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APPLYING THE CAPITAL ASSET PRICING MODEL

This note discusses how some of the most financially sophisticated companies and financial advisers 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 ranked by peer companies as industry leaders and (2) a sample of 11 of the most active financial advisers (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 90% of firms and all the financial advisers employing this model. Moreover firms and advisers seldom mentioned other asset-pricing models.

Yet disagreements exist on how to apply the CAPM. The CAPM states that the required return (R) on any asset can be expressed as **Equation 1**:

$$R = R_f + \beta(R_m - R_f) \quad (1)$$

[1] Survey evidence and much of the discussion is adapted from T. Brotherson, K. Eades, R. Harris, and R. Higgins, "'Best Practices' in Estimating the Cost of Capital: An Update," *Journal of Applied Finance* 23, no. 1 (2013), which is an update of an earlier article: R. Bruner, K. Eades, R. Harris, and R. Higgins, "'Best Practices' in Estimating the Cost of Capital: Survey and Synthesis," *Financial Practice and Education* (Spring/Summer 1998). The 2013 study reports these results plus others on the weighted average cost of capital. The study chose leading firms using *Fortune's* list of Most Admired Companies. Firms were selected based a survey of 698 companies that ranked other companies on a number of criteria including wise use of corporate assets. "Activity" for investment banks was defined as aggregate U.S. mergers and acquisitions deal volume (in 2011) based on Thomson's SDC Mergers and Acquisitions database. Brotherson et al. use the four top-selling, graduate-level textbooks in corporate finance (2011) and two leading trade books.

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

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 = *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. Short-term T-bill yields are more consistent with the CAPM as originally derived and reflect risk-free returns in the sense that T-bill investors avoid material loss in value from interest rate movements. Long-term bond yields, however, 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: all the corporations and financial advisers use Treasury bond yields for maturities of 10 years or greater, with the 10-year rate being the most popular choice. Many corporations said they matched the term of the risk-free rate to the tenor of the investment maturity. Because ordinarily the yield curve is relatively flat beyond 10 years, the choice of which particular long-term yield to use often is not a critical one.[2]

[2] We note, however, that turmoil in financial markets can make the choice of the risk-free rate more complex. For instance, in 2012 (the year of the survey evidence), short-term treasury rates were close to zero, and the spread between 10- and 30-year Treasury yields averaged over 100 basis points in the wake of a financial crisis and expansive monetary policy. Although the text and trade books do not directly address the question of how to deal with such markets, it is clear that some practitioners look for ways to "normalize" what they see as unusual circumstances in government bond markets. For example, 21% of corporations and 36% of financial advisers resort to some historical average of interest rates rather than the spot rate in the markets. Such an averaging practice is at odds with finance theory in which investors see the current market rate as the relevant opportunity.

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. Typically, this involves using beta estimates derived from historical data.

The usual methodology is to estimate beta as the slope coefficient of the market model of returns (**Equation 2**):

$$r_{it} = \alpha_i + \beta_i (r_{mt}) \quad (2)$$

where:

r_{it} = *past return on stock i in time period (e.g., day, week, month) t,*

r_{mt} = *past return on the market portfolio in period t,*

α_i = *regression constant for stock i.*

β_i = *beta for stock i.*

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.

Another approach is to "predict" beta based on underlying characteristics of a company. According to Barra, a leading risk measurement service:

> Predicted beta, the beta Barra derives from its risk model, is a forecast of a stock's sensitivity to the market. It is also known as fundamental beta because it is derived from fundamental risk factors…such as size, yield, and volatility—plus industry exposure. Because we reestimate these risk factors daily, the predicted beta reflects changes in the company's underlying risk structure in a timely manner.[3]

Table 1 below shows the compromises underlying the beta estimates of three prominent providers (Bloomberg, Value Line, and Barra) and their combined effect on the beta estimates of our sample companies. The mean beta of our sample companies is similar from all providers: 0.96 from Bloomberg, 0.93 according to Value Line, and 0.91 from Barra. But the averages mask differences for individual companies. For instance, for the sample companies, the median range between the highest and lowest beta estimate was .21, and the range was .30 or higher for 16% of the sample.

Table 1. Compromises underlying beta estimates
and their effect on estimated betas of sample companies.

	Bloomberg*	**Value Line***	**Barra**
Number of observations	102	260	Statistical models
Time interval	Weekly over 2 yrs.	Weekly over 5 yrs.	using company
Market index proxy	S&P 500	NYSE composite	characteristics
Sample mean beta	0.96	0.93	0.91
Sample median beta	0.98	0.90	0.96

*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 baseline or default-estimation approach used if one does not specify other approaches. Value Line states that "the Beta coefficient is derived from a regression analysis of the relationship between weekly percentage changes in the price of a stock and weekly percentage changes in the NYSE Index over a period of five years. In the case of shorter price histories, a smaller time period is used, but two years is the minimum. The betas are adjusted for their long-term tendency to converge toward 1.00."

Over half of the corporations in our sample cite Bloomberg as the source for their beta estimates, and some of the 37% that say they calculate their own might use Bloomberg data and programs. Out of the sample companies, 26% cite some other published source, and 26% explicitly compare a number of beta sources before making a final choice. Among financial advisers, there is strong reliance on fundamental betas with 89% of the advisers using Barra as a source. Many advisers (44%) also use Bloomberg. In response to a question about using data from other firms, the majority of companies and all advisers take advantage of data on comparable companies to inform their estimates of beta and capital costs. In other words, practitioners routinely use comparable company data realizing the inherent measurement error in any single beta calculation. To deal with differences in debt-equity mix across companies, about a third of both companies and

[3] *Barra Risk Model Handbook*, MSCI, 2007, www.Barra.com/support/library\. The actual quote from 2007 mentions monthly updating. In obtaining Barra data, we learned that updates are now daily, so we have substituted that in the quotes since we did not find an updated reference.

financial advisers mentioned levering and unlevering betas even though we did not ask them for this information.

Within these broad categories, the comments below indicate that many survey participants use pragmatic approaches to combine published beta estimates or adjust published estimates in various heuristic ways.

We asked our sample companies and advisers what they used as their beta estimate. A sampling of responses shows the choice is not always a simple one.

- "We use Bloomberg's default calculation. We take special care to support beta chosen if doing an acquisition or major investment."
- "We use Bloomberg (both historical and historical adjusted) plus Barra and calibrate based on comparing the results."
- "We use our beta and check against those of competitors. We unlever the peers and then relever to our capital structure. The results come pretty close to our own beta, so that's confirming."
- "We use the median beta of comparable companies, based on analysis of size and business. We have a third party identify comparable companies and betas."
- "We use Barra and Bloomberg and triangulate based on those numbers. The problem comes up for getting a pure play for a division or a company that hasn't been public for a long time. We then have to pick comparable companies."
- "Each line of business has its own peer group of companies and cost of capital. Using five-year betas from Bloomberg, we find an average unlevered beta for the peer group and then relever to our corporate-wide capital structure."

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, past surveys of practice have routinely revealed a wide array of choices for the market risk premium.[4]

How do our best practice companies cope? Among financial advisers, 73% extrapolate U.S. historical returns into the future on the presumption that past experience heavily conditions

[4] For instance, Fernandez et al. (2011) survey professors, analysts, and companies on what they use as a U.S. market risk premium. Of those who reported a reference to justify their choice, the single most-mentioned source was Ibbotson/Morningstar, but even among those citing this reference, there was a wide dispersion of market risk premium estimates used.

future expectations.[5] Among companies, 43% cite historical data, and another 16% use various sources inclusive of historical data. Unlike the results of our earlier study (1998) in which historical returns were used by all companies and advisers, we found a number of respondents (18% of financial advisers and 32% of companies) using forward-looking estimates of the market risk premium. The advisers cited versions of the dividend discount model. The companies used a variety of methods including Bloomberg's version of the dividend discount model.[6]

Even when historical returns are used to estimate the market risk premium, a host of differences emerge including what data to use and what method to use for averaging. For example, a leading textbook cites U.S. historical data[7] back to 1900 from Dimson, Marsh, and Staunton,[8] while 73% of our financial advisers cite Ibbotson data, which traces U.S. history back to 1926. Among companies, only 32% explicitly cite Ibbotson as their main reference for data, and 11% cite other historical sources.

Even using the same data, another chief difference was in their use of *arithmetic* versus *geometric* averages. 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 widens as returns become more volatile.[9]

Based on Ibbotson data (2012) from 1926 to 2011, **Table 2** 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. Even wider variations in market risk premiums can arise when one changes the historical period for averaging or decides to use data from outside the United States.

[5] With only minor exceptions, respondents used U.S. data rather than relying on global indices for both their estimates of beta and the market risk premium. Dimson, Marsh, and Staunton (2011a) discuss historical estimates of the market risk premium using data from many countries.

[6] Company respondents sometimes noted that they used the Bloomberg estimate of the market risk premium but did not have detailed knowledge of the calculation. As described by Bloomberg, their estimates of country risk premiums are based on projections of future dividends in a multistage dividend discount model.

[7] Richard R. Brealey, Stewart C. Myers, and Franklin Allen, *Principles of Corporate Finance* (New York: McGraw-Hill/Irwin, 2011), 158.

[8] E. Dimson, P. Marsh, and M. Staunton, "Equity Premia around the World," SSRN London Business School working paper, October 7, 2011, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1940165 (accessed Mar. 20, 2014).

[9] See Brealey, Myers, and Allen, 158–59, for the argument to support use of an arithmetic mean. For large samples of returns, the geometric average can be approximated as the arithmetic average minus one-half the variance of realized returns.

Table 2. Historical averages to estimate the equity market risk premium, ($R_m - R_f$).

	Relative to T-Bill Returns	Relative to T-Bond Returns
Arithmetic mean	8.2%	5.7%
Geometric mean	6.0%	3.9%

Since our respondents all used longer-term Treasuries as their risk-free rate, the right-most column of table most closely fits that choice. But even when respondents explicitly referenced the arithmetic or geometric mean of historical returns, many rounded the figure or used other data to adjust their final choice. The net result is a wide array of choices for the market risk premium. For respondents who provided a numerical figure the average for companies was 6.49%, very close to the average of 6.6% from financial advisers. But these averages mask considerable variation in both groups. We had responses as low as 4% and as high as 9%. The 4% value is in line with the Ibbotson historical figures using the geometric mean spread between stocks and long-term government bonds. The upper end of 9% comes from forward-looking estimates done in 2012 when U.S. financial markets reflected a very low interest rate environment. We add a word of caution in how to interpret some of the differences we found in the market risk premium since the ultimate cost of capital calculation depends on the joint choice of a risk premium, the risk-free rate, and beta.

As shown below, comments in our interviews exemplify the diversity among survey participants. This variety of practice displays the challenge of application since theory calls for a forward-looking risk premium 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. And as is clear in some of the respondent comments, volatility in markets has made the challenge even harder.

As to the question of what companies used as their market risk premium, a sampling of responses from our best-practice companies shows the choice can be a complicated one:

- "We take an average of arithmetic mean and geometric mean for equity risk premium."
- "5.5% to 6.5%. Reflects a judgmental synthesis of various academic views and financial market perspectives."
- "Estimate a forward-looking risk premium. Use a methodology that incorporates S&P P/E ratio. It is a more volatile metric than using a historical risk premium. Use historicals as a sanity check."
- "6.5% to 7%. We ask several banks how we compare to comparable companies, including comparable size and industry."
- "Use the long-term (1926–2011) Ibbotson's S&P 500 premium over the risk-free rate."

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

- "We used to apply the geometric mean, and then we switched to arithmetic. Now we use 4.6% to 6.6%, so we'll show for both ends of that distribution. Based mainly on Ibbotson but may add to that for emerging market companies."
- "Forward-looking estimate using dividend discount model…bank's proprietary model, which is forward-looking and uses S&P price level, plus projections and payout to get an implied cost of equity."

A pragmatic bent of application comes to the fore when companies are asked how often they re-estimate capital costs. Even for those firms that 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 re-estimate] annually unless a fundamental event that is a game changer occurs, such as the banking crisis in 2008."
- "[We re-estimate] once a year."
- "We re-estimate twice a year and for special events such as a major acquisition."
- "We calculate the hurdle rate each year. We try to avoid any changes less than plus or minus 25 basis points."
- "Formally, we re-estimate our cost of capital every quarter, but generally we have used 10% for a long time, which seems to have been successful so far."

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. But 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 as the last word in project evaluation.

Conclusions

This note outlined the varieties of practice for 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. Moreover, practitioners often look to data on comparable companies to help benchmark an appropriate 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. While the market risk premium averages about 6.5% across both our best-practice companies and financial advisers, the range of values cited is high.

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. Best practice companies cannot expect to estimate their cost of equity with the types of precision typical in bond markets. Second, be careful not to throw out the baby with the bath water. Do not reject estimates of 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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