Risk-Adjusted Portfolio Performance Excel Add-in Documentation

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Purpose of the Add-in

The add-in was written 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 (https://github.com/Excel-DNA/ExcelDna) 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

For most of the calculations, I follow Bacon (Bacon, 2013) backed up by original papers (see references) and my own experience teaching some of this material for many years at MSU Denver. However, while I believe that the functions are accurate, please understand that I do not make any guarantees. Use them at your own risk (pun fully intended).

Most of these functions can be fairly easily calculated in Excel as can be seen in the Test Data.xlsx file, which is available on the GitHub site along with the add-in and the source code. In many cases, I make use of array formulas and the new calculation engine that was made available to Office Insiders in 2019. I also use the new Filter function for a number of calculations, which makes some calculations much easier. You will need a fairly new version of Office 365 to effectively use the spreadsheet calculations. However, the add-in should work fine in any recent version of Excel. Unfortunately, the add-in is not compatible with Office for Mac.

Note: Some 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.

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)
Adjusted Beta	AdjustedBeta(Asset Returns, Market Returns)
Bull Beta (beta in up markets)	BullBeta(Asset Returns, Market Returns)
Bear Beta (beta in down markets)	BearBeta(Asset Returns, Market 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)
Up Capture Ratio	UpCaptureRatio(Asset Returns, Benchmark Returns)
Down Capture Ratio	DownCaptureRatio(Asset Returns, Benchmark Returns)
Up Percentage Ratio	UpPercentageRatio(Asset Returns, Benchmark Returns)
Down Percentage Ratio	DownPercentageRatio(Asset Returns, Benchmark Returns)
Percentage Gain Ratio	PercentageGainRatio(Asset Returns, Benchmark Returns)
Percentage Loss Ratio	PercentageLossRatio(Asset Returns, Benchmark Returns)
Hurst Exponent	HurstExponent(Asset Returns)
Bias Ratio	BiasRatio(Asset Returns, Standard Deviations)

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:

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

If you do not supply an asset beta, then it will be treated as if it was 0 and the function will return a #DIV/0! error.

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)

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). If you wish to do this, then you can subtract the range of risk-free rates from the asset and market returns in the function. This will make it an array formula. This also applies to the other beta functions.

Adjusted Beta - AdjustedBeta(Asset Returns, Market 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)

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)

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."

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

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.

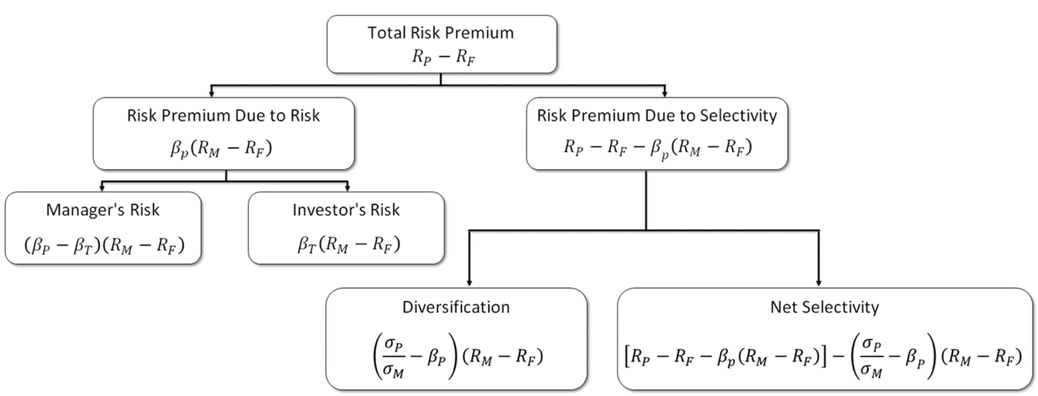

Figure 1: Fama's Decomposition of the Excess Return

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:

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

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

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

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.

Up Capture Ratio - UpCatureRatio(Asset Returns, Benchmark Returns)

This function calculates the average returns of the asset/portfolio and benchmark when the benchmark has a positive return, and then computes the ratio:

$$Up\ Capture\ Ratio = \frac{\bar{R}_p^+}{\bar{R}_b^+}$$

Obviously, we would like to see the up capture ratio be greater than 1. A value less than 1 would indicate that the manager is underperforming in up markets.

Down Capture Ratio - DownCatureRatio(Asset Returns, Benchmark Returns)

This function calculates the average returns of the asset/portfolio and benchmark when the benchmark has a negative return, and then computes the ratio:

$$Down\ Capture\ Ratio = \frac{\bar{R}_p^-}{\bar{R}_b^-}$$

Obviously, we would like to see the down capture ratio be less than 1. A value greater than 1 would indicate that the manager is underperforming in down markets.

Up Percentage Ratio - UpPercentageRatio(Asset Returns, Benchmark Returns)

This function returns the percentage of the time that the manager outperforms the benchmark in up markets. Ideally, this would be 100%, though that is unlikely. For example, say that the benchmark was up in 25 of the last 36 months, and that in 20 of those 25 months the portfolio outperformed the benchmark. This would give an up percentage ratio of 80% (= 20/25).

Down Percentage Ratio - DownPercentageRatio(Asset Returns, Benchmark Returns)

This function returns the percentage of the time that the manager outperforms the benchmark in down markets. Ideally, this would be 100%, though that is unlikely. For example, say that the benchmark was down in 12 of the last 36 months, and that in 8 of those 12 months the portfolio outperformed the benchmark. This would give a down percentage ratio of 66.67% (= 8/12).

Percentage Gain Ratio - PercentageGainRatio(Asset Returns, Benchmark Returns)

This compares the number of positive asset returns to the number of positive benchmark returns, without regard for when they occur. For example, assume that during the evaluation period the portfolio had a positive return in 18 months and the benchmark was positive for 15 months. This ratio would be 1.20 (= 18/15). Again, the positive returns of the asset and benchmark do not have to coincide. Higher numbers are better.

Percentage Loss Ratio - PercentageLossRatio(Asset Returns, Benchmark Returns)

This compares the number of negative asset returns to the number of negative benchmark returns, without regard for when they occur. For example, assume that during the evaluation period the portfolio had a negative return in 6 months and the benchmark was down for 7 months. This ratio would be 0.86 (= 6/7). Again, the negative returns of the asset and benchmark do not have to coincide. Lower numbers are better.

Hurst Exponent - HurstExponent(Asset Returns)

Calculates the Hurst Exponent, which indicates how predictable a time series is. According to Qian and Rasheed (Qian & Rasheed, 2004) values near 0.5 indicate randomness, values less than 0.5 indicate mean-reversion, and values greater than 0.5 indicate a strongly trending series. The range can be from 0 to 1. We would expect most asset return series to have $H \cong 0.5$ if markets are reasonably efficient. Most importantly for our purposes, a portfolio manager exhibiting skill would have H well above 0.5. The relevant formula is:

$$H = \frac{\ln\left(\frac{Range\ of\ Cumulative\ Deviations\ from\ Mean}{Standard\ Deviation\ of\ Returns}\right)}{\ln(Number\ of\ Observations)}$$

Bias Ratio – Bias Ratio(Asset Returns, Standard Deviations)

The bias ratio (Abdulali, 2006) attempts to identify smoothing of returns. It is said to be particularly useful in identifying smoothing of returns by hedge funds that trade a lot of illiquid (i.e., hard to value due to infrequent trades) assets. Values near 1.0 to 1.5 indicate a lack of smoothing, while values well-above 1.0 (say, above 2.5) are indicative of smoothing and possible fraudulent valuation. The bias ratio compares returns between 0% and one standard deviation above 0% to those that are between one standard deviation below 0% up to, but not including 0%:

$$Bias\ Ratio = \frac{Count\left(R_p^+\right)}{Count\left(R_p^-\right)}$$

where R_p^+ are those returns in the range $[0\%, +1\sigma]$ and R_p^- are the returns in the range $[-1\sigma, 0\%)$.

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