Investment Planning Answer Book by Jay L. Shein, Investment Statistical Concepts and Evaluation Methods

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Investment advisors, consultants, and investors are always interested in methodology to evaluate investment portfolio or performance. Mathematical and statistical concepts and formulas are used to help evaluate investment performance on an absolute basis, a relative basis, and/or a risk adjusted basis. All measures of performance have their advantages and disadvantages. No one statistic should be used in isolation. These statistical concepts are tools that help advisors make informed decisions.

Investment Planning Answer Book by Jay L. Shein, Q 20:1, What is a typical requirement of a portfolio manager?

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If advisors are placing an investor's money with money managers such as separate accounts or mutual funds, they are looking for managers that can produce above average returns on a risk adjusted basis. Additionally, advisors should be looking for managers that can significantly reduce systematic risk relative to that manager's benchmark. Modern Portfolio Theory teaches that higher risk adjusted returns can be achieved by good timing (top-down approach) decisions or high-quality security selection (bottom-up approach) decisions.

The following two managers are examples of using the top-down approach. A money manager who can decrease the risk of the portfolio by increasing the allocation to money market instruments in the anticipation of a declining market and increase the risk by increasing the allocation to higher beta securities in anticipation of rising markets would have better risk adjusted returns. A fixed income manager that can make adjustments to the portfolio duration by anticipating changes in interest rates can also provide superior risk adjusted returns.

Managers that can make good, frequent, and consistent top-down or bottom-up decisions will have higher risk adjusted returns. Investors are primarily rewarded for accepting systematic risk which is non-diversifiable risk. Many investors want mostly systematic (non-diversifiable) risk since diversifiable (unsystematic) risk can be diversified away. Some advisors will argue that investors are not sufficiently compensated for taking on diversifiable risk and therefore, should hold a completely diversified portfolio that is highly correlated to the benchmark. Others will argue that investors can achieve higher alpha in return for taking that diversifiable risk.

Investment Planning Answer Book by Jay L. Shein, Q 20:2, How did portfolio performance evaluation evolve?

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Before the 1960s, portfolios were generally evaluated on their absolute performance (their rate of return). Portfolio managers knew that various risks existed but were unaware of how to quantify these risks. By the 1960s, portfolio managers were using the variability of returns to help quantify the risk taken in a portfolio; however, this still looked at risk and return separately. In the 1960s, portfolio performance measurements that combined risk and return started to be developed.

Investment Planning Answer Book by Jay L. Shein, Q 20:3, What is peer group performance evaluation?

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A common method of evaluating a portfolio manager is to compare them to their peer group. This method gathers the risk and return calculations for a group of managers that are similar in style or strategy to the manager being evaluated. This group of managers could be divided into quartiles, and advisors could just select managers that are in the top quartile or could see where the selected manager compares to the other rankings of similar managers. Some consultants refer to this peer group as an active benchmark. Some of the problems with peer group comparisons include the following issues. They do not make adjustments for risk. The longer the period, the more they are subject to survivorship bias. It may be hard to find a large enough peer group that is truly a representative peer group of a manager being evaluated in order to make a valid ranking comparison. By concentrating on peer groups, which is a relative return method of comparison, investors are more likely to lose sight of whether they are accomplishing their personal objectives within the investment constraints that they have.

Investment Planning Answer Book by Jay L. Shein, Q 20:4, What is beta?

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Beta is a measure of relative risk. Beta is also discussed in the chapter on risk adjusted measure of return. Beta is a measure of the responsiveness of an investment relative to the movements in the market. The market is whatever you want it to be. In the U.S., the S&P 500 is sometimes used to represent the market. The beta coefficient measures systematic risk and is best used for a well-diversified portfolio where most or all of the unsystematic risk has been diversified away. The beta coefficient will then measure the volatility of return relative to the selected benchmark. An investment that has a beta of one would imply that the security or investment moves in tandem with the market. A beta higher than one means that the investment is riskier than the market, and a beta less than one means that the investment carries less risk than the market.

The beta for individual securities has not proven to be stable over time, but the beta for a portfolio of securities has. This is because in a portfolio of securities when the beta of one security increases, the beta of another tends to decrease therefore balancing them out in the long run. Many times, the historical beta of a portfolio is used as an indication of future volatility. While this may be a forecasting tool that is used by many, like with any method used to forecast the future, advisors and investors should remember that historical information is no guarantee or indication of the future. If the correlation between the returns of a portfolio of securities and the selected market benchmark are weak, the beta coefficient will be of little value. If the relationship of returns of the portfolio is strong relative to the selected market benchmark, then the beta coefficient will be a stronger indicator.

Investment Planning Answer Book by Jay L. Shein, Q 20:5, How is beta calculated?

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Beta can be calculated in the following manner:

$$\beta_p = \frac{COV_{p,m}}{\sigma_m^2}$$

Where:

β_p = beta of portfolio

$COV_{p,m}$ = covariance between the portfolio and the market

σ_m^2 = variance of the market

Notice that the variance of the market can easily be calculated by squaring the standard deviation of the market. The covariance of the market can be calculated as follows:

$$COV_{p,m} = \rho_{p,m} \cdot \sigma_p \cdot \sigma_m$$

Where:

$COV_{p,m}$ = covariance between the portfolio and the market

$\rho_{p,m}$ = correlation between the portfolio and the market

σ_p = standard deviation of the portfolio

σ_m = standard deviation of the market

With this, we can then calculate beta using other formulas such as:

$$\beta_p = \frac{\rho_{p,m} \cdot \sigma_p \cdot \sigma_m}{\sigma_m^2}$$

Where:

β_p = beta of portfolio

$\rho_{p,m}$ = correlation between the portfolio and the market

σ_p = standard deviation of the portfolio

σ_m = standard deviation of the market

σm^2 = variance of the market

This equation can be simplified as follows:

$$\beta_p = \frac{\rho_{p,m} \cdot \sigma_p}{\sigma_m}$$

Where:

β_p = beta of portfolio

$\rho_{p,m}$ = correlation between the portfolio and the market

σ_p = standard deviation of the portfolio

σ_m = standard deviation of the market

For example, assume a portfolio has a correlation between the portfolio and the market of 0.6, the standard deviation of the portfolio is 0.4, and the standard deviation of the market is 0.3. What is the beta of the portfolio?

$$\beta_p = \frac{\rho_{p,m} \cdot \sigma_p}{\sigma_m} = \frac{0.6 \cdot 0.4}{0.3} = 0.80$$

Another example is as follows: assume a portfolio has a correlation between the portfolio and the market of 0.5, the variance of the portfolio is 0.18, and the variance of the market is 0.10. What is the beta of the portfolio?

This can be calculated using the above formulas by first finding the standard deviation of the portfolio and the standard deviation of the market by taking the square root of the respective variances. Therefore, the standard

deviation of the portfolio would be 0.424, and the standard deviation of the market would be 0.316. These values can then be put into the formula as follows:

$$\beta_p = \frac{\rho_{p,m} \cdot \sigma_p}{\sigma_m} = \frac{0.5 \cdot 0.424}{0.316} = \mathbf{0.671}$$

Both of the examples calculated above show that the investment is less volatile than the selected market portfolio.

Beta can also be calculated using an Excel spreadsheet with the SLOPE function. The following example in Table 1 shows how to use Excel to calculate beta using just five years of return data. The advisor can use as many years as they desire by adding additional rows.

Table *1A* *B*

1	−0.02	−0.03
2	0.05	0.05
3	0.07	0.06
4	0.03	0.05
5	0.04	0.03
6		
7	**0.86**	

Column A1:A5 are the annual returns each year of the portfolio for five years. Column B1:B5 are the annual market returns each year for five years. Cell A7 is calculated by inserting the function (f_x) = SLOPE(A1:A5,B1:B5). In this example, cell A7 is the beta of the portfolio.

Investment Planning Answer Book by Jay L. Shein, Q 20:6, How can the advisor determine if the beta of a portfolio is significant?

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To determine how significant the relationship is between a security's return and the market, the advisor can use R-squared (R^2) which is also known as the coefficient of determination. R-squared tells the advisor how much of the returns of one investment can be explained by the other. If a portfolio has a low R-squared such as 0.30 to the market, the beta will have little significance. This low of an R-squared would indicate that much of the variation in returns can be explained by something other than market movements. This low R-squared would indicate an investment with a lot of diversifiable risk, also known as unsystematic risk. If a high R-squared such as 90 was observed in a portfolio relative to the market, the advisor could conclude that the variability of returns is mostly explained by the variability of returns of the market. A high R-squared indicates that a lot of the portfolio's risk is systematic, also known as non-diversifiable risk. There is no hard and fast rule, but one should consider using an R-squared of 70 or above if the beta of a diversified portfolio is being evaluated.

Investment Planning Answer Book by Jay L. Shein, Q 20:7, What does a correlation coefficient communicate?

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The correlation coefficient, also known as the Pearson correlation coefficient, communicates the degree of the relationship between any two investments. The correlation coefficient ranges from 1 to −1. A correlation of one (1) indicates two investments move in lock-step with each other relative to their individual means, and a correlation of negative one (−1) would indicate that two investments move opposite of each other relative to their individual means. The degree of association between two investments can easily be calculated with an Excel spreadsheet. The correlation coefficient can also be calculated using an Excel spreadsheet with the CORREL function. The following example in Table 2 shows how to use Excel to calculate the correlation coefficient using just five years of return data. The advisor can use as many years, months, or quarters as they desire by adding additional rows.

Table	*2A*	*B*
1	−0.02	−0.03
2	0.05	0.05
3	0.07	0.06
4	0.03	0.05
5	0.04	0.03
6		
7	**0.933**	

Column A1:A5 are the annual returns each year of investment A for five years. Column B1:B5 are the annual returns each year of investment B for five years. Cell A7 is calculated by inserting the function (f_x) = CORREL(A1:A5,B1:B5). In this example, cell A7 is the correlation coefficient of the two investments. A correlation of 0.933 is very high and would indicate that investment A and B move very similarly as they are highly correlated. The higher the correlation, the less the diversification benefit that is received. For diversification benefit, the advisor is looking for assets that have lower correlations to each other but have positive expected returns. The correlation coefficient is an important statistic used in investment portfolio management.

Investment Planning Answer Book by Jay L. Shein, Q 20:8, How can R-squared for two time series be calculated with an Excel spreadsheet?

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The R-squared (R^2) indicates how much of a portfolio or manager's return can be explained by the benchmark. The R-squared can also be calculated using an Excel spreadsheet with the RSQ function. The following example in Table 3 shows how to use Excel to calculate the correlation coefficient using just five years of return data. The advisor can use as many years, months, or quarters as they desire by adding additional rows.

Table	*3A*	*B*
1	−0.02	−0.03
2	0.05	0.05
3	0.07	0.06
4	0.03	0.05
5	0.04	0.03
6		
7	**87.1%**	

Column A1:A5 are the annual returns each year of the portfolio, manager, or investment (also known as the dependent variable) for five years. Column B1:B5 are the annual market (benchmark) returns (also known as the independent variable) each year for five years. Cell A7 is calculated by inserting the function (f_x) = RSQ(A1:A5,B1:B5). In this example, cell A7 is the R-squared for the investment. An R-squared of 87.1 is very high and would indicate that much of the return of investment A can be explained by the benchmark return. The higher the R-squared, the more explanatory power the benchmark has. The higher the R-squared, the more reliable other statistical measures such as beta will be. R-squared could also be calculated by squaring the correlation coefficient. The correlation coefficient from this portfolio in Table 3 is 0.933 which when squared equals 0.871. If the advisor already knew the R-squared, they could take the square root of the R-squared value to get the correlation coefficient.

Investment Planning Answer Book by Jay L. Shein, Q 20:9, What is the Treynor ratio?

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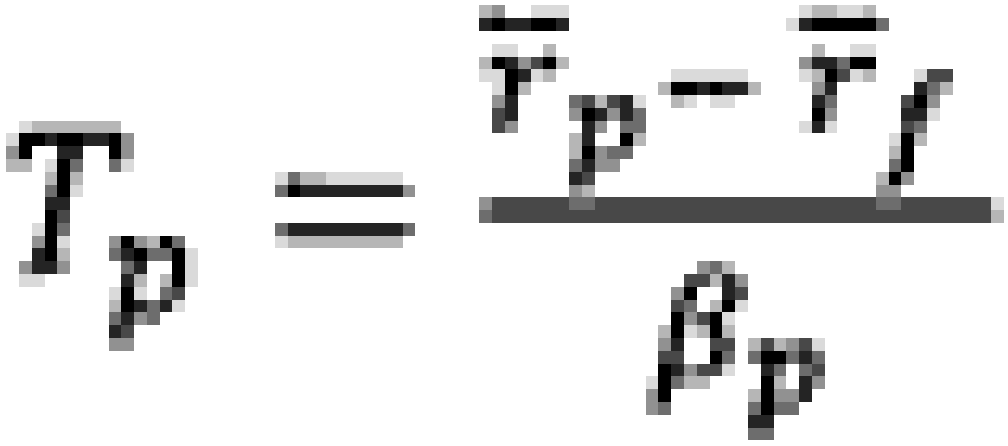
There are many methods to evaluate investment risk. The Treynor ratio, also referred to as the Treynor performance index, is a measure of risk adjusted performance. It evaluates returns in excess of the risk-free rate relative to the investment's beta. Unlike the Sharpe ratio, which uses standard deviation in its denominator which allows it to be benchmark independent, the Treynor ratio is very dependent on the benchmark chosen for overall validity. The Treynor ratio is calculated as follows:



Where:

T_p = Treynor ratio

r_p = the return of the portfolio

r_f = the risk-free rate

β_p = the beta of the portfolio or manager

Measurements of risk adjusted returns, such as the Treynor ratio, are used to determine if an investment, manager, or portfolio outperformed their benchmark on a risk adjusted basis. Just because one portfolio has a higher return than another does not mean that the higher returning portfolio was superior nor does it mean that the lowest returning portfolio was inferior. By adjusting for risk using risk adjusted measures of performance, the advisor and investor can have a better look at the performance after adjusting for risk. Like the Sharpe ratio (which is discussed in the chapter on risk adjusted measures of return), advisors are looking for the higher Treynor ratio. For example, the following Table 4 shows the use of the Treynor ratio.

Table 4	*Money Manager A*	*Money Manager B*	*Money Manager C*
Treynor Ratio	4.55	6.25	6.66

Money Manager C has the highest Treynor ratio when adjusted for its risk as measured by beta (systematic risk). Treynor ratio is best used with a diversified portfolio since the denominator of the Treynor ratio gives no indication of portfolio diversification. The Treynor ratio adjusts for the market wide risk. The Treynor ratio is okay to use to compare two managers if the managers' betas are significantly different.

Investment Planning Answer Book by Jay L. Shein, Q 20:10, What is M-squared?

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M-squared (M^2) is a measure of risk adjusted performance which can be used to rank portfolios or managers and is very similar to the Sharpe ratio in its conclusions. It was developed by Franco Modigliani, winner of the 1985 Nobel Prize in Economics, and his granddaughter Leah Modigliani, an investment strategist at Morgan & Stanley. It was introduced in the *Journal of Portfolio Management* winter 1997 issue in a paper titled "Risk-Adjusted Performance." In the original paper, M-squared was referred to as RAP or Risk Adjusted Performance. The consulting and investment community dubbed it M^2 after Modigliani and Modigliani. Like the Sharpe ratio, the objective is to evaluate a portfolio, money manager, or mutual fund on how well they perform when adjusted for risk. M^2 adjusts for risk by mixing the money manager that is being evaluated with a risk-free asset such as Treasury bills in such a manner that the weightings of the money manager and the Treasury bill match the risk of the benchmark selected.

$$M^2 = \left(1 - \frac{\sigma_m}{\sigma_p}\right) r_f + \frac{\sigma_m}{\sigma_p} r_p$$

Where:

M^2 = M-squared risk adjusted measure of performance

σ_m = standard deviation of the market (benchmark)

σ_p = standard deviation of the portfolio

r_f = risk-free rate of return

r_p = return of the portfolio or manager

M^2 is very similar to the Sharpe ratio in what it tells the investor. The measure of risk adjusted performance as measured by the Sharpe ratio is a little more difficult to interpret as the number is a little more abstract. The M^2 states the risk adjusted performance in performance terms (percentage). Like the Sharpe ratio, M-squared can only be used when comparing managers or portfolios to other managers or portfolios.

Also similar to the Sharpe ratio, the higher the M^2 the better the risk adjusted performance. For example, the following Table 5 shows how M^2 is used.

Table 5	*Money Manager A*	*Money Manager B*	*Money Manager C*
M^2	14.9%	12.1%	11.0%

Manager A has the highest return when adjusted for risk when using the M^2 calculation and is therefore the best manager. M-squared does not address how a portfolio is affected when a money manager such as Money Manager A in Table 5 is added as the effect of the correlation coefficients of Manager A and the other managers in the portfolio are not accounted for. This is similar to the Sharpe ratio caveat. Advisors might find that using the Treynor ratio of a manager or mutual fund is more valuable when adding that manager to a portfolio containing other managers. To make the best informed judgment, advisors should look at as many statistics and evaluation methods for any particular investment/money manager/mutual fund before using it in an investment portfolio.

Investment Planning Answer Book by Jay L. Shein, Q 20:11, What is the Calmar ratio?

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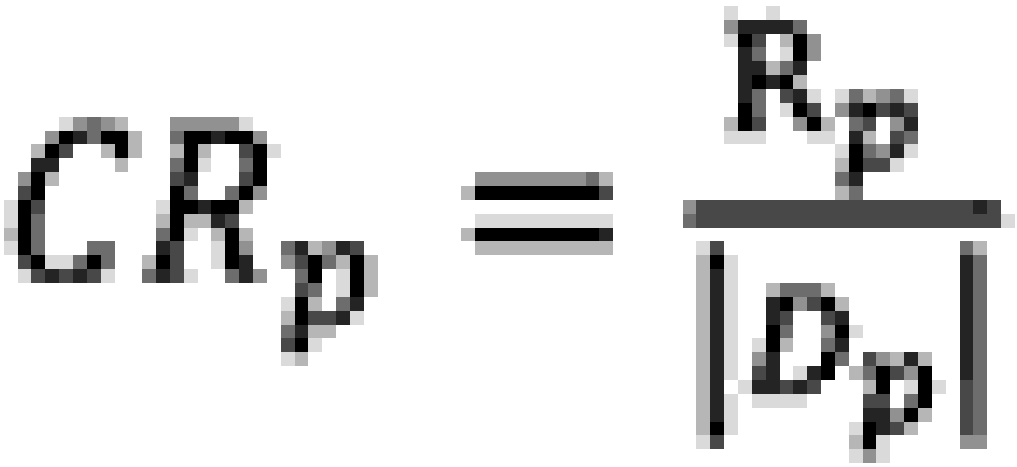
The Calmar ratio is a measure of return relative to risk. In this ratio, the numerator is the annualized compound rate of return over a specified period of years such as three years, and the denominator is the maximum drawdown in the same specified period of time. The Calmar ratio is a popular measurement used to evaluate hedge funds. In general, a higher Calmar ratio is better. The formula for the Calmar ratio is as follows:



Where:

CR_P = Calmar Ratio of portfolio or manager

R_p = compound annual return of the portfolio or manager

D_p = absolute maximum drawdown of the portfolio or manager

Some portfolios or hedge funds have very high returns while at the same time have experienced high drawdown risk. Maximum drawdown is the highest percentage drawdown that has occurred in the period being measured. The drawdown is defined as a losing period throughout an investment's duration. The period of time covers the time where the portfolio value goes from its lowest point to its new high. The Calmar ratio can assist the advisor in determining the risk adjusted return while considering downside risk. Three years of data is typically the amount used.

Investment Planning Answer Book by Jay L. Shein, Q 20:12, What is the Sterling ratio?

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The Sterling ratio is another measure of risk versus reward that helps determine which investment portfolio or hedge fund has the highest return while experiencing the least amount of volatility. The Sterling ratio, like the Calmar ratio, is a popular risk adjusted measure used to evaluate and compare hedge funds. The formula for the Sterling ratio is as follows:

$$SR_p = \frac{R_p}{\left| D_p - 10\% \right|}$$

Where:

SR_P = Sterling Ratio of portfolio or manager

R_p = compound annual return of the portfolio or hedge fund

D_p = the average maximum drawdown of the portfolio

The numerator in the Sterling ratio is the same as the Calmar ratio, but the denominator in the Sterling ratio is the absolute value of the average maximum drawdown minus an arbitrary 10 percent over the specified time period (typically three years). To calculate the average maximum drawdown (D_p) of the specified period of time, the following method can be used:

$$D_p = \frac{D_1 + D_2 + D_3 + \dots D_n}{n}$$

Where:

D_p = average maximum drawdown of the portfolio

D_1 = maximum drawdown for the first year

D_2 = maximum drawdown for the second year

D_3 = maximum drawdown for the third year

D_n = maximum drawdown for the n^{th} year

n = number of total years in the specified period of time

EXAMPLE 20-1

Assume a manager in the first year measured had a maximum drawdown of 10 percent, in year two it was 10 percent, and in year three it was 0 percent. The average return for the period was 10 percent. The average maximum drawdown (D_p) would be calculated by adding the three years of drawdowns and dividing by three. Then you would subtract the arbitrary 10 percent from the D_p and take the absolute value of that number. This is the denominator of the Sterling ratio. This example would be calculated as follows for a Sterling ratio of 3 percent.

$$D_p = \frac{10\% + 10\% + 0\%}{3} = 6.67\%$$

$$SR = \frac{R_p}{|D_p - 10\%|} = \frac{10\%}{|6.67\% - 10\%|} = 3\%$$

One criticism of the Sterling ratio is that drawdowns are cut off at the beginning of each calendar year. Drawdowns do not simply end December 31. Because of this, risk can be hidden in the Sterling ratio. For instance, if a 20 percent drawdown is split evenly (10 percent) between one year and the next, then the observed risk could be underestimated. Like the Calmar ratio, the higher the Sterling ratio, the better. A higher Sterling ratio indicates a higher return relative to the risk being taken.

Investment Planning Answer Book by Jay L. Shein, Q 20:13, What is the Capture ratio?

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There are two capture ratios, the upside capture ratio and the downside capture ratio. The upside capture ratio measures an investment manager or mutual fund's performance in up markets. An up market is defined as the months or quarters where the market index is above zero. The upside capture ratio shows what proportion as measured by percentages of the up market was captured by the investment manager or mutual fund. For example, if the investment manager had captured 120 percent of the up market, the manager has outperformed the market on the upside. Another way of describing the upside capture ratio is that it evaluates a manager's performance in up markets relative to a particular index. A manager that has a 120 percent upside capture ratio would have outperformed the specified index by 20 percent when the index has risen.

Some of the criticisms of the capture ratio include the following: that it is similar to beta but not as good, the academic evidence that it works is not overwhelming, and derivatives such as options and convertible series might give a good upside capture ratio and therefore obscure some of the conclusions. Another problem with capture ratios is that when only looking at the upside, a lot of good data is not used. In essence, the capture ratio is throwing away good data and is considered too simplistic by some. Others like the capture ratio as it is easy to explain and communicate to investors. For an upside capture ratio, the advisor is looking for a higher ratio. It is calculated as follows:

$$CR_u = \frac{R_{p+}}{R_{i+}}$$

Where:

CR_u = upside capture ratio

R_{p+} = portfolio or fund's returns during index's positive return periods

R_{i+} = index's returns during index's positive return periods

For example, suppose a mutual fund's annualized return looking only at those periods (e.g., monthly or quarterly) when the selected index's returns were positive was 10 percent, and the selected index's annualized returns during theindex's positive periods was 12 percent. The capture ratio would be 83.33 percent. This was calculated as follows:

$$CR_u = \frac{R_{p+}}{R_{i+}} = \frac{10\%}{12\%} = 83.33\%$$

This would indicate that the mutual fund only captured 83.33 percent of the upside return relative to the index.

The downside capture ratio measures an investment manager or mutual fund's performance in down markets. A down market is defined as the months or quarters where the market index is below zero. The downside capture ratio shows what proportion as measured by percentages of the down market was captured by the investment manager or mutual fund. For example, if the investment manager had captured 80 percent of the down market, the manager has outperformed the market on the downside. Another way of describing the downside capture ratio is that it evaluates a manager's performance in down markets relative to a particular index. A manager that has an 80 percent downside capture ratio would have outperformed the specified index by 20 percent when the index has declined. For a downside capture ratio, the advisor is looking for a lower ratio. It is calculated as follows:

$$CR_d = \frac{R_{p-}}{R_{i-}}$$

Where:

CR_d = downside capture ratio

R_{p-} = portfolio or fund's returns during index's negative return periods

R_{i-} = index's returns during index's negative return periods

For example, suppose a mutual fund's annualized return looking only at those periods (e.g. monthly or quarterly) when the selected index's returns were negative was 8 percent, and the selected index's annualized returns during the index's negative periods was 12 percent. The downside capture ratio would be 66.7 percent. This was calculated as follows:

$$CR_d = \frac{R_{p-}}{R_{i-}} = \frac{8\%}{12\%} = 66.7\%$$

This would indicate that the mutual fund only captured 66.7 percent of the downside return relative to the index.

The ideal situation when evaluating a manager or fund is to have a higher than 100 percent upside capture ratio and a less than 100 percent downside capture ratio. When using the capture ratio, managers that have high upside capture ratios and low downside capture ratios are preferred.

Investment Planning Answer Book by Jay L. Shein, Q 20:14, What are some popular financial calculators used by investment advisors?

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The following calculators are popular and used by many financial advisors. Each has its merits and detractors. They are as follows: HP-12C, HP-12C Platinum, HP-17BII+, Texas Instruments BA II Plus, and Texas Instruments BA II Plus Professional. The HP-12C only allows for Reverse Polish Notation (RPN) entry. The other calculators mentioned allow for algebraic entry which many people prefer. The HP-12C Platinum and HP-17BII+ allow the user to choose between RPN and algebraic entry.

Investment Planning Answer Book by Jay L. Shein, Q 20:15, What is the importance of present value and future value calculations?

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Many financial calculations such as present value and future value calculations are done with spreadsheets or financial calculators. Because these Time Value of Money calculations are important for advising clients in investments and other areas of financial planning, it is important to understand the methodology as it can be calculated by hand or with a simple calculator. The present value calculates the current value of a sum of money given a particular rate of return and is the basis for making many investment decisions. For example, it can be used for calculating the current value of a bond. For instance, a question it can answer is whether receiving a $100,000 now is more valuable than receiving $100,000 five years from now. If you had the choice between receiving $100,000 now or $100,000 in five years, it would make more sense to take the funds now because you could invest the $100,000 and receive added return over the next five years.

Present value calculations use an assumed discount rate chosen by the investor to estimate the value of the investment.

EXAMPLE 20-2

Suppose an investor wanted to know the present value of a zero coupon bond that pays 5 percent and matures in ten years with a terminal value of $1,000. The present value can be calculated as follows:

$$PV_i = \frac{FV_i}{(1+R)^n} = \frac{\$1000}{(1+.05)^{10}} = \$613.91$$

$$FV_i = PV_i(1+R)^n = \$1,000,000(1+.06)^{10} = \$1,790,847.70$$

Where:

PV_i = present value of the investment (in this case, the zero coupon bond)

FV_i = future value of the investment (in this case, the zero coupon bond)

R = return or discount rate

n = number of periods

In this example, you should not pay more than $613.91 for the zero coupon bond as that is its present value.

Future value can be used to extrapolate investment values into the future.

EXAMPLE 20-3

Assume that a $1 million portfolio has an expected return of 6 percent over the next ten years. You could calculate the future value in the following manner:

Where:

PV_i = present value of the investment (in this case, the zero coupon bond)

FV_i = future value of the investment (in this case, the zero coupon bond)

R = return or discount rate

n = number of periods

In this example, the future value of the $1 million investment would be $1,790,847.70 with these assumptions.

Investment Planning Answer Book by Jay L. Shein, Q 20:16, How is the current yield of a stock or bond calculated?

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The current yield of a stock or bond is calculated by dividing the dividend in the case of a stock or the coupon in the case of a bond by the current price.

EXAMPLE 20-4

If the current annual dividend on a stock is $2.50 and the stock is selling for $50, the current yield would be 5 percent. This is calculated as follows:

Current yield = $2.50 / $50.00 = 5%

EXAMPLE 20-5

If the coupon payment on the bond is 6 percent which has a par value of $1,000, and the current price of the bond is $950, then the coupon payment would be $60. This would then be divided by the price of the bond which would give a current yield of 6.3 percent.

Current yield = $60 / $950 = 6.3%

When a bond such as this is selling at a discount, the current yield will always exceed the coupon rate. When a bond is selling at a premium, the current yield will be lower than the coupon rate.

Investment Planning Answer Book by Jay L. Shein, Q 20:17, What is inflation adjusted return?

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One of the most important return numbers that an investor should look at for a portfolio is the inflation adjusted return. The nominal return which is the actual return does not account for the toll that inflation takes on the purchasing power of a portfolio. A simple approximation to adjust for inflation would be to subtract the inflation rate either assumed or actual from the assumed or actual return. To more accurately account for the inflation rate during the period so the investor can see the real rate of return which is the return after adjusting for inflation, they can use the following formula:

$$IAR = \frac{(1 + R)}{(1 + I)} - 1$$

Where:

IAR = inflation adjusted return

R = nominal return

I = inflation rate

EXAMPLE 20-6

Assume the return of an investment portfolio was expected to be 6 percent, and the inflation rate was expected to be 3%. The inflated adjusted return would be as follows:

$$IAR = \frac{(1 + .06)}{(1 + .03)} - 1 = 2.91\%$$

When looking at the real return, an investor can see the real earning potential of the investment while removing any external economic issues. For example, if an investor owned a bond that returned 5 percent at the end of a year, they would assume a positive return. However, if inflation was 6 percent, the real return of that bond would be −0.94 percent. Investors should be most concerned with the real return on their investments as they can only spend real returns and not nominal returns. Inflation over long periods of time can significantly reduce the purchasing power of an investment portfolio.

Investment Planning Answer Book by Jay L. Shein, Q 20:18, What formula can be used to annualize monthly or quarterly data?

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Annualizing monthly data is fairly simple and can be used to extrapolate into the future how an investment might grow if it continued to grow at a given rate. The formula is as follows:

$$R_a = [(1 + R_m)^{12} - 1] \bullet 100$$

Where:

R_a = annualized return

R_m = monthly return

For example, if the return in January of a year was 0.5%, and the annualized return assuming that the return continued for the rest of the year would be as follows:

$$R_a = [(1 + .005)^{12} - 1] \bullet 100 = 6.17\%$$

For annualizing quarterly data, use 4 instead of 12 for the exponent in the formula.

Investment Planning Answer Book by Jay L. Shein, Q 20:19, What is the formula for annualizing year-to-date returns based on monthly data?

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Annualizing year to date returns can be used to extrapolate returns for the balance of the year. The following formula can be used:

$$R_a = \left[\left(1 + R_{ytd}\right)^{\frac{12}{m}} - 1 \right] \bullet 100$$

Where:

R_a = annualized return

R_{ytd} = year-to-date return

m = m^{th} month

EXAMPLE 20-7

If the year-to-date return through the end of April was 4%, the annualized return would be as follows:

$$R_a = \left[(1 + .04)^{\frac{12}{4}} - 1 \right] \bullet 100 = 12.49\%$$

If the returns continued the same for the rest of the year, this year-to-date return would tell you that the return for the year would be 12.49 percent.

Investment Planning Answer Book by Jay L. Shein, Q 20:20, How is a bond valued?

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A bond value is the sum of the bond's discounted cash flows. It can be calculated with the following formula:

$$\text{Value of Bond} = \sum_{t=0}^{T} \frac{CF_t}{(1+\text{YTM})^t}$$

Where:

CF_t = cash flow for the time period

YTM = yield to maturity

t = time period to cash flow

T = last value to be summed

An example assuming a bond with a par value of $1,000 that matures in four years with a 6 percent annual coupon and a yield to maturity of 8 percent is as follows:

Period	*Cash flows*	*PV(CF)*
1	60	55.56
2	60	51.44
3	60	47.63
4	1060	779.13
Totals		**933.76**

The value or price of the bond is $933.76.

Investment Planning Answer Book by Jay L. Shein, Q 20:21, What does duration of a bond measure?

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Duration is a measure of a bond's price sensitivity to changes in yield that are small. This is referred to as interest rate risk for a bond. Duration is only a measure of interest rate risk. It does not measure credit risk, convexity, or other factors that can effect the change in price of a bond. Duration is the weighted average for the present value of cash flows. It is always less than or equal to the number of years until the bond matures. Bonds with higher coupons have a lower duration, and bonds with lower coupons have a higher duration. Bonds with longer maturity have higher duration, and bonds with shorter maturities have a lower duration. One basic method for estimating duration is known as Macaulay's duration. Macaulay's duration equals the time to maturity for zero coupon bonds. Macaulay's duration measures the percentage change that comes from a percentage change in the yield to maturity. Basically, duration is telling the investor that a bond such as one with a duration of five years will go down 5 percent in value with a 1 percent increase in interest rates (yield to maturity) or will go up 5 percent with a 1 percent decrease in interest rates (yield to maturity). The Macaulay duration is equal to the weighted sum of the present value (discounted) cash flows divided by the current price of the bond. An example assuming a bond with a par value of $1,000 that matures in four years with a 6 percent annual coupon and a yield to maturity of 8 percent is as follows:

Period	*Cash flows*	*PV(CF)*	*Period x PV(CF)*
1	60	55.56	55.56
2	60	51.44	102.88
3	60	47.63	142.89
4	1060	779.13	3116.53
	Totals	**933.76**	**3417.85**

To calculate the weighted sum of the discounted cash flows, the period (year) is multiplied by the present value of cash flow to get each weighted present value (discounted) cash flow; these individual weighted present values of cash flows are summed ($3,417.85). To calculate the Macaulay duration of the bond, this weighted sum of the present value of cash flows is divided by the price of the bond ($933.76) as follows:

Macaulay's duration = $3,417.85 / $933.76 = **3.66 years**

The 3.66 years is the duration of the bond.

Investment Planning Answer Book by Jay L. Shein, Q 20:22, What is yield to maturity?

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Yield to maturity is a measure of return on a bond that assumes that coupon payments received are reinvested at the same rate until the bond matures. If coupon payments that are received are reinvested at a higher yield to maturity, then the compound return that is actually realized will be greater than the yield to maturity. If the coupon payments are reinvested at a lower yield to maturity, then the compound return that is actually realized will be less than the yield to maturity. An example of calculating a yield to maturity with a HP-17BII+ calculator is as follows:

EXAMPLE 20-8

- Assume a bond has a current price of $900 with a face value of $1000 and a coupon rate of 6 percent paid semi-annually. The bond will mature in 5 years.
- The calculator should have payments set for end of period.
- The calculator should be set for Time Value of Money (TVM) calculations.
- 10 should be entered for the number of periods (N).
- −900 should be entered for the present value (PV).
- 30 should be entered for the payment (PMT) because $30 is the semi-annual payment.
- 1000 should be entered for the future value (FV).
- Hit the I percent YR key, then multiply that by 2 since there are 2 payments per year.

Using this information, the yield to maturity would be 8.5 percent.

Investment Planning Answer Book by Jay L. Shein, Q 20:23, What are some bond components?

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Bonds are debt instruments where the issuer repays the lender (investor) based on the terms of the bond contract. Advisors, consultants and investors typically have some type(s) of bonds included in a diversified portfolio. Bonds can reduce portfolio risk and add more of an income oriented component to diversified portfolios. On average, bonds are more likely to have lower returns than stocks, but the volatility of bond returns is also usually lower than stocks in the long run.

Bond trading is not as transparent or liquid as stock trading. It is more difficult to easily find bonds to buy and sell, although this has improved in recent years. Whether an advisor is using bond mutual funds, separate account managers, or individual bonds, they should be familiar with bond features, statistics and terminology. The basic features of a bond contract include the following:

- Face or Par Value: the payment received at maturity.
- Maturity: the date at which principal is repaid.
- Coupon Payments: Regular interest payments. Most corporate and municipal bonds have semi-annual coupon payments.
- Coupon Types: Fixed rate, floating rate, inverse floating rate, and zero coupon. A fixed rate coupon bond makes equal payments each year – such as 5 percent per year. A floating rate coupon bond will adjust its coupon based on some other variable. For example, a floater may be tied to the 6 month LIBOR rate plus 150 basis points. Inverse floating rate bonds have a coupon payment that declines if interest rates rise and vice versa. Zero coupon bonds do not pay any coupon. Zero coupon bonds are purchased at a discount to par and the investor generally benefits as the bond value converges on par as it draws closer to maturity. There are other types of coupon payments such as, but not limited to, payments in kind, deferred coupon and step-up.
- Coupon Rate: The percent interest the bond pays calculated as the annual coupon payment divided by the par value.

Investment Planning Answer Book by Jay L. Shein, Q 20:24, What are measurements of bond yield?

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There are various measurements of yield that advisors should be familiar with. *Yield to Maturity* (YTM) measures the annual return an investor receives based on the current value if holding the bond to maturity. A bond's *equivalent yield* is the simple interest rate. For example, if a bond pays a semi-annual coupon, the equivalent yield is calculated as the semi-annual YTM × 2. The *effective yield* is the compound annual yield. The effective yield calculation is $[(1+i/n)^n]-1$.

Where:

i = Coupon Rate

n = number of coupon payments per year

The *current yield* is the annual coupon payment divided by the current bond price. *Yield to Call* or *Yield to Put* (YTC/YTP) is similar to YTM except the par value is the call or put price and maturity is the time to the call or put date. The *Yield to Worst* (YTW) is the worst yield produced by the YTM, YTC or YTP of a bond. *Holding Period Return* (HPR) is the income earned (bond appreciation and interest earned) divided by the price of the bond at the beginning of the period. *Duration* reflects the interest rate risk. More specifically, it is the magnitude of the bond price change given a small change in the interest rate. Two commonly referred to measures of duration are *Macaulay's duration* and *Modified duration. Convexity* reflects how duration changes for larger changes in interest rates. Bonds rating services focus on the credit worthiness of the issuer and or bond issue. Some familiar rating services are Moody's, S&P, Fitch, Egan-Jones and Duff & Phelps.

Investment Planning Answer Book by Jay L. Shein, Q 20:25, What is the price to yield curve?

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When looking at bond prices and yields, an inverse relationship between price and yield is evident. The price of a bond moves in an opposite direction of the bond yield. There also usually is a convex relationship between price and yield. At lower yields, the price is more sensitive to yield changes, while at higher yields, the price is less sensitive to yield changes. The value of a bond is the sum of the discounted cash flows; however, the relationship between value and yield is not linear.

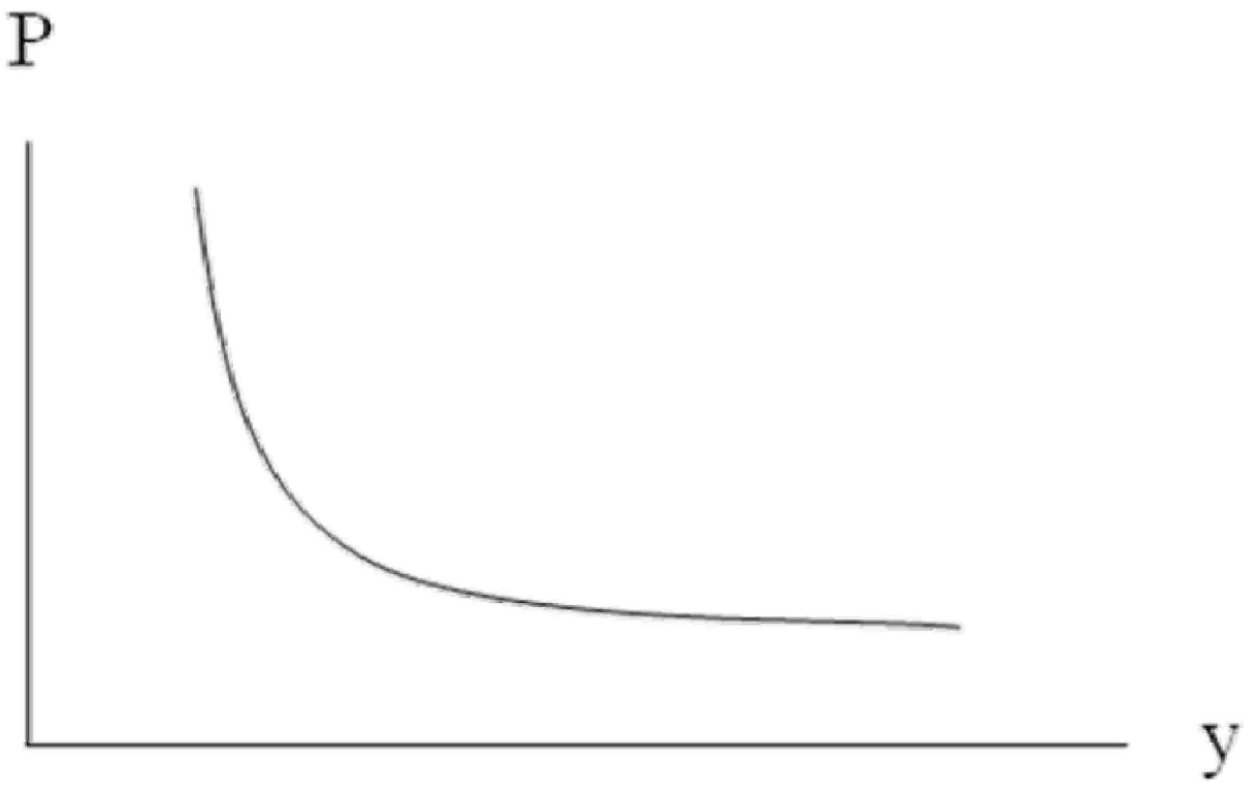
$$\text{Bond Value} = \sum_{t=0}^{T} \frac{CF_t}{(1+\text{YTM})^t}$$

Where:

CF = Cash Flow

YTM = Yield to Maturity

Usually there is a convex relationship between price and yield as seen in this graph.



Investment Planning Answer Book by Jay L. Shein, Q 20:26, How is duration and convexity related?

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Duration measures the sensitivity of the price of a bond to small changes in yields (i.e. interest rate risk). It is equal to the weighted average of the present value of cash flows. Duration is always less than or equal to the years to maturity. Lower coupon bonds and/or longer maturity bonds have a higher duration. Two basic duration estimation methods are Macaulay's duration (MAC) and Modified duration (MOD). For zero coupon bonds, Macaulay's duration equals its maturity.

Macaulay's duration calculation: Assume that you want to calculate the MAC of a $1,000 par value bond that has a 6 percent annual coupon, 4 years remaining until maturity and a Yield to Maturity of 8 percent.

The formula for Macaulay's duration is as follows:

$$MAC = \frac{\sum_{t=1}^{n}\left[\frac{CF \times t}{(1+i)^t}\right]}{Current \cdot Bond \cdot Value}$$

Period	***Cash flows***	***PV(CF)***	***Year of CF*PV(CF)***
1	60	55.56	55.56
2	60	51.44	102.88
3	60	47.63	142.89
4	1060	779.13	3116.53
	Totals	933.76	3417.85

Macaulay duration = Weighted sum of the discounted cash flows divided by the current bond price. The bond price is the sum of the present value (PV) of cash flows (CF).
Macaulay duration = 3,417.85/933.76 = 3.6603 "years"
MAC is the first derivative of the price-yield curve with respect to YTM.

Modified duration calculation: Assume that you want to calculate the MOD of a $1,000 par value bond that has a 6 percent annual coupon, 4 years remaining until maturity and a Yield to Maturity of 8 percent.

MOD = MAC/(1+YTM)

MOD = 3.6603/(1+0.08) = 3.3892

If interest rates increase by 0.2 percent in our bond example (8 percent to 8.2 percent) how much will the value of the bond change? The estimated percentage bond price change = -MOD × Interest rate change

---

Estimated percentage bond price change = -3.3892 × 0.002 = -0.0068 = -0.68%.

The price of the bond will decrease by $6.35 (-0.0068 x 933.76)

How accurate is this estimation? For small changes in interest rates, this method of estimation is fairly accurate. However, the larger the change in interest rates the less accurate the estimation. This estimation method can be improved when including convexity, which is discussed below.

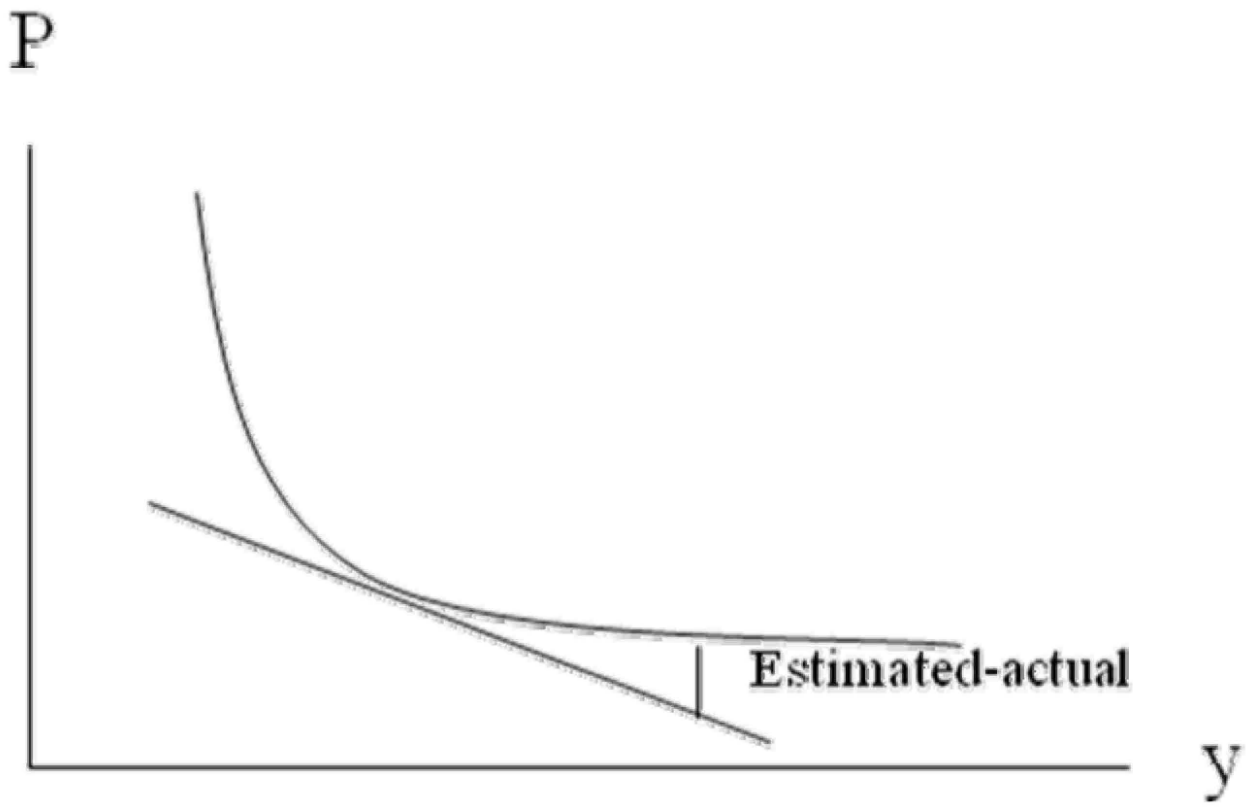
The two measures MAC and MOD are slightly different but complimentary measures of duration. MAC measures percentage change resulting from a percentage change in YTM. MOD measures percentage change resulting from a small change in the YTM. MOD is measured in percentage points (i.e. 8 percent to 8.2 percent is a 0.2 percent change). MOD can be used to estimate price changes.

> Duration can be improved with the use of convexity. *Convexity* is essentially the rate at which duration changes. Convexity is the second derivative of the price-yield curve with respect to changes in yield. Duration is the first derivative.

Convexity Graph where:

P = Bond Price

Y= Bond Yield



Where:

$$Convexity = \frac{1}{P}\sum_{t=1}^{T}\frac{t(t+1)CF_t}{(1+y)^{t+2}}$$

P = Bond Price

t = Period

CF = Cash Flow

y = Yield to Maturity

The following illustration shows the convexity calculation of the previous bond example of the $1,000 par value bond with a 6 percent annual coupon, 4 years remaining until maturity and a Yield to Maturity of 8 percent. Values may not precisely add up due to rounding.

Period	***Cash flows***	***1: t(t+1)CF***	***2: $(1+y)^{(t+2)}$***	***Col 1/Col 2***
1	60	120.00	1.26	95.26
2	60	360.00	1.36	264.61
3	60	720.00	1.47	490.02
4	1060	21,200.00	1.59	13,359.60
			Total	14,209.49
			Convexity (Total/Price)	15.2175

Convexity can improve accuracy particularly for large changes in yield to maturity (interest rates). If interest rates increase by 2 percent (8 percent to 10 percent how much will the value of our sample bond change? Estimated percentage bond price change = -MOD × Interest rate change + (1/2)Convexity(Interest rate change2)

Estimated percentage bond price change = (-3.3892 × 0.02) + (0.5)(15.2175)(0.022)= -0.0647 = -6.47%.

So the price of the bond will decrease by $60.41 (-0.0647 x 933.76). How accurate is this estimation? Actual bond price decreases by $60.55 if the YTM is 10 percent. Without convexity, the estimate decreases is $63.29. The convexity estimate improves our precision.

Duration and convexity can be used to compare the riskiness of fixed income instruments. If an advisor has an economic view point, they could alter duration of a portfolio to maximize value. If an advisor believes interest rates are increasing, they may decrease the duration of the portfolio to minimize the value loss. Duration does have limitations such as, but not limited to, the lack of direct accounting for credit risk, although some would argue that it is accounted for through YTM.

Investment Planning Answer Book by Jay L. Shein, Q 20:27, What are some other important statistical concepts and evaluation methods that are important?

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Other important statistical concepts are the Sharpe ratio, Sortino ratio, Information ratio, tracking error, downside measures of risk, and alpha which are included in the chapter on risk adjusted measures of return. Value at Risk (VaR) is covered under the chapter titled "Value at Risk." Portfolio Opportunity Distributions (PODs), a peer group evaluation method, is explained in the chapter titled "Portfolio Opportunity Distributions."

Investment Planning Answer Book by Jay L. Shein, Q 20:28, What is Active Share?

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Active Share measures the extent of active money/portfolio management of an investment manager and uses portfolio holdings to establish differences between the index and the manager. Active Share considers the percentage of securities in a portfolio that differ from those in the benchmark index by name and weights of that holding. The Active Share measure determines the degree an active manager deviates from the appropriate benchmark. Cremers and Petajisto (2009) argue that the Active Share degree captures the uniqueness of a manager's stock picking relative to the benchmark.

In a seminal article, [Cremers, M., & Petajisto, A., How Active Is Your Fund Manager? A New Measure that Predicts Performance, Rev. of Fin. Stud., 22(9): 3329-3365 (2009)] Cremers and Petajisto define the Active Share relation by the following formula:

$$Active\ Share = \frac{1}{2}\sum_{i=1}^{N}\left|w_{fund,i} - w_{index,i}\right|$$

where $W_{fund,\ i}$ and $W_{\ index,\ i}$ are the weights of each investment i in the fund and index.

The authors sum the differences and divide by two to obtain the percentage Active Share. The Active Share formula establishes the absolute difference between as investment managers' securities weights and the index's weight. Therefore, the Active Share formula represents the manager's active security selection. Active Share percentage takes on values between 0 percent and 100 percent, where zero represents no difference from the index and is accordingly unmanaged, and 100 percent is completely different from the index, which represents full active management. Because the Active Share measurement is a holdings-based approach, it differs from active management measures that compare a manager's historical returns to those of its benchmark index, such as the tracking-error. The original research for Active Share shows that money managers who significantly deviate from their index relative to both the stock name and the weight of that name are more likely to outperform its index in the future.

In a more recent research study, Petajisto finds that high active share mutual funds outperform their benchmark after fees and transactions costs. [Petajisto, A., Active Share and Mutual Fund Performance, Fin. Analysts J., (2013) forthcoming] Conversely, those funds with a low active share (less than or equal to 60 percent), labeled closet indexers by Petajisto, match their benchmark returns before fees. Petajisto suggests that Active Share works well when there is cross-sectional dispersion in stock returns, if so then active share outperforms indexes. The study finds that active stock pickers outperform indexes by 1.26 percent per year after fees and expenses. [Id., p.77] Petajisto recommends that investors select portfolios that are either fully indexed or with high active share, and avoid portfolios that are in between index and high active share, because the investor pays for active management but only receives index returns before fees.

Investment Planning Answer Book by Jay L. Shein, Q 20:29, Are there criticisms of Active Share?

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Active Share is not without criticism; Schlanger, Phillips, and LaBarge find that while possibly useful, the Active Share measure can mislead investors who do not consult other qualitative and quantitative methods. [Schlanger, T., Philips, C., & LeBarge, K., The Search for Outperformance: Evaluating "Active Share," Vanguard Research, May 2012, retrieved from *https://institutional.vanguard.com/VGApp/iip/site/institutional/researchcommentary/article/InvResSearchOutperformance*] Schlanger, Phillips, and LaBarge test, mutual fund money managers, specifically whether Active Share is predicts excess returns in mutual funds. The authors suggest that:

- Higher levels of active share did not predict outperformance.
- Contrary to conventional wisdom, "high-conviction funds" with high active share did not significantly outperform low-active-share funds.
- The higher the active-share level, the larger the dispersion of excess returns.
- The higher the active-share level, the higher the fund costs.
- Funds with the highest level of active share tended to be concentrated in mid- and small-capitalization equities.

Lastly, the investment literature is consistent with and establishes the lack of persistence of fund managers' outperformance other than for funds with high cost that persist in less than benchmark performance. [See Carhart, M. (1997); Jensen, M. (1968); and Fama, E. & French, K. (2010) for more details.] It seems evident that funds with high active share work well when there is a chance for cross-section excess return dispersion and may be one of several factors to consider in selection of an active strategy. It seems logical that managers with high active share have a better chance of outperforming (i.e., positive excess returns) the index. Other factors not developed here are those factors captured by tracking error and that Petajisto's findings are long-term in nature (1980-2009) and may not be predictive for shorter periods.