Summary: “The Economic Underpinnings of Beta

By Mary Ann Lerch and Walter Furman

The Capital Asset Pricing Model was developed independently by both William Sharpe and Harry Markowitz at approximately the same time for the purpose of altering portfolio risk with the use of leverage, by buying a mix of stocks and safe bonds rather than a mix of all risky stocks. In so doing the investor could arrive at a more efficient frontier than with a portfolio of all stocks.

The model takes the return on the market and bifurcates the rate into a risk free portion, and an equity risk premium. The equity risk premium is then multiplied by a portfolio beta to specify the total risk-adjusted rate of return on the portfolio.

Algebraically, the model is specified:

\[ R = R_f + \beta(R_m - R_f) \]

where \( R \) is the portfolio or security rate of return, \( R_m \) is the return on the market, and \( R_f \) is the risk free rate. The CAPM model has been used successfully by business valuation experts to find an appropriate industry specific rate of return in valuation of an estimated income stream to arrive at a value.

The “beta” value assigned to a stock by the securities industry is an indicator of that stock’s sensitivity to changes in the stock market. The precise figure is generally derived by a regression analysis of the individual stock’s return to the investor (as measured by changes in price plus any dividend distributions), using historical data. But what makes stocks volatile?

It is widely known that certain characteristics of the stock affect the trading pattern and therefore the volatility. Academic research on beta has been ongoing for fifty years.

Beta is characterized in standard finance texts as an indicator of systematic risk. This term refers to the risk inherent in holding any stock within a particular market, in addition to the presence of any “unsystematic risk,” or the risk associated with individual firms (e.g. strikes, lawsuits, scandals). Fabozzi and Modigliani’s Capital Markets: Institutions and Instruments (2003) refers to beta as indicative of the, “general market and economic conditions that cannot be diversified away.”
But earlier (1958) Modigliani and Miller postulated that financial risk by the underlying firm with debt and preferred stock levered the balance sheet of the corporation and therefore contributed to its stock volatility of both earnings and consequently, the market price of the stock.

Hamada (1972) studied the effect of capital structure on the firm’s beta in the microeconomic sense. He studied 10 industries in 1972:

“Specifically, if the MM corporate tax leverage propositions are correct, then approximately 21 to 24% of the observed systematic risk of common stocks (when averaged over 304 firms) can be explained merely by the added financial risk taken on by the underlying firm with its use of debt and preferred stock. Corporate leverage does count considerably.”

Robichek and Cohn (1974) list a number of writers who have addressed the determinants of beta.

Explanatory relationships that have been examined include those of stock indices to interest rates and corporate profits, stock indices to the growth of the money supply, and stock indices to gross national product. More recent examples of investigation into the determinants of beta include Andersen, Bollerslev, Diebold and Wu, who find covariance between beta and industrial production growth. Our research used regression analysis to identify more specific economic variables that influence the magnitude of beta.

In context, Modigliani and Miller were referring to financial leverage having to do with debt in the capital structure. In economic theory and practice, the impact of fixed costs and interest on the income statement has the effect of leveraging the earnings of the company, and to some extent, its stock price.

We identified and measured two types of factors that tie to beta. The first is the stock characteristic variable, including stock price, number of shares outstanding, institutional holdings, trading volume, institutional holdings as a percent of shares outstanding, etc. The second type is what we called an economic variable. We developed these variables from amounts reported on the corporate income statement. These included percent changes in revenue, the operating income and the net income from the prior year, operating marginal effect, and financial marginal effect, economic marginal effect, which is defined in this paper, financial leverage, and financial elasticity. We tested all these variables with a classic OLS regression, arriving at our final models through the process of backwards

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elimination. We concluded that our economic variables did indeed enhance the degree of explained variance in nearly all the models tested.

Although our research was original, the idea was not new. Earlier, Baruch Lev (1974) studied betas for three industries, utilities, oil and steel manufacturing, all with high relative fixed costs. He found:

“With the exception of oil, all were significant at the 0.05 level, although the $R^2$ was modest. The operating leverage explained more of the variance in the overall risk measure than in beta, and he concedes that operating leverage is not the only (and may not even be the major) variable contributing to cross-sectional risk differentials.”

Robert G. Bowman (1979) studied the relationship between earnings variability and beta. He proves mathematically that there is no direct relationship between earnings variability and systematic risk (which is beta in the CAPM equation). However, when he relaxed the CAPM assumptions, he finds an expected correlation between earnings variability and beta.

An excellent paper by Mandelker and Rhee (1984) measured beta against operating and financial risk in a broad study of 255 stocks in ten industry sectors. The authors smoothed their data by ranking the operating leverages, financial leverages and betas, and organized the data into 51 portfolios of five stocks each. The authors then regressed average betas on operating and financial leverage, measuring financial leverage the same way we did, and found a 30% negative correlation between the two types of leverage. We had suspected this all along although we could not measure the same type of covariance in our limited industry specific studies.

We have identified certain specific economic variables that we believe influence the magnitude of beta. Specifically these are: percent changes in revenue, the operating income and the net income from the prior year, operating marginal effect, financial marginal effect, economic marginal effect, financial leverage, and financial elasticity. We also know that certain stock characteristic variables affect beta, such as number of shares traded, percent of institutional holdings, and others. Our hypothesis is that if we test our economic variables in the presence of these stock characteristic variables, we will find a significant correlation between beta and one or more of these variables. Mathematically our hypothesis is written:

\[2 \text{ Ibid, p. 636} \]

\[ \beta = f(\text{Economic Risk, Operating Risk, Financial Risk, Financial Leverage, Financial Elasticity, and } Z \text{ [stock characteristics including Shares outstanding, Trading Volume, Institutional Holdings, Percent Changes in Revenue, Operating Income, Net Income, and Stock Price from the previous year]}) \].

Our testable equation for OLS regression is:

\[ \beta = \alpha_0 + \alpha_1(\text{EME}) + \alpha_2(\text{OME}) + \alpha_3(\text{FME}) + \alpha_4(\text{Financial Leverage}) + \alpha_5(\text{Financial Elasticity}) + Z \]

(2)

where \( Z \) is a vector of stock characteristic variables which are needed to explain variation and increase the statistical power of the model.

Our work tests this theory for two years, 2005 and 2006, and on two industry groups. The first industry group is telecom, including foreign and domestic telecom equipment, telecom services and wireless communications. The second industry group is media, including advertising, cable TV, entertainment and entertainment technology. We selected the two most recent years for which full data sets are available, and we tested only stocks traded on the New York Stock Exchange (NYSE).

Findings:

We did find that economic variables identified enhanced the explained variance in beta by 20% or more. We found that financial leverage or financial risk alone was not sufficient an economic variable to explain much if any variance in beta. We found that in all cases, the economic variables enhanced the amount of explained variance in beta. Usually it was higher.

For example in 2005, for the telecom sector with a 3-year regression beta, our economic variables raised the adjusted \( R^2 \) on the model from 18.6% without the variables to 45.6% with them. In 2006 with the Value Line Beta, our economic variables raised the adjusted \( R^2 \) from -0.3% (zero effectively) to 21.97%. With the Reuters beta, economic variables raised the adjusted \( R^2 \) from 18.793% to 26.88% in the model.

In the media sector for the 3-year regression beta in 2005, our economic variables raised the adjusted \( R^2 \) from 0.26788 to 0.301 and for the Value Line beta, adjusted \( R^2 \) increased from 0.3205 to 0.3709. In 2006, our economic variables raised adjusted \( R^2 \) from 0.139225 to 0.233013 or by 40%.

We also found strong industry specificity of beta in each sector. And this is the most profitable of all our industry research. We set up dummy variables for each specific industry within the sector and got strong results in
both industries in both years with both betas. For example, we found that our dummy variables for industry explained 37% of the variance in the Value Line beta in 2006, with all coefficients significant at the 95% level. In fact, this analysis yielded some of the best results in our study.

Industry specificity is more easily seen and more helpful to the analyst seeking to find an industry specific beta in the estimation of a capitalization rate.

Table I: Media Telecom 2005
OLS estimates using the 91 observations 1-91
Dependent variable: BetaVL

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>3.13</td>
<td>0.347795</td>
<td>8.9995</td>
<td>&lt;0.00001 ***</td>
</tr>
<tr>
<td>Advertising</td>
<td>-2.154</td>
<td>0.411517</td>
<td>-5.2343</td>
<td>&lt;0.00001 ***</td>
</tr>
<tr>
<td>CableTV</td>
<td>-1.42333</td>
<td>0.449002</td>
<td>-3.1700</td>
<td>0.00215 ***</td>
</tr>
<tr>
<td>Entertainment</td>
<td>-2.22421</td>
<td>0.365643</td>
<td>-6.0830</td>
<td>&lt;0.00001 ***</td>
</tr>
<tr>
<td>EntTech</td>
<td>-1.27</td>
<td>0.602399</td>
<td>-2.1082</td>
<td>0.03810 **</td>
</tr>
<tr>
<td>Newspaper</td>
<td>-2.28692</td>
<td>0.373592</td>
<td>-6.1214</td>
<td>&lt;0.00001 ***</td>
</tr>
<tr>
<td>Publishing</td>
<td>-2.178</td>
<td>0.380991</td>
<td>-5.7167</td>
<td>&lt;0.00001 ***</td>
</tr>
<tr>
<td>ForeignT</td>
<td>-2.12077</td>
<td>0.373592</td>
<td>-5.6767</td>
<td>&lt;0.00001 ***</td>
</tr>
<tr>
<td>TelEquip</td>
<td>-1.296</td>
<td>0.411517</td>
<td>-3.1493</td>
<td>0.00229 ***</td>
</tr>
<tr>
<td>Services</td>
<td>-1.8005</td>
<td>0.364771</td>
<td>-4.9360</td>
<td>&lt;0.00001 ***</td>
</tr>
</tbody>
</table>

Unadjusted R^2 = 0.440325          Adjusted R^2 = 0.378138,          F-statistic (9, 81) = 7.08075 (p-value < 0.00001)

Interpretatively, the securities analyst would start with a beta of 3.13 if the industry was wireless networking or wireless communication. If it was any of the other industries, he (she) would subtract the coefficient for the industry from the constant to derive the industry specific beta.

Our future research proposal is to test one more factor. Our original theory which we would like to test is the impact on beta of the company’s business risk in terms of where it is in the production process. From Stolper-Samuelson Theorem, we learn that any price change in the final goods is magnified in the factor market. We propose that depending upon where the company is in the production process, its beta should reflect the company’s market positioning in its industry. In other words, we know that betas for retailers are considerably lower than for companies in the factor market for raw materials in that sector. We demonstrated this in the difference between betas on telecom equipment and telecom service providers. We would like to pursue research along these lines.
References Consulted


Data Sources

Damodaran, Aswath. Damodaran Online: The Data Page. Available at: http://pages.stern.nyu.edu/~adamodar/


BigCharts, a Service of Market Watch. Historical Prices. Available at: http://bigcharts.marketwatch.com/historical/


Data Application

The “gretl” regression program is freeware and is available at: http://gretl.sourceforge.net/

It is maintained by Allin Cottrell, Wake Forest University and Riccardo "Jack" Lucchetti, Università Politecnica delle Marche.

(We employed version gretl-1.6.5.exe (May 17, 2007) for Windows.)

Vector of Stock Characteristic Variables:

\[ Z = \alpha_6(\text{Shares Outstanding}) + \alpha_7(\text{Trading Volume}) + \alpha_8(\text{Institutional Hldgs}) + \alpha_9(\%\text{chg StockPrice05,06}) + \alpha_9(\%\text{change in Revenue}) + \alpha_{10}(\%\text{Change in Operating Income}) + \alpha_{11}(\%\text{Change in Net Income}) \]

Z is different in each regression. We included the Z vector in each regression which is why the alpha subscripts start at six.