A CLEARER UNDERSTANDING OF BETA

In the spreadsheet below, beta is calculated for Apple (AAPL) using the S&P500 as the market return, and basing beta on 5 years of monthly returns for Apple and the S&P500, then adjusting all of these returns to real returns by subtracting out the 30-Yr Zero Coupon U.S. T-Bond. This same technique was outlined in another blog post called [Capital Asset Pricing Model (CAPM Equation)]

The beta is calculated for Apple (1.20) in cell C5 of the Analysis worksheet. Checking this against Google's reported beta for Apple (1.25), and Yahoo's reported beta of 1.34, it appears that Google must be using a similar beta calculation, whereas Yahoo differs consistently and significantly in their betas, so must be using a different (and potentially incorrect) methodology for determining their beta.

The standard deviations for each stock (both population and sample standard deviations), the correlation, and the covariance (both population and sample) were also calculated.

Using the Markowitz portfolio equation for a two stock portfolio, a 1% blend of AAPL with the S&P500 portfolio was calculated for the sample (cell C21) and population (cell C20) portfolio standard deviations. By taking the ratio of the blended portfolio's standard deviation, less 99% of the market index (Cells F20 and F21), and the market's standard deviation, less 99% of this same deviation, beta is obtained (Cells H20 and H21). In effect this is giving the ratio of the spreads for a 1% change in the market portfolio by adding 1% AAPL to the portfolio, and the spread of adding 1% of the portfolio to itself. As can be seen, this ratio is beta itself, with a calculated value of 1.22 in cells H20 and H21 matching the previously calculated beta of 1.20 in cell C5. It also appears to be immaterial whether population or sample statistics are utilized.

In conclusion, beta is how much more the individual stock will be affected by adding 1% of the stock to a well-diversified portfolio (S&P 500 in this case), relative to the original portfolio itself, but it is the percent increase (for beta greater than one) or percent decrease (for beta less than one) that the stock will be required over or underperform relative to the portfolios performance (as measured by real returns) due to the inherent company-specific risk of the individual stock, when added to a well diversified portfolio. In a nut shell, it is the risk of the stock when added to a well diversified portfolio.

	AAPL		S&P500			
Yahoo Beta =	1.34	Beta =	1.00			
Google Beta =	1.25	5-Yr CAGR =	16.37%			
Calculated Beta =	1.20	5-Yr St.Dev.P =	9.35%			
5-Yr CAGR =	18.29%	5-Yr St.Dev.S =	9.43%			
5-Yr St.Dev.P =	23.83%	CV =	0.57			
5-Yr St.Dev.S =	24.03%					
CV =	1.30					
Correl (R) =	0.4686					
R^2 =	0.2196	Excel				
Covar.P =	0.0104	0.0104				
Covar.S =	0.0106	0.0106				
w_A =	1%					
w_B =	99%					
	1% AAPL	S&P500	$\Delta_{1\%P}$	$\Delta_{S\&P500}$	β	
$\sigma.P_P$ =	9.37%	9.35%	0.114%	0.094%	1.22	
$\sigma.S_P$ =	9.45%	9.43%	0.115%	0.094%	1.22	

This can be seen by the CAPM equation itself, because the increase or decrease in beta relative to the market beta of one (1), is applied against the portfolio's historical market risk premium (MRP, calculated via $r_{M,H} - r_{RFR,H}$), to generate the stock's theoretical required spread over the current risk free rate $r_{RFR,C}$.

Clearly with a higher standard deviation and CV for Apple than the S&P500, we would expect to be rewarded for this risk with a higher return on Apple than the market, which we see by the beta of 1.20, versus the market beta of 1.00.

Someone might believe that standard deviation contains both market risk as well as company specific risk (i.e., standalone risk), whereas beta only contains diversified risk (i.e., only market risk). The reason this thought seems true is because beta was derived using the Markowitz portfolio equation, by blending a 1% stock with 99% market portfolio, thus fully diversifying the company specific risk. If this were true though, then why wouldn't the beta then become one (1)? The company specific risk is still contained in beta, but for the stock when it is added to the well diversified portfolio, whereas the standard deviation of the stock's historical returns contains the full non-diversified risk of an individual stock that is held in isolation. Perhaps a better way to express beta is that it is the individual stock's standalone risk when added to a well diversified portfolio.

Assuming a MRP of 6.24%, the 0.20 increase in Apple's beta equates to a 1.27% premium for AAPL over the S&P500 due to the company-specific risk that is still associated with AAPL even after adding it to a well diversified portfolio. The market return, using a beta of one (1) and assuming a $r_{RFR,C}$ of 2.85% is thus 9.09%, and adding the company specific risk of AAPL to this, we get the required rate of return for Apple to be 10.36% (i.e., 1.27% + 9.09%). The CAPM confirms this:

$r_{AAPL} = r_{RFR,C} + b(r_{M,H} - r_{RFR,H}) = 2.85\% + 1.20(6.24\%) = 10.36\%$