Risk-Adjusted Portfolio Performance Excel Add-in Documentation

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Purpose of the Add-in

The add-in was written in order to provide an easy way to calculate risk-adjusted portfolio performance and related measures in Microsoft Excel. Once installed (see below), the functions can be used just like any built-in Excel function. I chose to use the C# programming language along with the Excel-DNA library because it is easier to provide function and argument documentation in the Insert Function dialog box than it is with VBA. Additionally, I wanted to learn the C# language.

Add-in Installation

Installing the add-in is easy. After you have downloaded the add-in, click the File tab and then choose Options. Next, click Add-ins and then the Go button. In the Add-ins dialog box, click the Browse button and then navigate to the directory where you saved the add-in. Select the PortfolioPerformance.xll file and then click Ok. You should see that the add-in has been added to the list and that the check box next to it has a check mark. From this point on, the add-in will be loaded and the functions available to be used every time you start Excel.

Removing the Add-in

If you decide that you don't want the add-in to load when you start Excel, or that you want to unload it, simply return to the Add-ins dialog box and uncheck the box. To remove it completely, delete the PortfolioPerformance.xll file. If you delete the file, then the next time Excel starts it will give a message saying that it can't find the add-in. If you return to the Add-ins dialog box after deleting the add-in, Excel will ask if you want to remove the add-in from the list.

Usage Instructions

Using the functions contained in the add-in is very similar to using Excel's built-in functions. You can access the functions directly by typing =Function (e.g., =SharpeRatio). Alternatively, you can access the functions through the Insert Function (Shift + F3) dialog box in the Portfolio Performance category.

Available Functions and Discussion

Note: Many of the functions in the add-in accept optional arguments. Most often this is the range of risk-free returns. In this case, you have three choices:

1. Omit the argument. If you do this, then the risk-free rate is set to 0% for each period.
2. Provide a single number. If you do this, then that number is used for the risk-free rate in each period. If you provide 0%, then this is the same as omitting the argument.
3. Provide a range of risk-free returns. This range should contain the risk-free returns for each period, and it should be of the same length as the asset returns. If the number of risk-free returns does not equal the number of asset returns, then the first risk-free return will be used for all periods (this is effectively the same as option 2).

I believe that the above behavior makes sense for the risk-free returns because it is often assumed that the risk-free rate is a constant. On the other hand, you may wish to treat the risk-free rate as a variable, and that is allowed in the functions. Be aware that this can have consequences. For example, when calculating a beta (β) some people subtract the risk-free rate from the asset and market returns. If the risk-free rate is a constant, then the beta is the same as if you do not subtract it. However, if the risk-free rate is a variable, then the beta will be somewhat different.

Here is a list of the functions contained in the add-in:

Purpose	Function Name and Arguments
Sharpe Ratio	SharpeRatio(Asset Returns, Risk-Free Returns)
Revised Sharpe Ratio	RevisedSharpeRatio(Asset Returns, Risk-Free Returns)
M-Squared (i.e., the Modigliani & Modigliani measure)	MSquared(Asset Returns, Market Returns, Risk-Free Returns)
Information Ratio	InformationRatio(Asset Returns, Benchmark Returns)
Treynor Index	TreynorIndex(Asset Returns, Risk-Free Returns, Asset Beta)
Tracking Error	TrackingError(Asset Returns, Benchmark Returns)
Beta	Beta(Asset Returns, Market Returns, Risk-Free Returns)
Adjusted Beta	AdjustedBeta(Asset Returns, Market Returns, Risk-Free Returns)
Bull Beta (beta in up markets)	BullBeta(Asset Returns, Market Returns, Risk-Free Returns)
Bear Beta (beta in down markets)	BearBeta(Asset Returns, Market Returns, Risk-Free Returns)
Beta Timing Ratio (ratio of bull beta to bear beta)	BetaTimingRatio(Asset Returns, Market Returns)
Jensen's Alpha	JensensAlpha(Asset Returns, Market Returns, Risk-Free Returns)
Fama's Decomposition	FamaDecomposition(Asset Returns, Market Returns, Risk-Free Returns, Target Beta)

Function Descriptions

Sharpe Ratio – SharpeRatio(Asset Returns, Risk-Free Returns)

The Sharpe Ratio (Sharpe, 1966), also known as Reward to Variability, is the difference between the average portfolio return and the risk-free rate divided by the standard deviation of the portfolio returns:

$$S_p = \frac{\bar{R}_p - \bar{R}_f}{\sigma_p}$$

The function takes in a series of asset/portfolio returns and risk-free returns. As noted above, you can omit the risk-free returns, supply a single number, or supply a range.

Revised Sharpe Ratio - RevisedSharpeRatio(Asset Returns, Risk-Free Returns)

The revised Sharpe Ratio (Sharpe, 1994) is identical to the original Sharpe Ratio, except that the denominator is the standard deviation of the differences between the asset/portfolio returns and the risk-free returns:

$$Revised\ S_p = \frac{\bar{R}_p - \bar{R}_f}{\sigma_{p-Rf}}$$

It is the same as the Information Ratio if the benchmark was the risk-free asset.

M-Squared - MSquared(Asset Returns, Market Returns, Risk-Free Returns)

M-squared (Modigliani & Modigliani, 1997) is a variation of the Sharpe Ratio that presents the result as a risk-adjusted return that can be directly compared to the market/benchmark return:

$$M^2 = \left(\frac{\sigma_m}{\sigma_p}\right)\left(R_p - R_f\right) + R_f = S_p\sigma_m + R_f$$

Essentially, the portfolio is levered up or down until its risk is the same as the market return. The return of the resulting portfolio is the M-squared.

Information Ratio - InformationRatio(Asset Returns, Benchmark Returns)

The information ratio (Treynor & Black, 1973) is very similar to the revised Sharpe Ratio, except that a benchmark portfolio is substituted for the risk-free asset:

$$IR_p = \frac{\bar{R}_p - \bar{R}_b}{\sigma_{p-b}}$$

Treynor Index - TreynorIndex(Asset Returns, Risk-Free Returns, Asset Beta)

The Treynor Index (Treynor, 1965) is identical to the original Sharpe Ratio, except that it uses the security's beta in the denominator instead of the standard deviation:

$$T_p = \frac{\bar{R}_p - \bar{R}_f}{\beta_p}$$

Tracking Error - TrackingError(Asset Returns, Benchmark Returns)

The tracking error is a measure of how closely an asset/portfolio matches the returns of its benchmark. Specifically, it is the standard deviation of the differences in the asset/portfolio returns and the benchmark returns:

$$Tracking\ Error = \ \sigma_{p-b}$$

If the difference in these returns is constant over time, then the asset/portfolio is said to perfectly track its benchmark (the tracking error would be 0).

Beta - Beta(Asset Returns, Market Returns, Risk-Free Returns)

Beta (β) is an index of systematic risk; that is, it measures the sensitivity of the asset/portfolio returns to market risk factors. It is best known as the risk measure used in the Capital Asset Pricing Model (CAPM). It is also the denominator of the Treynor Index and is used in Fama's Decomposition of the excess return.

Note that beta is usually calculated as the slope of the single index model regression:

$$\beta_p = \frac{\sigma_{p,m}}{\sigma_m^2} = \frac{Cov(p,m)}{Var(m)}$$

However, it is sometimes calculated by using excess returns (i.e., returns in excess of the risk-free rate). This function allows for both measures. If you omit the risk-free returns argument, then you will get back the typical beta. If you include a series of risk-free returns, then you will get back the excess return version. Also, if you provide a single risk-free return, then you get the excess return version using that one risk-free rate in each period. It should be further noted that with a constant risk-free rate, the beta will be the equivalent of the original beta (not the excess return version) because subtracting a constant from all data points will not change the slope.

Adjusted Beta - AdjustedBeta(Asset Returns, Market Returns, Risk-Free Returns)

This is the beta, adjusted for the tendency to revert to the mean of 1.00. That is, it has been noted by Blume and others that beta tends move towards 1 over time. The adjustment that I use here is to multiply beta by 2/3 and then to add 1/3:

$$\beta_{Adj} = \frac{2}{3}\beta_p + \frac{1}{3}$$

This is the same beta adjustment that was historically used by Merrill Lynch (Levy & Sarnat, 1984). This adjustment, though, is slightly different than that used in Blume (Blume, 1975), who had different adjustments for different time periods. I'm not sure where this exact adjustment comes from originally, though it is a close approximation to Blume's.

Bull Beta - BullBeta(Asset Returns, Market Returns, Risk-Free Returns)

This is the same as the beta, except it uses only returns from those periods when the market portfolio had a positive return. Again, note that the risk-free returns are optional.

Bear Beta - BearBeta(Asset Returns, Market Returns, Risk-Free Returns)

This is the same as the beta, except it uses only returns from those periods when the market portfolio had a negative return. Again, note that the risk-free returns are optional.

Beta Timing Ratio - BetaTimingRatio(Asset Returns, Market Returns)

This is the ratio of the bull beta to the bear beta. Ideally, we would like to see a portfolio manager with a beta much greater than one when the market is rising, and much less than one when it is falling. This ratio attempts to measure that ability.

$$Beta\ Timing\ Ratio = \frac{Bull\ \beta_p}{Bear\ \beta_p}$$

Note, however, that if the portfolio manager has a negative bear beta (which would indicate exceptional bear market performance) then this ratio would be negative. So, it does have the ability to be misleading.

Jensen's Alpha - JensensAlpha(Asset Returns, Market Returns, Risk-Free Returns)

Jensen's alpha (α) is a per period measure of the excess return earned by the asset/portfolio, where excess means "in excess of that expected based on the CAPM."

$$Jensen's\ \alpha = \bar{R}_p - \bar{R}_f - \beta_p\left(\bar{R}_m - \bar{R}_f\right)$$

This is somewhat different from what portfolio managers usually mean when they talk about alpha. They generally mean the excess return over their benchmark portfolio, which is not a risk-adjusted return (i.e., they could have earned that excess return by taking on a lot of extra risk).

Fama's Decomposition - FamaDecomposition(Asset Returns, Market Returns, Risk-Free Returns, Target Beta)

Fama's decomposition of the excess return (Fama, 1972) is one of the earliest attempts at attribution analysis. It calculates the excess return as the asset/portfolio return minus the risk-free rate, and then decomposes this into the excess return due to selectivity (same as Jensen's alpha) and the excess return due to risk (based on the beta). These can be further decomposed into manager's risk and investor's risk (if you have a target beta) and diversification and net selectivity.

This function returns an array of values that it can calculate, depending on if a target beta is given. Therefore, in older versions of Excel you will need to pre-select the output area and use the Ctrl + Shift + Enter keystroke combination to enter it. The newer Excel versions, with the new calculation engine, do not require that "magic" keystroke combination.

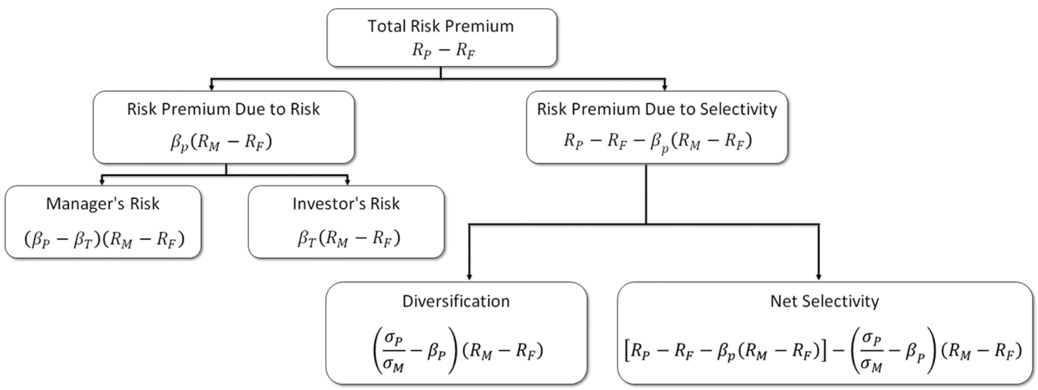

Figure 1: Fama's Decomposition of the Excess Return

Most textbooks show a graph of the security market line (SML) with the components of Fama's decomposition, but I've never felt that was all that helpful. I prefer to think of it in terms of the hierarchy (org chart) shown in Figure 1.

In addition to the outputs shown in the figure, the function also reports the hypothetical beta, which is what the beta would be if the portfolio was perfectly diversified (i.e., perfectly correlated with the market portfolio. Note that:

$$Total\ Risk = \sigma_p^2 = \beta_p^2\sigma_p^2 + \sigma_e^2$$

If the portfolio is perfectly diversified, then the company-specific risk will be 0, so we have:

$$\sigma_p^2 = \beta_p^2\sigma_p^2$$

and solving for β_p we get:

$$\beta_p = \sqrt{\frac{\sigma_p^2}{\sigma_m^2}} = \frac{\sigma_p}{\sigma_m} = Hypothetical\ Beta$$

We can insert the hypothetical beta into the CAPM to get the return that the portfolio would have earned if it was perfectly diversified. If we then subtract the risk-free rate, we get the hypothetical risk premium, which can be directly compared to the actual risk premium.

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