CHAPITRE 13 DU LIVRE REGULATORY FINANCE
DU DR. ROGER A. MORIN
(PUBLIC UTILITIES REPORT INC., ARLINGTON, VA, 1994)

Chapter 13
CAPM Extensions

13.1 Empirical Validation

The last chapter showed that the practical difficulties of implementing the CAPM approach are surmountable. Conceptual and empirical problems remain, however.

At the conceptual level, the CAPM has been submitted to criticisms by academicians and practitioners.[1] Contrary to the core assumption of the CAPM, investors may choose not to diversify, and bear company-specific risk if abnormal returns are expected. A substantial percentage of individual investors are indeed inadequately diversified. Short selling is somewhat restricted, in violation of CAPM assumptions. Factors other than market risk (beta) may also influence investor behavior, such as taxation, firm size, and restrictions on borrowing.

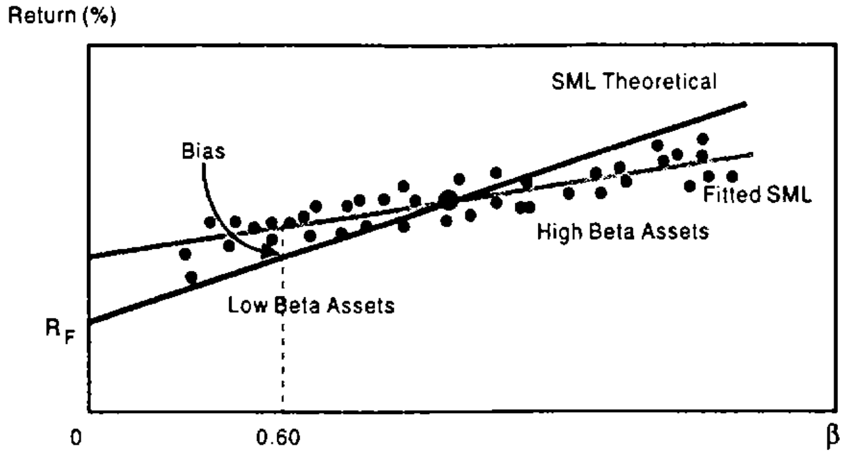
At the empirical level, there have been countless tests of the CAPM to determine to what extent security returns and betas are related in the manner predicted by the CAPM.[2] The results of the tests support the idea that beta is related to security returns, that the risk-return tradeoff is positive, and that the relationship is linear. The contradictory finding is that the empirical Security Market Line (SML) is not as steeply sloped as the predicted SML. With few exceptions, the empirical studies agree that the implied intercept term exceeds the risk-free rate and the slope term is less than predicted by the CAPM. That is, low-beta securities earn returns somewhat higher than the CAPM would predict, and high-beta securities earn less than predicted. This is shown in Figure 13-1.

---

[1] The use of the CAPM in regulatory proceedings has not escaped criticism. See for example Malko and Enholm (1985), Chartoff, Mayo, and Smith (1982), and the Autumn 1978 issue of *Financial Management,* in which several prominent finance scholars address the use of the CAPM in regulatory proceedings.

[2] For a summary of the empirical evidence on the CAPM, see Jensen (1972) and Ross (1978). The major empirical tests of the CAPM were published by Friend and Blume (1975), Black, Jensen, and Scholes (1972), Miller and Scholes (1972), Blume and Friend (1973), Blume and Husic (1973), Fama and Macbeth (1973), Basu (1977), Reinganum (1981B), Litzenberger and Ramaswamy (1979), Banz (1981), Gibbons (1982), Stambaugh (1982), and Shanken (1985). CAPM evidence in the Canadian context is available in Morin (1981).

FIGURE 13-1
THEORETICAL V. EMPIRICAL ESTIMATE OF THE CAPM



The slope is less than predicted by the CAPM, and the intercept term is greater than the risk-free rate. This result is particularly pertinent for public utilities whose betas are typically less than 1.00. Based on the evidence, as shown in Figure 13-1, a CAPM-based estimate of the cost of capital underestimates the return required from such securities.

The empirical evidence also demonstrates that the SML is highly unstable over short periods and differs significantly from the long-run relationship. This evidence underscores the potential for error in cost of capital estimates that apply the CAPM using historical data over short time periods. The evidence[3] also shows that the addition of specific company risk, as measured by standard deviation, adds explanatory power to the risk-return relationship.

Roll (1977) argued that the CAPM has never been tested and that such a test is infeasible. Roll argued, moreover, that the market index proxy used in empirical tests of the CAPM is inadequate; since a true comprehensive market index is unavailable, such tests will be biased in the direction shown by the actual empirical results. Deviations of empirical results from the predictions of the CAPM does not necessarily mean that the CAPM is misspecified, but rather that the market index used in testing is inefficient. Roll's conclusion is that the CAPM is not testable unless the exact composition of the true market portfolio is known and used in the tests. Moreover,

[3] See Friend, Westerfield, and Granito (1978) and Morin (1980).

the CAPM is a forward-looking expectational model and to test the model it is necessary to predict investor expectations correctly. Any empirical test of the CAPM is thus a test of the joint hypothesis of the model's validity and of the function used to generate expected returns from historical returns.

In short, the currently available empirical evidence indicates that the simple version of the CAPM does not provide a perfectly accurate description of the process determining security returns. Explanations for this shortcoming include some or all of the following:

1. The CAPM excludes other important variables that are important in determining security returns, such as size, skewness, taxes, and uncertain inflation.
2. The market index used in the tests excludes important classes of securities, such as bonds, mortgages, and business investments.
3. Constraints on investor borrowing exist contrary to the assumption of the CAPM.
4. Investors may value the hedging value of assets in protecting them against shifts in later investment opportunities. See Merton (1973) and Morin (1981).

Revised CAPM models have been proposed relaxing the above constraints, each model varying in complexity, each model attempting to inject more realism into the assumptions. Ross (1978) and, more recently, Tallman (1989) presented excellent surveys of the various asset pricing theories and related empirical evidence. These enhanced CAPMs produce broadly similar expressions for the relationship between risk and return and a SML that is flatter than the CAPM prediction. Section 13.2 focuses on the more tractable extensions of the CAPM that possess some applicability to public utility regulation.

13.2 CAPM Extensions

Several attempts to enrich the model's conceptual validity and to salvage the CAPM's applicability have been advanced. In this section, extensions of the CAPM and pragmatic solutions to safeguard the model's applicability are discussed. The first explanation of the CAPM's inability to explain security returns satisfactorily is that beta is insufficient and that other systematic risk factors affect security returns. The implication is that the effects of these other independent variables should be quantified and used in estimating the cost of equity capital. The impact of the supplementary variables can be expressed as an additive element to the standard CAPM equation as follows:

Letting *a* stand for these other effects, the CAPM equation becomes:

$$K = R_F + a + \beta\,(R_M - R_F) \quad (13\text{-}1)$$

To capture the variables' impact on the slope of the relationship, a coefficient *b* is substituted for the market risk premium. The revised CAPM equation becomes:

$$K = R_F + a + b \times \beta \quad (13\text{-}2)$$

The constants *a* and *b* capture all the market-wide effects that influence security returns, and must be estimated by econometric techniques. Factors purported to affect security returns include dividend yield, skewness, and size effects.

Dividend Yield Effect

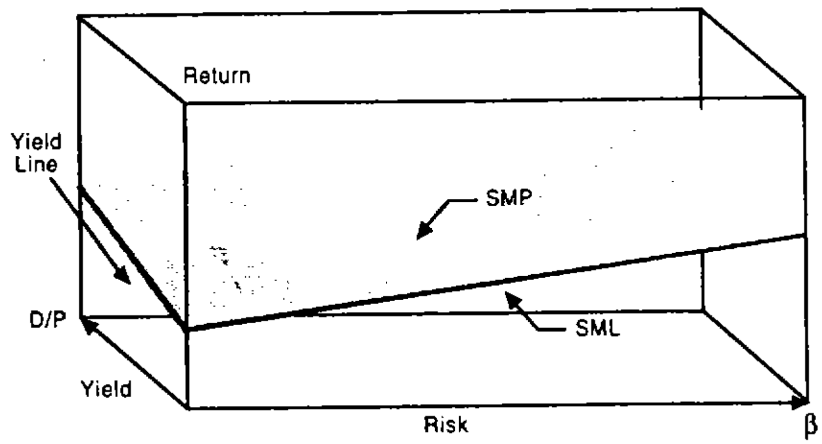
Empirical studies by Litzenberger and Ramaswamy (1979), Litzenberger, Ramaswamy, and Sosin (1980), and Rosenberg and Marathe (1975) find that security returns are positively related to dividend yield as well as to beta. These results are consistent with after-tax extensions of the CAPM developed by Brennan (1970) and Litzenberger and Ramaswamy (1979) and suggest that the relationship between return, beta, and dividend yield should be estimated and employed to calculate the cost of equity capital.

The dividend yield effects stem from the differential taxation on corporate dividends and capital gains. The standard CAPM does not consider the regularity of dividends received by investors. Utilities generally maintain high dividend payout ratios relative to the market, and by ignoring dividend yield, the CAPM provides biased cost of capital estimates. To the extent that dividend income is taxed at a higher rate than capital gains, investors will require higher pre-tax returns in order to equalize the after-tax returns provided by high-yielding stocks with those of low-yielding stocks. In other words, high-yielding stocks must offer investors higher pre-tax returns.[4] Even if dividends and capital gains are undifferentiated for tax purposes, there is still a tax bias in favor of earnings retention (lower dividend payout), as capital gains taxes are paid only when gains are realized.

[4] The strength of the tax effect on yield is diluted by non-taxable institutional ownership and by the personal tax exemption on dividend income from electric utility stocks.

The traditional return-beta relationship described by the SML fails to recognize the dividend yield dimension. But the two-dimensional SML can be expanded into a three-dimensional security market plane (SMP) by adding a dividend yield line as in Figure 13-2, which portrays the relationship among return, beta, and dividend yield. The positive effect of yield on return can be seen on the graph. In a given risk class, the required return increases with the dividend yield. Some institutional portfolio managers have in fact implemented the SMP approach for actual investment management decision making, in effect recommending for purchase undervalued securities situated above the SMP.

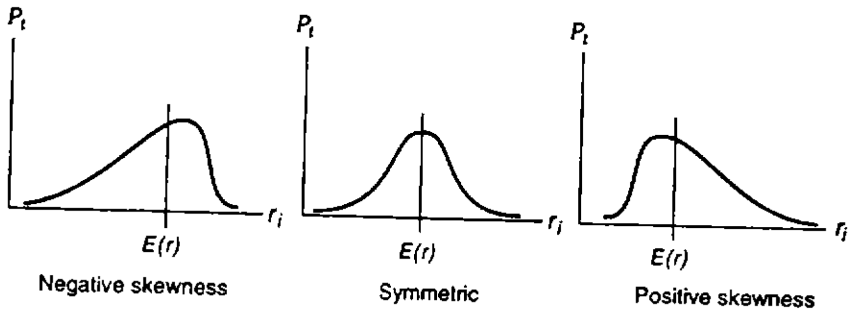
FIGURE 13-2
THE RELATIONSHIP AMONG RETURN, BETA, AND DIVIDEND YIELD



Skewness Effects

Investors are more concerned with losing money than with total variability of return. If risk is defined as the probability of loss, it appears more logical to measure risk as the probability of achieving a return that is below the expected return. Figure 13-3 shows three frequency distribution of returns, one symmetrical, one skewed left, and one skewed right. If the probability distribution is symmetrical, specialized measures of downside risk are unnecessary, since a normal symmetrical distribution has no skewness; the areas on either side of the mean expected return are mirror images of one another.

FIGURE 13-3
RETURN DISTRIBUIONS



Three probability distributions with different types of skewness

In the context of the CAPM, the traditional CAPM provides downward-biased estimates of cost of capital to the extent that these skewness effects are significant. As shown by Kraus and Litzenberger (1976), expected return depends on both on a stock's systematic risk (beta) and the systematic skewness:

RETURN = RISK-FREE RATE + MARKET RISK + SKEWNESS RISK

Denoting the risk-free rate by R_F, the return on the market as a whole by R_M, the stock's systematic market risk by β, the stock's systematic skewness by γ, and the market price of skewness reduction by S_M, the amended CAPM is stated as follows:

$$K_e = R_F + \beta(R_M - R_F) + \gamma(S_M - R_F) \qquad (13\text{-}3)$$

Systematic skewness, γ, is measured as the ratio of the co-skewness of the stock with the market to the skewness of the market.

Empirical studies by Kraus and Litzenberger (1976), Friend, Westerfield, and Granito (1978), and Morin (1980) found that, in addition to beta, skewness of returns has a significant negative relationship with security returns. This result is consistent with the skewness version of the CAPM developed by Rubinstein (1973) and Kraus and Litzenberger (1976).

This may be particularly relevant for public utilities whose future profitability is constrained by the regulatory process on the upside and relatively unconstrained on the downside in the face of socio-political realities of public utility regulation. The distribution of security returns for regulated utilities is more likely to resemble the negatively skewed distribution displayed in the left-hand portion of Figure 13-3. The process of regulation, by restricting the upward potential for returns and responding sluggishly on the downward side, may impart some asymmetry to the distribution of returns, and is more likely to result in utilities earning less, rather than more, than their cost of capital. The traditional CAPM provides downward-biased estimates of the cost of capital to the extent that these skewness effects are significant. A security market plane (SMP) similar to that envisaged in the case of dividend yield effects can be imagined, substituting a skewness line for the dividend yield line.

Skewness effects can be illustrated by the nature of the probability distribution of security returns for California water utilities in the 1990s. Because of the asymmetry in the future water supply, there is a greater probability of downside returns to investors under adverse supply conditions, but essentially no probability of correspondingly large positive returns. That is, these water utilities' future profitability is constrained by both the regulatory process and by a negatively skewed water supply. Hence, measures of variability and covariability, such as standard deviation and beta, are likely to provide downward-biased estimates of the true risk relative to that of unregulated firms and other utilities.

The implication is that an additional risk premium must be added to the business-as-usual return on equity to compensate for the added risks. The lack of symmetry in investor returns must be considered. A risk premium sufficient to compensate investors for the limited upside returns/unlimited downside returns versus comparable risk companies and other utilities is required.

To illustrate, Figure 13-4 shows the hypothetical probability distributions of revenues, earnings before interest and taxes (EBIT), and net income under normal conditions for a California water utility. Note that fluctuations in revenues are magnified when transmitted to EBIT because of operating leverage, and further magnified when transmitted to net income because of financial leverage. The coefficient of variation of revenue, EBIT, and net income are 0.14, 0.47, and 1.11, respectively.

FIGURE 13-4A
HYPOTHETICAL PROBABILITY DISTRIBUTIONS OF REVENUE, EBIT, AND NET INCOME

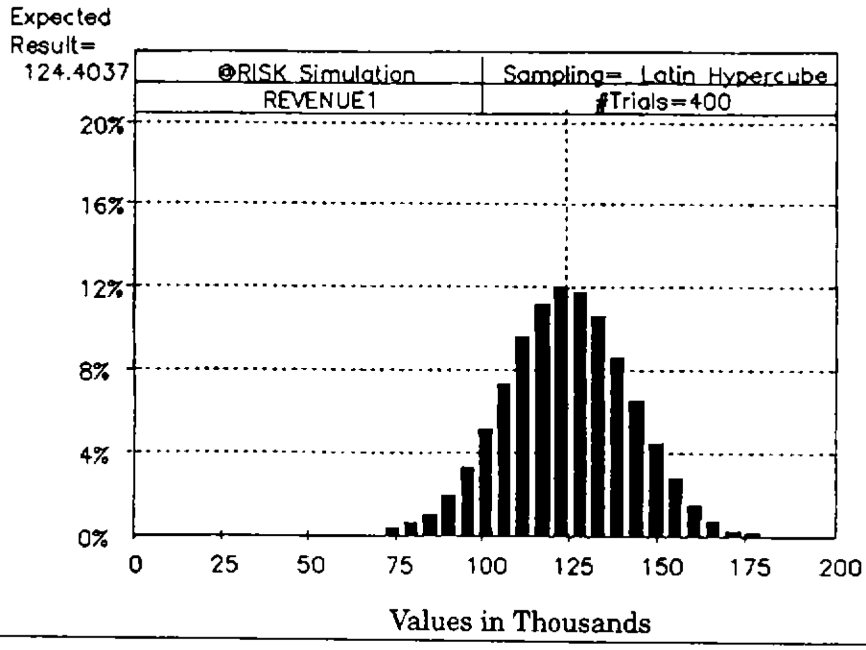


FIGURE 13-4B

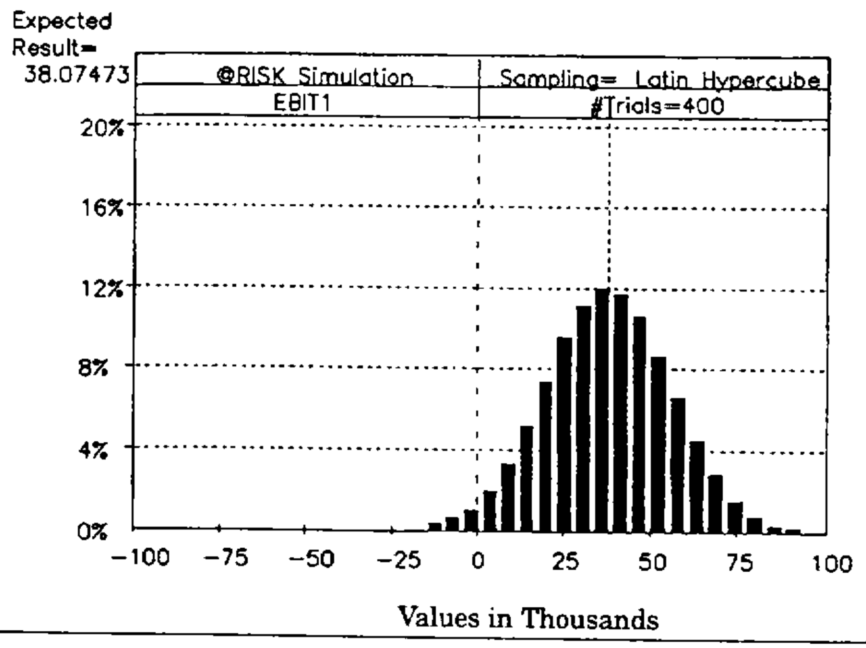


FIGURE 13-4C

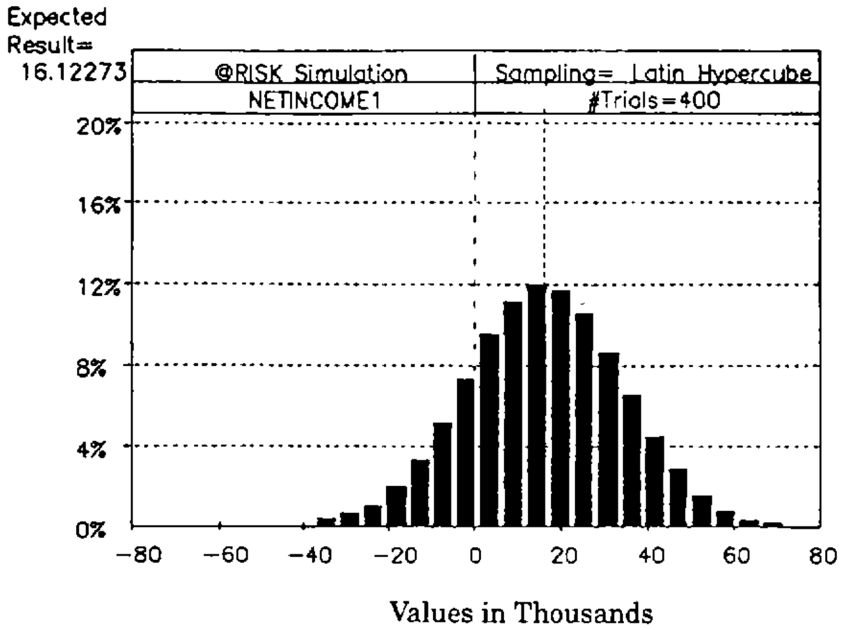


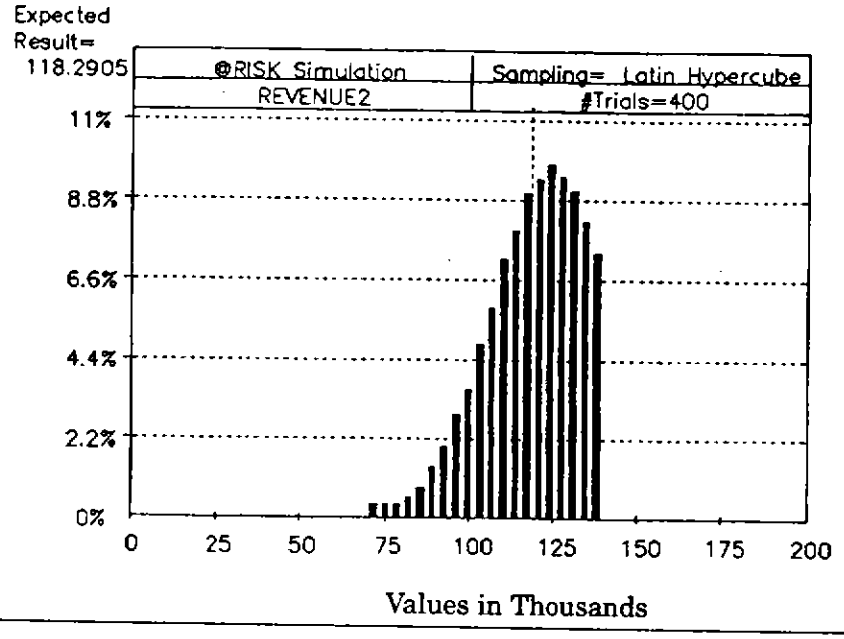
Figure 13-5 shows the same probability distributions if revenues are negatively skewed. Note the increased downside net income potential and, hence, the increased risk. The coefficient of variation of revenue, EBIT, and net income become 0.12, 0.43, and 1.41, respectively. The risk to the shareholder increases from 1.11 to 1.41 as a result of leverage and skewness effects.

This result reinforces that notion that an added premium is required to offset the lack of upside potential. The added premium must be sufficient to produce the same average return that would prevail under conditions of perfect symmetry.

Size Effects

Investment risk increases as company size diminishes, all else remaining constant. The size phenomenon is well documented in the finance literature. Empirical studies by Banz (1981) and Reinganum (1981A) have found that investors in small-capitalization stocks require higher returns than predicted by the standard CAPM. Reinganum (1981A) examined the relationship between the size of the firm and its P/E ratio, and found that small firms experienced average returns greater than those of large firms that were of equivalent systematic risk (beta). He found that small firms produce greater returns than could be explained by their risks. These results were confirmed in a separate test by Banz (1981) who examined stock returns

FIGURE 13-5A
HYPOTHETICAL PROBABILITY DISTRIBUTIONS:
NEGATIVELY SKEWED REVENUES



over the much longer 1936-1975 period, finding that stocks of small firms earned higher risk-adjusted abnormal returns than those of large firms.

Small companies have very different returns than large ones, and on average they have been higher. The greater risk of small stocks does not fully account for their higher returns over many historical periods. Ibbotson Associates' widely-used annual historical return series publication covering the period 1926 to the present reinforces this evidence (Ibbotson Associates, 1993). They found that for the period 1926-1992 the average small stock premium was 6% over the average stock, more than could be expected by risk differences alone, suggesting that the cost of equity for small stocks is considerably larger than for large capitalization stocks. One plausible explanation for the size effect is the higher information search costs incurred by investors for small companies relative to large companies. This effect is likely to be negligible for all but the very small public utilities whose equity market value is less than $60 million.

In addition to earning the highest average rates of return, the small stocks also had the highest volatility, as measured by the standard deviation of returns. Ibbotson defines small stocks as those in the lowest size decile among NYSE stocks, with size defined as the dollar value of shares outstanding. The size trigger point occurs at a market value of $60 million.

FIGURE 13-5B

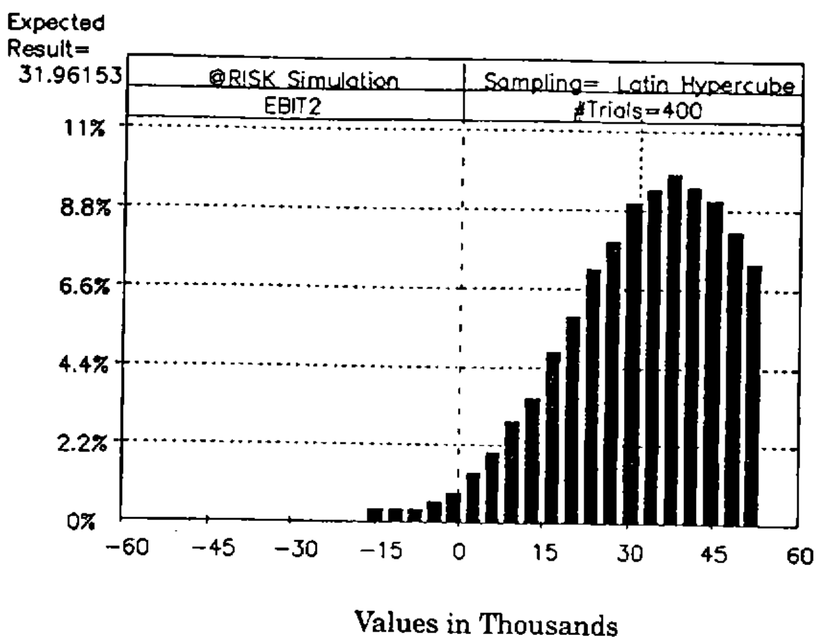
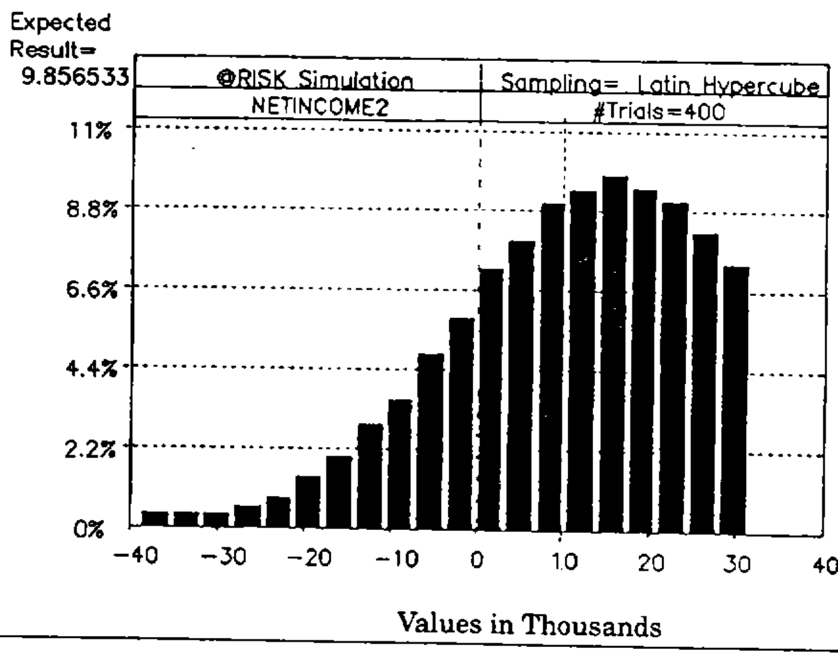


FIGURE 13-5C



The bond ratings of small firms are typically less than those of large firms. Figure 13-6 contrasts the Standard & Poor's bond and stock ratings of small versus large capitalization stocks. For bond ratings, the first quintile of companies ranked in descending order of market value of equity is ranked A- on average, versus CC for the last quintile. For stock ratings, the first quintile of companies is ranked A- to B+, versus C for the last quintile.

FIGURE 13-6A
STANDARD & POOR'S AVERAGE BOND RATING:
TOP 20% AND BOTTOM 20% OF MARKET
(Compustat Data Base Ranked by Market Value)

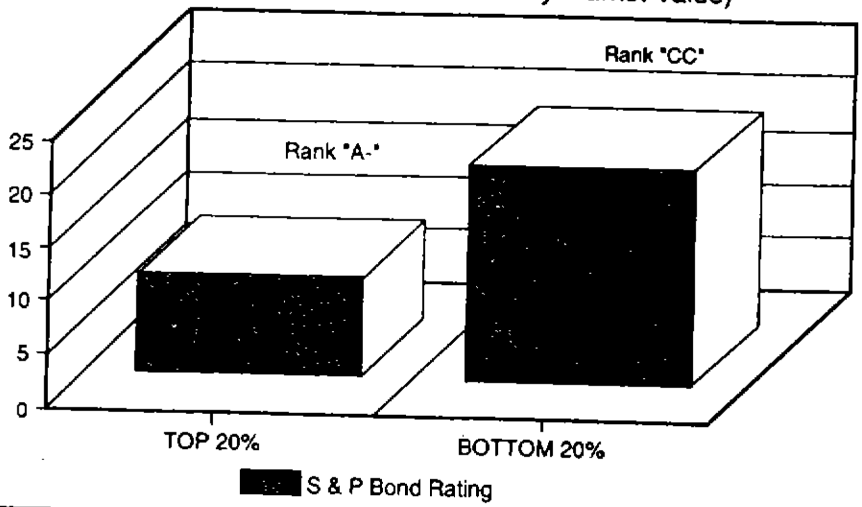
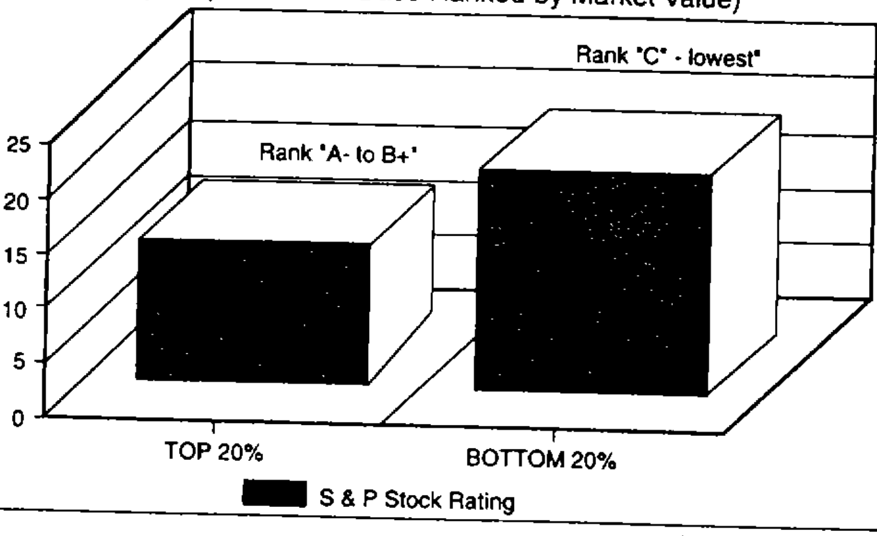


FIGURE 13-6B
STANDARD & POOR'S AVERAGE STOCK RATING:
TOP 20% AND BOTTOM 20% OF MARKET
(Compustat Data Base Ranked by Market Value)



Much research effort has gone into investigating the size effect. In addition to statistical measurement problems, the economic rationale for the size effect is difficult to unravel. In fact, Roll (1981) even questioned the evidence on the small firm effect. Presumably, small stocks provided less utility to the investor, and require a higher return. The size effect may be a statistical mirage, whereby size is proxying for the effect of different economic variables. Small firms may have low price-earnings ratios or low market prices, for example. The size effect is most likely the result of a liquidity premium, whereby investors in small stocks demand greater returns as compensation for lack of marketability and liquidity. Investors prefer high to low liquidity, and demand higher returns from less liquid investments, holding other factors constant.

Market Index and Missing Assets

A second explanation for the CAPM's inability to fully explain the process determining security returns involves the use of an inadequate or incomplete market index. Empirical studies to validate the CAPM invariably rely on some stock market index as a proxy for the true market portfolio. The exclusion of several asset categories from the definition of market index misspecifies the CAPM and biases the results found using only stock market data. Kolbe and Read (1983) provide an illustration of the biases in beta estimates that result from applying the CAPM to public utilities. Unfortunately, no comprehensive and easily accessible data exist for several classes of assets, such as mortgages and business investments, so that the exact relationship between return and stock betas predicted by the CAPM does not exist. This suggests that the empirical relationship between returns and stock betas is best estimated empirically rather than by relying on theoretical and elegant CAPM models expanded to include missing assets effects. In any event, stock betas may be highly correlated with the true beta measured with the true market index.

Constraints on Investor Borrowing

The third explanation for the CAPM's deficiency involves the possibility of constraints on investor borrowing that run counter to the assumptions of the CAPM. In response to this inadequacy, several versions of the CAPM have been developed by researchers. One of these versions is the so-called zero-beta, or two-factor, CAPM which provides for a risk-free return in a market where borrowing and lending rates are divergent. If borrowing rates and lending rates differ, or there is no risk-free borrowing or lending, or there is risk-free lending but no risk-free borrowing, then the CAPM has the following form:

$$K = R_Z + \beta\,(R_M - R_F) \qquad (13\text{-}4)$$

The model is analogous to the standard CAPM, but with the return on a minimum risk portfolio that is unrelated to market returns, R_Z, replacing the risk-free rate, R_F. The model has been empirically tested by Black, Jensen, and Scholes (1972), who found a flatter than predicted SML, consistent with the model and other researchers' findings.

The zero-beta CAPM cannot be literally employed in cost of capital projections, since the zero-beta portfolio is a statistical construct difficult to replicate. Attempts to estimate the model are formally equivalent to estimating the constants, a and b, in Equation 13-2.

13.3 Empirical CAPM

Whatever the explanation for the flatter than predicted SML, whether it be dividend yield, skewness, size, missing assets, or constrained borrowing effects, the general suggestion is that the empirical relationship between returns and betas should be estimated empirically rather than asserted on an a priori basis. Equation 13-2 has gradually evolved to become known as the Empirical Capital Asset Pricing Model (ECAPM), and represents a pragmatic solution to the limitations of the standard CAPM, whether it be data limitations, unrealistic assumptions, or omitted variables. All the potential vagaries of the model are telescoped into the 2 constants, a and b, which must be estimated econometrically from market data. The technique is formally applied by Litzenberger, Ramaswamy, and Sosin (1980) to public utilities in order to rectify the CAPM's basic shortcomings. Not only do they summarize the criticisms of the CAPM insofar as they affect public utilities, but they also describe the econometric intricacies involved and the methods of circumventing the statistical problems. Essentially, the average monthly returns over a lengthy time period on a large cross-section of securities grouped into portfolios, are related to their corresponding betas by statistical regression techniques; that is, Equation 13-2 is estimated from market data. The utility's beta value is substituted into the equation to produce the cost of equity figure. Their own results demonstrate how the standard CAPM underestimates the cost of equity capital of public utilities because of the utilities' high dividend yield and return skewness.

As discussed in Section 13.1, empirical tests of the CAPM have shown that the risk-return tradeoff is not as steeply sloped as that predicted by the CAPM. That is, low-beta securities earn returns somewhat higher than the CAPM would predict, and high-beta securities earn less than predicted.

Several finance scholars have developed refined and expanded versions of the standard CAPM by relaxing the constraints imposed on the CAPM, such as dividend yield, size, and skewness effects. In doing so, they obtained broadly similar expressions for the relationship between risk and expected return. These enhanced CAPMs typically produce a risk-return relationship that is flatter than the CAPM prediction. In other words, they obtained a result that is closer to the actual risk-return relationship.[5]

The empirical CAPM formula described below produces a risk-return tradeoff that is flatter than the predicted tradeoff, and approximates the observed relationship between risk and return on capital markets. The empirical approximation to the CAPM is consistent with both theory and empirical evidence, and has the added advantage of computational simplicity. Whereas the traditional version of the CAPM is given by the following:

$$K = R_F + \beta\,(R_M - R_F)$$

the empirical evidence found by Morin (1989) indicates that the expected return on a security over the period 1926-1984 was actually given by:

$$\text{RETURN} = .0829 + .0520\beta$$

Given that the risk-free rate over the estimation period was approximately 6%, this relationship implies that the intercept of the risk-return relationship is higher than the 6% risk-free rate, contrary to the CAPM's prediction. Given the Ibbotson Associates' result that the average return on an average risk stock exceeded the risk-free rate by about 8% during the period from 1926 through 1984, that is $(R_M - R_F) = 8\%$, the intercept of the observed relationship between return and beta exceeds the risk-free rate by about 2%, or 1/4 of 8%, and that the slope of the relationship, .0520, is close to 3/4 of 8%. Therefore, the empirical evidence suggests that the expected return on a security is related to its risk by the following approximation:

$$K = R_F + x\,(R_M - R_F) + (1 - x)\,\beta\,(R_M - R_F) \qquad (13\text{-}5)$$

where x is a fraction to be determined empirically. The value of x is actually derived by systematically varying the constant x in that equation from zero

5 An excellent overview of variants of the CAPM is provided in the corporate finance textbook by Brealey and Myers (1991A), Chapter 8, and particularly in the accompanying instructor's manual (1991B).

to 1.00 in steps of 0.05 and choosing that value of x that minimized the mean square error between the observed relationship,

$$RETURN = .0829 + .0520\,\beta$$

and the empirical shortcut CAPM formula.[6] The value of x that best explains the observed relationship is between 0.25 and 0.30. If $x = 0.25$, the equation becomes:

$$K = R_F + 0.25\,(R_M - R_F) + 0.75\,\beta\,(R_M - R_F) \qquad (13\text{-}6)$$

Using a simple numerical example, assuming a risk-free rate of 7%, a market risk premium of 7%, and a beta of 0.80, the empirical CAPM equation above yields a cost of equity estimate of 12.95% as follows:

$$K = 7\% + 0.25\,(14\% - 7\%) + 0.75 \times 0.80\,(14\% - 7\%)$$

$$= 7\% + 1.75\% + 4.2\%$$

$$= 12.95\%$$

The actual historical relationship between risk premiums and the risk of a large population of common stocks can be observed over a long time period and used to estimate the appropriate risk premium for a given utility. The utility's cost of equity can then be estimated as the yield on long-term Treasury bonds plus the estimated risk premium. To illustrate, the actual relationship between risk premiums and betas on common stocks over a long time period can be estimated, and this historical relationship be used to estimate the risk premium on the utility's common equity, on the grounds that over long time periods, investors' expectations are realized.

To execute this method, monthly rates of return for all common stocks listed on the New York Stock Exchange from 1926 to the present are obtained from the University of Chicago's Center for Research in Security Prices (CRISP) data tapes. Five-year betas are then computed for each month for each company. For each month, the securities are assigned to one of 10 portfolios on the basis of ranked betas, from the lowest to the highest beta. Monthly returns for each of the portfolios are compounded to produce annual rates of return on each of the 10 portfolios from 1931 to the

6 The corresponding evidence for Canadian capital markets is scant. For studies of the relationship between return and risk in Canada, see Morin (1980) and Jobson and Korkie (1985)

present. Historical risk premiums for each of the 10 portfolios are calculated for the period 1931 to the present by averaging the difference between the portfolio's annual rate of return and the government bond yield. For example, if the following hypothetical relationship between the risk premium and the portfolios' betas is obtained for the period 1931 - 1992[7]:

$$Risk\ Premium = 4.21\% + (3.94\%\ x\ Beta)$$

Using the utility's beta of 0.60, for example, the risk premium for the hypothetical utility is:

$$4.21\% + (3.94\%\ x\ 0.60) = 6.6\%$$

A long-term cost of equity capital estimate for the company is obtained by adding the risk premium of 6.6% to the current yield on long-term Treasury bonds or to the projected long-term yield implied by the closing prices on the Treasury bond futures contract traded on the Chicago Board of Trade. The latter measures the consensus long-term interest rate expectation of investors.[8] If the yield on long-term Treasury bonds is 6%, then the cost of equity implied by the empirical relationship is 6.00% + 6.60% = 12.60%. A similar procedure could be developed based on the standard deviation of return rather than on beta as risk measure.

13.4 Conclusions

Although financial theory has shown that beta is a sufficient risk measure for diversified investors and although most of the empirical literature has confirmed its importance in determining expected return, there are notable exceptions. Over the course of its history, the death of beta has been peridically announced, inevitably followed by its rebirth. The Fama and French (1992) article is a case in point. These authors found little explanatory power in beta. But here again the autopsy of beta was premature, and "reports of beta's death are greatly exaggerated." For one thing, the CAPM specifies a relationship between expected returns and beta, whereas Fama and French employed realized returns. Moreover, in a subsequent re-

7 See Litzenberger (1988) for an excellent example of this empirical CAPM technique.

8 The average market forecasts of rates in the form of interest rate Treasury securities futures contracts data can be used as a proxy for the expected risk-free rate.

compensation for beta risk and little relation to M/B ratios, unlike Fama and French. They also found that market risk premiums are much larger when betas are estimated using annual rather than monthly data.

On the positive side, as a tool in the regulatory arena, the CAPM is a rigorous conceptual framework, and is logical insofar as it is not subject to circularity problems, since its inputs are objective, market-based quantities, largely immune to regulatory decisions. The data requirements of the model are not prohibitive, although the amount of data analysis required can be substantial, especially if CAPM extensions are implemented.

On the negative side, the input quantities required for implementing the CAPM are difficult to estimate precisely. These problems are not insurmountable, however, provided that judgment is exercised and that the logic underlying the methodology is well supported. The techniques outlined in this chapter should prove helpful in this regard. Sensitivity analysis over a reasonable range of risk-free rate, market return, and beta is strongly recommended to enhance the credibility of the estimates.

The standard form of the CAPM must be used with some caution. There is strong evidence that the CAPM does not describe security returns perfectly, especially for public utilities. Beta is helpful in explaining security returns only when complemented with other risk indicators, such as dividend yield, size, and skewness variables. Rather than theorize on the effects of such extraneous variables, a more expedient approach to estimating the cost of equity capital is to estimate directly the empirical relationship between return and beta, and let the capital markets speak for themselves as to the relative impact of such variables. The empirical form of the CAPM provides an adequate model of security returns. If a utility's beta can be estimated for a given period, then by knowing the empirical relationship between risk and return, the security's expected return, or cost of capital, can be estimated. Here again, the cost of capital estimates produced by an ECAPM procedure should be sensitized to produce a range of estimates.

The CAPM is one of several tools in the arsenal of techniques to determine the cost of equity capital. Caution, appropriate training in finance and econometrics, and judgment are required for its successful execution, as is the case with the DCF or risk premium methodologies.

It is only natural that the next generation of CAPM models formally account for the presence of several factors influencing security returns. A new finance theory, which extends the standard CAPM to include sensitivity to several market factors other than market risk, has been proposed to replace the CAPM. Proponents of the Arbitrage Pricing Model (APM) contend that APM provides better results than does the CAPM and is not plagued by the shortcomings of the CAPM, while retaining its basic intuition. Chapter 15 discusses this latest paradigm in financial theory, and explores its pertinence in cost of capital determination. But first, Chapter 14 presents numerous applications of the CAPM that are relevant to utilities.

References

Banz, R.W. "The Relationship Between Return and Market Value of Common Stock." *Journal of Financial Economics,* March 1981, 3-18.

Basu, S. "Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Markets Hypothesis." *Journal of Finance,* June 1977, 663-682.

Black, F., Jensen, M.C., and Scholes, M. "The Capital Asset Pricing Model: Some Empirical Tests." Reprinted in *Studies in the Theory of Capital Markets,* edited by M.C. Jensen, 79-124. New York: Praeger, 1972.

Blume, M.E. and Friend, I. "A New Look at the Capital Asset Pricing Model." *Journal of Finance,* March 1973, 19-34.

Blume, M.E. and Husic, F. "Price, Beta, and Exchange Listing." *Journal of Finance,* May 1973, 283-299.

Brealey, R. and Myers, S. *Principles of Corporate Finance,* 4th ed. New York: McGraw-Hill, 1991A.

Brealey, R. and Myers, S. *Principles of Corporate Finance,* Instructors' Manual, Appendix C. New York: McGraw-Hill, 1991B.

Brennan, M. J. "Taxes, Market Valuation, and Corporate Financial Policy." *National Tax Journal,* December 1970, 417-427.

Chartoff, J., Mayo, G.W., and Smith, W.A. "The Case Against the Use of the CAPM in Public Utility Ratemaking." *Energy Law Journal,* 1982, 62-93.

Fama, E.F. and French, K. R. "The Cross-Section of Expected Stock Returns." *Journal of Finance,* June 1992, 427-465.

Fama, E.F. and Macbeth, J. "Risk, Return, and Equilibrium: Empirical Tests." *Journal of Political Economy,* June 1973, 607-636.

Friend, I. and Blume, M.E. "The Demand for Risky Assets." *American Economic Review,* December 1975, 900-922.

Friend, I., Westerfield, R., and Granito, M. "New Evidence on the Capital Asset Pricing Model." *Journal of Finance,* June 1978, 903-916.

Gibbons, M.R. "Multivariate Tests of Financial Models: A New Approach." *Journal of Financial Economics,* March 1982, 3-28.

Ibbotson Associates. *Stocks, Bonds, Bills, and Inflation, 1992 Yearbook.* Chicago: Ibbotson Associates, 1993.

Jensen, M.C. "Capital Markets: Theory and Evidence." *Bell Journal of Economics and Management Science,* Autumn 1972, 357-398.

Jobson, J.D. and Korkie, R.M. "Some Tests of Linear Asset Pricing with Multivariate Normality." *Canadian Journal of Administrative Sciences,* June 1985, 114-138.

Kolbe, A.L. and Read, J.A. *Missing Assets and the Systematic Risk of Public Utility Shares.* Boston MA: Charles River Associates, May 1983.

Kothari, S.P., Shanken, J., and Sloan. R.G. "Another Look at the Cross-section of Expected Stock Returns." Bradley Policy Research Center of the University of Rochester, W. Simon Graduate School of Business Admin., No. 93-01,1993.

Kraus, A. and Litzenberger, R.H. "Skewness Preference and the Valuation of Risk Assets." *Journal of Finance,* September 1976, 1085-1099.

Litzenberger, R. H. and Ramaswamy, K. "The Effect of Personal Taxes and Dividends on Capital Asset Prices: Theory and Empirical Evidence." *Journal of Financial Economics,* June 1979, 163-196.

Litzenberger, R.H., Ramaswamy, K., and Sosin, H. "On the CAPM Approach to the Estimation of a Public Utility's Cost of Equity Capital." *Journal of Finance,* May 1980, 369-383.

Malko, J.B. and Enholm, G.B. "Applying CAPM in a Utility Rate Case: Current Issues and Future Directions." *Electric Ratemaking,* September-October 1985, 29-34.

Merton, R.C. "An Intertemporal Capital Asset Pricing Model." *Econometrica,* Sept. 1973, 867-887.

Miller, M. and Scholes, M. "Rates of Return in Relation to Risk: A Re-examination of Some Recent Findings." In *Studies in the Theory of Capital Markets,* edited by M. C. Jensen, 47-78. New York: Praeger, 1972.

Morin, R.A. "Market Line Theory and the Canadian Equity Market." *Journal of Business Administration,* Fall 1980, 57-76.

Morin, R.A. "Intertemporal Market-Line Theory: An Empirical Test." *Financial Review,* Proceedings of the Eastern Finance Association, 1981.

Morin, R.A. US West Communications (Mountain Bell), Rebuttal Testimony, Arizona Corporation Commission, March 1989.

Reinganum, M.R. "Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings, Yields and Market Values." *Journal of Financial Economics,* March 1981A, 19-46.

Reinganum, M.R. "The Arbitrage Pricing Theory: Some Empirical Results." *Journal of Finance,* May 1981B, 313-321.

Roll, R.W. "A Critique of the Asset Pricing Theory's Tests." *Journal of Financial Economics,* March 1977, 129-176.

Roll, R.W. "A Possible Explanation of the Small Firm Effect." *Journal of Finance,* Sept. 1981, 879-888.

Rosenberg, V. and Marathe, V. "The Prediction of Investment Risk: Systematic and Residual Risk." Proceedings of the Seminar on the Analysis of Security Prices. Chicago: University of Chicago, 20, November 1975.

Ross, S.A. "The Current Status of the Capital Asset Pricing Model." *Journal of Finance,* September 1978, 885-902.

Rubinstein, M.E. "A Mean-Variance Synthesis of Corporate Financial Theory." *Journal of Financial Economics,* March 1973, 167-182.

Shanken, J. "Multivariate Tests of the Zero-Beta CAPM." *Journal of Financial Economics,* September 1985, 327-348.

Stambaugh, R.F. "On the Exclusion of Assets from Tests of the Two-Parameter Model: A Sensitivity Analysis." *Journal of Financial Economics,* Nov. 1982, 237-268.

Tallman, E.W. "Financial Asset Pricing theory: A Review of Recent Developments." *Economic Review,* Federal Reserve Bank of Atlanta, November-December 1989, 26-41.

Additional References

Litzenberger, R.H. Wisconsin Bell, Prepared Testimony, Wisconsin Public Service Commission, 1988.

Roll, R.W. and Ross, S.A. "An Empirical Investigation of the Arbitrage Pricing Theory." *Journal of Finance,* December 1980, 1073-1103.