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APPLYING THE CAPITAL ASSET PRICING MODEL

This note discusses how some of the most financially sophisticated companies and financial advisors estimate the cost of equity capital. We particularly focus on areas where finance theory is silent or ambiguous and practitioners are left to their own devices.

Conclusions are based on interviews with two groups: 1) Well-regarded firms selected by their peers as being among those with the best financial management, and 2) A sample, of ten of the most active financial advisors (investment banks). For context on academic advice, we also cite recommendations from top-selling graduate-level textbooks and trade books in corporate finance.[1]

Findings

The Capital Asset Pricing Model (CAPM) is the dominant model for estimating the cost of equity, with over 80% of firms and financial advisors employing this model. While firms mentioned other asset-pricing models, these were in a small minority. No firm reported using a modified version of the CAPM either.

On the other hand, disagreements exist on how to apply the CAPM. The CAPM states that the required return (R) on any asset can be expressed as:

[1]Survey evidence and much of the discussion is adapted from "'Best Practices' in Estimating the Cost of Capital: Survey and Synthesis" (R. Bruner, K. Eades, R. Harris, and R. Higgins), *Financial Practice and Education* (Spring/Summer 1998). That study reports these results plus others on the weighted average cost of capital. The study chose leading firms using *World-Class Financial Management: Strategies of 50 Leading Companies, Research Report No. 1-110*, Business International Corporation, New York, 1992, (238 pages), pages vii-viii. Firms were chosen for excellence in strategic financial risk management, tax and accounting, performance evaluation, and other areas of financial management. "Activity" for investment banks was defined as aggregate deal volume (years 1993–1995) in merger and acquisition volume presented in *Institutional Investor*. Bruner et al. report that financial advisor interest in promoting deals did not lead them to lower cost of capital estimates than those estimated by operating companies. Bruner et al. use the four top-selling textbooks (1994) and three tradebooks.

This note, prepared by Professor Robert Harris, draws, in part, directly from "'Best Practices' in Estimating the Cost of Capital: Survey and Synthesis," and thanks go to the authors for their permission to reproduce these results.

$$R = R_f + \beta(R_m - R_f)$$

where:

R_f = *interest rate available on a risk-free bond.*

R_m = *return required to attract investors to hold the broad market portfolio of risky assets.*

β = *the relative risk of the particular asset.*

According to CAPM then the required return on a company's stock (also known as the cost of equity), R_{equity}, depends on three components: returns on risk-free bonds (R_{f}), the stock's equity "beta," which measures risk of the company's stock relative to other risky assets ($\beta = 1.0$ is average risk), and the market risk premium (R_{m} - R_{f}) necessary to entice investors to hold risky assets generally, versus risk-free bonds.

In theory, each of these three components must be a *forward-looking* estimate—estimates of what will be true in the future. In practice, survey results show substantial disagreements on how to estimate all three components.

The risk-free rate of return

As originally derived, the CAPM is a single-period model, so the question of which interest rate best represents the risk-free rate never arises. But in a many-period world, typically characterized by upward-sloping yield curves, the practitioner must choose. Interviews show the choice is typically between the 90-day T-bill yield and a long-term Treasury bond yield. (Because the yield curve ordinarily is relatively flat beyond 10 years, the choice of which particular long-term yield to use is not a critical one.) The difference between realized returns on the 90-day T-bill and the 10-year T-bond has averaged 150 basis points over the past 70 years, which emphasizes the material impact that the choice of a risk-free rate can have on estimates of the cost of equity.

Ninety-day T-bill yields are more consistent with the CAPM as a single period model and reflect truly risk-free returns in the sense that T-bill investors avoid material loss in value from interest-rate movements. However, long-term bond yields more closely reflect the default-free holding period returns available on long-lived investments, and thus more closely mirror the types of investments made by companies.

Survey results reveal a strong preference on the part of practitioners for long-term bond yields. For both corporations and financial advisors, 70% use Treasury-bond yields maturities of 10 years or greater. None of the financial advisors, and only 4% of the corporations used the Treasury-bill yield. Many corporations said they matched the term of the risk-free rate to the tenor of the investment. For example, here is the response to the question, "What do you use for a risk-free rate?": "Ten-year Treasury bond or other duration Treasury bond if needed to better match project horizon." In contrast, 43% of the books advocated the T-bill yield, while only 29% used long-term Treasury yields.

Beta estimates

Finance theory calls for a forward-looking beta, one reflecting investors' uncertainty about the future cash flows to equity. Because forward-looking betas are unobservable, practitioners are forced to rely on proxies of various kinds. Most often, this involves using beta estimates derived from historical data and published by such sources as Bloomberg, Value Line, and Standard & Poor's.

The usual methodology is to estimate beta as the slope coefficient of the market model of returns:

$$r_{it} = \alpha_i + \beta_i (r_{mt})$$

$$\begin{aligned} \text{where : } r_{it} &= \text{past return on stock i in time period (e.g., day, week, month) t,} \\ r_{mt} &= \text{past return on the market portfolio in period t,} \\ \alpha_i &= \text{regression constant for stock i.} \\ \beta_i &= \text{beta for stock i.} \end{aligned}$$

In addition to relying on historical data, use of this equation to estimate beta requires a number of practical compromises, each of which can materially affect the results. For instance, increasing the number of time periods used in the estimation may improve the statistical reliability of the estimate, but it risks including stale, irrelevant information. Similarly, shortening the observation period from monthly to weekly or even daily, increases the size of the sample, but it may yield observations that are not normally distributed and may introduce unwanted random noise. A third compromise involves choice of the market index. Theory dictates that r_m is the return on the "market portfolio," an unobservable portfolio consisting of all risky assets—including human capital and other nontraded assets—in proportion to their importance in world wealth. Beta providers use a variety of stock market indices as proxies for the market portfolio on the argument that stock markets trade claims on a sufficiently wide array of assets to be adequate surrogates for the unobservable market portfolio.

The table below shows the compromises underlying the beta estimates of three prominent providers and their combined effect on the beta estimates for the sample companies interviewed. Note, for example, that the mean beta of sample companies, according to Bloomberg is 1.03, while the same number, according to Value Line, is 1.24.

Compromises Underlying Beta Estimates and Their Effect on Estimated Betas of Sample Companies

	Bloomberg*	Value Line	Standard & Poor's
Number of observations	102	260	60
Time interval	weekly over 2 yrs.	weekly over 5 yrs.	monthly over 5 yrs.
Market index proxy	S&P 500	NYSE composite	S&P 500
Sample mean beta	1.03	1.24	1.18
Sample median beta	1.00	1.20	1.21

**With the Bloomberg service it is possible to estimate a beta over many differing time periods, market indices, and smoothed or unadjusted. The figures presented here represent the base-line or default-estimation approach used, if one does not specify other approaches.*

Over half of the corporations rely on published sources for their beta estimates, although 30% calculate their own. Among financial advisors, 40% rely on published sources, 20% calculate their own, and another 40% use what might be called "fundamental" beta estimates. These are estimates that use multi-factor statistical models, drawing on fundamental indices of firm and industry risk to estimate company betas. The best-known provider of fundamental beta estimates is the consulting firm BARRA (http://www.barra.com).

Within these broad categories, the following comments indicate that a number of survey participants use more pragmatic approaches, which combine published beta estimates or adjust published estimates in various heuristic ways.

"What do you use as your volatility or beta factor?" A sampling of responses shows the choice is not always a simple one.

- "We use adjusted betas reported by Bloomberg. At times, our stock has been extremely volatile. If at a particular time the factor is considered unreasonably high, we are apt to use a lower (more consistent) one."
- "We begin with the observed 60-month covariance between our stock and the market. We also consider Value Line, Barra, S&P betas for comparison and may adjust observed beta to match assessment of future risk."
- "We average Merrill Lynch and Value Line figures and use Bloomberg as a check."
- "We do not use betas estimated on our stock directly. Our company beta is built up as a weighted average of our business segment betas—the segment betas are estimated using pure-play firm betas of comparable companies."

Equity market risk premium

The topic of the equity market risk premium ($R_m - R_f$) prompted the greatest variety of responses among survey participants. Finance theory says the equity market risk premium should equal the excess return expected by investors on the market portfolio, relative to riskless assets. How one measures expected future returns on the market portfolio and on riskless assets is a problem left to practitioners. Because expected future returns are unobservable, all of the survey respondents extrapolated historical returns into the future on the presumption that past experience heavily conditions future expectations. Where respondents chiefly differed was in their use of arithmetic versus geometric-average historical equity returns, and in their choice of realized returns on T-bills versus T-bonds to proxy for the return on riskless assets.

The arithmetic mean return is the simple average of past returns. Assuming the distribution of returns is stable over time and that periodic returns are independent of one another, the arithmetic return is the best estimator of expected return. The geometric mean return is the internal rate of return between a single outlay and one or more future receipts. It measures the compound rate of return investors earned over past periods. It accurately portrays historical investment experience. Unless returns are the same each time period, the geometric average will always be less than the arithmetic average, and the gap will widen as returns become more volatile.[2]

Based on Ibbotson's data (1995) from 1926 to 1995, the matrix below illustrates the possible range of equity market risk premiums depending on use of the geometric as opposed to the arithmetic mean-equity return, and on use of realized returns on T-bills as opposed to T-bonds.[3] Even wider variations in market-risk premiums can arise when one changes the historical period for averaging. Extending U.S. stock experience back to 1802, Siegel (1992) shows that historical market premia have changed over time and were typically lower in the pre-1926 period. Carleton and Lakonishok (1985) illustrate considerable variation in historical premia using different time periods and methods of calculation even with data since 1926.

[2] For instance, if one invested a dollar today and received \$1.21 in two years, the geometric average annual return would be calculated as $\$1.21 = \$1(1 + r)^2$. Solving yields a return r of 10%. For large samples of returns the geometric average can be approximated as the arithmetic average minus one half the variance of realized returns. Ignoring sample size adjustments, the variance of returns in the current example is .09 yielding an estimate of .10 - ½(.09) = .055 = 5.5% versus the actual 5.8% figure. Kritzman (1994) provides an interesting comparison of the two types of averages.

[3] These figures are drawn from Table 2-1, Ibbotson (1995), where the market return was drawn from the "Large Company Stocks" series, and the risk-free rate drawn from the "Long-Term Government Bonds" and "U.S. Treasury Bills" series. These long-term averages change slowly over time and the figures in the table reflect data at the time of the survey. By year end 2003, using the same source of data, the figures were 8.6% and 6.7% (versus T-bills) and 6.6% and 5.0% (versus T-bonds).

The Equity Market Risk Premium
(R_m - R_f)
Estimated Using U.S. Historical Data (1926-1995)

	T-Bill Returns	T-Bond Returns
Arithmetic Mean Return	8.5%	7.0%
Geometric Mean Return	6.5%	5.4%

Among texts and trade books in our survey, 71% support use of the arithmetic mean return over T-bills as the best surrogate for the equity market-risk premium. A minority view is that of Copeland, Koller, and Murrin (1990, pp. 193–194), writing on behalf of the Corporate Financial Practice at McKinsey & Company: "We believe that the geometric average represents a better estimate of investors' expected over long periods of time." Ehrhardt (1994) recommends use of the geometric mean return if one believes stockholders are "buy-and-hold" investors.

Half of the financial advisors queried use a premium consistent with the arithmetic mean and T-bill returns, and many specifically mentioned use of the arithmetic mean. Corporate respondents, on the other hand, evidenced more diversity of opinion, and tend to favor a lower market premium: 37% use a premium of 5–6%, and another 11% use an even lower figure.

One concern sometimes mentioned in using past U.S. returns to estimate a risk premium is the belief that the U.S. equity market (over the last 70 years) reflects a particularly strong period for the U.S. economy relative to the rest of the world. If the U.S. companies and markets are not expected to do as well in the future, then historical U.S. returns will lead to overestimates of a forward-looking premium.

Comments contained in interviews (as shown in the following box) suggest the diversity among survey participants. While most of the sample companies appear to use a 60-plus year historical period to estimate returns, one cited a window of less than 10 years, two cited windows of about 10 years, one began averaging with 1960, and another with 1952 data.

"What do you use as your market risk premium?" A sampling of responses from our best practice companies shows the choice can be a complicated one.

- "Our 400-basis-point market premium is based on the historical relationship of returns on an actualized basis and/or investment bankers' estimated cost of equity based on analysts' earnings projections."

- "We use an Ibbotson arithmetic average starting in 1960. We have talked to investment banks and consulting firms with advice from 3 to 7%."

- "A 60-year average of about 5.7%. This number has been used for a long time in the company and is currently the subject of some debate and is under review. We may consider using a time horizon of less than 60 years to estimate this premium."

- "We are currently using 6%. In 1993, we polled various investment banks and academic studies on the issue as to the appropriate rate and got anywhere between 2 and 8%, but most were between 6 and 7.4%."

Comments from financial advisors also were revealing. While some simply responded that they use a published historical average, others presented a more complex picture.

- "We employ a self-estimated 5% (arithmetic average). A variety of techniques are used in estimation. We look at Ibbotson data and focus on more recent periods, around 30 years (but it is not a straight 30-year average). We use smoothing techniques, Monte Carlo simulation, and a dividend discount model on the S&P 400 to estimate what the premium should be, given our risk-free rate of return."

- "We use a 7.4% arithmetic mean, after Ibbotson, Sinquefeld. We used to use the geometric mean, following the then-scholarly advice, but we changed to the arithmetic mean when we found later that our competitors were using the arithmetic mean and scholars' views were shifting."

This variety of practice should not come as a surprise since theory calls for a forward-looking risk premium, one that reflects current market sentiment and may change with market conditions. What is clear is that there is substantial variation as practitioners try to operationalize the theoretical call for a market risk premium. A glaring result is that few respondents specifically cited the use of any forward-looking method to supplement or replace reading the tea leaves of past returns.[4]

A pragmatic bent of application comes to the fore when companies are asked how often they re-estimate capital costs. Even for those firms who re-estimate relatively frequently, the comments below show that they draw an important distinction between estimating capital costs and policy changes about the capital cost figure used in the firm's decision making.

How frequently do you re-estimate your company's cost of capital? Here are responses from best practice companies.

- "We usually review it quarterly, but would review more frequently if market rates changed enough to warrant the review. We would only announce a change in the rate if the recomputed number was materially different than the one currently being used."
- "We re-estimate it once or twice a year, but we rarely change the number that the business units use for decision and planning purposes. We expect the actual rate to vary over time, but we also expect that average to be fairly constant over the business cycle. Thus, we tend to maintain a steady discount rate within the company over time."
- "Usually every six months, except in case of very large investments, in which it is re-estimated for each analysis."
- "Whenever we need to, such as for an acquisition or big investment proposal."
- "Re-evaluate as needed, e.g., for major tax changes, but unless the cost of capital change is significant (a jump to 21%, for instance), our cutoff rate is not changed; it is used as a *yardstick* rather than the last word in project evaluation."
- "Probably need 100 basis point change to publish a change. We report only to the nearest percent."

[4]Only two respondents (one advisor and one company) specifically cited forward-looking estimates, although others cited use of data from outside sources (e.g., a company using an estimate from an investment bank) where we cannot identify whether forward-looking estimates were used. Some studies using financial analyst forecasts in dividend growth models suggest market risk premia average in the 6 to 6.5% range and change over time with higher premia when interest rates decline. See for instance, Harris & Marston (1992). Ibbotson (1994) provides industry-specific cost-of-equity estimates using analysts' forecasts in a growth model.

Firms consider administrative costs in structuring their policies on capital costs. For a very large venture (e.g., an acquisition), capital costs may be revisited each time. On the other hand, only large material changes in costs may be fed into more formal project-evaluation systems. Firms also recognize a certain ambiguity in any cost number and are willing to live with approximations. While the bond market reacts to minute basis-point changes in investor-return requirements, investments in real assets—where the decision process itself is time-consuming and often decentralized—involve much less precision. To paraphrase one of our sample companies, we use capital costs as a rough yardstick rather than the last word in project evaluation.

Conclusions

This note outlined the varieties of practice applying the CAPM, the arguments in favor of different approaches, and the practical implications.

In summary, we believe that the following elements represent "best current practice."

- The *CAPM* is currently the preferred model for estimating the cost of equity.
- *Betas* are drawn substantially from published sources, preferring those betas using a long interval of equity returns. Where a number of statistical publishers disagree, best practice often involves judgment to estimate a beta.
- The *risk-free rate* should match the tenor of the cash flows being valued. For most capital projects and corporate acquisitions, the yield on the U.S. government Treasury bond of 10 or more years in maturity would be appropriate.
- *Choice of an equity market risk premium* is the subject of considerable controversy, as to both its value and method of estimation. Most of our "best practice" companies use a premium of 6% or lower, while many texts and financial advisors use higher figures.

The survey results are a reminder that applying the CAPM requires practical compromises. This has important implications for how managers estimate the cost of capital and use it in decision making. First, do not mistake capital budgeting for bond pricing. Despite the tools available, effective capital appraisal continues to require thorough knowledge of the business and wise business judgment. Second, be careful not to throw out the baby with the bath water. Do not reject the cost of capital and attendant advances in financial management because your finance people are not able to give you a precise number. When in need, even an approximate figure is better than nothing.

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