

Beta

In the First 1997 Edition of Ibbotson Associates' *Beta Book*, we introduced new methodologies for estimating betas for individual companies. In this edition of the *Cost of Capital Yearbook*, we employ these new methodologies to estimate the betas of both companies and composites on a levered and unlevered basis.

Selection of Companies

A company from the Compustat database is included in this analysis if it meets three conditions. First, a company must have at least thirty-six months of return data. Second, it must have generated sales greater than \$100,000 in the most recent year. Third, a company must have a market capitalization greater than \$10,000 for the most recent month.

Time-Series Regressions

Raw Betas are estimated by the traditional method of running a simple regression in which excess monthly returns on a company or composite is the dependent variable and the excess return on the market is the independent variable.

The beta calculations are based on the capital asset pricing model as developed by Mossin [1966], Lintner [1965], and Sharpe [1964]. According to the CAPM, there is a direct linear relationship between the risk of an asset relative to the market and the return that can be expected from that asset. The measure of this systemic risk is the security's beta. An investment with a beta of zero has an expected return equal to that of the risk-free rate. An asset with a beta of one has an expected return equal to that of the market.

To estimate the beta of a company, monthly total returns of the company's stock in excess of the risk-free asset are regressed against the monthly total returns of the stock market in excess of the return on the risk-free asset.

In all of the beta regressions, the total returns of the S&P 500 are used as the proxy for the market returns. The series used as a proxy for the risk-free asset is the yield on the 30-day T-bill. Total returns for both individual stocks and the market proxy are determined by calculating price appreciation and dividend reinvestment. A sixty month time frame is used for the regression. If fewer than sixty months of data are available for a company, the beta is then calculated using the months of data that are

available, with a minimum of thirty-six months as acceptable. In this edition, all betas have been calculated using the sixty-month period ending March 2004.

Raw Beta

The Raw Beta of a company is computed by running a simple regression with the company's monthly excess stock returns over Treasury bill returns as the dependent variable and the monthly excess returns of the market over Treasury bill returns as the independent variable. A Raw Beta estimate greater than five in absolute value is discarded.

Adjusted Betas

Adjusted betas are calculated by a multistage process. First, historical monthly return data is used to calculate regression betas. Then regression betas are analyzed to calculate full-information industry betas. Full-information industry betas are then used to calculate company (or composite) specific peer group weights. Finally, regression betas and peer group betas are combined to calculate adjusted betas.

The rationale behind this process is that a company's beta tends to move towards its peer group average over the long term. However, many companies participate in more than one industry. Therefore, company specific peer group betas must be formed from industry betas based on the degree to which each company participates in each industry. Since companies can participate in multiple industries, industry betas cannot be calculated by simply averaging the betas of companies within each industry. Cross-sectional regression analysis is used to extract full-information industry betas from the betas of *all* companies included in the analysis.

Full-Information Industry Betas

Many of the companies in multiple lines of business are among the largest participants in their industries. To avoid eliminating them from the analysis, we use a "Full-Information" procedure for estimating industry betas. In this procedure, a single cross-sectional regression including all companies is used to estimate industry betas from the betas of the companies and their percentage of sales in all of the industries.

across companies. To obtain market capitalization-weighted industry betas, Kaplan and Peterson [1998] developed a capitalization-weighted regression technique. The full-industry betas that are used to form peer group betas for Raw Betas are estimated using this procedure.

“Full-Information” industry betas are estimated from Raw Betas of all of the companies using the market capitalization-weighted cross-sectional regression procedure described by Kaplan and Peterson [1998].¹ In this procedure each observation in the sample represents a company that participates in different industries. The dependent variable is the regression beta and the independent variables are the percentages of participation in the various industries. Since the percentages add up to one and the observations are market capitalization-weighted, the estimated coefficients on the participation percentages are the estimates of the pure-play industry betas.

All companies that have Raw Beta less than five in absolute value are included in the sample.

For the purpose of the “Full-Information” analysis, industries are defined by two-digit SIC codes. The industry participation percentages of a company are measured by assigning the sales of each business segment to the industry defined by the first two digits of its primary SIC, and then dividing industry sales by total sales of the company.

An industry must have at least five companies to have an independent variable represent it in the regression. This leads to 66 distinct industries being defined.

Peer Group Betas

The peer group beta takes into consideration the industry betas of all industries in which a company is involved. It is the sales-weighted average of the betas for each industry in which a company has sales.

For example, the fictional company ABC Corp. has a peer group beta of .90 and lists sales in 4 different two-digit SIC codes. The peer group beta is calculated in the following manner:

¹ When analyzing unlevered betas, total value (debt plus equity) weights are used instead of equity value weights.

SIC Code	Industry Raw Beta	Sales in Industry (million\$)	% of Sales in Industry	Sales-Weighted Raw Beta Component
13	0.97	6,978	22.73%	0.22
65	0.47	46	0.15%	0.00
28	1.12	5,655	18.42%	0.21
29	0.81	<u>18,018</u>	<u>58.70%</u>	<u>0.48</u>
Totals		30,697	100.00%	0.90

Shrinkage Technique

This method of averaging a regression beta with a peer group beta is known as "shrinkage." Calculating an adjusted beta makes a forecast of the true beta in the future, which can be used to estimate the expected return.

The adjusted beta calculation can be written as follows:

$$\text{Adjusted Beta} = [(1 - \text{weight}) \times \text{peer group beta}] + (\text{weight} \times \text{company beta})$$

where,

$$\text{weight} = \frac{(\text{cross sectional standard error})^2}{(\text{cross sectional standard error})^2 + (\text{time series beta standard error})^2}$$

This adjustment equation reflects the theory that over time company betas will tend toward their industry average beta. For example, the betas of public utility companies tend to be less than one. Therefore, when adjusting the beta of a public utility company, it is appropriate to adjust its beta towards the average beta of the other companies that make up its industry group.

The formula for *weight* is based on the formula suggested by Vasicek [1973]. The greater the statistical confidence in the regression beta, the closer that *weight* is to one.

Composites

Raw Betas are calculated for composites from the historical time series of their returns. The same regressions are performed for the composites and the companies, but with composite returns instead of company returns. Each regression results in a regression beta and a standard error, which can be used in the shrinkage formula.

The peer group beta of a composite is calculated by taking the capitalization weighted average of the peer group betas of the companies that make up the composite.² Each adjusted beta is calculated by shrinking the regression beta towards the peer group using the Vasicek formula for the weight.

Levered Beta

A levered beta measures the systematic risk for the equity shareholders of the company. No adjustment is made for the debt financing undertaken by the company. A levered equity beta incorporates the business and financing risks undertaken by the company and born by the equity shareholders.

For each company and for each composite we calculate the Raw Beta and Adjusted Beta estimates of systematic risk.

Unlevered Betas

The unlevered beta (also known as asset beta) removes a company's financing decision from the beta calculation. The unlevered beta reflects a company's business risks. The unlevered beta is computed as follows:

$$\beta_{Ui} = \frac{\beta_{Li}}{1 + \frac{BD_i}{EC_i} (1 - t_i)}$$

where,

$$BD_i = STD_i + LTD_i + PSTK_i$$

$$EC_i = P_i \times S_i$$

- β_{Ui} = the unlevered beta for company i ;
- β_{Li} = the levered beta for company i ;
- BD_i = Book debt for company i ;
- EC_i = Equity capitalization for company i ;
- STD_i = Book value of debt in current liabilities for company i ;
- LTD_i = Book value of long-term debt for company i ;
- $PSTK_i$ = Book value of preferred stock for company i ;
- P_i = Price per common share for company i ;
- S_i = Common shares outstanding for company i ; and,
- t_i = Marginal tax rate for company i .

Professor John Graham supplied the necessary marginal tax rate data by company. Recent research by John Graham (1996a, 1996b) demonstrates that the usual approach to estimating the marginal tax rate is prone to

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substantial measurement error. By modeling the uncertainty of taxable earnings, as well as the major features of the U.S. tax code, Graham shows that only about one-third of Compustat firms have an expected marginal tax rate equal to the top rate. There is substantial variation in tax rates across firms and through time, with up to one-third of firms having a tax rate greater than zero but less than the top statutory rate.

Thus, for the majority of firms, it is inaccurate to assume that they are subject to the top statutory tax rate. For more information or to purchase company tax rate data, please visit our Cost of Capital Center web site found at www.ibbotson.com.

Our model assumes that the state tax rate is 0 percent. Technically, our model should include state taxes. However, state tax regulations vary so greatly that they are difficult to incorporate into a generalized model. For this reason, we have chosen to ignore them. For each company and for each composite, we calculate the Levered Adjusted Ordinary Least Squares Beta and apply the above equation to obtain estimates of unlevered beta.

Costs of Equity Capital

For composite costs of equity in excess of 100 percent or below the risk-free rate of 4.74 percent, NMF will be displayed. It is our opinion that costs of equity below the risk-free rate are not meaningful. It is also our opinion that costs of equity above a certain level are not meaningful. We have chosen this level to be 100 percent. Costs of equity above 100 percent or below 4.74 percent are included in the percentile statistics because they provide valuable information to the reader. Costs of equity to such extremes are indicative of the cost of equity model failing due to the nature of the data for companies in the industry.

CAPM

$$k_i = R_f + (\beta_i \times ERP)$$

where,

k_i = Cost of equity;

R_f = Rate on risk-free asset; long-term government bond yield for March 31, 2004 (4.74 percent);

β_i = Levered adjusted ordinary least squares beta of company i ; and,

ERP = Expected equity risk premium. Long horizon version from Ibbotson Associates' *Stocks, Bonds, Bills, and Inflation: Valuation Edition, 2004 Yearbook* (7.10 percent).

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¹ *Journal of Applied Corporate Finance*, Vol. 15, No. 4, pp. 31-49, 2003. Copyright © 2003 by Harvard Business School Publishing. All rights reserved. This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

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