which is the spread between long and short term Treasury debt securities; and DEF, which is the spread between long term corporate and long term Treasury bonds. The model is

$$r - r_f = \beta_1(r_m - r_f) + \beta_2\text{SMB} + \beta_3\text{HML} + \beta_4\text{TERM} + \beta_5\text{DEF}. \tag{13}$$

As before, we estimate the model using a least squares regression

$$r - r_f = \alpha + \beta_1(r_m - r_f) + \beta_2\text{SMB} + \beta_3\text{HML} + \beta_4\text{TERM} + \beta_5\text{DEF} + \epsilon. \tag{14}$$

We use the same series for $r - r_f$ in this regression as before. We use the FF series for SMB and HML, which are available on the above-cited website. We obtain TERM and DEF from the 1999 Ibottson Associates year book. As before, we run a separate regression for each of the data years.

As before, we estimate the means of each of our factors by taking their averages from July 1927 to December of the data year. These averages are then substituted into equation (13) to obtain an estimate of the risk premium. The results of our regressions for data years 1988 through 1998, and the estimates for the risk premiums and their standard errors, appear in Appendix Table 2. The list of BHCs used in these peer group portfolios are listed in Appendix Table 3. Each column labeled by a regression variable name contains the corresponding coefficient estimates with their t statistics directly below in italics and parentheses.

These results are strong, but not as good as those of the CAPM. The α is significant for data year 1990 and is close to significant for data years 1993, 1991, and 1994, contrary to what theory would predict. The fact that SMB is insignificant for all years is also problematic. These results suggest that the multi-factor model is over-specified in this context, and therefore we believe the CAPM method better serves our purposes.

Appendix Table 2. Regression Results for Multi-Beta Model based on the BHC Peer Group Portfolios

Data Year	$r - r_f$	σ	α	$r_m - r_f$	HML	SMB	TERM	DEF
1988	9.95	3.04	-0.43	0.98	0.42	0.05	0.43	0.56
			(1.47)	*(13.09)*	*(3.71)*	*(0.41)*	*(4.51)*	*(2.11)*
1989	10.26	3.03	-0.46	0.99	0.44	0.07	0.42	0.55
			(1.63)	*(13.70)*	*(3.88)*	*(0.59)*	*(4.48)*	*(2.08)*
1990	10.33	3.13	-0.58	1.04	0.45	0.11	0.41	0.49
			(2.07)	*(14.06)*	*(3.88)*	*(0.98)*	*(4.19)*	*(1.78)*
1991	10.76	3.14	-0.45	1.06	0.44	0.11	0.41	0.47
			(1.64)	*(14.88)*	*(3.85)*	*(1.03)*	*(4.22)*	*(1.73)*
1992	10.92	3.10	-0.41	1.06	0.45	0.13	0.40	0.47
			(1.56)	*(15.30)*	*(4.26)*	*(1.21)*	*(4.25)*	*(1.74)*
1993	10.98	3.03	-0.43	1.05	0.45	0.11	0.39	0.50
			(1.71)	*(15.61)*	*(4.53)*	*(1.11)*	*(4.27)*	*(1.92)*
1994	10.64	2.98	-0.38	1.05	0.45	0.08	0.38	0.51
			(1.61)	*(16.15)*	*(4.66)*	*(0.84)*	*(4.19)*	*(1.99)*
1995	10.67	2.87	-0.30	1.04	0.43	0.05	0.38	0.46
			(1.34)	*(16.43)*	*(4.64)*	*(0.52)*	*(4.4)*	*(1.87)*
1996	10.75	2.84	-0.23	1.05	0.44	0.03	0.37	0.47
			(1.05)	*(16.94)*	*(4.82)*	*(0.28)*	*(4.35)*	*(1.93)*
1997	11.15	2.85	-0.21	1.07	0.45	-0.02	0.37	0.46
			(0.98)	*(17.65)*	*(5.05)*	*(0.18)*	*(4.37)*	*(1.88)*
1998	11.10	2.82	-0.23	1.09	0.41	-0.04	0.33	0.58
			(1.07)	*(18.61)*	*(4.67)*	*(0.44)*	*(3.96)*	*(2.43)*

Appendix Table 3. BHCs in the Peer Group Portfolios for the Multi-Beta Models

List of Banks Used in Implementing the Multi-Beta Model

BankName*	Cusip	Data Years Used
AMSOUTH BANCORPORATION	03216510	93,94,95,96,97,98,99
B B & T CORP	05493710	95,96,97,98,99
BANK NEW ENGLAND CORP	06384010	88,89,90
BANK NEW YORK INC	06405710	88,89,90,91,92,93,94,95,96,97,98,99
BANK OF AMERICA CORP	06050510	88,89,90,91,92,93,94,95,96,97
BANK ONE CORP	06423A10	88,89,90,91,92,93,94,95,96,97,98,99
BANK WEST FINANCIAL CORP	06563110	98,99
BANKAMERICA CORP	06605010	88,89,90,91,92,93,94,95,96,97,98,99
BANKBOSTON CORP	06605R10	88,89,90,91,92,93,94,95,96,97,98,99
BANKERS TRUST CORP	06636510	88,89,90,91,92,93,94,95,96,97,98,99
BARNETT BANKS INC	06805510	88,89,90,91,92,93,94,95,96,97
BAYBANKS INC	07272310	95
BOATMENS BANCSHARES INC	09665010	88,89,90,91,92,93,94,95
CENTRAL FIDELITY BANKS INC	15346910	95
CHASE MANHATTAN CORP	16161010	88,89,90,91,92,93,94
CHASE MANHATTAN CORP NEW	16161A10	88,89,90,91,92,93,94,95,96,97,98,99
CITICORP	17303410	88,89,90,91,92,93,94,95,96,97,98,99
CITIGROUP INC	17296710	98,99
CITIZENS & SOUTHERN CORP	17312410	88,89
COMERICA INC	20034010	88,89,90,91,92,93,94,95,96,97,98,99
COMPASS BANCSHARES INC	20449H10	96,98,99
CONTINENTAL BANK CORP	21111310	91,92,93
CORESTATES FINANCIAL CORP	21869510	88,89,90,91,92,93,94,95,96,97
CRESTAR FINANCIAL CORP	22609110	90,91,92,93,94,95,96,97
FIFTH THIRD BANCORP	31677310	93,94,95,96,97,98,99
FIRST CHICAGO CORP	31945510	88,89,90,91,92,93,94,95,96,97
FIRST CHICAGO N B D CORP	31945A10	88,89,90,91,92,93,94
FIRST CITY BANCORPORATION	31959310	88,89,90
FIRST FIDELITY BANCORP	32019510	88,89,90,91,92,93,94
FIRST INTERSTATE BANCORP	32054810	88,89,90,91,92,93,94
FIRST OF AMERICA BANK CORP	31890610	88,89,90,91,92,93,94,95,96,97,98,99
FIRST SECURITY FED FINANCIAL	33639210	96,97,98,99
FIRST TENNESSEE NATIONAL CORP	33716210	96,98,99
FIRST UNION CORP	33735810	88,89,90,91,92,93,94,95,96,97,98,99
FIRSTAR CORP NEW	33763V10	91,92,93,94,95,96,97,98,99
FLEETBOSTON FINANCIAL CORP	33903010	88,89,90,91,92,93,94,95,96,97,98,99
H S B C HOLDINGS PLC	40428040	99
HUNTINGTON BANCSHARES INC	44615010	88,89,90,91,92,93,94,95,96,97,98,99
INTEGRA FINANCIAL CORP	45810410	93,94
KEYCORP NEW	49326710	88,89,90,91,92,93,94,95,96,97,98,99
M & T BANK CORP	55261F10	96,97,98,99
M B N A CORP	55262L10	95,96,97,98,99
M N C FINANCIAL INC	55310710	88,89,90,91,92
MANUFACTURERS HANOVER CORP	56480910	88,89,90
MANUFACTURERS NATIONAL CORP	56500410	90,91
MARSHALL & ILSLEY CORP	57183410	95,96,97,98,99
MELLON FINANCIAL CORP	58551A10	88,89,90,91,92,93,94,95,96,97,98,99
MERCANTILE BANCORPORATION INC	58734210	95,96,97,98,99
MERIDIAN BANCORP INC	58958010	88,89,90,91,92,93,94
MIDLANTIC CORP	59780E10	88,89,90,91,92,93,94
MORGAN J P & CO INC	61688010	88,89,90,91,92,93,94,95,96,97,98,99
NATIONAL CITY CORP	63540510	88,89,90,91,92,93,94,95,96,97,98,99
NATIONAL WESTMINSTER BANK PLC	63853940	88,89,90,91,92,93,94
NORTHERN TRUST CORP	66585910	91,92,93,94,95,96,97,98,99
OLD KENT FINANCIAL CORP	67983310	95,96,98,99
P N C BANK CORP	69347510	88,89,90,91,92,93,94,95,96,97,98,99
PACIFIC CENTURY FINANCIAL CORP	69405810	91,92,93,95,96,97,98,99
POPULAR INC	73317410	97,98,99
REGIONS FINANCIAL CORP	75894010	94,95,96,97,98,99

*Bank name as of the last trading day of the last data year used.

BankName(Cont'd)*	Cusip(Cont'd)	Data Years Used(Cont'd)
REPUBLIC NEW YORK CORP	76071910	88,89,90,91,92,93,94,95,96,97,98,99
SECURITY PACIFIC CORP	81482310	88,89,90,91
SHAWMUT NATIONAL CORP	82048410	88,89,90,91,92,93,94
SIGNET BANKING CORP	82668110	88,89,92,94,95
SOCIETY CORP	83366330	90,91,92,93
SOUTHEAST BANKING CORP	84133810	88,89,90
SOUTHTRUST CORP	84473010	92,93,94,95,96,97,98,99
SOVRAN FINANCIAL CORP	84610410	88,89,90
STATE STREET CORP	85747710	91,92,93,94,95,96,97,98,99
SUMMIT BANCORP	86600510	91,92,93,94,95,96,97,98,99
SUNTRUST BANKS INC	86791410	88,89,90,91,92,93,94,95,96,97,98,99
U S BANCORP DEL	90297310	88,89,90,91,92,93,94,95,96
UNION PLANTERS CORP	90806810	96,97,98,99
UNIONBANCAL CORP	90890610	95,96,97,98,99
UNITED STATES BANCORP	91159610	88,89,90,91,92,93,94,95,96,97,98,99
WACHOVIA CORP NEW	92977110	88,89,90,91,92,93,94,95,96,97,98,99
WELLS FARGO & CO	94974010	88,89,90,91,92,93,94,95,96,97,98,99
WELLS FARGO & CO NEW	94974610	88,89,90,91,92,93,94,95,96,97
ZIONS BANCORP	98970110	98,99

*Bank name as of the last trading day of the last data year used.

References

A. Antoniou, I. Garrett and R. Priestley (1998): "Calculating the equity cost of capital using the APT: the impact of the ERM." *Journal of International Money and Finance*, 14, 949–965.

F. Black, M. Jensen and M. Scholes (1972): "The capital asset pricing model: Some empirical tests." *Studies in the Theory of Capital Markets*, ed. by M. Jensen. Praeger, New York.

F. Black (1972): "Capital market equilibrium with restricted borrowing." *Journal of Business*, 45, 444–454.

F. Black (1993): "Beta and return." *Journal of Portfolio Management*, 20, 8–18.

Z. Bodie, A. Kane and A. Marcus (1999): *Investments*, 4th edition, Irwin McGraw-Hill.

T. Bollerslev, R. Engle and J. Wooldridge (1988) "A capital asset pricing model with time varying covariances." *Journal of Political Economy*, 96, 116–131.

D. Bower, R. Bower and D. Logue (1984): "Arbitrage pricing and utility stock returns." *Journal of Finance*, 39, 1041–1054.

R. Bower and G. Schink (1994): "Application of the Fama-French model to utility stocks." *Financial Markets, Institutions and Instruments*, 3, 74–96.

R. Brealey and S. Myers (1996): *Principles of Corporate Finance*, McGraw-Hill.

N. Chen, R. Roll and S. Ross (1986): "Economic forces and the stock market." *Journal of Business*, 59, 383–403.

G. Connor and R. Korajczyk (1986): "Performance measurement with the Arbitrage Pricing Theory: A new framework for analysis." *Journal of Financial Economics*, 15, 373–394.

W. De Bondt and R. Thaler (1990): "Do security analysts overreact?" *American Economic Review*, 30, 52-57.

F. X. Diebold and J. A. Lopez (1996): "Forecast Evaluation and Combination," *The Handbook of Statistics, Volume 14: Statistical Methods in Finance*, 241-268, ed. by G.S. Maddala and C.R. Rao. Amsterdam: North-Holland.

L. M. DiValentino (1994): "Preface." *Financial Markets, Institutions and Instruments*, 3, 6-8.

E. Elton, M. Gruber and J. Mei (1994): "Cost of capital using arbitrage pricing theory: A case study of nine New York utilities." *Financial Markets, Institutions and Instruments*, 3, 46–73.

E. Fama and K. French (1992): "The cross-section of expected stock returns." *Journal of Finance*, 47, 427–465.

E. Fama and K. French (1993): "Common risk factors in the returns on stocks and bonds." *Journal of Financial Economics*, 33, 3–56.

E. Fama and K. French (1997): "Industry costs of equity." *Journal of Financial Economics*, 43, 153–193.

W. Ferson and C. Harvey (1999): "Conditioning variables and the cross section of stock returns." *Journal of Finance*, 54, 1325–1360.

D. Goldenberg and A. Robin (1991): "The arbitrage pricing theory and cost-of-capital estimation: The case of electric utilities." *Journal of Financial Research*, 14, 181–196.

C. W. J. Granger and P. Newbold (1986): *Forecasting Economic Time Series.* London: Academic Press.

L. Hansen and R. Jagannathan (1991): "Restrictions on intertemporal marginal rates of substitution implied by asset returns." *Journal of Political Economy*, 99, 225–262.

L. Hansen and R. Jagannathan (1997): "Assessing specification errors in stochastic discount factor models." *Journal of Finance*, 52, 557–590.

L. Hansen and K. Singleton (1982): "Generalized instrumental variables estimation of non-linear rational expectations models." *Econometrica*, 63, 767–804.

L. Hansen and K. Singleton (1983): "Stochastic consumption, risk aversion and the temporal behavior of asset returns.", *Journal of Political Economy*, 91, 249–268.

C. Harvey (1989): "Time-varying conditional covariances in tests of asset pricing models." *Journal of Financial Economics*, 24, 289–317.

R. Jagannathan and Z. Wang (1996): "The conditional CAPM and the cross section of expected returns." *Journal of Finance*, 51, 3–53.

R. Jagannathan and Z. Wang (1998): "An asymptotic theory for estimating beta pricing models using cross-sectional regressions." *Journal of Finance*, 53, 1285–1309.

P. Knez, M. Ready (1997): "On the robustness of size and book-to-market in cross-sectional regressions." *Journal of Finance*, 52, 1355–1382

S. Kothari, J. Shanken and R. Sloan (1995): "Another look at the cross-section of expected returns." *Journal Finance*, 50, 185–224.

S. Kwan and R. A. Eisenbeis (1999): "Mergers of publicly traded banking organizations revisisted." *Federal Reserve Bank of Atlanta Economic Review*, Fourth quarter, 26-37.

D. Laster, P. Bennett and I. Geoum (1999): "Rational bias in macroeconomic forecasts." *Quarterly Journal of Economics*, 293–318.

A.C. MacKinlay and L. Pastor (2000): "Asset Pricing Models: Implications for Expected Returns and Portfolio Selection," NBER Working Paper #W7162.

R. Mehra and E. Prescott (1985): "The equity premium: A puzzle." *Journal of Monetary Economics*, 15, 145–161.

R. Merton (1973): "An intertemporal capital asset pricing model." *Econometrica*, 41, 867–887.

R. Michaely and K. Womack (1999): "Conflict of interest and the credibility of underwriter analyst recommendations," *Review of Financial Studies*, 12, 653–686.

S. Myers and L. Boruchi (1994): "Discounted cash flow estimates of the cost of equity cpital

— a case study." *Financial Markets, Institutions and Instruments*, 3, 9–45.

L. Pastor and R. Stambaugh (1999): "Costs of equity capital and model mispricing." *Journal of Finance*, 54, 67–122.

S. Pilloff (1996): "Performance changes and shareholder wealth creation associated with mergers of publicly traded banking institutions." *Journal of Money, Credit and Banking*, 28, 294-310.

R. Roll (1977): "A critique of the asset pricing theory's tests: Part I." *Journal of Financial Economics*, 4, 129–176.

B. Rosenberg and J. Guy (1976): "Prediction of beta from investment fundamentals, parts 1 and 2." *Financial Analysts Journal*, May-June and July-August 1976.

S. Ross (1976): "The arbitrage theory of capital asset pricing." *Journal of Economic Theory*, 13, 341–360.

S. Ross, R. Westerfield and J. Jaffe (1996): *Corporate Finance*, Irwin.

J. Shanken (1992): "On the estimation of beta pricing models." *Review of Financial Studies*, 5, 1–34.

J. J. Siegel (1998): *Stocks for the Long Run*, second edition, McGraw Hill.

O. Vasicek (1973): "A note on using cross-sectional information in Bayesian estimation of security betas." *Journal of Finance*, 28, 1233–1239.

Z. Wang (2000): "A shrinkage theory of asset allocation using asset-pricing models." Working paper, Columbia University.

K. Womack (1996): "Do brokerage analysts' recommendations have investment value?" *Journal of Finance*, 51, 137–167.

V. Zarnowitz and P. Braun (1993): "Twenty-two years of the NBER-ASA quarterly economic outlook surveys: aspects and comparisons of forecasting performance," in *Business Cycles, Indicators, and Forecasting*, edited by James Stock and Mark Watson, University of Chicago Press.

Appendix Table A. List of BHCs used in the CAE method

	Data years																	
BHC Name	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
AmSouth Corporation													X	X	X	X	X	X
Bancorp Hawaii, Inc.											X	X	X		X	X		
BancWest Corp.																		X
Bank of Boston Corp.			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bank of New England Corporation						X	X	X	X	X								
Bank of New York								X	X	X	X	X	X	X	X	X	X	X
Bank One Corporation									X	X	X	X	X	X	X			
BankAmerica Corporation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bankers Trust New York Corp	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Barnett Banks, Inc.							X	X	X	X	X	X	X	X	X	X	X	
BayBanks, Inc.															X			
BB&T Corp.																	X	X
Boatmen’s Bancshares, Inc.									X	X	X	X	X	X	X			
Central Fidelity Banks Inc.															X			
Chase Manhattan Corporation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chemical Banking Corporation	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Citigroup	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Citizens & Southern Corporation									X									
Citizens Bancorp																	X	X
Comerica Incorporated									X	X	X	X	X	X	X	X	X	X
Compass Bancshares																X		X
Continental Bank Corporation											X	X	X					
Continental Illinois Corporation	X	X	X	X	X	X	X	X										
CoreStates Financial Corp.									X	X	X	X	X	X	X	X	X	
Crestar Financial Corp.										X	X	X	X	X	X	X	X	
Crocker National Corporation		X	X	X	X													
Fifth Third Bank													X	X	X	X	X	X
First American Bankshares									X									
First Bank System Inc.			X	X	X	X	X		X	X	X	X	X	X	X	X		
First Chicago Corporation	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
First Chicago NBD Corporation															X	X	X	
First City Bancorporation of Texas			X	X					X	X								
First Empire State Corp																X	X	
First Fidelity Bancorporation								X	X	X	X	X	X	X				
First Interstate Bancorp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
First Maryland Bancorp.																		X
First of America Bank Corporation									X	X	X	X	X	X	X	X	X	X
First Security Corp.																X	X	X
First Tennessee National Corp.																X		X
First Union Corporation						X	X	X	X	X	X	X	X	X	X	X	X	X
First Wachovia Corporation									X	X								
Firstar Corp.											X	X	X	X	X	X	X	X
Fleet Financial Group, Inc.							X	X	X	X	X	X	X	X	X	X	X	X
Harris Bankcorporation, Inc									X	X	X	X	X	X	X	X	X	X
HSBC Americas, Inc.															X		X	X
Huntington Bancshares, Inc.									X	X	X	X	X	X	X	X	X	X
Integra Financial Corp.													X	X				
InterFirst Corporation			X	X	X													
Irving Trust Corporation			X	X	X	X	X											

Appendix Table A (continued). List of BHCs used in the CAE method

	Data years																	
BHC Name	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
J.P.Morgan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
KeyCorporation									X	X	X	X	X	X	X	X	X	X
LaSalle National Corp.														X			X	X
M & T Bank Corp.																		X
Manufacturers Hanover Corporation	X	X	X	X	X	X	X	X	X	X								
Manufacturers National Corp.										X	X							
Marine Midland			X	X	X	X	X	X	X	X	X	X	X	X				
Marshall & Ilsley Corp.															X	X	X	X
MBNA Corp.															X	X	X	X
Mcorp				X	X	X												
Mellon Bank Corporation			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mercantile Bancorporation Inc.															X	X	X	X
Meridian Bancorp									X	X	X	X	X	X				
Midlantic Corporation									X	X	X	X	X	X				
MNC Financial, Incorporated									X	X	X	X						
National City Corporation									X	X	X	X	X	X	X	X	X	X
National Westminster Bancorporation									X	X	X	X	X	X				
NationsBank Corporation											X	X	X	X	X	X	X	
NBD Bancorp			X			X			X	X	X	X	X	X				
NCNB Corporation			X	X	X	X	X	X	X	X								
Northern Trust Corp.											X	X	X	X	X	X	X	X
Norwest Corporation			X	X	X	X			X	X	X	X	X	X	X	X	X	
Old Kent Financial Corp.															X	X		X
Pacific Century Financial Corp.																	X	X
PNC Financial Corporation						X	X	X	X	X	X	X	X	X	X	X	X	X
Popular, Inc.																	X	X
Regions Financial														X	X	X	X	X
Republic New York Corporation									X	X	X	X	X	X	X	X	X	X
RepublicBank Corporation			X	X	X		X											
Security Pacific Corporation	X	X	X	X	X	X	X	X	X	X	X							
Shawmut National Corporation								X	X	X	X	X	X	X				
Signet Banking Corp.									X			X		X	X			
Society Corporation										X	X	X	X					
Southeast Banking Corporation									X	X								
Southern National Corp.															X	X		
SouthTrust Corp.												X	X	X	X	X	X	X
Sovran Financial Corporation									X	X								
State Street Boston Corp.											X	X	X	X	X	X	X	X
Summit Bancorp.																X	X	X
SunTrust Banks Inc.					X	X	X	X	X	X	X	X	X	X	X	X	X	X
Texas Commerce Bancshares			X	X	X													
U.S. Bancorp									X	X	X	X	X	X	X	X	X	X
UJB Financial Corp.									X	X	X	X	X	X	X			
Union Bank of California																X	X	X
Union Planters Corp.															X	X	X	X
Wachovia Corporation											X	X	X	X	X	X	X	X
Wells Fargo & Company, Inc.	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Zions Bancorp.																		X

Appendix Table B. List of BHCs used in the DCF method

		Data years																	
BHC Name	**CRSP ident.**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
Ameritrust Corporation	13980						X												
AmSouth Bancorp.	62770													X	X	X	X	X	X
Banc One Corporation	65138				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bank of America Corporation	59408	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Bank of Boston Corporation	51772	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bank of New England Corporation	16695					X	X	X	X	X	X								
Bank of New York Co.	49656	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BankAmerica Corporation	58827	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bankers Trust New York Corp	48354	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Barnett Banks, Incorporated	61284	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
BayBanks, Inc.	17196															X			
BB&T Corp.	71563															X	X	X	X
Boatmen’s Bancshares, Inc.	18551						X	X	X	X	X	X	X	X	X	X			
Central Fidelity Banks Inc.	22075															X			
Chase Manhattan Corp.	47896	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chase Manhattan Corporation	41718	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Citigroup	70519																		X
Citigroup	47079	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Comerica, Inc.	25081	X		X	X	X			X	X	X	X	X	X	X	X	X	X	X
Compass Bancshares Inc.	22032																X		X
Continental Bank Corporation	57250	X	X	X		X	X	X				X	X	X					
Corestates Financial Corporation	27263			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Crestar Financial Corp.	79354										X	X	X	X	X	X	X	X	
Fifth Third Bank	34746													X	X	X	X	X	X
First Bank System Inc.	66157					X	X	X	X	X	X	X	X	X	X	X	X		
First Chicago Corporation	53858	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
First City Bancorporation of Tex	75344								X	X	X								
First Fidelity Bancorporation	52505								X	X	X	X	X	X	X				
First Interstate Bancorp.	26550	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
First of America Bank Corp	35204								X	X	X	X	X	X	X	X	X	X	X
First Tennessee National Corp.	36397																		X
First Union Corporation	36469	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Firstar Corp.	36127											X	X	X	X	X	X	X	X
Fleet Financial Group, Inc.	47159						X	X	X	X	X	X	X	X	X	X	X	X	X
Huntington Bancshares	42906								X	X	X	X	X	X	X	X	X	X	X
Integra Financial Corp.	61990													X	X				
Irving Trust Company	46842				X	X	X	X											
J. P. Morgan & Company, Inc.	48071	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
KeyCorp	64995							X	X	X	X	X	X	X	X	X	X	X	X
M & T Bank Corp.	35554																X	X	X
Manufacturers Hanover Corp.	48223	X	X	X	X	X	X	X	X	X	X								
Manufacturers National Corp.	51351										X	X							
Marshall & Ilsley Corp.	51706															X	X	X	X
MBNA Corp.	76557															X	X	X	X
Mellon Bank Corporation	59379	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mercantile Bancorporation Inc.	52821															X	X	X	X
Meridian Bancorp	52944								X	X	X	X	X	X	X				
Midlantic Corporation	53891						X	X	X	X	X	X	X	X	X				
MNC Financial, Incorporated	51781							X	X	X	X	X							
National City Corporation	56232	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
National Westminster Bancorp.	70885													X	X				
NBD Bancorp	56450	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Northern Trust Corp.	58246	X	X	X								X	X	X	X	X	X	X	X
Old Kent Financial Corp.	59345															X	X		X
Pacific Century Financial Corp.	16548											X	X	X		X	X	X	X

Appendix Table B. List of BHCs used in the DCF method

		Data years																	
BHC Name	**CRSP ident.**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
PNC Bank Corporation	60442			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Popular, Inc.	16505																	X	X
Regions Financial Corp.	35044														X	X	X	X	X
Republic New York Corp	53938	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Security Pacific Corporation	60839	X	X	X	X	X	X	X	X	X	X	X							
Shawmut National Corp.	41081								X	X	X	X	X	X	X				
Signet Banking Corp	51764								X	X			X		X	X			
Southeast Banking Corporation	55247	X	X	X	X	X	X	X	X	X	X								
SouthTrust Corp.	71686												X	X	X	X	X	X	X
Sovran Financial Corporation	71889					X	X	X	X	X	X								
State Street Boston Corp.	72726											X	X	X	X	X	X	X	X
Summit Bancorp.	51588											X	X	X	X	X	X	X	X
SunTrust Banks, Incorporated	68144							X	X	X	X	X	X	X	X	X	X	X	X
U.S. Bancorp	78968	X		X					X	X	X	X	X	X	X	X	X	X	
Union Bank of California	78263																	X	X
Union Planters Corp.	20694															X	X	X	X
Wachovia Corporation	68443							X	X	X	X	X	X	X	X	X	X	X	X
Wells Fargo & Co.	38703	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wells Fargo & Co.	50024	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Zions Bancorp.	84129																		

NOTE: The BHC name is identified with the unique CRSP identifier (or permno) that corresponds to its stock issue.
A BHC name may appear more than once if an acquirer retains the name of the acquired; for example, Norwest acquired Wells Fargo and retained that name, leading to two entries for Wells Fargo with different CUSIP identifiers.

Appendix Table C. List of BHCs used in the CAPM method

		Data year																	
BHC name	**CRSP ident.**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
Affiliated Banc Group, Inc.	42831												X	X	X	X	X	X	X
Affiliated Bankshares of Co	11173											X	X	X	X	X	X	X	X
Allied Bancshares	11870		X	X	X	X													
Ameribanc Inc	12416											X	X	X	X	X	X	X	X
AmeriTrust Corp	13980	X					X					X	X	X	X	X	X	X	X
AmSouth Bancorp.	62770													X	X	X	X	X	X
Baltimore Bancorp	85762														X	X	X	X	X
Banc One Corporation	65138			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BancWest Corp.	81474																		X
Bank of America Corporation	59408	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bank of Boston Corporation	51772	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bank of New England	16695					X	X	X	X	X	X								
Bank of New York Co.	49656	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bank South Corporation	16716															X	X	X	X
BankAmerica Corporation	58827	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bankers Trust New York Corp	48354	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Banks of Iowa Inc	16847										X	X	X	X	X	X	X	X	X
BankWorcester	10581													X	X	X	X	X	X
Barnett Banks	61284	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bay Banks	17196															X	X	X	X
BB&T Corp.	71563															X	X	X	X
Boatmen’s Bancshares	18551						X	X	X	X	X	X	X	X	X	X	X	X	X
Boulevard Bancorp Inc	10651													X	X	X	X	X	X
C&S / Sovran Corporation	76285													X	X	X	X	X	X
California Bancshares	75613																X	X	X
Capital Bancorp	81853																	X	X
CCNB Corp	20096											X	X	X	X	X	X	X	X
Central Fidelity Banks	22075															X		X	X
Central Jersey Bancorp	22083														X	X	X	X	X
Chase Manhattan Corp	41718	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chase Manhattan Corp.	47896	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Citigroup	47079	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Citigroup	70519																		X
Citizens & Southern	23705		X	X	X	X	X	X	X	X									
Citizens and Southern	23692											X	X	X	X	X	X	X	X
Citizens Bancorp	23713																X	X	X
Colorado National Bankshares	24767												X	X	X	X	X	X	X
Comerica, Inc.	25081	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
Commonwealth Banchshares	25260													X	X	X	X	X	X
Compass Bancshares Inc.	22032																X		X
Constellation Bancorp	56742													X	X	X	X	X	X
Continental Bank Corporation	57250	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X
Corestates Financial Corp	27263			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Crestar Financial Corp.	79354										X	X	X	X	X	X	X	X	
Dominion Bankshares	30430												X	X	X	X	X	X	X
Equimark Corp	52863												X	X	X	X	X	X	X
Fidelcor, Inc.	34631						X	X											
Fifth Third Bank	34746													X	X	X	X	X	X
First American Corp.	10485																		
First Bank System Inc.	66157	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
First Chicago Corp	53858	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
First Chicago NBD Corp	56450	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X
First City Bancorp of Texas	75344								X	X	X								
First Colonial Bankshares	87899														X	X	X	X	X
First Commerce	35378																	X	X
First Eastern Corp	35423													X	X	X	X	X	X

Appendix Table C (continued). List of BHCs used in the CAPM method

		Data year																	
BHC name	**CRSP ident.**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
First Fidelity Inc.	52505								X	X	X	X	X	X	X	X	X	X	X
First Florida Banks Inc	35722												X	X	X	X	X	X	X
First Illinois Corp	35802											X	X	X	X	X	X	X	X
First Interstate Bancorp	26550	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
First Interstate of Iowa Inc	78511											X	X	X	X	X	X	X	X
First Michigan Bank Corp	35909																	X	X
First National Bancorp	35960															X	X	X	X
First of America Bank Corp	35204								X	X	X	X	X	X	X	X	X	X	X
First Pennsylvania	53903	X																	
First Peoples Financial Corp	36250												X	X	X	X	X	X	X
First Republicbank Corp.	59109	X	X	X	X	X	X	X											
First Security Corp of KY	36282											X	X	X	X	X	X	X	X
First Security Corp.	85468																X	X	X
First Tennessee National Corp	36397																X		X
First Union Bancorp	22008	X																	
First Union Corporation	36469	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Firstar Corp.	36127											X	X	X	X	X	X	X	X
Firstbank of Illinois	36549																		X
FirsTier Financial Inc	36602															X	X	X	X
Fleet Financial Group, Inc.	47159						X	X	X	X	X	X	X	X	X	X	X	X	X
FNW Bancorp Inc	87821											X	X	X	X	X	X	X	X
Fort Wayne Natl Corp	88130																		X
Fourth Financial Corp	37461															X	X	X	X
Gainer Corp	10822											X	X	X	X	X	X	X	X
Grenada Sunburst System	10296														X	X	X	X	X
Hawkeye Bancorp	41233															X	X	X	X
HSBC Americas Inc.	87033															X		X	X
Huntington Bancshares	42906								X	X	X	X	X	X	X	X	X	X	X
INB Finanical Corp	43976												X	X	X	X	X	X	X
Independence Bancorp	43800													X	X	X	X	X	X
Integra Financial Corp	61990													X	X	X	X	X	X
Intercontinental Bank	76611															X	X	X	X
Interfirst Corp.	56805	X	X	X	X	X	X												
Irving Trust Company	46842	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
J. P. Morgan & Company, Inc.	48071	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Jefferson Bankshares Inc	46413																	X	X
Key Centurion Bancshares, WV	10020												X	X	X	X	X	X	X
KeyCorp	64995							X	X	X	X	X	X	X	X	X	X	X	X
Lake Shore Bancorp Inc	11515													X	X	X	X	X	X
Lanmark Bancshares Corp	66982																		X
Liberty Bancorp Inc	16855																X	X	X
Liberty National Bancorp	49403													X	X	X	X	X	X
Lincoln Financial Corp	49649												X	X	X	X	X	X	X
M & T Bank Corp.	35554																X	X	X
Magna Group Inc	50885																		X
Manufacturers Hanover Corporation	48223	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Manufacturers National Corp	51351										X	X	X	X	X	X	X	X	X
Marine Corp, Springfield, IL	10121											X	X	X	X	X	X	X	X
Mark Twain Bancshares	51610																X	X	X
Marshall & Ilsley Corp.	51706															X	X	X	X
MBNA Corp.	76557															X	X	X	X
MCORP	59950	X	X	X	X	X	X	X											
Mellon Bank Corporation	59379	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mercantile Bancorporation Inc.	52821															X	X	X	X
Merchants National Corporation	52920											X	X	X	X	X	X	X	X
Meridian Bancorp Inc	52944								X	X	X	X	X	X	X	X	X	X	X

Appendix Table C (continued). List of BHCs used in the CAPM method

		Data year																	
BHC name	**CRSP ident.**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
Metrobank NA	10880															X	X	X	X
Michigan National Corp.	53402	X	X	X															
Midlantic Bank, N.A.	53891						X	X	X	X	X	X	X	X	X	X	X	X	X
MNC Financial Inc	51781							X	X	X	X	X	X	X	X	X	X	X	X
Multibank Financial Corp	55483												X	X	X	X	X	X	X
National City Corporation	56232	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
National Community Banks Inc	56291													X	X	X	X	X	X
National Westminster Bancorporat	70885								X	X	X	X	X	X	X				
NBB Bancorp Inc	75237														X	X	X	X	X
Norstar Bancorp	64055				X		X	X											
Northeast Bancorp Inc	58150												X	X	X	X	X	X	X
Northern Trust Corp.	58246	X	X	X								X	X	X	X	X	X	X	X
Ohio Bancorp	59118													X	X	X	X	X	X
Old Kent Financial Corp.	59345															X	X		X
ONBANCorp Inc	11558																	X	X
One Valley Corp.	10126																		
Pacific Century Financial Corp.	16548											X	X	X		X	X	X	X
Pacific Western Bancshares	60821													X	X	X	X	X	X
Peoples Bancorp, Rocky Mount, NC	62085										X	X	X	X	X	X	X	X	X
Peoples First Corp	76078																	X	X
PNC Bank Corporation	60442	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Popular, Inc.	16505																	X	X
Premier Bancorp	89712															X	X	X	X
Puget Sound Bancorp	64689												X	X	X	X	X	X	X
Rainier Bancorporation	65569	X	X		X														
Regions Financial Corp.	35044														X	X	X	X	X
Republic New York Corp	53938	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Seafirst Corporation	60134																X	X	X
Security Bancorp, Southgate, MI	69762											X	X	X	X	X	X	X	X
Security Capital	80150																	X	X
Security Pacific Corporation	60839	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Shawmut National Corp	41081								X	X	X	X	X	X	X	X	X	X	X
Signet Banking Corp	51764								X	X			X		X	X		X	X
Signet Banking Corp.	12076																	X	X
Society Corp.	70958										X	X	X	X					
South Carolina National	71328											X	X	X	X	X	X	X	X
Southeast Banking Corporation	55247	X	X	X	X	X	X	X	X	X	X								
SouthTrust Corp.	71686												X	X	X	X	X	X	X
Sovran Financial Corporation	71889			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
State Street Boston Corp.	72726											X	X	X	X	X	X	X	X
Sumitomo Bank of California	73315																		X
Summcorp, Fort Wayne, Indiana	92145											X	X	X	X	X	X	X	X
Summit Bancorp.	51588											X	X	X	X	X	X	X	X
Summit Bancorporation	73358															X	X	X	X
SunTrust Banks, Incorporated	68144					X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sunwest Financial Services	73577												X	X	X	X	X	X	X
Texas Commerce Bancshares	58093	X	X	X	X	X	X												
Trans Finl	10242																		X
Travelers Corporation	47300													X	X	X	X	X	X
U.S. Bancorp	78968	X		X				X	X	X	X	X	X	X	X	X	X	X	X
Union Bank of California	78263																X	X	X
Union Planters Corp.	20694															X	X	X	X
United Banks of Colorado	78466										X	X	X	X	X	X	X	X	X
United Carolina Bancshares	78503																X	X	X
United Counties Bancorp	78597														X	X	X	X	X
US Trust Corp	79274														X	X	X	X	X

Appendix Table C (continued). List of BHCs used in the CAPM method

		Data year																	
BHC name	**CRSP ident.**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**
Valley Capital Corp, Las Vegas	11261											X	X	X	X	X	X	X	X
Valley National Corp.	80099		X	X	X	X	X	X											
Victoria Banksahres Inc	80967															X	X	X	X
Wachovia Corporation	68443					X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wells Fargo & Co.	38703	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wells Fargo & Co.	50024	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
West One Bancorp	55117															X	X	X	X
Worthen Banking	65269														X	X	X	X	X
Zions Bancorp.	84129																		X

NOTE: The BHC name is identified with the unique CRSP identifier (or permno) that corresponds to its stock issue.
A BHC name may appear more than once if an acquirer retains the name of the acquired; for example, Norwest acquired Wells Fargo and retained that name, leading to two entries for Wells Fargo with different CUSIP identifiers.