

## The Equity Risk Measurement Handbook

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- The corporate cost of equity capital is determined in part by the market risk premium for equities – that is, the amount by which the return on stocks as a group is expected to exceed the risk-free rate. Our study estimates the market risk premium over today's long bond to be about 5 percentage points.
- The long bond is considered a risk-free investment in terms of the risk of default. However, bond returns are positively correlated with the stock market, implying that the bonds have a level of systematic risk. Thus, the truly riskless (or zero-beta) interest rate is lower than the long bond yield by the systematic, or market, component of the risk.
- Market risk premiums have been understated by the same amount that the riskless rate has been overstated. In our study, we increased the historical market risk premium by the systematic component of the risk of holding bonds to arrive at an adjusted market risk premium.
- We present several alternative methods to derive more reliable estimates of beta.
- Finally, we provide benchmark reference data for cost of capital by industry.

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## OVERVIEW

**Perceived limitations of the CAPM arise largely from application difficulties ...**

Estimating the cost of capital is a critical step both in valuing investment opportunities and in evaluating the ongoing operating performance of business units. In valuing a business or contemplated investment, the weighted average cost of capital provides the discount rate in the net present value (NPV) calculation. And, for value-based management systems like EVA<sup>®</sup>, the weighted average cost of capital serves as the benchmark to create value.

This article focuses on issues that arise when using the Capital Asset Pricing Model to calculate the cost of equity capital. The CAPM formulates the expected, or minimum required, rate of return on a company's stock (or any asset) as follows:

**... we propose assistance with two common areas of difficulty – the market risk premium, and the measure of systematic risk in companies, or “beta”**

$$E(R_i) = R_f + \beta_i \times [E(R_m) - R_f]$$

where  $R_f$  is the return on a risk-free asset,  $E(R_m)$  is the expected return on the market, and  $\beta_i$  is a measure of the risk of company or asset in question relative to the market. While there have been challenges to the CAPM, it remains the most practical approach available to determine a cost of equity. In fact, the perceived limitations of the model arise in large part from problems in applying the model. In this article, we draw on our research and consulting experience to provide suggestions for dealing with two of the primary difficulties in applying the CAPM: (1) estimating the market risk premium, and (2) measuring the systematic risk, or “beta,” of a company.

## WHAT DO INVESTORS REALLY EXPECT?

**Estimates of market risk premium vary from 3% to 8% ...**

Depending on whom you ask, the return premium afforded by stocks over government long bonds is anywhere from 3 to 8 percentage points. Not surprisingly, sellers hope to use the lower end of this range to justify a higher price, while buyers tend to the upper range. And, in the wake of the run-up in stock prices and P/E ratios in recent years, analysts who wish to reconcile intrinsic values with market prices are more inclined to use lower premiums.

**... we suggest investors expect about a 5% premium over long term government bonds ...**

Other observers, however – a group that includes many academic economists – continue to use the higher estimates. For example, following the example of the widely cited Ibbotson and Sinquefeld study, most academic studies of the U.S. market risk premium start from 1926 (some go back even farther). The assumption underlying this practice is the more data the better. Provided the data represent a “random walk” and there are no discernible trends up or down, more observations lead to greater predictive accuracy.

But what if structural trends enter the picture? We believe that structural economic and market changes in the past century have in fact produced a trend that makes the early data much less relevant for estimating current expected returns on capital<sup>1</sup>. As summarized below, several factors have worked together to cause us to use a shorter history (50 year) for our analysis than do most.

**... structural trends work to reduce the relevance of the earlier data ...**

We show that the resulting risk of holding equities has generally declined. At the same time, the risk of investing in government bonds has increased, thus reducing the premium between the two classes of securities. Indeed, we believe that stock market investors today expect about a 5% premium over long-term government bonds. As discussed below, this estimate is based on the arithmetic average of annualized monthly stock return premiums.<sup>2</sup>

<sup>1</sup> In “The End of the Business Cycle” (*Foreign Affairs*, Volume 76 Number 4 (July/August 1997), Steven Weber of University of California at Berkeley makes a strong case for fundamental structural economic and capital market changes making observations of events in U.S. history less representative of responses in the future. Consistent with this argument, Rick Escherich of JPMorgan’s M&A Department Analysis Policy Group argues for both a shorter relevant history in developing the U.S. market risk premium and a beta-adjusted risk-free rate to allocate all market risk to the market risk premium, “Estimating the U.S. Cost of Equity” (September, 1994).

<sup>2</sup> The study is based on monthly returns on the S&P500 index (which included only 90 stocks before 1957) and on U.S. Treasury long bonds, from 1926 through 2000. We reran the study using a value-weighted index that included all NYSE, AMEX and NASDAQ stocks as a market proxy. Because the results were not materially different from the ones using



### What Has Changed?

Several factors contribute to support the notion that earlier history may be less relevant to the ex post derivation of expected equity returns. However, in addition to the following qualitative, theoretical underpinning, we have empirically measured and documented the effects of structural change, charted in these pages.

We outline below some of the forces that have led us to rely principally on the past five decades, rather than the more conventional 75-year view.

**Globalization and growth.** Worldwide market capitalization has tripled in the past ten years. Larger markets afford more liquidity, less volatility, and hence less risk. Whether in toys, textiles, automobiles or commodities, global sourcing and production have increasingly become a fact of life. The growth of emerging markets (typically double those for the developed world) often serve to buffer the down cycles of developed economies.

Emerging markets also help drive developed economies to invest further in human and technical capital. Emerging market volatility is often, in turn, buttressed by the developed markets. Although claims of a borderless global economy are vastly overstated, there is a reduced sensitivity to the economics of any single nation, which reduces systematic risk.<sup>3</sup>

**Labor mobility.** The nature of employment has changed with tremendous growth in the total service sector. Service and manufacturing cycles can be somewhat offsetting. Service economies also have less fixed cost and are thus less susceptible to pricing pressures in times of overcapacity. The trend toward marketable and mobile knowledge workers helps reduce fixed costs and increase resource allocation within the economy.

**Market sophistication.** The proliferation of risk management products (i.e., derivatives) has increased the liquidity of risk, allowing it to be isolated, traded, syndicated and more actively managed. Most individuals invest in the market through funds and institutions leading to an increased sophistication and fundamental change in the nature of our equity markets.

**Information & information technology.** Disclosure is more immediate and comprehensive, reducing uncertainty and thus required returns. Notwithstanding, Regulation FD, segment data, reporting requirements, and analyst coverage are all more extensive and of higher quality today than 50 years ago. Information technology has reduced the price and raised the quality of information processing.

**Agency costs.** From the success of LBOs to the widespread adoption of EVA®, large investors today are much more active in influencing companies to maximize shareholder value, which also reduces the risk of common stock. The importance of reduced agency costs and ownership concentration in improving corporate performance are well documented.

**Government regulation and policy.** An international political economy with subdued business cycles in the industrial core operates differently than earlier political economies. Liberalization of developing economies, establishment of trading blocks, and opening of international trade have all contributed to global economic growth, despite tremendous political change and upheaval. Prudent monetary policies of the Federal Reserve and its foreign counterparts, as well as the general liberalization of regulatory policies, have also reduced the volatility of business cycles.

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S&P500 data, and since S&P500 returns are easier for practitioners to access, we recommend using the S&P500 index as a market proxy.

<sup>3</sup>This is documented empirically for the case of Bestfoods. See Justin Pettit, Mack Ferguson and Bob Gluck, "Global Corporate Capital Costs: The Case of Bestfoods," *Journal of Applied Corporate Finance*, Vol. 12 No. 3 (Fall 1999).



**Some have suggested that the U.S. may be our best proxy for a global market risk premium ...**

### **A Global Risk Premium?**

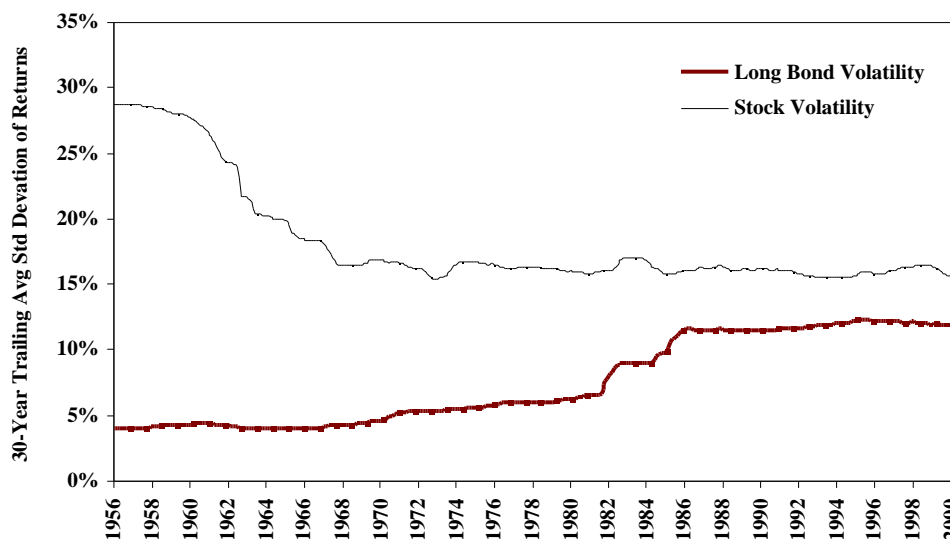
Under the forces of globalism and capital market convergence, some experts have suggested that, increasingly, the U.S. market may serve as the best proxy for a future global market risk premium.<sup>4</sup> The United States has the largest economy and the most sophisticated and liquid capital markets. Consequently, the 5 percent risk premium might be used in other markets, after adjusting for differences in tax, etc.

Current and future differences in taxes, treatment of dividends, etc. may make a global market risk premium premature. Yet foreign market derivations of market risk premiums can be undermined by inadequate or unreliable historical information, irrelevant history and liquidity issues, making much of the analysis and its conclusions suspect both for many major and emerging markets.

### **Converging Volatilities & Risk Migration**

**The volatility of stocks versus bonds has decreased ...**

The volatility of stock returns versus bond returns has decreased. As shown in Figure 1, the trailing average standard deviation of annualized monthly stock returns fell from 29% in the 1950s to about 16% in 2000. During that period, the standard deviation of bond returns increased from 4% to almost 12%.<sup>5</sup>



**Figure 1: Converging Volatility of Stocks and the Long Bond**

**... the return premiums of stocks versus bonds has decreased ...**

The premium of stock returns over bond returns has decreased. As shown in Figure 2, the trailing average real return on stocks fell from over 12% in the 1950s to less than 10% by the end of 2000. During the same time, the average real return on bonds, after falling from about 2% to -2% in the early '80s, increased to almost 5% by the end of 2000. And, since the average rate of inflation increased sharply over this period, the nominal return on bonds increased even more.

<sup>4</sup> An excellent discussion of globalism and its impact on integrated and integrating capital markets leading both to falling risk premiums and risk premium convergence is presented by Rene Stulz, "Globalization, Corporate Finance, and the Cost of Capital," *Journal of Applied Corporate Finance*, Vol. 12 No. 3 (Fall 1999).

<sup>5</sup> In our study we used all available historical returns, from 1926 through 2000. Because we used 30 years of data to calculate the trailing averages, the graphs begin in 1956. The same trends emerge when using 10 and 20-year averaging periods instead of 30 years.

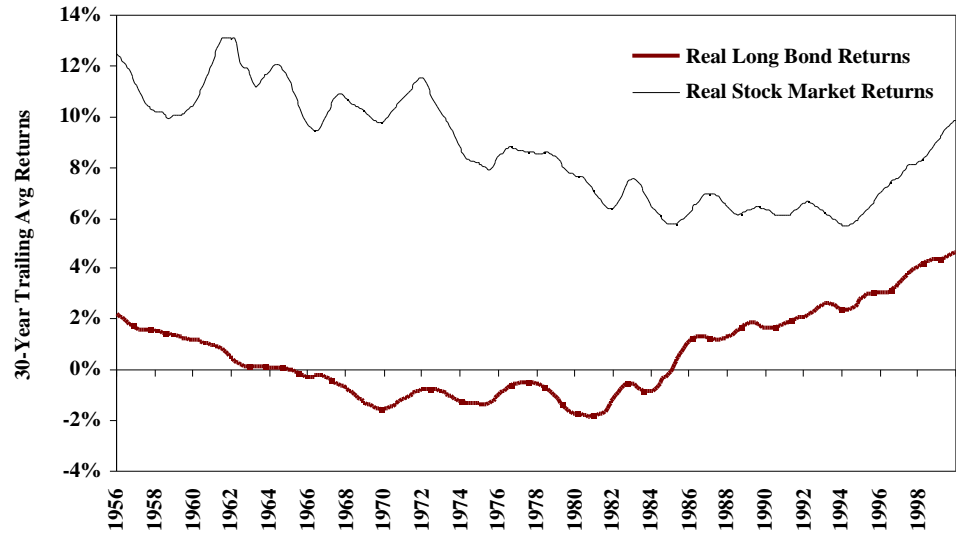


Figure 2: Converging Real Total Returns – Stocks and the Long Bond

**The risk premium between stocks and bonds is about 5%**

Thus, consistent with the changes in relative volatility over the past five decades, the premium investors received for stocks relative to bonds (as shown in Figure 3) fell from over 10% to about 5%. This drop in the risk premium was attributable not only to a reduction in the level of stock market risk, but also to an increase in real required returns on bonds.

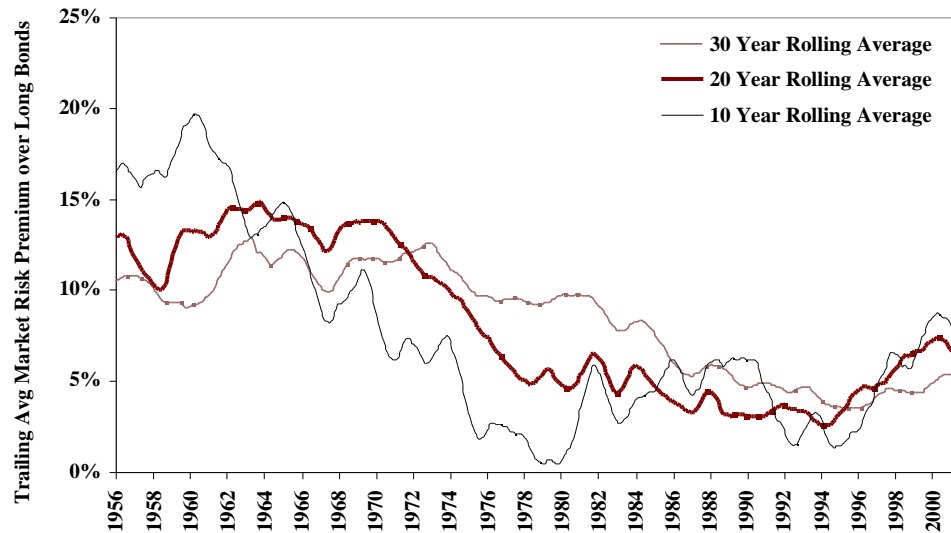


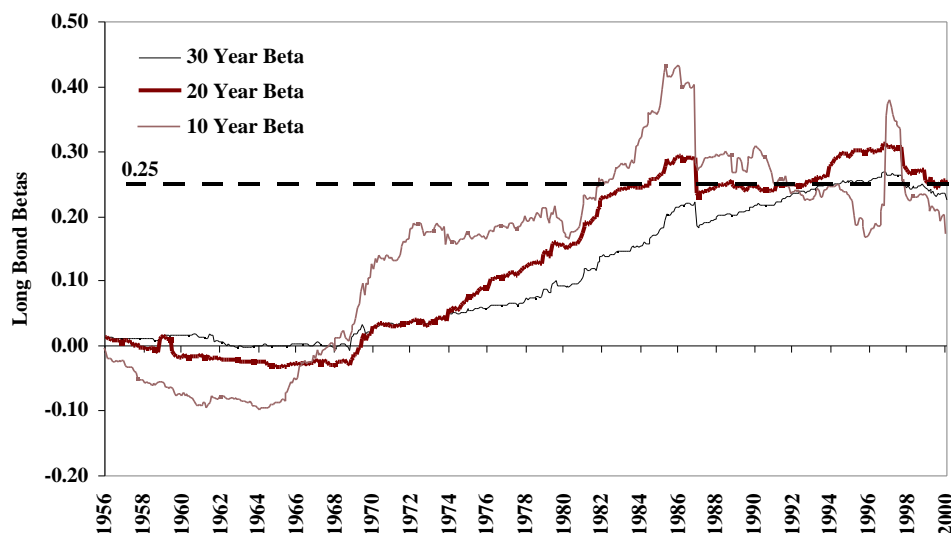
Figure 3: Declining Unadjusted Market Risk Premium



### “Risk-free” Is Not “Riskless”

**The long bond rate is not a truly riskless rate ...**

As we know, the market risk premium represents the amount by which the return on the market portfolio of stocks is expected to exceed the risk-free interest rate. Thus far, we have been using the long bond rate as a proxy for the risk free rate.<sup>6</sup> But, in fact, as recent research<sup>7</sup> has shown, our risk-free rate proxy is not completely riskless.



**Figure 4: Rising Systematic Risk (Beta) for the Long Bond**

**Government bond returns have been positively correlated with the stock market since the early 1970s**

As shown in Figure 4, long term government bond returns have been positively correlated with the stock market since the early 1970s. While these returns are realized only if the bond is sold, this covariability does imply a degree of systematic risk. In fact, a beta can be calculated to measure the systematic risk of a bond just like a stock. Depending on the measurement period, the beta of long bonds has varied over the past five decades from  $-0.1$  to over  $0.4$ . Analysis of monthly returns suggests  $0.25$  is a reliable estimate of the current beta of long government bonds.<sup>8</sup>

The next step in our analysis is to develop a truly riskless (or zero-beta) interest rate – one that is devoid of any systematic, or market, risk. To estimate a riskless rate, the current yield on the long bond must be reduced by the systematic component of that yield. And, to estimate that systematic component, we multiply the bond beta ( $0.25$ ) not by the actual historical risk premium, but by a higher, adjusted market risk premium – one that reflects the fact that market risk premiums have been understated since the early 1970s by the overstatement of the riskless rate.

<sup>6</sup> In practice, investors use as a proxy for the risk-free rate any number of government bond rates, each with its own strengths and weaknesses. Those who use T-bill rates argue that the shorter duration and lower correlation of the T-bill with the stock market make it truly riskless. However, because T-bill rates are more susceptible to supply/demand swings, central bank intervention, and yield curve inversions, T-bills provide a less reliable estimate of long-term inflation expectations and do not reflect the return required for holding a long-term asset. For valuation, long-term forecasts, and capital budgeting decisions, the most appropriate risk-free rate is derived from long-term government bonds. They capture long-term inflation expectations, are less volatile and subject to market movements, and are priced in a liquid market. See Bruner, Eades, Harris and Higgins, “Best Practices in Estimating the Cost of Capital: Survey and Synthesis,” *Financial Practice and Education*, Spring/Summer 1998.

<sup>7</sup> Laurence Booth, “Estimating the Equity Risk Premium: New Ways of Looking at Old Data,” *Journal of Applied Corporate Finance*, Vol. 12 No. 1 (Spring 1999).

<sup>8</sup> The  $0.25$  value is admittedly subjective. It represents an average value of trailing 30-year betas. We calculated historical betas for rolling time periods of 120 months ( $-0.10$  to  $0.43$ ), 240 months ( $-0.03$  to  $0.31$ ) and 360 months ( $-0.01$  to  $0.27$ ). The long term average was used because shorter periods are overly sensitive to the specific months selected (as illustrated in section “What Bond Beta?”).



**We estimate an adjusted market risk premium at about 6.5% over a current truly riskless rate of about 4% ...**

From the past fifty years, we estimate this adjusted market risk premium to be about 6.5 % and the systematic component of the long bond yield to be 1.5 %.<sup>9</sup> Thus, in applying the CAPM, if we assume that the long bond yield is 5.5%, we will end up using only 4% as truly riskless rate and 6.5 % as the market risk premium. In effect, this method takes the equity risk embedded in the long bond and transfers it to the equity risk in stocks.<sup>10</sup>

But if this adjustment simply reduces the risk-free rate by the same amount that the market risk premium is raised, then why bother? While the net effect is zero for the market or any stock with a beta of 1.0, this is not the case for individual securities with betas either above or below 1.0. Consider three stocks: Stock “UtilCo” has a beta of 0.5, stock “BanCo” a beta of 1.0, and “BioCo” a beta of 2.0. Now compare the estimates of cost of equity, where we do not combine the equity risk embedded in the long bond with the equity risk in the market, with the estimates in those cases where we do.

	UtilCo (0.5)		BanCo (1.0)		BioCo (2.0)	
	Unadj.	Adj.	Unadj.	Adj.	Unadj.	Adj.
Risk-Free Rate	5.30	4.00	5.30	4.00	5.30	4.00
Beta	0.50	0.50	1.00	1.00	2.00	2.00
MRP	5.20	6.50	5.20	6.50	5.20	6.50
Cost of Equity	7.9%	7.3%	10.5%	10.5%	15.7%	17.0%

**Table 1: Adjusted Riskless Rate Avoids Misstating Cost of Equity**

As Table 1 illustrates, for the market as a whole, or companies such as BanCo with betas at or near 1.0, the process of unlevering the risk-free rate and combining the systematic equity risk of stocks and bonds into one premium is a lot of work with no observable benefit.

But for lower beta businesses, such as UtilCo (where the cost of equity changes from 7.9% to 7.3%), the process avoids overstating the required return. Similarly, for higher systematic risk businesses, such as BioCo (where 15.7% increases to 17%), we avoid underestimating the cost of equity capital.

Underpricing risk by a mere 1.3% would significantly inflate the valuation of BioCo. To illustrate this point we assume that the firm, which is 100% equity financed, produces a perpetual stream of constant free cash flow. The value of the firm calculated by using the unadjusted cost of capital (15.7%) is 8% higher than the value based on the adjusted cost of capital (17%).

**... adjustment is material for securities with betas above 0.8 or below 1.2 ...**

**... we avoid the risk of overvaluing, say, a technology company.**

<sup>9</sup> Assuming a constant bond beta, we can solve algebraically for the adjusted risk premium (MRP') by starting with the formula  $MRP' = R_m - R_f'$  (where  $R_f'$  equals the truly risk-free rate) and ending with the formulation  $MRP' = (R_m - R_f)/(1 - \text{bond beta})$ . Due to the increasing beta of the long bond, we were forced to “unlever” each point of historical returns by its own beta. The result of this process was that 1.5% was effectively subtracted from the historical long bond yield ( $R_f$ ) and shifted to the MRP.

<sup>10</sup> The point of calculating a bond beta is to better quantify how much systematic risk has migrated to the risk-free rate, to improve the application of the CAPM in cases where the company beta is either very high or very low – say, a beta outside of the 0.8 to 1.2 range. For most cases, this refinement is immaterial, but for many technology stocks it is significant. While critics will argue that this approach creates a synthetic construct – a theoretical riskless investment that does not exist – we believe that the benefits of a practical tool and true barometer of the riskless rate offset this loss of transparency.



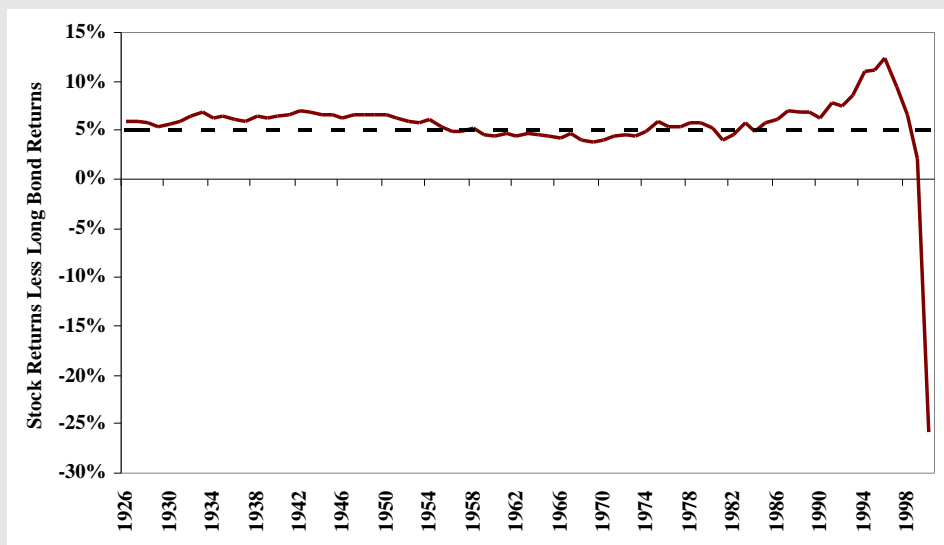
### How Much History?

The fact that there seems to be such a clear trend in the data toward lower equity premiums suggests that it would be a mistake to go too far back in time when estimating the market risk premium. But this raises the issue: How far back should one go?

A less useful but only partly facetious answer to this question is to decide what you would like the market risk premium to be and then choose the time period that gives you the answer you want!

As shown in Figure 5, the estimate of the market risk premium depends on how much history you choose to use. Indeed, the figure suggests that you could justify almost any premium. (Note that the far right observation on the graph uses only December returns for 2000, which compound to a negative annualized return. Moving further left adds more history. The estimate at the extreme left (on the Y-intercept) uses all 75 years of available history.)

**The ex post MRP estimate is highly dependent on your choice of history.**



**Figure 5: Market Risk Premium Depends on How Much History Is Used**

As noted earlier, structural changes in the economy and markets may suggest that more recent data provide a better basis for predicting the future. Provided you choose a period that goes back at least as far as the early 1980s, it is clear that the market risk premium has drifted down. The question that the analyst must answer is: How far down, and can we expect it to cycle back up?

We have chosen to use the second part of the past century (instead of .75), a sufficiently long period to achieve statistical reliability, while avoiding the potentially less relevant early market returns.

Consequently, our study estimates the market risk premium over the long bond to be about 5% over an unadjusted government long bond. When adjusted for the systematic component in bond returns, the market risk premium over the truly riskless (zero-beta) interest rate becomes 6.5%.



Uncertainty in the long bond beta is another moving part in the MRP estimate ...

... we provide tools to get a better estimate of beta ...

### What Bond Beta?

To illustrate further the difficulty in estimating the market risk premium for stocks over bonds, we examine the bond beta issue. The estimated beta dropped dramatically in 1998, as shown in Figure 6. In August of that year global markets experienced a crisis that was touched off by Russia's default on its loan obligations. Consequently, the respective monthly return on the S&P 500 index was -14.4% while the return on the long bond was 6%. Because of a relatively small number of observations, the inclusion of returns for a single month can significantly change a beta estimate. The weaker correlation between the two markets continued in 1999 and 2000.

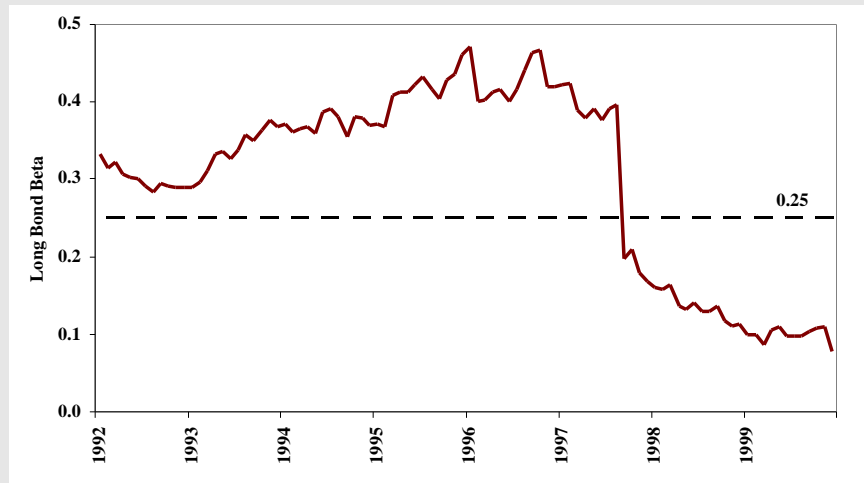


Figure 6: Long Bond Beta (based on 60-month rolling averages)<sup>11</sup>

### TOWARDA BETTER BETA

A common source of problems in the calculation of the cost of equity capital is the determination of a robust proxy for the systematic risk. This measure, known as beta, is the regression coefficient that describes the slope of a line of "best fit" through a history of individual (dividend-adjusted) stock returns and market-wide returns. Reasonable and statistically meaningful betas can be difficult to determine, but we provide some alternative methods to apply CAPM with a reliable measure of systematic risk.

#### 1. Direct Regression

While typically calculated using the most recent 60 monthly returns, other sampling periods and frequencies can be more appropriate. How much history is relevant to your company or industry? Beyond a qualitative assessment, check the data.<sup>12</sup> If no discernible trend is evident and thus represents a random walk, the period might be lengthened to provide more data and improve reliability. But if there does appear to be a trend, or if sufficient history is unavailable, more recent daily or weekly returns might be used to provide enough data for a meaningful regression. Analyze the residuals of a regression by plotting or sorting – what is not explained by the regression and why? Re-regressing the interquartile range of data should provide a similar slope but can give a much better "fit" (i.e., a more statistically significant coefficient of determination).

<sup>11</sup> Our long term estimate of beta is 0.25.

<sup>12</sup> Potential questions might probe the interpretation and sensibility of the regression coefficients, summary statistics, and residuals. Sorting the residuals will help you to flag and understand suspect data, as well as to guide your choices regarding the amount of history and length of the return periods to be used.



## 2. Industry Beta

**An industry beta may be used as a proxy for a company beta ...**

Many stocks are less liquid, leading to spurious results if the beta determination is performed too mechanically. A simple solution in such cases, and for divisions or for private companies, is to determine a proxy for systematic risk by calculating an industry instead of a company-specific beta. The underlying assumption is that the systematic risk of an industry applies to all firms and divisions that operate in that industry.

### a) Median Beta

The median, unlevered beta from a list of pure-play peers is a proxy for company beta.<sup>13</sup> Division betas are medians of the respective sets of pure-play peers. A beta for a privately held conglomerate can be calculated as a weighted average of division betas. The weighting is based on the division's contribution to the firm's intrinsic value, with capitalized net operating profit after tax (NOPAT) or earnings before interest and income tax (EBIT) used as a proxy. The firm's asset beta is then relevered based on the target capital structure.

### b) Portfolio Beta

When the leverage ratio is similar across the industry, a portfolio beta may be used as a proxy for a company's beta. The portfolio beta is obtained through a single regression of cross-sectional returns for all companies' monthly returns. Because the accuracy of the estimate increases with the number of companies in a portfolio, as many of them as possible should be included. An objective selection of peers will minimize bias.

A potential drawback of the industry beta approach, however, is that the answer can be very sensitive to the choice of peers. Furthermore, this approach ignores company-specific volatility, which could still be measured and used as a check for evaluating the pure-play beta.

## 3. Segment Beta Regression

**Secondary regressions can develop segment betas where integration prevents pure-play peers ...**

In cases where there are no pure-play peer companies (as is often the case) a segment beta regression can be employed. This is particularly helpful for estimating segment, or line-of-business, costs of capital within integrated industries like natural resources and financial services. In this kind of regression, the dependent variable is each company's unlevered beta while the independent variables are the percentage exposures to different lines of business (typically by revenue, but can be based on any segment information available).

Company	Beta	% Debt	Unlev. Beta	% Lumber	% Paper	% Other
International Paper	0.99	40%	0.70	49%	44%	7%
Temple-Inland	1.26	51%	0.77	12%	57%	31%
Boise Cascade	1.19	54%	0.69	17%	36%	47%
:	:	:	:	:	:	:
<b>Industry</b>				<b>0.50</b>	<b>0.66</b>	<b>nmf</b>

**Table 2: Results of Segment Beta Regression**

Table 2 shows an unlevered beta of 0.50 for the lumber industry versus 0.66 for paper products.<sup>14</sup>

<sup>13</sup> We refer to this beta that is adjusted to exclude financial risk as the unlevered beta, using the Hamada approach to unlever and relever beta for financial risk:  $\text{Beta} = [1 + (1-t) \cdot D/E] \times \text{Unlevered Beta}$ . Alternatively, an M&M approach can be used, assuming an asset beta equivalent to an equity beta – a debt beta of zero, commonly producing cost of capital results 50 to 100 bps lower, particularly in more highly leveraged companies.

<sup>14</sup> While the t-statistics were all highly significant, the "other" beta is clearly not meaningful due to the wide mix of other segments within which diversified forest products companies operate.



A constructed beta uses company-specific volatility ...

#### 4. Constructed Beta

##### a) Method a

Alternatively, betas can be constructed as the product of an industry-portfolio correlation coefficient and a company-specific relative volatility coefficient (as shown below).

$$\text{Constructed Beta} = \text{Correlation Coefficient}_{\text{INDUSTRY}} \times (\text{Volatility}_{\text{COMPANY}} / \text{Volatility}_{\text{MARKET}})$$

In applying this formula, one could measure the volatility of company returns as the standard deviation of changes in capitalized NOPAT. The volatility of market returns can be measured directly from stock price data, as can a correlation coefficient for the industry.

##### b) Method b

Another way of estimating equity beta for illiquid stocks and privately held companies is by regressing capitalized NOPAT or EBIT against market returns. Operating results, which are generally available on monthly basis, often exhibit seasonal cyclicity. Thus, we recommend regressing the percentage change in capitalized NOPAT or EBIT over the same month a year ago against respective annual market returns. The regression should include at least five years of history. The tendency to ‘smooth’ earnings, which would bias the estimate, can be avoided by making accounting corrections (adjustments) that have a material effect on operating results.

#### 5. Multi-Variable Regression Beta

A multi-variable regression works well for ‘hybrid’ companies ...

Asimilar construct can apply to a “hybrid” company that defies industry categorization. For example, a hypothetical, privately owned industrial biotechnology company might share characteristics with both pharmaceutical and biotechnology industries, while competing primarily against specialty chemicals companies. In such a case, a simple “peer” beta would not be an appropriate choice because peer selection is an emotional hot button with results that can be highly subjective. Furthermore, such an approach overlooks valuable, company-specific data. Company data can be used better to quantify the systematic risk with a regression model.

Company	Unlevered Beta	Ln (Capital)	Sales Growth	R&D % Sales	NOPAT % Sales	Sales to Capital
Alza	1.33	14.3	25%	7%	30%	0.67x
Dow Chemical	0.90	16.9	-1%	4%	13%	0.93x
Eli Lilly	1.16	16.4	9%	16%	25%	0.57x
:	:	:	:	:	:	:
<b>Hybrid Co.</b>	<b>1.49</b>	<b>10.0</b>	<b>25%</b>	<b>15%</b>	<b>25%</b>	<b>1.50x</b>

**Table 3: Results of Multivariable Regression Beta**

As shown in Table 3, a multi-variable regression yields an estimate of unlevered beta of 1.49 based on an objective analysis of some of the company’s key value drivers (including size, growth, R&D, margins, and capital turn characteristics) relative to those of publicly-traded pharmaceutical, biotechnology, and specialty chemicals companies.<sup>15</sup>

<sup>15</sup> We found significant and intuitively appealing coefficients with this model:  $0.214 \times \text{sales growth} + 0.687 \times \text{R\&D/sales} - 0.205 \times \text{sales/capital} - 0.081 \times \ln(\text{capital}) + 0.394 \times \text{net operating profit after tax (NOPAT) margin} + 2.348$  (intercept).



## CONCLUSION

**The market risk premium over the long bond is about 5% ...**

When applying the Capital Asset Pricing Model, the corporate cost of equity capital is determined in part by the market risk premium for equities – that is, the amount by which the return on stocks as a group is expected to exceed the risk-free rate. Over the past half a century, stock returns have exceeded returns on long bonds by about 5%.

**... expected returns on U.S. equities are about 10.5 % ...**

In this paper, we presented a method for using the CAPM that attempts to calculate a truly riskless (or zero-beta) interest rate. While lowering the long bond (risk-free) rate by 150 basis points, our method calls for adding the same 150 basis points to the historical market risk premium (again, 5%) to yield an adjusted market risk premium of 6.5 %. Based on the current long bond rate of about 5.5 %, the truly riskless interest rate is currently about 4%. Consequently, our study implies an expected long-term return on U.S. equities of about 10.5 %.

**... don't throw out CAPM just because you can't get a good beta – we provide alternatives to get a better beta.**

We also provide tools for deriving more reliable estimates of beta. Direct regression is the most commonly used approach. For less liquid stocks and for private companies, an industry beta can be used as a proxy for company beta. In cases where there are no pure-play companies, a segment beta regression can be employed. A constructed beta is the product of an industry-portfolio correlation coefficient and a company-specific relative volatility coefficient. Multi-variable regression beta applies to a “hybrid” company that defies industry categorization. In the Appendix, we also provide benchmark industry capital costs and components.



## Appendix: Industry Costs of Capital

Industry	Industry Levered Beta	Cost of Equity	Bond Rating	Cost of Debt	Debt/Capital	Debt/Market Value	Cost of Capital
Aerospace	0.68	8.6%	BBB-	9.1%	38.6%	40.5%	7.3%
Airlines	0.89	10.8%	BB+	9.8%	70.4%	70.4%	7.4%
Aluminum	0.93	10.4%	BBB-	9.1%	91.7%	78.0%	6.6%
Apparel	0.96	10.6%	A-	8.3%	72.6%	19.2%	9.6%
Appliances	0.95	10.6%	A-	8.3%	49.7%	23.6%	9.3%
Auto Parts	0.86	10.3%	BBB	8.6%	40.3%	42.3%	8.2%
Beverages	0.89	10.0%	A	8.1%	45.7%	15.6%	9.3%
Broadcasting	0.95	10.5%	BB-	10.6%	55.7%	31.7%	9.2%
Building Materials	0.82	9.8%	BBB	8.6%	42.8%	34.8%	8.2%
Cars & Trucks	1.03	12.4%	BBB+	8.5%	46.6%	51.3%	8.7%
Chemicals	0.78	9.4%	BBB	8.6%	53.2%	35.3%	8.0%
Computer Software & Services	1.50	13.9%	BB	10.0%	21.2%	2.9%	13.6%
Computers & Peripherals	1.36	12.9%	BBB	8.6%	30.7%	2.8%	12.7%
Construct. & Eng. Services	0.87	10.1%	A-	8.3%	39.5%	25.5%	8.8%
Containers	0.72	8.4%	BB	10.0%	56.7%	53.2%	7.2%
Drug Distribution	0.75	9.1%	A	8.1%	28.8%	23.0%	8.2%
Drugs & Research	0.95	10.2%	A	8.1%	27.1%	4.3%	10.0%
Electrical Equipment	0.99	10.6%	BBB-	9.1%	33.3%	13.6%	9.9%
Electronics	1.51	14.1%	BB-	10.6%	39.1%	7.9%	13.5%
Food Chains	0.53	7.2%	BBB-	9.1%	48.9%	34.5%	6.7%
Food Processing	0.62	8.1%	BBB+	8.5%	43.9%	24.9%	7.4%
Gold and Precious Metals	0.90	10.1%	BB+	9.8%	32.1%	24.4%	9.1%
Health Care Services	1.00	11.0%	BBB-	9.1%	34.8%	39.3%	8.9%
Hotel & Motel	0.88	10.0%	BB	10.0%	54.4%	45.2%	8.3%
Household Products	0.84	9.7%	A+	8.0%	34.5%	14.4%	9.0%
Machine & Hand Tools	0.78	9.4%	BBB	8.6%	43.5%	32.8%	8.0%
Machinery	0.89	10.4%	BBB	8.6%	44.7%	37.8%	8.5%
Manufacturing - General	0.91	10.3%	BBB+	8.5%	40.7%	25.1%	9.0%
Manufacturing - Specialized	0.80	9.3%	BBB	8.6%	38.6%	12.8%	8.8%
Media	0.94	10.8%	BBB-	9.1%	59.0%	33.0%	9.0%
Medical Products	0.94	10.3%	BBB	8.6%	25.0%	14.5%	9.6%
Metal Fabricators	0.87	10.3%	BB	10.0%	54.8%	37.3%	8.7%
Mining	0.88	10.7%	BB+	9.8%	51.8%	50.3%	8.3%
Office Equipment & Supplies	0.84	9.6%	BBB+	8.5%	34.2%	12.5%	9.1%
Oil & Gas (Equipment and Services)	1.18	12.4%	BBB+	8.5%	37.2%	23.2%	10.7%
Oil & Gas (Expl. & Prod.)	0.77	9.2%	BBB	8.6%	49.3%	30.0%	8.0%
Oil & Gas (Integrated)	0.60	7.9%	BBB	8.6%	46.7%	39.3%	6.9%
Other Leisure	0.82	9.5%	BB+	9.8%	53.0%	35.1%	8.3%
Other Services	0.88	9.9%	BBB-	9.1%	37.1%	15.0%	9.3%
Paper & Forest Products	0.84	10.1%	BBB	8.6%	55.1%	39.1%	8.2%
Paper Containers	0.78	9.4%	BBB	8.6%	48.4%	36.6%	7.9%
Personal Care	0.85	9.7%	A	8.1%	33.3%	12.3%	9.1%
Printing & Advertising	0.93	10.2%	A	8.1%	35.5%	12.4%	9.5%
Publishing	0.70	8.7%	A-	8.3%	49.9%	20.5%	8.0%
Railroads	0.72	9.0%	BBB	8.6%	51.3%	43.4%	7.4%
Restaurants	0.80	9.5%	BB	10.0%	46.4%	27.2%	8.6%
Retail - Computer/Electronics	0.90	10.9%	BBB-	9.1%	99.0%	39.1%	8.8%
Retail - Department/Discount Stores	0.90	10.3%	BBB	8.6%	47.8%	28.7%	8.9%
Retail - Specialty	1.01	11.4%	BBB-	9.1%	52.7%	35.6%	9.3%
Semiconductors	1.95	17.0%	BBB-	9.1%	56.1%	5.1%	16.4%
Steel	0.91	10.6%	BB-	10.6%	59.8%	59.6%	8.1%
Telecommunications	1.24	12.7%	BB	10.0%	75.3%	27.4%	10.9%
Textiles	0.85	9.9%	BB+	9.8%	33.0%	28.2%	8.8%
Tobacco	0.34	6.2%	A-	8.3%	34.3%	6.6%	6.1%
Transportation Services	1.09	12.5%	BBB	8.6%	53.3%	43.0%	9.4%
Trucking	0.81	10.0%	BBB+	8.5%	53.8%	38.4%	8.1%
Unadj. Risk-Free Rate		5.5%	Adj. Risk-Free Rate		4.0%		
Unadj. Market Risk Premium		5.0%	Adj. Market Risk Premium		6.5%		
Tax Rate			39.0%				

\* Data were gathered from the pool of companies used in the Stern Stewart Performance 1000. Ratings and corresponding cost of debt are from a corporate bond yield table. All figures are based on the median of the companies in the sector. The risk-free rate and market risk premium were adjusted as described in this article

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