The following is a review of the Performance Evaluation and Attribution principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

**EVALUATING PORTFOLIO PERFORMANCE**

**EXAM FOCUS**

Performance evaluation has been an important topic on the Level III exam. It is covered here and in the next topic review. The calculations in this material can be very long, involved, repetitive, and use extensive subscript notation; begin by understanding the intent of the calculations and then practice making them. There is an equal chance the questions will focus on understanding the output of performance evaluation as on making calculations. Plan to spend some time on these two readings. Also be aware there are differences of opinion on the best way to perform some of the calculations. The CFA material is presenting some of the possible approaches. For the exam, do it the way it is presented in the material.

**PERFORMANCE EVALUATION**

**LOS 41.a:** Demonstrate the importance of performance evaluation from the perspective of fund sponsors and the perspective of investment managers.

CFA® Program Curriculum, Volume 6, page 119

Professor's Note: In a large portfolio with multiple managers there are typically decisions made by the fund sponsor as well as decisions made by the individual managers within the fund that affect portfolio performance. Performance evaluation can deconstruct return to show which decisions made by whom add or subtract value in the fund. The fund sponsor perspective will capture all value added or lost while the manager perspective will focus only on what a particular manager did to add or lose value for the fund. This material presumes a fund sponsor is an entity like a pension fund, endowment, or foundations using several investment managers.

**Fund sponsor’s perspective.** Performance evaluation improves the effectiveness of a fund’s investment policy by acting as a feedback and control mechanism. It does the following:

1. Shows where the policy and allocation is effective and where it isn’t.

2. Directs management to areas of value added and lost.

3. Quantifies the results of active management and other policy decisions.

1. The terminology used throughout this topic review is industry convention as presented in Reading 41 of the 2013 CFA Level III exam curriculum.
4. Indicates where other, additional strategies can be successfully applied.

5. Provides feedback on the consistent application of the policies set forth in the IPS. The increased complexity of institutional investment management has led to a greater need for sophisticated performance evaluation from the fund sponsor’s perspective.

Investment manager’s perspective. As with the fund sponsor’s perspective, performance evaluation can serve as a feedback and control mechanism. Some investment managers may simply compare their reported investment returns to a designated benchmark. Others will want to investigate the effectiveness of each component of their investment process.

COMPONENTS OF PERFORMANCE EVALUATION

LOS 41.b: Explain the following components of portfolio evaluation (performance measurement, performance attribution, and performance appraisal).

Performance evaluation will involve:

1. Performance measurement to calculate rates of return based on changes in the account’s value over specified time periods.

2. Performance attribution to determine the sources of the account’s performance.

3. Performance appraisal to draw conclusions regarding whether the performance was affected primarily by investment decisions, by the overall market, or by chance.

RETURN CALCULATIONS WITH EXTERNAL CASH FLOWS

Professor’s Note: External cash flows are funds the client adds or withdraws from the portfolio. They must be removed from the change in market value of the portfolio to determine the remaining change in value that is due to investment performance. They must also be considered to determine how much money was available for use. Several approaches will be covered to deal with this issue in the course of this and the next reading. The approaches differ in details but are conceptually related; the percentage return is the investment gain or loss divided by the weighted average of the funds available to use.

The rate of return on an account is the percentage change in the account’s market value over a defined time period (known as the measurement or evaluation period). An account’s rate of return needs to factor in external cash flows. External cash flows refer to contributions and withdrawals made to and/or from an account, as opposed to internal cash flows, such as interest or dividends.
If there is an external cash flow at the beginning of the evaluation period, the account’s return is calculated as follows:

\[ r_t = \frac{MV_t - (MV_0 + CF)}{MV_0 + CF} \]

If there is an external cash flow at the end of the evaluation period, it should be subtracted from (if a withdrawal, added to) the account’s ending value, as it has no impact on the investment-related value of the account:

\[ r_t = \frac{(MV_t - CF) - MV_0}{MV_0} \]

**Example: Rate of return calculation**

The Keane account was valued at $12,000,000 at start of the month (before any contributions). At the month end, its value was $12,260,000. During the month, the account received a contribution of $40,000.

Calculate the rate of return if the contribution was received (1) on the first day of the month and (2) on the last day of the month.

**Answer:**

If the contribution was received on the first day of the month, the rate of return for the month would be:

\[ r_t = \frac{12,260,000 - (12,000,000 + 40,000)}{12,000,000 + 40,000} = 0.018272 = 1.8272\% \]

If the $40,000 contribution was received on the last day of the month, the rate of return would be:

\[ r_t = \frac{(12,260,000 - 40,000) - 12,000,000}{12,000,000} = 0.018333 = 1.8333\% \]

Note: A contribution on the last day of the month has no impact on the investment-related value of the account. This is because the contribution is deducted before calculating the return.

When the external cash flows do not occur at the beginning or end of the period, other approaches are required.
CALCULATING TIME- AND MONEY-WEIGHTED RETURNS

LOS 41.c: Calculate, interpret, and contrast time-weighted and money-weighted rates of return and discuss how each is affected by cash contributions and withdrawals.

CFA® Program Curriculum, Volume 6, page 124

For the Exam: The fact that these return calculations also appear in Study Session 18 (GIPS®) tells me you should be ready to perform them on the exam.

Time-Weighted Rate of Return

The time-weighted rate of return (TWRR) calculates the compounded rate of growth over a stated evaluation period of one unit of money initially invested in the account. It requires a set of subperiod returns to be calculated covering each period that has an external cash flow. This approach requires a fund market value on the date of each external cash flow. The subperiod results are then compounded together. The resulting TWRR is unaffected by the external cash flows.

Example: Time-weighted rate of return

The Rooney account was $2,500,000 at the start of the month and $2,700,000 at the end. During the month, there was a cash inflow of $45,000 on day 7 and $25,000 on day 19. The values of the Rooney account are $2,555,000 and $2,575,000 (inclusive of the cash flows for the day) on day 7 and day 19, respectively. Calculate the time-weighted rate of return (assuming 30 days in the month).

Answer:

First, calculate three subperiod returns using the rate of return calculation when external cash flows occur at the end of the evaluation period:

Subperiod 1 (days 1–7)

\[
r_{t,1} = \frac{[\text{\$2,555,000} - \text{\$45,000}] - \text{\$2,500,000}}{\text{\$2,500,000}} = 0.004 = 0.4\%
\]

Subperiod 2 (days 8–19)

\[
r_{t,2} = \frac{[\text{\$2,575,000} - \text{\$25,000}] - \text{\$2,555,000}}{\text{\$2,555,000}} = -0.002 = -0.2\%
\]
Subperiod 3 (days 20–30)

\[ r_{t,3} = \frac{($2,700,000 - $2,575,000)}{2,575,000} = 0.049 = 4.9\% \]

Second, compound the returns together (chain-link) to calculate an overall time-weighted rate of return:

\[ \text{TWRR} = (1 + 0.004)(1 - 0.002)(1 + 0.049) - 1 = 0.051 = 5.1\% \]

Money-Weighted Rate of Return

The money-weighted rate of return (MWRR) is an internal rate of return (IRR) on all funds invested during the evaluation period, including the beginning value of the portfolio. In equation form, the periodic MWRR is the rate, \( R \), that solves:

\[ \text{MV}_1 = \text{MV}_0 (1 + R)^M + \sum_{i=1}^{n} CF_i (1 + R)^{L(i)} \]

where:
- \( \text{MV}_1 \) = ending value of the portfolio
- \( \text{MV}_0 \) = beginning value of the portfolio
- \( M \) = number of time units in the evaluation period (e.g., number of days in the month)
- \( CF_i \) = cash flow \( i \)
- \( L(i) \) = number of time units (days, etc.) cash \( i \) is in the portfolio or cash \( i \) is absent from the portfolio

For the Exam: Solving any IRR equation (including MWRR) is a trial and error process of guessing a return and solving for ending value until a return is guessed that produces a result equal to the actual ending value of the portfolio. The text states that solving MWRR is better suited to spreadsheet software. In the unlikely event the subperiods between cash flows are of equal length, the IRR functions of a calculator can be used to find the periodic IRR.

Example: Using equal subperiods

The Owen account is valued at $900,000 at the start of the month. On day 15, a contribution of $50,000 is made. At the end of the month, the account is worth $1,466,553. Calculate the MWRR (assuming 30 days in a month).
Answer:

The 15-day periodic MWRR is:

\[ MV_t = MV_0(1 + R)^2 + CF_1(1 + R) \]

\[ $1,466,553 = $900,000(1 + R)^2 + $50,000(1 + R) \]

\[ R = 24.9\% \ (15\text{-}day \ return) \]

Keystrokes on the TI BA II Plus® are as follows:

- **CF** 900,000 ENTER
- 50,000 ENTER
- -1,466,553 ENTER
- **IRR** CPT \( \rightarrow \) 24.904

This compounds to a monthly return of:

\[ 1.24904^2 - 1 = 0.5601 = 56.01\% \]

I don’t know about you, but I sure wish I had known ahead of time to invest with this manager.

**TWRR vs. MWRR**

MWRR is an average growth rate of all funds in the account. It is affected by both the returns generated on the assets and the timing of external cash flows. For example, if the assets first appreciate significantly and then depreciate significantly and a large external cash flow is made, the timing of the external cash flow will significantly affect the MWRR. If a large external cash flow is received at the very beginning of the period it is exposed to the increase and decrease in asset values. If it occurs after the appreciation period but before the decline, the MWRR will be lower because relatively more funds were exposed to the decline than to the increase. In contrast, TWRR is only a linking of subperiod returns and is not affected by external cash flows.

- Generally, TWRR is used for manager evaluation and GIPS® reporting because it reflects only the return of the assets and not client decisions to add or subtract funds.
- A special case can exist if the manager controls the timing of fund additions and withdrawals. This can happen with some portfolios, such as hedge funds and other limited partnership investments. If the manager controls the timing of cash flows, MWRR is appropriate for performance reporting and GIPS®.
- TWRR reflects what would have happened to the beginning value if no external cash flows had occurred.
- TWRR calculations can be data intensive and expensive to perform because they require a portfolio market value on the date of all external cash flows.
- MWRR only requires a beginning and end of period market value.
A Bank Administration Institute (BAI)\(^2\) study recommends that TWRR can be approximated by calculating the MWRR over frequent time intervals and then chain-linking those returns over the evaluation period. The BAI study concluded that only if there are large (> 10% of the account’s value) external cash flows or volatile performance swings will this linked internal rate of return (LIRR) fail to provide a close approximation to the true TWRR.

*Professor’s Note: To comply with the GIPS® standards, for periods beginning January 1, 2010, firms are required to value portfolios on the date of all large external cash flows. GIPS® does not define what constitutes a large external cash flow. Any flow that produces a significant difference in MWRR and TWRR should be considered large.*

### The Effect of External Contributions and Withdrawals

If the external cash flows are large relative to the account’s value, and the account’s performance is quite volatile, there can be a significant difference between the TWRR and MWRR.

#### Example: TWRR vs. MWRR

The Neville account is valued at $400,000 at the beginning of the month. On day 8, it is valued at $1,300,000 after receiving a $900,000 contribution on that day. At the end of the month, the account is valued at $2,695,398. The TWRR is:

**Subperiod 1 (days 1–8)**

\[
\tau_{1} = \frac{($1,300,000 - $900,000) - $400,000}{$400,000} = 0.0 = 0\%
\]

**Subperiod 2 (days 9–30)**

\[
\tau_{2} = \frac{($2,695,398 - $1,300,000)}{$1,300,000} = 1.0734 = 107.34\%
\]

Compounding the returns produces a time-weighted rate of return:

\[
TWRR = (1 + 0)(1 + 1.0734) - 1 = 2.0734 - 1 = 1.0734 = 107.34\%
\]

The MWR is:

\[
$2,695,398 = $400,000(1 + R)^{30} + $900,000(1 + R)^{22}
\]

---

By trial and error, \( R = 0.03 \). Converting to a monthly basis:

\[
MWRR = 1.0303^3 - 1 = 1.427 = 142.7\%
\]

Explain why based on the specific circumstances in the Neville account, the MWRR is much higher than the TWRR.

**Answer:**

The first subperiod had a 0.0% return and the second subperiod had a 107.34% return. The client added funds right before the second subperiod so more funds where in the account during the subperiod of high return. MWRR weights returns by the amount of funds invested; more funds in the high return subperiod produce a higher MWRR than TWRR. TWRR is unaffected by external cash flows.

**DATA QUALITY**

**LOS 41.d:** Identify and explain potential data quality issues as they relate to calculating rates of return.

The phrase “garbage in, garbage out” is quite appropriate for return calculations. That is, the calculated return is only as accurate as the inputs. The following are potential problems relating to data quality:

- When accounts contain illiquid (infrequently priced) assets, estimates or educated guesses must sometimes be used to calculate returns.
- For many thinly-traded fixed-income securities, current market prices may not be available. Estimated prices may be derived from dealer quoted prices on securities with similar attributes. This is known as matrix pricing.
- Highly illiquid securities may be carried at cost or the price of the last trade, thus, not reflecting the current price.
- Account valuations should include trade date accounting, including accrued interest and dividends.
PORTFOLIO RETURN COMPONENTS

LOS 41.e: Demonstrate the decomposition of portfolio returns into components attributable to the market, to style, and to active management.

Professor's Note: The three components of return (market, style, and active management) are the foundation for portfolio performance attribution. This approach decomposes portfolio return into overall market return, the style of the manager, and active management decisions the manager makes. These building blocks of attribution analysis are important and are a prime illustration of the use of benchmarks.

A portfolio return can be broken up into three components: market, style, and active management.

\[ P = M + S + A \]

where:
- \( P \) = investment manager's portfolio return
- \( M \) = return on the market index
- \( S = B - M \) = excess return to style; difference between the manager's style index (benchmark) return and the market return. \( S \) can be positive or negative.
- \( A = P - B \) = active return; difference between the manager's overall portfolio return and the style benchmark return.

This relationship recognizes first that the manager's style benchmark can earn more or less than the market. Had the manager taken a passive position in a broad market index, the return on that index, \( M \), would be an appropriate benchmark, and \( S = 0 \). Because the manager might specialize in a particular style, however, we add (if \( B > M \), \( S > 0 \)) or subtract (if \( B < M \), \( S < 0 \)) the difference between the benchmark and market returns. Finally, the return to active management, \( A \), is the difference between the manager's portfolio return and the benchmark return and is attributed to active management.

Example: Portfolio return components

The Pallister account has a total monthly return of 5.04%. During the same period, the portfolio benchmark returned 5.32% and the market index returned 3.92%. Calculate the amount of the portfolio return attributable to the manager's active management and style.
Answer:

The return to active management is the difference between the portfolio return, $P$, and the manager's style benchmark, $B$:

$$A = P - B = 5.04\% - 5.32\% = -0.28\%$$

The return to style is the difference between the manager's style benchmark, $B$, and the market, $M$:

$$S = B - M = 5.32\% - 3.92\% = 1.4\%$$

**BENCHMARK PROPERTIES**

**LOS 41.f:** Discuss the properties of a valid benchmark and explain the advantages and disadvantages of alternative types of performance benchmarks.

To effectively evaluate performance, a valid benchmark should possess the following seven characteristics, which should align the benchmark’s style and risk with that of the manager and provide the manager with an appropriate management objective:

1. **Specified in advance.** The benchmark is known to both the investment manager and the fund sponsor. It is specified at the start of an evaluation period.

2. **Appropriate.** The benchmark is consistent with the manager’s investment approach and style.

3. **Measurable.** Its value and return can be determined on a reasonably frequent basis.

4. **Unambiguous.** Clearly defined identities and weights of securities constituting the benchmark.

5. **Reflective of the manager’s current investment opinions.** The manager has current knowledge and expertise of the securities within the benchmark.

6. **Accountable.** The manager(s) should accept the applicability of the benchmark and agree to accept differences in performance between the portfolio and benchmark as caused only by his active management.

7. **Investable.** It is possible to replicate the benchmark and forgo active management.
Advantages and Disadvantages of Benchmarks

The seven primary types of benchmarks in use are:

1. **Absolute.** An absolute benchmark is a return objective (i.e., aims to exceed a minimum target return).

   Advantage:
   - Simple and straightforward benchmark.

   Disadvantage:
   - An absolute return objective is not an investable alternative.

2. **Manager universes.** The median manager or fund from a broad universe of managers or funds is used as the benchmark. The *median manager* is the fund that falls at the middle when funds are ranked from highest to lowest by performance.

   Advantage:
   - It is measurable.

   Disadvantages:
   - Manager universes are subject to "survivor bias," as underperforming managers often go out of business and their performance results are then removed from the universe history.
   - Fund sponsors who choose to employ manager universes have to rely on the compiler's representations that the universe has been accurately compiled.
   - Cannot be identified or specified in advance so it is not investable.

3. **Broad market indices.** There are several well-known broad market indices that are used as benchmarks [e.g., the S&P 500 for U.S. common stocks, the Morgan Stanley Capital International (MSCI) and Europe, Australasia and Far East (EAFE) for non-U.S. developed market common stocks, and so on.].

   Advantages:
   - Well recognized, easy to understand, and widely available.
   - Unambiguous, generally investable, measurable, and may be specified in advance.
   - It is appropriate to use if it reflects the approach of the manager.
Disadvantage:
• The manager’s style may deviate from the style reflected in the index. For example, it is not appropriate to use the S&P 500 for a small-capitalization U.S. growth stock manager.

4. **Style indices.** Investment style indices represent specific portions of an asset category. Four well-known U.S. common stock style indices are (1) large-capitalization growth, (2) large-capitalization value, (3) small-capitalization growth, and (4) small-capitalization value.

Advantage:
• Widely available, widely understood, and widely accepted.
• If the index reflects the manager’s style and it is investable, it is an appropriate benchmark.

Disadvantages:
• Some style indices can contain weightings in certain securities and sectors that may be larger than considered prudent.
• Differing definitions of investment style can produce quite different benchmark returns.
• In these cases they are not appropriate benchmarks.

5. **Factor-model-based.** Factor models involve relating a specified set of factor exposures to the returns on an account. A well-known 1-factor model is the market model where the return on a portfolio is expressed as a linear function of the return on a market index. A generalized factor model equation would be:

\[ R_p = a_p + b_1 F_1 + b_2 F_2 + \ldots + b_K F_K + \varepsilon \]

where:
- \( R_p \) = periodic return on an account
- \( a_p \) = “zero factor” term, representing the expected value of \( R_p \) if all factor values were zero
- \( F_i \) = factors that have a systematic effect on the portfolio’s performance, \( i = 1 \) to \( K \)
- \( b_i \) = sensitivity of the returns on the account to the returns generated from factor \( i \)
- \( \varepsilon \) = error term; portfolio return not explained by the factor model

Some examples of factors are the market index, industry, growth characteristics, a company’s size, and financial strength.

The benchmark portfolio (i.e., the *normal portfolio*) is the portfolio with exposures to the systematic risk factors that are typical for the investment manager. The manager’s past portfolios are used as a guide.
Advantage:
• Useful in performance evaluation.
• Provides managers and sponsors with insight into the manager’s style by capturing factor exposures that affect an account’s performance.

Disadvantages:
• Focusing on factor exposures is not intuitive to all managers or sponsors.
• The data and modeling are not always available and may be expensive.
• It may be ambiguous because different factor models can produce different output.

6. **Returns-based.** Returns-based benchmarks are constructed using (1) the managed account returns over specified periods and (2) corresponding returns on several *style indices* for the same periods.

These return series are submitted to an allocation algorithm that solves for the combination of investment style indices that most closely tracks the account’s returns.

Advantages:
• Generally easy to use and intuitive.
• Meets the criteria of a valid benchmark.
• Useful where the only information available is account returns.

Disadvantages:
• The style indices may not reflect what the manager owns or what the manager or client would be willing to own.
• A sufficient number of monthly returns would be needed to establish a statistically reliable pattern of style exposures.
• Will not work when applied to managers who change style.

7. **Custom security-based.** Custom security-based benchmarks are designed to reflect the manager’s security allocations and investment process. (See the following LOS for further discussion.)

Advantages:
• Meets all of the required benchmark properties and all of the benchmark validity criteria.
• Allows continual monitoring of investment processes.
• Allows fund sponsors to effectively allocate risk across investment management teams.

Disadvantages:
• Can be expensive to construct and maintain.
• A lack of transparency by the manager (e.g., hedge funds) can make it impossible to construct such a benchmark.
CONSTRUCTING CUSTOM SECURITY-BASED BENCHMARKS

LOS 41.g: Explain the steps involved in constructing a custom security-based benchmark.

The construction of a custom security-based benchmark entails the following steps:

Step 1: Identify the important elements of the manager’s investment process.
Step 2: Select securities that are consistent with that process.
Step 3: Weight the securities (including cash) to reflect the manager’s process.
Step 4: Review and adjust as needed to replicate the manager’s process and results.
Step 5: Rebalance the custom benchmark on a predetermined schedule.

VALIDITY OF USING MANAGER UNIVERSES AS BENCHMARKS

LOS 41.h: Discuss the validity of using manager universes as benchmarks.

Fund sponsors often use the median account in a particular “universe” of account returns as a benchmark. However, even though finishing in the top half of all managers with the same style might be a good performance objective, this form of benchmark has a number of drawbacks:

1. Apart from being measurable, it fails the other properties of a valid benchmark:
   - It is not possible to identify the median manager in advance.
   - Because the median manager cannot be determined ahead of time, the measure also fails the unambiguous property.
   - The benchmark is not investable, as the median account will differ from one evaluation period to another.
   - It is impossible to verify the benchmark’s appropriateness due to the ambiguity of the median manager.

2. Fund sponsors who choose to employ manager universes have to rely on the compiler’s representations that the accounts within the universe have been appropriately screened, input data validated, and calculation methodology approved.

3. As fund sponsors will terminate underperforming managers, universes will be subject to “survivor bias.” As consistently underperforming accounts will not survive, the median will be biased upwards. Without a valid reference point, evaluating manager performance using this benchmark becomes suspect.
Tests of Benchmark Quality

LOS 41.i: Evaluate benchmark quality by applying tests of quality to a variety of possible benchmarks.

An important part of performance evaluation and risk management, it is essential to distinguish good benchmarks from bad ones. Some issues to consider in benchmark evaluation are:

• **Systematic bias.** There should be minimal systematic bias in the benchmark relative to the account. To assess the relationship between returns on the benchmark and the account, the manager can calculate the *historical beta* of the account relative to the benchmark (i.e., regress the portfolio returns on the benchmark returns). A beta near 1.0 would indicate that the benchmark and portfolio tend to move together (i.e., they are sensitive to the same systematic factors). If the beta differs significantly from 1.0, the benchmark may be responding to different factors and thus have a different set of risk factor exposures.

Another method to identify systematic bias is looking at correlations. Consider the relationships seen earlier:

\[
A = P - B \\
S = B - M
\]

where:
- \(A\) = excess return attributable to the management’s active management decisions
- \(P\) = investment manager’s portfolio return
- \(B\) = benchmark return
- \(S\) = excess return attributable to the manager’s investment style

Returns to the manager’s active decision making \((A)\) should be *uncorrelated* with the manager’s investment style \((S)\). That is, whether the style benchmark performs well should have no effect on the manager’s ability to generate active return, \(A\).

An interesting multiple correlation is that between the style benchmark return \((B)\), the return on the market \((M)\), and the return on the portfolio \((P)\). Specifically, if the style benchmark outperforms the market (i.e., \(B > M\)), we would expect to see the manager’s portfolio outperform the market (i.e., \(P > M\)). Accordingly, there should be a strong positive relationship between \((B - M)\) and \((P - M)\).

• **Tracking error.** Tracking error is defined as the volatility (standard deviation) of \(A\), the excess return earned due to active management (i.e., \(P - B\)). If the appropriate benchmark has been selected, the standard deviation of the difference between the returns on the portfolio and the benchmark (the tracking error) will be smaller than that of the difference between the portfolio and a market index. This would indicate that the benchmark is capturing important elements of the manager’s investment.
style. Further differences between the portfolio and benchmark returns can be attributed primarily to active management.

- **Risk characteristics.** An account’s exposure to systematic sources of risk should be very similar to those of the benchmark; that is, the systematic risk may be higher or lower during individual periods but should average that of the benchmark over time. If the account tends to consistently exhibit more or less risk than the benchmark, this would indicate a systematic bias.

- **Coverage.** Benchmark coverage is defined as the percentage of a portfolio that is made up of securities that are also in the benchmark. The coverage ratio is the market value of the securities that are in both the portfolio and the benchmark as a percentage of the total market value of the portfolio. The higher the coverage ratio, the more closely the manager is replicating the benchmark (i.e., the more the benchmark reflects the manager’s universe).

- **Turnover.** Benchmark turnover is the proportion of the benchmark’s total market value that is bought or sold (i.e., turned over) during periodic rebalancing. Passively managed portfolios should utilize benchmarks with low turnover.

- **Positive active positions.** An active position is the difference between the weight of a security or sector in the managed portfolio versus the benchmark. For example, if the account has 5% in Vodafone and the benchmark has 3%, the active position is 5% - 3% = 2%.

If the benchmark includes many securities for which the manager has no opinions and does not own, the number of negative active positions will be large. If the portion of negative positions is large, it may indicate the benchmark does not reflect the manager’s process and is not appropriate for the manager.

**HEDGE FUND BENCHMARKS**

**LOS 41.j: Discuss the issues that arise when assigning benchmarks to hedge funds.**

*CFA® Program Curriculum, Volume 6, page 141*

Professor’s Note: This section is qualitative in nature even when presenting formulas. No calculations are shown or covered. The issue is the difficulty of identifying suitable benchmarks.

The diversity and lack of transparency of hedge funds makes benchmark identification difficult or impossible.

1. The difficulties start with calculating the return of a hedge fund. Most hedge funds hold long and short positions and some hedge funds have minimal or theoretically zero capital in relation to the total of long and short positions. Trying to apply the basic accounting rate of return calculation when $V_0$ is very small or theoretically zero can produce results that are difficult to interpret.

$$r = \frac{V_1 - V_0}{V_0}$$
2. One approach is to evaluate performance in terms of value-added return:

\[ R_V = R_P - R_B \]

where:
- \( R_V \) = value-added return
- \( R_P \) = portfolio return
- \( R_B \) = benchmark return

To replicate a zero net asset hedge fund, \( R_V \) is the value-added return on a long-short portfolio. Although the weights can sum to zero, a return can be calculated by summing up the returns on all the individual security positions, long and short. Even this seemingly simple process is complicated, however, as active managers trade frequently, resulting in changing asset positions.

The calculations associated with determining the manager’s value-added return (not required by the LOS) must distinguish between the return earned by simply holding an asset and the value-added return due to over- (under-) weighting the asset relative to the benchmark. Recall that, for a long-only manager, overweighing a security relative to the benchmark results in a positive active weight. For hedge fund managers, determining a value-added return is, of course, complicated by the manager’s ability to sell short. In addition, the extremely wide range of funds that fall under the hedge fund classification makes it difficult, if not impossible, to define a benchmark that is applicable to all hedge funds.

3. Some hedge funds target an absolute return target and argue comparison benchmarks are irrelevant.

4. Other funds may have clearly defined styles (such as long-short equity) and it may be possible to compare results of the manager to other managers of the same style. But other funds have no definable style on which to base a comparison.

5. The difficulty of defining benchmarks has led others to use the Sharpe ratio as the basis of comparing hedge fund managers. The same difficulties in identifying comparable managers with which to compare still arise. In addition, the use of standard deviation is questionable when many hedge funds show skewed returns.
The second phase of performance evaluation is performance attribution. The basic concept is to identify and quantify the sources of returns that are different from the designated benchmark. There are two basic forms of performance attribution: micro and macro attribution. **Macro performance attribution** is done at the fund sponsor level. The approach can be carried out in percentage terms (i.e., rate-of-return) and/or in monetary terms (i.e., dollar values). **Micro performance attribution** is done at the investment manager level.

*Professor’s Note:* Essentially, the goal of macro attribution is to gain insight into the decisions made by the sponsor and measure the effect of those decisions on the portfolio. One of those sponsor decisions is which managers to hire and how those managers perform. The goal of micro attribution is to analyze an individual manager’s decisions and determine how that manager added or lost value for the sponsor. The CFA text focuses on the concept and use of macro analysis. For micro attribution the attention is more evenly divided between concept, use, and calculations. All of this is prime test material.

### Macro Performance Attribution

There are three main inputs into the **macro attribution** approach: (1) policy allocations; (2) benchmark portfolio returns; and (3) fund returns, valuations, and external cash flows.

1. **Policy allocations.** It is up to the sponsor to determine asset categories and weights as well as allocate the total fund among asset managers. As in any IPS development, allocations will be determined by the sponsor’s risk tolerance, long-term expectations, and the liabilities (spending needs) the fund must meet.

2. **Benchmark portfolio returns.** A fund sponsor may use broad market indices as the benchmarks for asset categories and use narrowly focused indices for managers’ investment styles.
3. Fund returns, valuations, and external cash flows. When using percentage terms, returns are calculated at the individual manager level. This enables the fund sponsor to make decisions regarding manager selection.

If also using monetary terms, account valuation and external cash flow data are needed to compute the value impacts of the fund sponsor’s investment policy decision making.

**Conducting a Macro Attribution Analysis**

Macro attribution starts with the fund’s beginning market value and ends with its ending market value. In between are six levels of analysis that attribute the change in market value to sources of increase or decrease in market value. The levels are:

1. Net contributions.
2. Risk-free asset.
3. Asset categories.
4. Benchmarks.
5. Investment managers.
6. Allocation effects.

Level 1, net contributions, is the net sum of external cash flows made by the client into or withdrawn from the portfolio. Net contributions increase or decrease ending market value but are not investment value added or lost.

Level 2, risk-free investment, simulates what the fund’s ending value would have been if the beginning value and external cash flows had earned the risk-free return.

Level 3, asset categories, recognizes that most sponsors will consider risk-free investments as too conservative. It simulates the ending value of beginning value and external cash flows if funds had been invested in asset category benchmarks weighted in accord with the fund’s strategic policy (in other words, passively replicating the strategic asset allocation with index funds).
The incremental return to the asset category level is the weighted average of the categories’ returns over the risk-free asset. Level 3’s incremental return could be calculated as:

$$R_{AC} = \sum_{i=1}^{A}(w_i)(R_i - R_F)$$

where:
- $R_{AC}$ = incremental return (above the risk-free rate) for the asset category strategy
- $(R_i - R_F)$ = excess return (above the risk-free rate) for asset category $i$
- $w_i$ = weight of asset category $i$
- $A$ = number of asset categories

Up to this point, all results could have been achieved by passively implementing the fund’s strategic asset allocation.

Level 4, the benchmark level, allows the sponsor to select and assign managers a benchmark different from the policy benchmark. This is tactical asset allocation by the sponsor. For example, 60% in the S&P 500 might fit the fund’s strategic objective but the sponsor may expect value stocks to outperform the S&P. The sponsor could direct the manager to use the S&P value index as that manager’s target or manager benchmark.

Level 4 simulates the return of the beginning market value and external cash flows if invested in manager benchmarks. The Level 4 result can also be passively achieved but reflects active decision making by the sponsor to deviate from strategic benchmarks. The level 4 incremental return could be calculated as:

$$R_B = \sum_{i=1}^{A} \sum_{j=1}^{M}(w_i)(w_{ij})(R_{B,ij} - R_i)$$

where:
- $R_B$ = incremental return for the benchmark strategy
- $w_i$ = policy weight of asset category $i$
- $w_{ij}$ = weight assigned to manager $j$ in asset category $i$
- $R_{B,ij}$ = return for manager $j$’s benchmark in category $i$
- $R_i$ = return on asset category $i$
- $A$ = number of asset categories
- $M$ = number of managers in asset category $i$

The formula allows for more than one portfolio manager in each asset category. If we assumed only one manager per category, the formula would simplify to:

$$R_B = \sum_{i=1}^{A}(w_i)(R_{B,ij} - R_i)$$

Level 5, investment managers or active management, simulates the results of investing the fund’s beginning value and external cash flows and earning the returns actually produced by the managers. The simulation assumes the sponsor has actually allocated
funds in accord with the policy allocations, an assumption that is usually not perfectly implemented. The level 5 incremental return could be calculated as:

\[
R_{IM} = \sum_{i=1}^{A} \sum_{j=1}^{M} (w_i)(w_{i,j})(R_{A_{i,j}} - R_{B_{i,j}})
\]

where:
- \( R_{IM} \) = incremental return for the investment manager level
- \( w_i \) = policy weight of asset category \( i \)
- \( w_{i,j} \) = weight assigned to manager \( j \) in asset category \( i \)
- \( R_{A_{i,j}} \) = return for manager \( j \)'s portfolio in category \( i \)
- \( R_{B_{i,j}} \) = return for \( j \)th manager's benchmark for asset category \( i \)
- \( A \) = number of asset categories
- \( M \) = number of managers in asset category \( i \)

Level 6, allocation effects, is simply a residual plug to sum to the portfolio ending value. If all policies were perfectly implemented, the allocation effect would be zero.

**Professor's Note:** You will find many attribution models include a residual "plug." It should not be surprising that complex calculations designed to analyze events will not always add up perfectly. As a rough analogy you could think of residual error in quantitative modeling. You will find that one of the reasons that multiple approaches to attribution are discussed is that a given approach may be more suited to a given situation. In general, if an approach to a specific situation has a large residual plug, it would be wise to consider if another approach yields better results or if the calculations are just wrong.

---

**Figure 1: Macro Attribution Analysis, Brice Pension Fund, September 2012**

<table>
<thead>
<tr>
<th>Decision-Making Level</th>
<th>Fund Value</th>
<th>Incremental % Return Contribution</th>
<th>Incremental Value Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning value</td>
<td>$447,406,572</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Net contributions</td>
<td>449,686,572</td>
<td>0.00%</td>
<td>$2,280,000</td>
</tr>
<tr>
<td>Risk-free asset</td>
<td>451,067,710</td>
<td>0.30%</td>
<td>1,381,138</td>
</tr>
<tr>
<td>Asset category</td>
<td>466,122,089</td>
<td>3.33%</td>
<td>15,054,379</td>
</tr>
<tr>
<td>Benchmarks</td>
<td>467,329,262</td>
<td>0.28%</td>
<td>1,207,173</td>
</tr>
<tr>
<td>Investment managers</td>
<td>467,390,654</td>
<td>0.02%</td>
<td>61,392</td>
</tr>
<tr>
<td>Allocation effects</td>
<td>467,559,838</td>
<td>0.03%</td>
<td>169,184</td>
</tr>
<tr>
<td>Ending value</td>
<td>$467,559,838</td>
<td>3.96%</td>
<td>$20,153,266</td>
</tr>
</tbody>
</table>

1. **Net contributions.**

   Net contributions during September 2012 were a positive $2,280,000. Net contributions added to the starting value equals a value of $449,686,572.
2. Risk-free asset.

If the fund's starting value and its net external cash inflows are invested at the risk-free rate the fund value would have increased by 0.30%, an incremental increase of $1,381,138 above the value from the net contributions level, giving a total fund value of $451,067,710.

Professor's Note: The increment of $1,381,138 cannot be replicated by multiplying $449,686,572 by 0.30%, as the net $2,280,000 contribution was not a single start of the month cash flow. The composition of the net contribution is also unknown. There could have been a large contribution on day 1 and an almost equally large withdrawal just before month end.

The formulas from the previous pages are used to calculate the asset, benchmark, and manager effects.

3. Asset category.

This asset category level assumes that the fund's net contributions value is invested based on the fund sponsor's policy allocations to the specified asset category benchmarks. This is a pure index fund approach reflecting SAA. The policy allocations lead to a 3.33% increase above the risk-free rate, increasing the value of the fund by $15,054,379.

4. Benchmarks.

The benchmarks level assumes that the beginning value and external cash flows of the fund are passively invested in the aggregate of the managers' respective benchmarks. This is also a pure index fund approach but reflecting the sponsor's TAA decisions. The aggregate manager benchmark return was 0.28%, producing an incremental gain of $1,207,173. The difference between the manager benchmarks and the asset category benchmarks (aggregated) is also known as the “misfit return” or “style bias.” For the Brice fund, the misfit return was 0.28%.

5. Investment managers (value of active management).

The investment managers level assumes that the beginning value and external cash flows of the fund invested are the actual results of the managers. This is not an index approach but still reflects sponsor decision making as the sponsor selects the managers. This incremental return reflects the value added by the managers. The aggregate actual return of the managers (using policy weights) exceeded the return on the aggregate manager investment style benchmark by 0.02%. In monetary terms, it has added $61,392.

6. Allocation effects.

This is a balancing “plug” figure. It is the difference between the fund’s ending value and the value from the investment managers level. This is created if fund sponsors
deviate slightly from their policy allocations. It was an incremental increase of $169,184 or +0.03%.

**MICRO PERFORMANCE ATTRIBUTION**

Micro performance attribution analyzes individual portfolios relative to designated benchmarks. The value-added return (portfolio return minus benchmark return) can be broken into three components: (1) pure sector allocation, (2) allocation/selection interaction, and (3) within-sector selection.

\[
R_v = \sum_{j=1}^{S} (w_{P,j} - w_{B,j})(R_{B,j} - R_B) + \sum_{j=1}^{S} (w_{P,j} - w_{B,j})(R_{P,j} - R_{B,j}) + \sum_{j=1}^{S} w_{B,j}(R_{P,j} - R_{B,j})
\]

where:
- \( R_v \) = value-added return
- \( w_{P,j} \) = portfolio weight of sector \( j \)
- \( w_{B,j} \) = benchmark weight of sector \( j \)
- \( R_{B,j} \) = portfolio return of sector \( j \)
- \( R_{B,j} \) = benchmark return of sector \( j \)
- \( R_B \) = return on the portfolio’s benchmark
- \( S \) = number of sectors

**For the Exam:** Spend the time to understand the micro attribution calculations and get past the notation; the concepts of the calculations are rather intuitive. The CFA text spends considerable time on both concept and calculation for micro attribution. Be ready for both conceptual, interpretation, and calculation questions.

Pure sector allocation looks at whether the manager over- or underweighted a market sector that over- or underperformed the total return of the benchmark. It ignores the return of the stocks the manager selected so it purely captures the ability of the manager to emphasize outperforming sectors and avoid underperforming sectors.

Within-sector selection does the opposite. It uses benchmark weights, so it ignores the manager’s sector weighting decisions and only focuses on the manager’s performance within a sector versus that of the benchmark within that sector. Essentially it measures the manager’s stock picking skill.

Adding the previous two components will not total to the portfolio incremental return in most situations. A joint allocation/selection interaction is needed that sums over-/underweighting and stock selection.
Joint effects are common in many models that break down return. They are mathematically necessary. Candidates are often confused because there will not be an allocation/selection interaction component in global attribution. The global model will be complicated by the need to break out currency effects. The global model will use portfolio weights rather than benchmark weights for within-selector effects. As a result, there is no joint allocation/selection interaction. To further complicate your task, the naming of the calculations will be different, as will the notations used. Take this one step at a time. Rushing through attribution calculations does not work.

1. **Pure sector allocation.**

Pure sector allocation assumes the manager holds the same sectors as in the benchmark and that within each sector the same securities are held in the same proportion as in the benchmark. The performance is attributed to the manager’s decisions to hold each sector in a different weight in his portfolio relative to the weight of that sector in the benchmark.

**Example: Pure sector allocation**

One of the investment managers of the Gigg's fund has the following results of a micro attribution analysis:

**Figure 2: Sector Weighting/Stock Selection Micro Attribution**

<table>
<thead>
<tr>
<th>Economic Sectors</th>
<th>Portfolio Sector Weight (%)</th>
<th>Benchmark Sector Weight (%)</th>
<th>Portfolio Sector Return (%)</th>
<th>Benchmark Sector Return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital goods</td>
<td>6.77</td>
<td>6.45</td>
<td>-0.82</td>
<td>-0.73</td>
</tr>
<tr>
<td>Consumer durables</td>
<td>8.52</td>
<td>8.99</td>
<td>-3.28</td>
<td>-4.34</td>
</tr>
<tr>
<td>Energy</td>
<td>36.22</td>
<td>37.36</td>
<td>1.96</td>
<td>1.98</td>
</tr>
<tr>
<td>Financial</td>
<td>5.24</td>
<td>4.65</td>
<td>0.44</td>
<td>0.24</td>
</tr>
<tr>
<td>Financial</td>
<td>18.53</td>
<td>16.56</td>
<td>2.98</td>
<td>2.22</td>
</tr>
<tr>
<td>Technology</td>
<td>14.46</td>
<td>18.8</td>
<td>2.32</td>
<td>-0.48</td>
</tr>
<tr>
<td>Utilities</td>
<td>9.22</td>
<td>7.12</td>
<td>0.54</td>
<td>-0.42</td>
</tr>
<tr>
<td>Cash and equivalents</td>
<td>1.04</td>
<td>0.00</td>
<td>0.17</td>
<td>—</td>
</tr>
<tr>
<td>Portfolio + cash</td>
<td>100.00</td>
<td>100.00</td>
<td>1.34</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Using data from Figure 2, calculate the performance impact due to the financial sector allocation.

**Answer:**

\[
R_{FS, Allocation} = \left( w_{P,FS} - w_{B,FS} \right) \left( R_{B,FS} - R_B \right)
\]

\[
= (0.1853 - 0.1656)(0.0222 - 0.0056)
\]

\[
= (0.0197)(0.0166) = 0.000327 = 0.0327\
\]
This example shows that the decision to overweight a sector that outperformed the overall benchmark resulted in a positive contribution to portfolio performance. Note that underweighting the sector would have produced a negative contribution.

The manager’s goal should be for the two terms in the equation to have the same signs, either both positive or both negative:

- Overweight (+) an outperforming (+) sector → positive impact.
- Underweight (-) an underperforming (-) sector → positive impact.
- Underweight (-) an outperforming (+) sector → negative impact.
- Overweight (+) an underperforming (-) sector → negative impact.

2. **Within-sector selection return.**

   This calculates the impact on performance attributed only to security selection decisions. The within-sector selection return is assuming that the manager weights each sector in the portfolio in the same proportion as in the overall benchmark.

   **Example: Within-sector selection return**

   Using Figure 2 from the previous example, *calculate* the utilities within-sector allocation return.

   **Answer:**

   \[
   \text{utilities within-sector allocation return} = w_{\text{utilities}}(R_{\text{P utilities}} - R_{\text{B utilities}})
   \]

   \[
   = 0.0712 \times [0.54\% - (-0.42\%)]
   \]

   \[
   = +0.068\%
   \]

   The positive contribution shows that the portfolio held utilities stocks that performed better than the utilities stocks contained in the sector benchmark.

3. **Allocation/selection interaction return.**

   This return involves the joint effect of assigning weights to both sectors and individual securities. A decision to increase the allocation of a particular security will also increase the weighting of the sector to which the security belongs.
Example: Allocation/selection interaction return

Using Figure 1 from the pure sector allocation example, calculate the allocation/selection interaction return for consumer durables.

Answer:

consumer durables allocation/selection interaction return

\[ \varrho_{\text{durables}} = (w_{\text{durables}} - w_{\text{B,durables}})(R_{\text{durables}} - R_{\text{B,durables}}) \]

\[ = [(0.3622 - 0.3736)(0.0196 - 0.0198)] \]

\[ = (-0.0114)(-0.0002) \]

\[ = 0.00000228 = 0.000228\% \]

Generally speaking, the allocation/selection interaction impact tends to be relatively small if the benchmark is appropriate. Thus, some analysts group the impact with the within-sector selection impact.

FUNDAMENTAL FACTOR MODEL MICRO ATTRIBUTION

LOS 41.m: Discuss the use of fundamental factor models in micro performance attribution.

It should be possible to construct multifactor models to conduct micro attribution. This involves combining economic sector factors with other fundamental factors (e.g., a company’s size, its growth characteristics, its financial strength, etc.).

Constructing a suitable factor model involves the following:

- Identify the fundamental factors that will generate systematic returns.
- Determine the exposures of the portfolio and the benchmark to the fundamental factors at the start of the evaluation period. The benchmark could be the risk exposures of a style or custom index or a set of normal factor exposures that are typical of the manager’s portfolio.
- Determine the manager’s active exposure to each factor. The manager’s active exposures are the difference between his normal exposures as demonstrated in the benchmark and his actual exposures.
- Determine the active impact. This is the added return due to the manager’s active exposures.
The results of the fundamental factor micro attribution will indicate the source of portfolio returns, based on actual factor exposures versus the manager's normal factor exposures (e.g., sector rotation), the manager's ability to time the market (e.g., adjust the portfolio beta and/or duration in response to market expectations), and so on.

The results will look very similar to a returns-based style analysis, where the returns to the portfolio are regressed against the returns to several different indices to determine factor exposures. The primary difference between them is the use of other fundamental factors (e.g., management's use of leverage, market timing, sector rotation, and the size of the firm,) that would not ordinarily be used in a returns-based style analysis.

The strengths and limitations of the micro and fundamental factor model attributions are summarized in Figure 3.

Figure 3: Strengths and Limitations of Micro Attribution and Fundamental Factor Model Attribution

<table>
<thead>
<tr>
<th></th>
<th>Micro Attribution</th>
<th>Fundamental Factor Model Attribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Disaggregates performance effects of managers' decisions between sectors and securities. Relatively easy to calculate.</td>
<td>Identifies factors other than just security selection or sector allocation.</td>
</tr>
<tr>
<td><strong>Limitations</strong></td>
<td>The need to identify an appropriate benchmark with specified securities and weights at the start of the evaluation period. Security selection decisions will affect sector weighting (allocation/selection interaction).</td>
<td>Exposures to the factors need to be determined at the start of the evaluation period. Can prove to be quite complex, leading to potential spurious correlations.</td>
</tr>
</tbody>
</table>
FIXED-INCOME ATTRIBUTION: INTEREST RATE EFFECTS AND MANAGEMENT EFFECTS

LOS 41.n: Evaluate the effect of the external interest rate environment and the effect of active management on fixed-income portfolio returns.

CFA® Program Curriculum, Volume 6, page 158

LOS 41.o: Explain the management factors that contribute to a fixed-income portfolio's total return and interpret the results of a fixed-income performance attribution analysis.

CFA® Program Curriculum, Volume 6, page 161

For the Exam: LOS 41.n and LOS 41.o refer to evaluate, explain, and interpret. Past test questions on fixed income attribution models have followed the LOS and CFA text. Computers are used to simulate returns for the portfolio and break out components of return. The simulation mathematics are not covered. Focus on a conceptual understanding of each component and realize that these must sum up to the actual portfolio return as you will see in the example below. Questions may come down to nothing more than solving for the missing number, explaining one of the return components, or interpreting the relative performance of two or more fixed-income managers.

Attribution analysis of a fixed-income portfolio is different than that of equity. Duration and interest rates are typically the dominant factor in return. Therefore, the attribution focuses on simulations of what the external interest rate environment would have been expected to produce and the manager's contribution.

Changes in the external interest rate environment, consisting of shifts and twists in the Treasury yield curve, are beyond the individual manager's control and should neither penalize nor benefit the manager's evaluation. Therefore, the attribution begins with simulating what the portfolio would have done based on these external changes. The external interest rate effect is based on a term structure analysis of default-free securities (Treasury securities in the United States). The external interest rate effect can be subdivided into two components:

- First, a simulation of what the manager's benchmark would have returned if interest rates had moved in the manner of the forward curve. For example, if part of the benchmark is invested in 5 year securities yielding 4% and the 1-month forward rate for 4 year and 11 month securities is 4.1%, the expected return is calculated assuming rates do move to 4.1%. This must be done for all securities in the benchmark and aggregated. It is the expected interest rate effect. Notice it does not consider any actions of the manager or what actually happened to rates.
Second, the benchmark return is simulated based on what actually happened to interest rates. The difference in simulated benchmark returns is due to changes in forward rates (i.e., change not in accord with starting forward rates). It is the **unexpected interest rate effect**. It still does not consider any actions of the manager.

The sum of these two effects is the external interest rate effect and is the return of a default-free benchmark return. The portfolio could have passively earned this return.

The next four simulations capture value added or lost versus the index by the actions of the manager.

- **Interest rate management effect** measures the manager's ability to anticipate changes in interest rates and adjust the portfolio duration and convexity accordingly. Each portfolio asset is priced as if it were a default-free bond (i.e., price each using Treasury forward rates). This is compared to another simulation, still using Treasury interest rates but including changes the manager made to duration and positioning on the yield curve. The difference is the interest rate management effect because it captures the consequences of the manager's changes to duration and curve positioning if only Treasury securities were used. It can be further subdivided into duration, convexity, and yield-curve shape effects if desired.

- **Sector/quality management effect** considers what happened to the yield spreads on the actual sectors and quality of assets held in the portfolio. For example, if the manager holds corporate bonds and corporate spreads narrow, the portfolio will outperform the previous Treasury-only simulation. These increments of value added or lost versus the previous Treasury-only simulation are aggregated for all non-Treasury sectors the manager holds to produce the sector/quality management effect. This effect does not look at the actual securities the manager used.

- **Security-selection effect** examines the actual securities selected by the manager. For example, if corporate bond spreads narrowed 20 basis points and the corporate bonds held by the manager narrowed more, the manager's selection effect is positive for corporate bonds. It is calculated as the total return of each security less all the previous components. It is analogous to security selection in equity attribution. The aggregate of all the individual security selection effects is the manager's security selection effect.

- **Trading effect** is a plug figure. The trading effect assumes any additional unexplained component of the portfolio return is due to the manager's trading activities. It is calculated as the total portfolio return less the other effects: the external interest rate effect, the interest rate management effect, the sector/quality management effect, and the security selection effect.
Example: Management factors

The table below outlines the performance attribution analysis for two fixed-income managers of the Helix fund for the year ended December 31, 2012:

<table>
<thead>
<tr>
<th>Performance Attribution Analysis</th>
<th>Alpha Asset Management</th>
<th>Alpha Asset Management</th>
<th>Bond Portfolio Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interest rate effect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Expected</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>ii. Unexpected</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
</tr>
<tr>
<td>Subtotal</td>
<td>1.22</td>
<td>1.22</td>
<td>1.22</td>
</tr>
<tr>
<td>2. Interest rate management effect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii. Duration</td>
<td>0.18</td>
<td>-0.17</td>
<td>0.00</td>
</tr>
<tr>
<td>iv. Convexity</td>
<td>-0.07</td>
<td>-0.07</td>
<td>0.00</td>
</tr>
<tr>
<td>v. Yield-curve change</td>
<td>0.10</td>
<td>0.18</td>
<td>0.00</td>
</tr>
<tr>
<td>Subtotal</td>
<td>0.21</td>
<td>-0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>3. Other management effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi. Sector</td>
<td>-0.08</td>
<td>1.17</td>
<td>0.00</td>
</tr>
<tr>
<td>vii. Bond selection</td>
<td>0.16</td>
<td>-0.13</td>
<td>0.00</td>
</tr>
<tr>
<td>viii. Transaction costs</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Subtotal</td>
<td>0.08</td>
<td>1.04</td>
<td>0.00</td>
</tr>
<tr>
<td>4. Trading activity return</td>
<td>0.09</td>
<td>0.10</td>
<td>0.00</td>
</tr>
<tr>
<td>5. Total return</td>
<td>1.60</td>
<td>2.30</td>
<td>1.22</td>
</tr>
</tbody>
</table>

Alpha Asset Management states that its investment strategy is to outperform the index through active interest rate management and bond selection.

Beta Asset Management states its investment strategy is to immunize against interest rate exposure and to yield positive contribution through bond selection.

Assess whether both managers' positive performances were primarily through their stated objectives.
Answer:

Alpha’s active management process yielded 38 basis points overall (subtotals of 2, 3, and 4). Twenty-one basis points were due to Alpha’s interest rate management process (subtotal 2). Sixteen basis points were due to bond selection (category vii).

Thus, a substantial proportion of Alpha’s positive contribution of 38 basis points came from its stated strategies of interest rate management and bond selection.

Although Beta has remained fairly neutral to interest rate exposure (−6 basis points), its main positive contribution has come from identifying undervalued sectors (117 basis points from category vi) rather than bond selection (−13 basis points from category vii).

Thus, the analysis seems to contradict Beta’s stated aim of enhancing portfolio returns through bond selection.

RISK-ADJUSTED PERFORMANCE MEASURES

LOS 41.p: Calculate, interpret, and contrast alternative risk-adjusted performance measures, including (in their ex post forms) alpha, information ratio, Treynor measure, Sharpe ratio, and $M^2$.

The final stage of the performance evaluation process is performance appraisal. Performance appraisal is designed to assess whether the investment results are more likely due to skill or luck. Should we hire or fire the manager? Risk-adjusted performance measures are one set of tools to use in answering such questions. Each of the following is ex post, meaning the actual return of the portfolio or manager is used to assess how well the manager did on a risk-adjusted basis. Five commonly used measures are:

1. **Alpha (also known as Jensen’s ex post alpha or ex post alpha).**

2. The information ratio (IR).

3. The Treynor measure.

4. The Sharpe ratio.

5. $M^2$ (Modigliani and Modigliani).

1. **Ex post alpha.**

Alpha is the difference between the actual return and the return required to compensate for systematic risk. Alpha uses the ex post security market line (SML) as a benchmark to appraise performance. Positive alpha suggests superior performance but the sponsor may also be concerned with the variability of alpha over time.
On an ex ante basis, the SML and CAPM project return to be:

\[ \hat{R}_A = R_F + \beta_A (\hat{R}_M - R_F) \]

where:
\[ \hat{R}_A = \text{expected return on the account (portfolio)} \]
\[ R_F = \text{risk-free rate of return} \]
\[ \hat{R}_M = \text{expected return on the market} \]
\[ \beta_A = \text{account's beta (systematic risk)} \]

Using data on actual returns (i.e., historical rather than expected returns), a simple linear regression is used to calculate ex post alpha:

\[ \alpha_A = R_{At} - \hat{R}_A \]

where:
\[ \alpha_A = \text{ex post alpha on the account} \]
\[ R_{At} = \text{actual return on the account in period } t \]
\[ \hat{R}_A = R_F + \beta_A (\hat{R}_M - R_F) = \text{predicted account return} \]

Professor's Note: This may look mysterious but a Level III candidate will have done this a dozen times in the course of Level I and II. Calculate the expected return of a portfolio given its beta, the market return, and the risk-free rate over a past period. Subtract the result from the actual return of the portfolio. The difference is alpha. Also remember that graphically, positive alpha means the portfolio plots above the SML and negative alpha plots below.

2. The Treynor measure.

The Treynor measure is related to alpha by using beta, a systematic measure of risk. Visually, a portfolio or manager with positive alpha will plot above the SML. If a line is drawn from the risk-free return on the vertical axis through the portfolio, Treynor is the slope of that line. That means a portfolio with positive alpha will have a Treynor measure that is greater than the Treynor of the market. A portfolio with negative alpha will have a Treynor that is less than the Treynor of the market.

\[ T_A = \frac{\bar{R}_A - \bar{R}_F}{\beta_A} \]

where:
\[ \bar{R}_A = \text{average account return} \]
\[ \bar{R}_F = \text{average risk-free return} \]
\[ \beta_A = \text{account beta} \]
3. The Sharpe ratio.

While the previous two ratios only consider systematic risk, Sharpe uses total risk (standard deviation). Sharpe would be plotted against the CML, which also assesses risk as standard deviation. The Sharp ratio of the market is the slope of the CML. For any portfolio the line between the risk-free rate and the intersection of that portfolio's return and standard deviation is its CAL and the slope of that portfolio's CAL is its Sharpe ratio. A superior manager will have a higher Sharpe than the market and a steeper CAL than the CML.

Sharpe is similar to the Treynor measure in using excess return but the Sharpe ratio uses standard deviation for risk and Treynor uses beta.

\[
S_A = \frac{\bar{R}_A - \bar{R}_F}{\sigma_A}
\]

where:
- \( \bar{R}_A \) = average account return
- \( \bar{R}_F \) = average risk-free return
- \( \sigma_A \) = standard deviation of account returns

4. The M² measure (from Modigliani and Modigliani).

M² also uses standard deviation as risk in the denominator and excess return in the numerator, which makes it very similar to Sharpe. M² measures the value added or lost relative to the market if the portfolio had the same risk (standard deviation) as the market. It measures the result of a hypothetical portfolio that uses leverage to increase risk and return if the portfolio has less risk than the market or lends at the risk-free rate to lower risk and return if the portfolio has more risk than the market:

\[
M^2_P = \bar{R}_F \left( \frac{\bar{R}_P - \bar{R}_F}{\sigma_P} \right) \sigma_M
\]

where:
- \( \bar{R}_P \) = average portfolio (account) return
- \( \bar{R}_F \) = average risk-free return
- \( \sigma_P \) = standard deviation of portfolio (account) returns
- \( \sigma_M \) = standard deviation of the market index

5. The information ratio.

The information ratio (IR) is quite similar to the Sharpe ratio in that excess return is measured against variability. For the IR, the excess return is the portfolio return less the return of an appropriate benchmark (rather than the risk-free rate). This
excess return is also called active return. The denominator of the IR is the standard deviation of the excess return in the numerator (also called active risk).

\[ IR_A = \frac{\text{active return}}{\text{active risk}} = \frac{\bar{R}_A - \bar{R}_B}{\sigma_{A-B}} \]

where:
- \( \bar{R}_A \) = average account return
- \( \bar{R}_B \) = average benchmark return
- \( \sigma_{A-B} \) = standard deviation of excess returns measured as the difference between account and benchmark returns

Professor's Note: The Sharpe ratio and the IR are even more similar than they appear. Both use a form of excess return for the numerator which is apparent from the formulas. Less obvious is that both use the standard deviation of their numerator for their denominator.

The Sharpe ratio uses the standard deviation of the portfolio in the denominator. However because the standard deviation of the risk-free asset in a single period is zero with a zero correlation to the portfolio return, the standard deviation of the portfolio is equal to the standard deviation of excess return used in the numerator of the Sharpe ratio.

Example: Risk-adjusted performance appraisal measures

The data in the table below has been collected to appraise the performance of four asset management firms:

<table>
<thead>
<tr>
<th>Performance Appraisal Data</th>
<th>Fund 1</th>
<th>Fund 2</th>
<th>Fund 3</th>
<th>Fund 4</th>
<th>Market Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>6.45%</td>
<td>8.96%</td>
<td>9.44%</td>
<td>5.82%</td>
<td>7.60%</td>
</tr>
<tr>
<td>Beta</td>
<td>0.88</td>
<td>1.02</td>
<td>1.36</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.74%</td>
<td>4.54%</td>
<td>3.72%</td>
<td>2.64%</td>
<td>2.80%</td>
</tr>
</tbody>
</table>

The risk-free rate of return for the relevant period was 3%. Calculate and rank the funds using ex post alpha, Treynor measure, Sharpe ratio, and M^2.
Answer:

<table>
<thead>
<tr>
<th>Evaluation Tool</th>
<th>Fund 1</th>
<th>Fund 2</th>
<th>Fund 3</th>
<th>Fund 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>6.45 - 7.05</td>
<td>8.96 - 7.69</td>
<td>9.44 - 9.26</td>
<td>5.82 - 6.68</td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Treynor</td>
<td>(6.45 - 3) / 0.88 = 3.92</td>
<td>(8.96 - 3) / 1.02 = 5.84</td>
<td>(9.44 - 3) / 1.36 = 4.74</td>
<td>(5.82 - 3) / 0.80 = 3.53</td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Sharpe</td>
<td>(6.45 - 3) / 2.74 = 1.26</td>
<td>(8.96 - 3) / 4.54 = 1.31</td>
<td>(9.44 - 3) / 3.72 = 1.73</td>
<td>(5.82 - 3) / 2.64 = 1.07</td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>$M^2$</td>
<td>$3 \times (1.26 \times 2.8) = 6.53%$</td>
<td>$3 \times (1.31 \times 2.8) = 6.67%$</td>
<td>$3 \times (1.73 \times 2.8) = 7.84%$</td>
<td>$3 \times (1.07 \times 2.8) = 6.00%$</td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Note that the alpha and Treynor measures give the same rankings, and the Sharpe and $M^2$ measures give the same rankings. However, when comparing the alpha/Treynor rankings to the Sharpe/$M^2$ measures, funds 2 and 3 trade places.

Fund 2 has a much higher total risk (standard deviation) than Fund 3 but has a much lower beta. Relatively speaking, for Fund 2’s total risk, a smaller proportion relates to systematic risk that is reflected in the low beta. Compared to Fund 3, it must have a bigger proportion of risk relating to non-systematic risk factors.

Hence, Fund 2 does better in the alpha and Treynor measures, as they only look at systematic risk (beta). It fairs less well when it comes to the Sharpe and $M^2$ measures that consider total risk.

Summary Points

Figure 4: Risk-Adjusted Measures

The slope of the line from $R_p$ to the portfolio is the portfolio’s Treynor.

The slope of the line from $R_p$ to any portfolio is the portfolio’s Sharpe.
• Alpha and Treynor both measure risk as systematic risk (beta). They will agree in that a manager with positive alpha will have a Treynor in excess of the market Treynor. They may not always agree in relative ranking. A manager with the highest alpha may not have the highest Treynor.
• Superior (inferior) Sharpe will mean superior (inferior) M^2. Both measure risk as total risk (standard deviation).
• Both Alpha and Treynor are criticized because they depend on beta and assumptions of the CAPM. The criticisms include (1) the assumption of a single priced risk rather than some form of multifactor risk pricing and (2) the use of a market proxy, such as the S&P 500, to stand for the market. Roll’s critique shows that small changes in what is assumed to be the market can significantly change the alpha and Treynor calculations and even reverse the conclusions of superior or inferior performance and rankings.
• Measures like M^2 that use a benchmark are also subject to the criticism the benchmark used may not be precisely replicable. As a related issue, transaction cost to replicate the market or a custom benchmark are not considered.
• Any ex post calculation is a sample of true results and actual results can be different in the future. Even if results do reflect true manager skill, the manager can change approach or style in the future.
• Alpha, Treynor, and Sharpe are the more widely used measures.
• Also remember from Levels I and II that the highest relative return measure does not necessarily mean the highest return. For example, a very low risk portfolio with low beta or standard deviation could have a higher alpha and Sharpe but a very risky portfolio with lower alpha and Sharpe can still have the higher absolute return.

LOS 41.q: Explain how a portfolio’s alpha and beta are incorporated into the information ratio, Treynor measure, and Sharpe ratio.

Professor’s Note: This is an odd LOS. You will find no direct section of material to cover it in the CFA text. Reading between the lines of what is covered:
• Positive (negative) alpha will directly correlate to a portfolio Sharpe ratio that is higher than (below) the market Sharpe ratio.
• Beta is directly used in the Treynor measure as the measure of risk and indirectly used in the IR because the IR uses a benchmark in calculating excess return. The benchmark is selected as appropriate to the account’s long-term objectives and the benchmark will reflect the appropriate systematic risk (one of which is beta) for the portfolio.
QUALITY CONTROL CHARTS

LOS 41.r: Demonstrate the use of performance quality control charts in performance appraisal.

One way of evaluating performance results is through quality control charts. To construct a chart, three important assumptions are made about the distribution of the manager’s value-added returns (i.e., the difference between the portfolio and benchmark returns):

1. The null hypothesis states the expected value-added return is zero.
2. Value-added returns are independent and normally distributed.
3. The investment process is consistent, producing more or less constant variability of the value-added returns (i.e., the distribution of the value-added returns about their mean is constant).

You will notice that these are assumptions we make in regression analysis. From these assumptions, a quality control chart is constructed, as in Figure 5.

Figure 5: Example Quality Control Chart

The manager’s cumulative value-added return is plotted on the vertical axis, and time is plotted on the horizontal axis. You will notice that the center of the vertical axis is at zero, the event where the portfolio and benchmark returns are equal, so the value-added return is zero. The solid, horizontal line originating at zero can be thought of as the benchmark return, and any portfolio returns plotting off the horizontal line would represent those occasions when the portfolio and benchmark returns are not equal.
Management can plot the manager’s cumulative value-added returns on the chart to determine whether they are randomly generated (happen by chance) or are derived through superior management. If deviations from the benchmark return are purely random, they should be distributed more or less randomly around the solid horizontal line (i.e., there will be no tendency for them to be positive or negative). If they tend to be consistently above or below the line, however, superior or inferior performance, respectively, could be indicated.

To this point, we have considered only the nominal value-added returns relative to the benchmark. We know from regression analysis, however, that we must also derive a measure of statistical significance (confidence). To do this, we calculate a confidence interval around the horizontal (zero value-added return) line. If the value-added return falls outside the confidence interval, we conclude that it is statistically different from zero.

The solid, cone-shaped-like lines surrounding the horizontal line in Figure 5 represent the confidence interval. The confidence interval is generated using the standard deviation of value-added returns and the empirical rule. For example, approximately 95% of all returns will fall within two standard deviations of the mean (zero in this case). When a value-added return falls outside the 95% confidence interval (see Figure 5), the null hypothesis is rejected. In other words, we say that the value-added return is statistically different from zero and, therefore, not the result of a random event.

**MANAGER CONTINUATION POLICY**

**LOS 41.s: Discuss the issues involved in manager continuation policy decisions, including the costs of hiring and firing investment managers.**

The costs of hiring and firing investment managers can be considerable because the fired manager’s portfolios will have to be moved to the new manager(s). This can be quite expensive, both in time and money:

1. A proportion of the existing manager’s portfolio may have to be liquidated if the new manager’s style is significantly different.

2. Replacing managers involves a significant amount of time and effort for the fund sponsor.

As a result, some fund sponsors have a formalized, written manager continuation policy (MCP) which will include the goals and guidelines associated with the management review process:

- Replace managers only when justified (i.e., minimize unnecessary manager turnover).
- Short periods of underperformance should not necessarily mean automatic replacement.
- Develop formal policies and apply them consistently to all managers.
• Use portfolio performance and other information in evaluating managers:
  • Appropriate and consistent investment strategies (i.e., the manager doesn’t continually change strategies based upon near-term performance).
  • Relevant benchmark (style) selections.
  • Personnel turnover.
  • Growth of the account.

Implementing the MCP process usually involves:

1. Continual manager monitoring.

2. Regular, periodic manager review.

The manager review should be handled much as the original hiring interview, which should have included the manager’s key personnel. Then, before replacing a manager, management must determine that the move will generate value for the firm (like a positive NPV project). That is, the value gained from hiring a new manager will outweigh the costs associated with the process.

**TYPE I ERRORS AND TYPE II ERRORS**

*LOS 41.1: Contrast Type I and Type II errors in manager continuation decisions.*

*CFA® Program Curriculum, Volume 6, page 177*

Type I and Type II errors refer to incorrectly rejecting or failing to reject the null hypothesis, respectively. Stating the null hypothesis as the manager generates no value-added and the alternative hypothesis as the manager adds value, there are two potential statistical errors:

\[ H_0: \text{The manager adds no value.} \]
\[ H_A: \text{The manager adds positive value.} \]

**Type I error**—Rejecting the null hypothesis when it is true. That is, keeping managers who are not adding value.

**Type II error**—Failing to reject the null when it is false. That is, firing good managers who are adding value.

**For the Exam:** To keep Type I and II errors straight, remember the phrase “Type I horn.” That is, a Type I error is when you incorrectly reject the null hypothesis, \( H_0 \). Putting “ho” with the first letters of reject null, you get the word “horn.”
KEY CONCEPTS

LOS 41.a
Fund sponsor’s perspective: Performance evaluation improves the effectiveness of a fund’s investment policy by acting as a feedback and control mechanism. It:
• Shows where the policy is effective and where it isn’t.
• Directs management to areas of underperformance.
• Indicates the results of active management and other policy decisions.
• Indicates where other, additional strategies can be successfully applied.
• Provides feedback on the consistent application of the policies set forth in the IPS.

Investment manager’s perspective: As with the fund sponsor’s perspective, performance evaluation can serve as a feedback and control mechanism. Some investment managers may simply compare their reported investment returns to a designated benchmark. Others will want to investigate the effectiveness of each component of their investment process.

LOS 41.b
The three primary concerns to address when assessing the performance of an account are:
1. The return performance of the account over the period. This is addressed through performance measurement, which involves calculating rates of return based on changes in the account’s value over specified time periods.

2. How the manager(s) attained the observed performance. This is addressed by performance attribution. This looks into the sources of the account’s performance (e.g., sector or security selection) and the importance of those sources.

3. Whether the performance was due to investment decisions. This is addressed by performance appraisal. The objective is to draw conclusions regarding whether the performance was affected primarily by investment decisions, by the overall market, or by chance.

LOS 41.c
The time-weighted rate of return (TWRR) calculates the compounded rate of growth over a stated evaluation period of one unit of money initially invested in the account. It requires a set of subperiod returns to be calculated covering each period that has an external cash flow. The subperiod results are then compounded together:

\[ R_p = (1 + R_{s1})(1 + R_{s2})(1 + R_{s3})(1 + R_{s4})\cdots(1 + R_{sk}) - 1 \]

The money-weighted rate of return (MWRR) is the internal rate of return (IRR) on all funds invested during the evaluation period, including the beginning value of the portfolio:

\[ MV_1 = MV_0(1 + R)^n + \sum_{i=1}^{n} CF_i(1 + R)^{L(i)} \]
The MWRR, unlike the TWRR, is heavily influenced by the size and timing of cash flows. The TWRR is the preferred method unless the manager has control over the size and timing of the cash flows. The MWRR will be higher (lower) than the TWRR if funds are added prior to a period of strong (weak) performance.

**LOS 41.d**
The phrase “garbage in, garbage out” is quite appropriate for return calculations. That is, the calculated return is only as good (i.e., accurate) as the inputs. The following are potential problems relating to data quality:

- When accounts contain illiquid (infrequently priced) assets, estimates or educated guesses must sometimes be used to calculate returns.
- For many thinly-traded fixed-income securities, current market prices may not be available. Estimated prices may be derived from dealer quoted prices on securities with similar attributes. This is known as matrix pricing.
- Highly illiquid securities may be carried at cost or the price of the last trade, thus not reflecting the current price.
- Account valuations should include trade date accounting, including accrued interest and dividends.

**LOS 41.e**
Portfolio return, $P$, can be broken into returns due to market, style, and active management:

$$P = M + S + A$$

where:

- $P$ = portfolio return
- $M$ = market index return
- $S$ = return to style
- $A$ = return due to active management
- $S = B - M$
- $B$ = portfolio benchmark return
- $A = P - B$

**LOS 41.f**
A valid benchmark should meet the following criteria:

1. **Specified in advance**: The benchmark is known to both the investment manager and the fund sponsor. It is specified at the start of an evaluation period.

2. **Appropriate**: The benchmark is consistent with the manager's investment approach and style.

3. **Measurable**: Its value can be determined on a reasonably frequent basis.

4. **Unambiguous**: Clearly-defined identities and weights of securities constitute the benchmark.

5. **Reflective of current investment opinions**: The manager has current knowledge and expertise of the securities within the benchmark.

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6. **Accountable**: The manager(s) should accept the applicability of the benchmark and be accountable for deviations in construction due to active management.

7. **Investable**: It is possible to replicate the benchmark and forgo active management.

There are seven primary types of benchmarks in use:

1. **Absolute**: An absolute benchmark is a return objective (e.g., aims to exceed a minimum return target).

2. **Manager universes**: The median manager or fund from a broad universe of managers or funds is used as the benchmark.

3. **Broad market indices**: There are several well-known broad market indices that are used as benchmarks (e.g., the S&P 500 for U.S. common stocks).

4. **Style indices**: Investment style indices represent specific portions of an asset category.

5. **Factor-model-based**: Factor models involve relating a specified set of factor exposures to the returns on an account.

6. **Returns-based**: Returns-based benchmarks are constructed using (1) the managed account returns over specified periods and (2) corresponding returns on several style indices for the same periods.

7. **Custom security-based**: A custom security-based benchmark reflects the manager’s investment universe, weighted to reflect a particular approach.

**LOS 41.g**

The construction of a custom security-based benchmark entails the following steps:

*Step 1*: Identify the important elements of the manager’s investment process.

*Step 2*: Select securities that are consistent with that process.

*Step 3*: Weight the securities (including cash) to reflect the manager’s process.

*Step 4*: Review and adjust as needed to replicate the manager’s process and results.

*Step 5*: Rebalance the custom benchmark on a predetermined schedule.

**LOS 41.h**

Using the median account as a benchmark has a number of drawbacks:

1. It fails several properties of a valid benchmark:
   - It is impossible to identify the median manager in advance.
   - It is ambiguous, as the median manager is unknown.
   - The benchmark is not investable.
   - It is impossible to verify the benchmark’s appropriateness due to the ambiguity of the median manager.

2. Fund sponsors who choose to employ manager universes have to rely on the compiler’s representations that the accounts within the universe have been screened, input data validated, and calculation methodology approved.
3. As fund sponsors will terminate underperforming managers, universes will be subject to “survivor bias.” As consistently underperforming accounts will not survive, the median will be biased upwards. Without a valid reference point, evaluating manager performance using this benchmark becomes suspect.

**LOS 41.i**

**Systematic bias:** There should be minimal systematic bias in the benchmark relative to the account.

**Tracking error:** Tracking error is defined as the volatility of the excess return earned due to active management.

**Risk characteristics:** An account’s exposure to systematic sources of risk should be similar to those of the benchmark over time.

**Coverage:** The coverage ratio is the market value of the securities that are in both the portfolio and the benchmark as a percentage of the total market value of the portfolio.

**Turnover:** Passively managed portfolios should utilize benchmarks with low turnover.

**Positive active positions:** An active position is the difference between the weight of a security or sector in the managed portfolio versus the benchmark.

**LOS 41.j**

The diversity of hedge funds has led to problems when designating a suitable benchmark. In most cases, hedge funds hold both short and long investment positions. This leads to performance measurement issues as well as administrative and compliance issues. Given these complications, other performance methods that may be more appropriate are:

1. **Value-added return:** One approach is to evaluate in terms of performance impact. A return can be calculated by summing up the performance impacts of the individual security positions, both long and short.

2. **Separate long/short benchmarks:** It may be possible to construct separate long and short benchmarks. These could then be combined in their relevant proportions to create an overall benchmark.

3. **The Sharpe ratio:** The confusion over exactly what constitutes a hedge fund, as well as the myriad strategies employed by hedge fund managers, has led to the popular use of the Sharpe ratio, which compares portfolio returns to a risk-free return rather than a benchmark.

**LOS 41.k**

The basic concept of performance attribution is to identify and quantify the sources of returns that are different from the designated benchmark. There are two basic forms of performance attribution:

1. **Macro performance attribution** is done at the fund sponsor level. The approach can be carried out in percentage terms (a rate-of-return metric) and/or in monetary terms (a value metric).
2. Micro performance attribution is used by both fund managers (to analyze the performance of the individual portfolio managers they use) and the portfolio managers themselves (to determine sources of excess returns). Note the distinction does not relate to who is carrying out the performance attribution, but rather to the variables being used.

There are three main inputs into the macro attribution approach:
1. Policy allocations: It is up to the sponsor to determine the asset categories and weights as well as to allocate the total fund among asset managers. As in any IPS development, allocations will be determined by the sponsor's risk tolerance, long-term expectations, and the liabilities (spending needs) the fund must meet.

2. Benchmark portfolio returns: A fund sponsor may use broad market indices as the benchmarks for asset categories and narrowly-focused indices for managers' investment styles.

3. Fund returns, valuations, and external cash flows: When using percentage terms, returns will need to be calculated at the individual manager level. This enables the fund sponsor to make decisions regarding manager selection.

If also using monetary values, account valuation and external cash flow data are needed to compute the value impacts of the fund sponsor's investment policy decision making.

LOS 41.1

Macro Attribution Analysis

There are six levels of investment policy decision-making, by which the fund's performance can be analyzed:
1. Net contributions.
2. Risk-free asset.
3. Asset categories.
4. Benchmarks.
5. Investment managers.
6. Allocation effects.

The levels represent investment strategies management can utilize to add value to the fund; these levels increase in risk, expected return, and tracking error as one progresses down the list.

Micro Attribution Analysis

Micro performance attribution consists of analyzing individual portfolios relative to designated benchmarks. The value-added return (portfolio return minus benchmark
return) can be broken into three components: (1) pure sector allocation, (2) allocation/
selection interaction, and (3) within-sector selection.

\[
R_V = \sum_{j=1}^{S} (w_{P,j} - w_{B,j})(R_{B,j} - R_B) + \sum_{j=1}^{S} (w_{P,j} - w_{B,j})(R_{P,j} - R_{B,j})
\]

1. **Pure sector allocation**
2. **Allocation/selection interaction**
3. **Within-sector selection**

**LOS 41.m**
It should be possible to construct multifactor models to conduct micro attribution.
This involves combining economic sector factors with other fundamental factors.
Constructing a suitable factor model would involve the following:
- Identify the fundamental factors that will generate systematic returns.
- Determine the exposures of the portfolio and the benchmark to the fundamental
factors at the start of the evaluation period.
- Determine the manager’s active exposure to each factor.
- Determine the active impact. This is the added return due to the manager’s active
exposures.

The results of the fundamental factor micro attribution will indicate the source of
portfolio returns, based upon actual factor exposures versus the manager’s normal factor
exposures (e.g., sector rotation), the manager’s ability to time the market (e.g., adjust the
portfolio beta and/or duration in response to market expectations), and so on.

**LOS 41.n**
Attribution analysis of a fixed-income portfolio amounts to comparing the return on the
active manager’s portfolio to the return on a passively managed, risk-free portfolio. The
difference between the two can be attributed to the effects of the external interest rate
environment and the manager’s contribution.
1. **Effect of the external interest environment:**
   - Return on the default-free benchmark assuming no change in the forward rates.
   - Return due to the actual changes in interest rates.

2. **Contribution of the management process:**
   - Return from interest rate management.
   - Return from sector/quality management.
   - Return from the selection of specific securities.
   - Return from trading activity.

**LOS 41.o**
The manager’s contribution to the portfolio return (i.e., the return to active
management) can be divided into four components:
1. **Interest rate management effect:** The ability of the manager to predict changes in
   relevant interest rates.
2. **Sector/quality effect:** The ability of the manager to select and overweight
   (underweight) outperforming (underperforming) sectors and qualities.
3. **Security selection effect**: The ability of the manager to select superior securities to represent sectors.

4. **Trading activity**: The residual effect; assumed to measure the return to active trading (buying and selling) over the period.

**LOS 41.p**

The final stage of the performance evaluation process, performance appraisal, measures compare returns on a risk-adjusted basis. The following are five methods of performance appraisal in their ex post (historical) forms:

1. **Ex post alpha (Jensen’s alpha)**: Alpha is the difference between the account return and the return required to compensate for systematic risk. Alpha uses the ex post SML as a benchmark to appraise performance.

2. **Information ratio**: Excess return is measured against variability.

3. **The Treynor measure**: The Treynor measure calculates the account’s excess return above the risk-free rate, relative to the account’s beta (i.e., systematic risk).

4. **The Sharpe ratio**: Unlike the previous two methods, the Sharpe ratio calculates excess returns above the risk-free rate, relative to total risk measured by standard deviation.

5. **M2**: Using the CML, M2 compares the account’s return to the market return if the two had equal risk.

**LOS 41.q**

Positive (negative) alpha will directly correlate to a portfolio Sharpe ratio that is higher than (below) the market Sharpe ratio.

Beta is directly used in Treynor as the measure of risk and indirectly used in the IR because IR uses a benchmark in calculating excess return. The benchmark is selected as appropriate to the accounts long-term objectives, and the benchmark will reflect the appropriate systematic risk (one of which is beta) for the portfolio.

**LOS 41.r**

Quality control charts plot managers’ performance relative to a benchmark, with a statistical confidence interval.

The manager’s value-added return is plotted on the vertical axis, and time is plotted on the horizontal axis. The center of the vertical axis is where the portfolio and benchmark returns are equal, so the value-added return is zero. The solid, horizontal line originating at zero can be thought of as the benchmark return, and any portfolio returns plotting off the horizontal line would represent those occasions when the portfolio and benchmark returns are not equal.

Management can plot the manager’s value-added returns on the chart to determine whether they are randomly generated or are derived through superior management.
If they tend to be consistently above or below the line, this could indicate superior or inferior performance, respectively.

**LOS 41.s**

Some fund sponsors have a formalized, written manager continuation policy (MCP) which includes the goals and guidelines associated with the management review process:

- Replace managers only when justified (i.e., minimize unnecessary manager turnover).
- Short periods of underperformance should not necessarily mean automatic replacement.
- Develop formal policies and apply them consistently to all managers.
- Use portfolio performance and other information in evaluating managers:
  - Appropriate and consistent investment strategies (i.e., the manager doesn’t continually change strategies based upon near term performance).
  - Relevant benchmark (style) selections.
  - Personnel turnover.
  - Growth of the account.

**LOS 41.t**

Type I and Type II errors refer to incorrectly rejecting or failing to reject the null hypothesis, respectively. Stating the null hypothesis as the manager generates no value-added and the alternative hypothesis as the manager adds value, there are two potential statistical errors:

\[
H_0: \text{The manager adds no value.}
\]

\[
H_A: \text{The manager adds positive value.}
\]

**Type I error**—Rejecting the null hypothesis when it is true. That is, keeping managers who are returning no value-added.

**Type II error**—Failing to reject the null when it is false. That is, firing good managers who are adding value.
CONCEPT CHECKERS

1. The Helix account was valued at $6,000,000 at start of the month. At the month-end, its value is $6,380,000. The account received a contribution of $80,000.

Calculate the rate of return for the month under the following conditions:
(a) The contribution was received at the start of the month.
(b) The contribution was received at the end of the month.

2. The Genesis account is valued at $1,000,000 at the start of the month and $1,200,000 at the end. During the month, there was a cash inflow of $30,000 on day 11 and $20,000 on day 17. The values of the account are $1,050,000 and $1,150,000 on days 11 and 17, respectively. Calculate the time-weighted rate of return (assuming 30 days in the month).

3. The Pygmalion account is valued at $750,000 at the start of the month. On day 22, a contribution of $20,000 is made. At the end of the month, the account is worth $1,266,513. Assuming 30 days in a month, the daily MWRR is closest to:
A. 1.5%.
B. 1.7%.
C. 1.9%.
4. Answer the following questions relating to rate of return calculations:
   (a) Outline the advantages and disadvantages of the time-weighted rate of return and the money-weighted rate of return.

   (b) If daily valuations are unavailable, describe a method that is an approximate estimate to the time-weighted rate of return.

   (c) Discuss circumstances where there could be significant differences between the time-weighted and money-weighted rates of return.

5. Rhombus Asset Management runs a U.S. small-cap equity portfolio. The portfolio generated an 8.9% return during 2005. Rhombus uses the Russell 2000® Index as the most appropriate benchmark. The Russell 2000® Index yielded 9.1% over the same evaluation period. The Wilshire 5000, a broad U.S. equity market index, yielded 8.5% over the same evaluation period.

   Calculate Rhombus Asset Management’s return due to style and due to active management. Assess Rhombus’s performance compared to the benchmark and to the market.
6. List and discuss the seven characteristics for a benchmark to effectively evaluate management performance.

7. Hexagon PLC is an investment management company based in London. It manages portfolios consisting of European equities only. It states that its benchmark is to beat the median manager. Discuss the validity of the median manager benchmark approach.

8. Discuss the problems associated with applying traditional performance measurement and evaluation techniques to a long-short hedge fund and suggest alternative measures that may be more appropriate.

9. Distinguish between macro and micro attribution, including their inputs.
10. The following is an extract from a micro attribution analysis of one of the investment managers of the Hiatus fund:

<table>
<thead>
<tr>
<th>Economic Sectors</th>
<th>Portfolio Weight (%)</th>
<th>Sector Benchmark Weight (%)</th>
<th>Portfolio Return (%)</th>
<th>Sector Benchmark Return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>8.38</td>
<td>7.72</td>
<td>3.55</td>
<td>3.32</td>
</tr>
<tr>
<td>Financial</td>
<td>15.48</td>
<td>13.42</td>
<td>1.66</td>
<td>1.10</td>
</tr>
<tr>
<td>Technology</td>
<td>17.89</td>
<td>22.01</td>
<td>3.21</td>
<td>3.18</td>
</tr>
</tbody>
</table>

*The overall benchmark return was 2.32%.

Using the above table, calculate and evaluate:

(i) The pure sector allocation return for the energy sector.

(ii) The within-sector selection return for the financial sector.

(iii) The allocation/selection interaction return for the technology sector.
11. (i) **Explain** management factors contributing to a fixed-income portfolio’s total return.

(ii) Delta Asset Management states that its investment strategy is to outperform the index through active interest rate management and identifying undervalued sectors. Kappa Asset Management states its investment strategy is to immunize against interest rate exposure and to yield positive contribution through bond selection. Using the data in the table, assess whether both managers’ positive performance was primarily through their stated objectives.

<table>
<thead>
<tr>
<th></th>
<th>Delta Asset Management</th>
<th>Kappa Asset Management</th>
<th>Bond Portfolio Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Interest rate effect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Expected</td>
<td>0.49</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>ii. Unexpected</td>
<td>0.59</td>
<td>0.59</td>
<td>0.59</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>1.08</td>
<td>1.08</td>
<td>1.08</td>
</tr>
<tr>
<td><strong>2. Interest rate management effect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii. Duration</td>
<td>-0.12</td>
<td>0.23</td>
<td>0.00</td>
</tr>
<tr>
<td>iv. Convexity</td>
<td>-0.02</td>
<td>-0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>v. Yield-curve change</td>
<td>0.10</td>
<td>0.16</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>-0.04</td>
<td>0.36</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>3. Other management effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi. Sector</td>
<td>1.02</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>vii. Bond selection</td>
<td>0.08</td>
<td>0.23</td>
<td>0.00</td>
</tr>
<tr>
<td>viii. Transaction costs</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>1.10</td>
<td>0.27</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>4. Trading activity return</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.05</td>
<td>0.07</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>5. Total return</strong></td>
<td>2.19</td>
<td>1.78</td>
<td>1.08</td>
</tr>
</tbody>
</table>
The following data has been collected to appraise the following four funds:

<table>
<thead>
<tr>
<th>Fund</th>
<th>Fund A</th>
<th>Fund B</th>
<th>Fund C</th>
<th>Fund D</th>
<th>Market Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>8.25%</td>
<td>7.21%</td>
<td>9.44%</td>
<td>10.12%</td>
<td>8.60%</td>
</tr>
<tr>
<td>Beta</td>
<td>0.91</td>
<td>0.84</td>
<td>1.02</td>
<td>1.34</td>
<td>1.00</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>3.24%</td>
<td>3.88%</td>
<td>3.66%</td>
<td>3.28%</td>
<td>3.55%</td>
</tr>
<tr>
<td>Tracking error*</td>
<td>0.43%</td>
<td>0.62%</td>
<td>0.33%</td>
<td>1.09%</td>
<td></td>
</tr>
</tbody>
</table>

* Tracking error is the standard deviation of the difference between the Fund Return and the Market Index Return.

The risk-free rate of return for the relevant period was 4%. Calculate and rank the funds using the following methods:

(i) Jensen's alpha

(ii) Treynor measure

(iii) Sharpe ratio

(iv) $M^2$

(v) Information ratio

Compare and contrast the methods and explain why the ranking differs between methods.
13. The Solus fund is in the process of implementing a Manager Continuation Policy in order to avoid excessive manager turnover yet remove inferior managers as required. At the moment, Solus believes it is being a bit too conservative and retaining managers even though they are producing weak performance. State and explain the type of statistical error Solus is currently making. Briefly explain the other kind of error Solus could make.

14. For a given portfolio over a particular time period, an analyst is given beginning market value, ending market value, and a specified cash flow. All of the given values are positive with a positive return for the year. The analyst represents the return for the period calculated as if the one cash flow came at the beginning of the period with the symbol $R_B$ and represents the return calculated as if the cash flow came at the end of the period with the symbol $R_E$. Based only on the given information:
   A. $R_B > R_E$
   B. $R_B = R_E$
   C. $R_B < R_E$

15. For a passively-managed portfolio, with respect to managing the portfolio and choosing the best benchmark, a manager would want a:
   A. low coverage ratio of the chosen benchmark, which has a low turnover ratio.
   B. low coverage ratio of the chosen benchmark, which has a high turnover ratio.
   C. high coverage ratio of the chosen benchmark, which has a low turnover ratio.

16. Specify one way each for how fundamental factor model micro attribution is similar to and different from a returns-based style analysis.
17. In calculating the Treynor and Sharpe measures for a given portfolio, other things constant, lowering unsystematic risk will most likely:
   A. increase both the Treynor measure and Sharpe measures.
   B. increase the Treynor measure but not the Sharpe measure.
   C. increase the Sharpe measure but not the Treynor measure.

18. A standard deviation measure appears in:
   A. the Sharpe measure but not the information ratio.
   B. the information ratio but not the Sharpe measure.
   C. both the information ratio and the Sharpe measure.

19. An analyst examines a quality control chart that depicts a manager's value-added return. The manager's value-added return is plotted on the vertical axis over time, which is on the horizontal axis. Above and below the horizontal axis are two confidence interval bounds. The analyst will say that the manager has added significant value when the plot of the manager's performance is:
   A. above zero only.
   B. below zero and below the lower bound of the 95% confidence interval.
   C. above zero and above the upper bound of the 95% confidence interval.
ANSWERS – CONCEPT CHECKERS

1. If the contribution of $80,000 had been at the start of the month:

\[
\frac{6,380,000 - (6,000,000 + 80,000)}{6,000,000 + 80,000} \times 100 = 4.93\%
\]

If the $80,000 contribution had occurred at the month end:

\[
\frac{(6,380,000 - 80,000) - 6,000,000}{6,000,000} \times 100 = 5.00\%
\]

2. Calculating rates of return for each subperiod:

Subperiod 1 (days 1–11)

\[
r_{t,1} = \frac{[1,050,000 - 30,000) - 1,000,000]}{1,000,000} = 0.02
\]

Subperiod 2 (days 12–17)

\[
r_{t,2} = \frac{[1,150,000 - 20,000) - 1,050,000]}{1,050,000} = 0.0762
\]

Subperiod 3 (days 18–30)

\[
r_{t,3} = \frac{1,200,000 - 1,150,000)}{1,150,000} = 0.0435
\]

Compounding the returns together to calculate an overall time-weighted rate of return:

\[
TWRR = (1 + 0.02)(1 + 0.0762)(1 + 0.0435) - 1 = 0.1455 = 14.55\%
\]

3. B For the daily MWRR, the following equation needs to be solved:

\[
$1,266,513 = $750,000(1 + R)^{30} + $20,000(1 + R)^{8}
\]

Using a trial and error process, the closest rate of return that equates the above formula is \( R = 0.017 \). (Note: Most calculators are unable to solve for an IRR when the time intervals between cash flows are unequal. If you are asked to perform a MWRR calculation on the exam, the time intervals will be equal.)

\[
$750,000(1.017)^{30} + $20,000(1.017)^{8} = $1,266,513
\]

4. TWRR

(a) The following outlines advantages and disadvantages of the TWRR and the MWRR:

Advantages

(i) The TWRR is not influenced by external cash flow activity. Therefore, it reflects what return an investor would achieve if he had placed the funds in the account at the start of the evaluation period.

(ii) As most investment managers have very little control over external cash activity, the TWRR would be an appropriate measure.
Disadvantages

(i) Account valuations are needed for every date an external cash flow takes place.

(ii) Administration costs may be higher as, potentially, daily valuations are required.

MWRR

Advantages

(i) The MWRR would be more appropriate if the investment manager retains control over external cash flows.

(ii) Only valuations at the start and end of the evaluation period are required.

Disadvantages

(i) The MWRR is sensitive to the size and timing of external cash flows.

(ii) If an investment manager has little or no control over the size or timing of external cash flows, the TWRR would be more appropriate.

(b) The TWRR can be approximated by calculating the MWRR over frequent time intervals and then chain-link those returns over the evaluation period. This process is known as the linked internal rate of return (LIRR).

(c) If the external cash flows are relatively large compared to the account's value, and the account's performance is varying considerably, there can be a significant difference between the TWRR and MWRR.

If funds are invested into an account prior to a period of strong (weak) performance, then the MWRR will be higher (lower) than the TWRR as the contribution is being invested just prior to the subperiod earning a high (low) growth rate.

5. Style return = B - M = 9.1% - 8.5% = +0.6%

Active management return = P - B = 8.9% - 9.1% = -0.2%

The positive style return tells us small-cap stocks outperformed the market as a whole.

However, the negative active management return tells us Rhombus has underperformed its benchmark for the evaluation period in question. Consistently underperforming the benchmark would bring Rhombus's investment management skills under question.

6. The following criteria are required from a benchmark to effectively evaluate performance:

- **Specified in advance.** The benchmark is known and specified at the start of an evaluation period.
- **Appropriate.** The benchmark is consistent with the manager's investment style.
- **Measurable.** It can be calculated on a reasonably frequent basis.
- **Unambiguous.** The identities and weights of securities constituting the benchmark are clearly defined.
- **Reflective of current investment opinions.** The manager has current knowledge of the securities within the benchmark.
- **Accountable.** The investment manager should be aware of and accept accountability of the constituents and performance of the benchmark (i.e., the manager exhibits ownership).
- **Investable.** It is possible to replicate the benchmark and forgo active management.
7. To assess the validity of a benchmark, use the letters from the word “SAMURAI.” The benchmark should be:

*Specified in advance:* The median manager cannot be specified in advance.

*Appropriate:* It is not possible to verify if the benchmark as the median manager is unknown.

*Measurable:* The median manager’s return can be calculated on a frequent basis.

*Unambiguous:* The median manager is unknown and therefore ambiguous.

*Reflective of current investment opinions:* Again, as the median manager is unknown, it is impossible to verify this.

*Accountable:* It is also impossible to verify the benchmark’s appropriateness due to the ambiguity of the median manager.

*Investable:* The benchmark is not investable, as the median account will differ from one evaluation period to another.

8. Problems with using traditional techniques to assess long-short hedge funds include:

- It is possible for $MV_0$ to be zero for a long-short portfolio, making the return calculation nonsensical.
- Many hedge funds use an “absolute return” approach, which makes relative performance comparisons with a traditional benchmark less useful.

Alternative performance methods that can be used instead:

A. **Value-added return.**

   This method evaluates in terms of performance impact:

   \[
   \text{value-added return} = \text{portfolio return} - \text{benchmark return}
   \]

   To replicate a zero net asset hedge fund, the value-added return on a long-short portfolio will be where the active weights sum to zero. Although the active weights sum to zero, a return can be calculated by summing up the performance impacts of the individual security positions, both long and short.

B. **Creating separate long/short benchmarks.**

   It may be possible to use either a returns-based or security-based benchmark approach to construct separate long and short benchmarks. The benchmarks could then be combined in their relevant proportions to create an appropriate overall benchmark.

C. **The Sharpe ratio.**

   The Sharpe ratio measures the excess return over a risk-free rate of return, relative to volatility (risk) of returns. A hedge fund’s Sharpe ratio can be compared to that of a universe of other similar hedge funds.

9. (i) **Macro attribution** is performance attribution carried out at the fund sponsor level. **Micro attribution** is performance attribution carried out at the investment manager level (i.e., to attribute the performance of an individual manager). The distinction relates to the decision variables being used, not who is carrying out the attribution analysis, as micro attribution is often employed by fund managers and portfolio managers.
(ii) Macro attribution analysis uses a value metric that uses account valuation and external cash flow data to calculate rates of return and dollar impacts. Micro performance attribution analysis uses a rate of return metric that calculates percentage returns at the level of the individual manager account.

(iii) There are three inputs into both approaches:

Macro attribution:
1. Policy allocations.
2. Benchmark portfolio returns.
3. Fund returns, valuations, and external cash flows.

Micro attribution:
1. Pure sector allocation.

10. (i) Pure energy sector allocation = \[(0.0838 - 0.0772) \times (3.32\% - 2.32\%)] = 0.0066\%
   This shows that the decision to overweight a sector that performed better than the overall benchmark resulted in a positive contribution to portfolio performance.

(ii) Financial sector within-sector allocation return = 0.1342 \times (1.66\% - 1.10\%) = +0.0752\%
   The positive contribution shows that the Hiatus portfolio held financial stocks that performed better than the financial stocks contained in the sector benchmark.

(iii) Technology sector allocation/selection interaction return = \[(0.1789 - 0.2201) \times (3.21\% - 3.18\%)] = -0.0012\%
   Underweighting the portfolio in the technology sector when the fund performed better than the sector benchmark has led to a negative contribution.

11. (i) There are four management factors contributing to a fixed-income portfolio's return:
1. Interest rate management effect—this indicates how well the manager predicts interest rate changes.
2. Sector/quality effect—this effect measures the manager's ability to select the best issuing sectors and quality groups.
3. Security selection effect—this measures how the return of a specific security within its sector relates to the average performance of the sector.
4. Trading activity—this encompasses the effect of sales and purchases of bonds over a given period.

(ii) Delta

Delta has yielded an overall positive contribution of 111 basis points through active management (subtotals 2, 3, and 4). Most of this positive contribution has come from sector management (102 basis points). Delta actually made a negative contribution of -4 basis points from active interest rate management.

Thus, the statement that Delta's strategy is to outperform the index through active interest rate management (incorrect) and identifying undervalued sectors (correct) appears to be only partially correct.
Kappa

Kappa has yielded 70 basis points overall through active management. This has primarily come from active interest rate management (36 basis points) and bond selection (23 basis points).

Thus, the statement that Kappa’s strategy is to immunize against interest rate exposure (incorrect) and to yield positive contribution through bond selection (correct) is also partially correct.

12. Jensen’s alpha and the Treynor measure will give the same ranking:

<table>
<thead>
<tr>
<th>Fund</th>
<th>Alpha</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund A</td>
<td>8.25% - 8.19% = +0.06%</td>
<td>2</td>
</tr>
<tr>
<td>Fund B</td>
<td>7.21% - 7.86% = -0.65%</td>
<td>4</td>
</tr>
<tr>
<td>Fund C</td>
<td>9.44% - 8.69% = +0.75%</td>
<td>1</td>
</tr>
<tr>
<td>Fund D</td>
<td>10.12% - 10.16% = -0.04%</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fund</th>
<th>Treynor</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund A</td>
<td>(8.25 - 4) / 0.91 = 4.67</td>
<td>2</td>
</tr>
<tr>
<td>Fund B</td>
<td>(7.21 - 4) / 0.84 = 3.82</td>
<td>4</td>
</tr>
<tr>
<td>Fund C</td>
<td>(9.44 - 4) / 1.02 = 5.33</td>
<td>1</td>
</tr>
<tr>
<td>Fund D</td>
<td>(10.12 - 4) / 1.34 = 4.57</td>
<td>3</td>
</tr>
</tbody>
</table>

The Sharpe ratio and M^2 will give the same ranking:

<table>
<thead>
<tr>
<th>Fund</th>
<th>Sharpe</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund A</td>
<td>(8.25 - 4) / 3.24 = 1.31</td>
<td>3</td>
</tr>
<tr>
<td>Fund B</td>
<td>(7.21 - 4) / 3.88 = 0.83</td>
<td>4</td>
</tr>
<tr>
<td>Fund C</td>
<td>(9.44 - 4) / 3.66 = 1.49</td>
<td>2</td>
</tr>
<tr>
<td>Fund D</td>
<td>(10.12 - 4) / 3.28 = 1.87</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fund</th>
<th>M^2</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund A</td>
<td>4 + [(8.25 - 4) / 3.24] = 8.65%</td>
<td>3</td>
</tr>
<tr>
<td>Fund B</td>
<td>4 + [(7.21 - 4) / 3.88] = 6.95%</td>
<td>4</td>
</tr>
<tr>
<td>Fund C</td>
<td>4 + [(9.44 - 4) / 3.66] = 9.29%</td>
<td>2</td>
</tr>
<tr>
<td>Fund D</td>
<td>4 + [(10.12 - 4) / 3.28] = 10.64%</td>
<td>1</td>
</tr>
</tbody>
</table>

The notable change in ranking between Alpha/Treynor and Sharpe/M^2 is Fund D. Fund D has a relatively low total risk (standard deviation of 3.28%) but a relatively high beta (1.34). This implies that Fund D has a high proportion of systematic risk but very little non-systematic risk.
The ranks based upon the information ratio are similar to that of the Sharpe and M² measures. This is because the measure of risk in the denominator is related to other measures of dispersion, and the information ratio uses the average return in the numerator, as do the other measures.

13. Solus is currently making a Type I error. A Type I error is incorrectly rejecting the null hypothesis. In management assessment, the null hypothesis is, “The manager contributes no value-added returns,” or, “The manager’s value-added returns are zero.” Rejecting the null would imply that the manager generates positive value-added returns. The error is that inferior managers are kept when they should be removed.

The other type of error Solus could make is a Type II error, which is failing to reject the null hypothesis when it is false. This is when good managers are removed when they should have been kept.

14. The cash flow is subtracted out of the numerator in both cases. If the cash flow comes at the beginning of the period, it is added to the denominator and decreases the measure of return even more.

15. The coverage ratio is the market value of the securities that are in both the portfolio and the benchmark, specified as a percentage of the total market value of the portfolio. The higher the coverage ratio, the more closely the manager is replicating the benchmark. Benchmark turnover is the proportion of the benchmark’s total market value that is bought or sold (turned over) during periodic rebalancing. Passively-managed portfolios should utilize benchmarks with low turnover.

16. The methods are similar in that they both use the following initial steps in constructing a suitable factor model:
   • Identify the fundamental factors that will generate systematic returns.
   • Determine the exposures of the portfolio and the benchmark to the fundamental factors.
   • Determine the performance of each of the factors.

In this way, the fundamental factor model micro attribution results will look very similar to a returns-based style analysis and can be determined the same way (e.g., the returns to the portfolio are regressed against the returns to several different indices to determine the factor exposures).

The primary difference between them is the use of other fundamental factors (e.g., management’s use of leverage, market timing, sector rotation, the size of the firm, and so on) that would not ordinarily be used in a returns-based style analysis.

17. The Treynor measure uses only systematic risk (i.e., beta) in the denominator, so lowering the unsystematic risk of the asset in question will have no affect on the Treynor measure. The Sharpe ratio uses standard deviation, which includes both unsystematic and systematic risk. Lowering unsystematic risk, therefore, will lower the denominator and increase the Sharpe ratio.

18. The Sharpe measure uses the standard deviation of the returns in the denominator, and the information ratio uses the standard deviation of the excess return. Although they measure standard deviation differently, they both incorporate a standard deviation measure.
19. C A quality control chart combines the average value added and its standard deviation to generate a confidence interval that can be used to determine statistical significance. The upper and lower confidence interval bounds are indicated with lines on the quality control chart. When the value added is above the upper bound of the confidence interval (i.e., outside the confidence interval), it means that we can reject the null hypothesis that the value was achieved by chance. We can conclude that the manager added value to the portfolio with her trading strategies.
The following is a review of the Performance Evaluation principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

**GLOBAL PERFORMANCE EVALUATION**

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**EXAM FOCUS**

Understand and be able to perform a global performance attribution. You should also understand risk measurement in a global context and the concept of risk budgeting. The likelihood of performance evaluation being tested on the exam is high.

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**CURRENCY MOVEMENTS AND PORTFOLIO RETURNS**

**LOS 42.a:** Evaluate the effect of currency movements on the portfolio rate of return, calculated in the investor’s base currency.

*Professor’s Note: Throughout the Level III curriculum, the currency in which the investment is denominated is referred to as the local currency and the investor’s home currency as the domestic currency. In this LOS, the investor’s currency is referred to as the base currency. Accordingly, throughout this review, I refer to the investor’s currency as the domestic and/or base currency and the currency of the foreign investment as the local or foreign currency.*

A foreign currency-denominated investment represents an investment in the underlying asset and the local currency. Therefore, the return on a foreign investment must be converted to return in the domestic (base) currency. A high return in a foreign currency asset can be more than offset by a decline in the value of the currency.

For a purely domestic portfolio, the return on the portfolio can be broken down into capital gains (price change) and cash flow yield (dividends or coupons):

\[ R_j = CG_j + CF_j \]

where:

- \( R_j \) = return on asset \( j \)
- \( CG_j \) = capital gain/loss on asset \( j \)
- \( CF_j \) = cash flow yield (dividend or coupon yield) for asset \( j \)
For a global portfolio, the equation must be modified to capture the effects of currency value fluctuations:

\[ R_{j,d} = CG_j + CF_j + C_j \]

where:
- \( R_{j,d} \) = return on asset \( j \) in the domestic (base) currency
- \( C_j \) = return due to currency movements = \( e_j(1 + CG_j + CF_j) \)
- \( e_j \) = percentage change in the value of currency \( j \)

Professor's Note: The percentage change in the value of currency \( j \), denoted \( e_j \), is multiplied by \((1 + CG_j + CF_j)\) because the change in the value of the currency must be reflected in the original principal invested, the capital gain, and the cash flow.

Example: Global portfolio currency component

XYZ Fund invested $100 million in the UK-based FT index on January 1, 2005. By December 31, 2005, the index had appreciated by 10%, and the pound had depreciated 3% against the U.S. dollar. Assuming no dividend yield, what is the return of the fund in U.S. dollars?

Answer:

Note: The domestic (base) currency is the U.S. dollar, and the local (foreign) currency is the British pound.

\[ CG_j = 0.10; \quad CF_j = 0; \quad e_j = -0.03 \]

\[ C_j = e_j(1 + CG_j + CF_j) = -0.03(1 + 0.10 + 0) = -0.033 \]

\[ R_{j,d} = CG_j + CF_j + C_j = 0.10 + 0 - 0.033 = 0.067 \text{ or } 6.70\% \]

Alternatively, the return in USD can be found by compounding the local capital gains return, \( CG_j \), by the currency effect, \( e_j \):

\[ R_{j,d} = (1 + CG_j)(1 + e_j) - 1 = (1 + 0.10)(1 - 0.03) - 1 = 0.067 \]

In the local (foreign) currency, the fund earned a return of 10%, but due to currency depreciation, the fund only earned 6.70% in the domestic (base) currency.

Professor's Note: Because the investment earned 10.0% and the currency depreciated 3.0%, you might be tempted to say the domestic return is 7.0%. However, the currency effect is –3.3%, not –3.0%. This is due to depreciation of the initial investment and the pound-denominated return, both of which must be converted back into dollars. That is, the initial investment depreciated 3% and the return (10%) also depreciated 3%, which contributed \((0.03)(0.10) = 0.003 = 0.3\%\) to the overall decline in value upon conversion to U.S. dollars.
For the Exam: The LOS asks you to evaluate the effect of currency movements on the portfolio return. Thus, be prepared to calculate the $C_j$ terms when provided with the other input data. In other words, given the total return in the local currency (or its components) and the change in the currency, be able to perform the middle calculation in the example.

GLOBAL RETURN DECOMPOSITION AND ATTRIBUTION

**LOS 42.b:** Explain how portfolio return can be decomposed into yield, capital gains in local currency, and currency contribution.

*CFA® Program Curriculum, Volume 6, page 200*

**LOS 42.c:** Explain the purpose of global performance attribution and calculate the contributions to portfolio performance from market allocation, currency allocation, and security selection.

*CFA® Program Curriculum, Volume 6, page 202*

For the Exam: LOS 42.c asks you specifically to calculate the three components of global portfolio performance attribution. For the exam, I recommend that you memorize the formulas and be able to calculate each when provided with necessary inputs.

We start our global performance attribution by decomposing the domestic return on the global portfolio into the local capital gain, local income yield, and currency effect for all the markets in the portfolio. Note that the capital gains and income components are calculated in the local (foreign) currencies because changes in values of the currencies are captured by the last term: (Note: All returns throughout this discussion are expressed as percentages.)

$$R_{p,d} = \sum_j w_{j,p} CG_{j,l} + \sum_j w_{j,p} I_{j,l} + \sum_j w_{j,p} C_j$$

where:
- $R_{p,d}$ = domestic return on the portfolio
- $w_{j,p}$ = weight of market $j$ in the portfolio
- $CG_{j,l}$ = capital gain for market $j$ in the local currency
- $I_{j,l}$ = income yield for market $j$ in the local currency
- $C_j$ = currency effect for market $j$

The capital gains component is the total percentage change in value for the market (i.e., the change in the value of the investment in the market) as measured in the local (foreign) currency.
The income yield is the percentage cash flow (e.g., dividends, coupons), also measured in the local currency.

The currency effect for each market is the difference between the local and domestic returns caused by translating back into the domestic currency. For each market $j$, the currency effect is calculated as the percentage change in the local currency relative to the domestic currency ($e_j$) multiplied by the total ending value of the market in its local currency. The total value of the market in its local currency includes the original principal invested plus any capital gains/losses and cash flows, so the currency effect for market $j$ is calculated as:

$$C_j = e_j \left(1 + CG_j + I_j \right)$$

where:
- $C_j$ = currency effect for market $j$
- $e_j$ = percentage change in the foreign currency $j$ relative to the domestic currency
- $CG_j$ = capital gain for market $j$ in the local currency
- $I_j$ = income yield for market $j$ in the local currency

### Market Return and Security Selection

To this point, we have worked with the basic expression for defining the return on any international investment. It breaks down the portfolio return into its basic components: capital gains and cash flows. By simply measuring capital gains and cash flows, however, it gives us nothing that helps explain how the values (e.g., $CG$) were generated. To determine whether the manager was able to effectively allocate the portfolio among and within the markets, we start by breaking out the market return and security selection components.

The market return component for each market is calculated as if the manager had invested in the index for each market rather than individual securities. By calculating the total market return in local currencies (i.e., the local index returns), we separate out the portion of the total portfolio return attributable to the returns of the markets.

Defining $R_{j,l}$ as the local return for market $j$, the total market return for the portfolio in local currencies is calculated as:

$$R_{p,l} = \sum w_{j,p} R_{j,l}$$

where:
- $R_{p,l}$ = total return for the portfolio in local currencies
- $w_{j,p}$ = weight of market $j$ in the portfolio
- $R_{j,l}$ = local return on market index $j$
Next, we want to determine the portion of the total portfolio return attributable to the manager's ability to select superior (i.e., outperforming) securities to represent each market. This is accomplished for each market by measuring the return for the market in the portfolio and subtracting the index return for the market. To determine the overall portfolio security selection effect, we sum all the individual market security selection effects. In those markets where the manager was (not) able to identify outperformers, the security selection effect is positive (zero or negative):

\[ R_{secSel,p} = \sum_j w_{j,p} R_{secSel,j} \]

where:
- \( R_{secSel,p} \) = portion of the total portfolio return attributable to security selection
- \( w_{j,p} \) = weight of market \( j \) in the portfolio
- \( R_{secSel,j} \) = return attributable to security selection in market \( j \)
- \( = R_{j,l} - R_{j,b} \)
- = local return for market \( j \) in the portfolio minus the local return for market \( j \) in the benchmark

(This is the security selection component requested in the same exam question, which shows up again in the following.)

The security selection effect compares the return for each market in the portfolio to the return for the same market in the index (in local currencies). By doing this we implicitly assume that the systematic risk of the market in the portfolio is the same as that of the market index. That is, we assume the difference in returns is due solely to security selection rather than different levels of systematic risk.

Let's return to our original equation for determining the domestic return to a global portfolio. We originally defined the domestic return as:

\[ R_{p,d} = \sum_j w_j CG_{j,l} + \sum_j w_j I_{j,l} + \sum_j w_j C_j \]

Now that we have broken down the capital gains component of the portfolio (i.e., \( CG_{j,l} \)) into market return and security selection, we can redefine the equation to include those components:

\[ R_{p,d} = \sum_j w_j CG_{j,l} + \sum_j w_j I_{j,l} + \sum_j w_j C_j \]

\[ = \sum_j w_j R_{j,l} + \sum_j w_j R_{secSel,j} + \sum_j w_j I_{j,l} + \sum_j w_j C_j \]
When we further define the security selection contribution, we arrive at the global return decomposition tested on the previous exam:

$$R_{p,d} = \sum_j w_j R_{j,l} + \sum_j w_j R_{\text{SecSel},j} + \sum_j w_j I_{j,l} + \sum_j w_j C_j$$

$$= \sum_j w_j R_{j,l} + \sum_j w_j (R_{j,p,l} - R_{j,b,l}) + \sum_j w_j I_{j,l} + \sum_j w_j C_j$$

where:

$$\sum_j w_j R_{j,l} = \text{portfolio market return in the local currencies}$$

$$\sum_j w_j (R_{j,p,l} - R_{j,b,l}) = \text{portfolio security selection effect in the local currencies}$$

$$\sum_j w_j I_{j,l} = \text{portfolio yield in local currencies}$$

$$\sum_j w_j C_j = \text{portfolio currency effect}$$

For the Exam: To this point, the only comparison we have made is between the market returns in the portfolio and the benchmark to determine whether the manager was successful in selecting superior securities. We decomposed the total portfolio domestic return into its components: market return, security selection, yield, and currency effect. In other words, we did not compare the manager’s performance against a global benchmark. To determine on the exam whether you are being asked to perform a return decomposition or attribution, look for data on a benchmark. If no benchmark data are provided, you are being asked to perform a return decomposition as we have done to this point. If you are provided with benchmark data, you will probably have to perform the attribution analysis that follows.

Allocation Effects

Thus far, we have only compared the manager’s performance to a passive investment in market indices. We assumed the manager selected various markets and then either invested passively in market indices or selected individual securities to represent the markets. We took the manager’s selection of markets as given and broke down the portfolio return. The analysis did not indicate the manager’s ability to select superior markets, and we did not measure the manager’s performance relative to a global benchmark.

We decomposed the manager’s total global return into a capital gains component, a yield component, and a currency effect. We then further decomposed the capital gains component into market return and security selection to determine whether the manager was successful in selecting superior securities to represent the markets or should have simply invested passively in the market indices. In doing so, you will notice that we considered only the weights of the markets in the manager’s portfolio (i.e., the manager’s absolute asset allocation).
Instead of selecting global markets and then deciding whether to passively invest in indices or actively invest by selecting securities, we could have assumed the manager's performance will be measured against a global index. In that case, the manager has the choice of passively investing in the global index (i.e., construct and weight each market in the portfolio as it is in the global index) or attempting to outperform the index by altering the portfolio allocation relative to the index. The manager now has the opportunity to weight markets differently from the index as well as select outperforming securities within each market. By studying the manager's relative asset allocation, we introduce allocation effects.

To analyze (i.e., attribute) the global portfolio manager's portfolio return, we will break it up into its component returns: the domestic return on the global index (i.e., the benchmark), the return to market allocation, the security selection component, the return to currency allocation, and the yield component.

**Benchmark domestic return.** The manager should be able to at least replicate the domestic (i.e., translated) return on the benchmark. (This is the return on the global index in the manager’s currency.) We will describe the benchmark domestic return as:

\[
R_{b,d} = \sum_j \left( w_{j,b} \right) \left( R_{j,b,d} \right)
\]

where:
- \( R_{b,d} \) = total domestic (translated) return on the benchmark
- \( w_{j,b} \) = weight of market \( j \) in the benchmark
- \( R_{j,b,d} \) = return on market \( j \) in the benchmark in the domestic currency

To passively index the portfolio to a global benchmark, the manager would weight each market and security in the portfolio as it is in the index. The domestic return on the global index accounts for translating the foreign currencies back into the manager’s domestic currency. Thus, the first component of the global portfolio manager’s domestic return is that attributable to the global index. This, by the way, should serve as the minimum return the manager should earn on the global investment. If the global portfolio manager cannot generate at least the return on a passive investment in the global index, he should not attempt active management through market/currency allocation or security selection.

**Market allocation contribution.** In an attempt to generate extra return relative to the benchmark, the manager can choose to alter the weights of the global markets relative to their weights in the index. Specifically, the manager seeks to overweight outperforming markets and underweight underperformers. We indicate the difference in weights as \( w_{j,p} - w_{j,b} \), the weight of the market in the portfolio minus the weight of the market in the benchmark.

To calculate the manager’s total market allocation contribution, we multiply the difference in weights for each market by the local return for the market and then sum across all markets. If the manager underweights (overweights) a market, the sign of the
first term is negative (positive). Notice that the benchmark returns used in the market allocation contribution are measured in the local currency:

\[
\text{market allocation contribution} = \sum_j (w_{j,p} - w_{j,b}) R_{j,b,l}
\]

where:
- \(w_{j,p}\) = weight of market \(j\) in the portfolio
- \(w_{j,b}\) = weight of market \(j\) in the benchmark
- \((w_{j,p} - w_{j,b})\) = amount by which the manager chose to over- or underweight market \(j\) relative to the benchmark
- \(R_{j,b,l}\) = return for market \(j\) in the benchmark in its local currency

For the Exam: On the exam, you might see the words market and sector used interchangeably in a global framework. For example, the euro market could be referred to as the euro sector. In a domestic framework, sectors are usually defined by industry, such as transportation sector, financial sector, et cetera.

Currency allocation contribution. Briefly defined, the currency contribution for any global investment is the percentage increase or decrease in the value of the investment due solely to translating it back into the investor’s domestic currency. It is the percentage change in the return due only to relative currency movements.

Measurement of the currency contribution for an individual investment is quite straightforward; you subtract the return for the investment in the local currency from the return for the investment in the domestic currency. For example, if the local return for the investment is 10% and the domestic (translated) return is 9%, the currency contribution is -1%. The manager’s obvious goal is allocating more heavily to currencies expected to appreciate against the domestic currency, so that the currency effect is positive.

To measure the manager’s currency allocation contribution, we compare the local and domestic returns for each market in the global portfolio and the benchmark. We
then sum these individual market currency contributions to arrive at the effect of the manager's overall currency allocation on the portfolio return:

\[
\text{currency allocation contribution} = \sum_j (w_{j,p} C_{j,p} - w_{j,b} C_{j,b})
\]

where:
- \( w_{j,p} \) = weight of market \( j \) in the portfolio
- \( w_{j,b} \) = weight of market \( j \) in the benchmark
- \( C_{j,p} \) = currency effect for market \( j \) in the portfolio
  \[
  = \left( R_{j,p,d} - R_{j,p,l} \right)
  \]
  = domestic return for market \( j \) in the portfolio minus the local return for market \( j \) in the portfolio
- \( C_{j,b} \) = currency effect for market \( j \) in the benchmark
  \[
  = \left( R_{j,b,d} - R_{j,b,l} \right)
  \]
  = domestic return for market \( j \) in the benchmark minus the local return for market \( j \) in the benchmark

For the Exam: Unless specifically told otherwise in the exam question, you can assume each country is a separate market and each has its own currency. Be on the lookout, however, for the situation where different countries use the same currency. In this case, you would probably be given a table containing a list of local and domestic returns by country and the currency utilized in each country.

To determine the weights to use in calculating the currency allocation contribution, you should combine the investments in all countries that use the same currency. For example, assume the euro is one of the currencies in the portfolio, and several countries in the portfolio utilize the euro. You would add the values of the investments in those countries in determining the weights to use in calculating the currency allocation contribution. However, to calculate the market allocation contribution, you will use the returns from the individual countries and their individual weights.

This would be an unusual structure for an exam question, even though it is not beyond the realm of possibility. For example, you are more likely to be given European stocks as a market rather than individual European countries. If you should see an attribution question where countries and currencies are not the same, the key will be reading the question carefully for instructions on how to treat the markets. If no instructions are provided, do what I have suggested here.
Combining these components with the yield and security selection components discussed earlier, we arrive at our final decomposition of the portfolio return when the manager is assessed relative to a global benchmark:

\[ R_p = \text{benchmark domestic return} + \text{market allocation contribution} + \]
\[ \text{currency allocation contribution} + \text{security selection contribution} + \text{yield component} \]

\[ = \sum_j \left( w_{j,b} R_{j,b,d} \right) + \sum_j \left( w_{j,p} - w_{j,b} \right) R_{j,b,l} + \]
\[ \sum_j \left( w_{j,p} C_{j,p} - w_{j,b} C_{j,b} \right) + \sum_j w_{j,p} \left( R_{j,p,l} - R_{j,b,l} \right) + \sum_j w_{j,p} I_{j,l} \]

Professor's Note: The yield and security selection components are calculated as we did earlier when we assumed the manager was not being compared to a benchmark. In that case, we used only portfolio weights.

For the Exam: Here is a brief summary of the components:

Remember the weights:
- For the benchmark domestic return (#1), use benchmark weights only.
- For the two allocation contributions (#2 and #3), which assume comparison to a benchmark, use both portfolio and benchmark weights.
- For the security selection contribution and yield component (#4 and #5), use portfolio weights only.

1. **Benchmark domestic return.** The domestic return the manager could earn by passively investing in a global index. To calculate, multiply the domestic return for the market by its weight in the benchmark and sum across all markets:

   \[ \text{benchmark domestic return} = \sum_j \left( w_{j,b} R_{j,b,d} \right) \]

2. **Market allocation contribution.** The return component generated by the manager weighting markets in the portfolio differently from their weights in the benchmark. To calculate, multiply the market's local return by the difference between the weight for the market in the portfolio and in the benchmark and sum across all markets:

   \[ \text{market allocation contribution} = \sum_j \left( w_{j,p} - w_{j,b} \right) R_{j,b,l} \]
3. **Currency allocation contribution.** The return component generated when the manager overweights currencies expected to outperform and underweights currencies expected to underperform. First, calculate for an individual market by subtracting its weighted currency effect in the benchmark from its weighted currency effect in the portfolio and then sum across all markets. Each currency effect is calculated as the domestic return minus the respective local return:

\[
currency\ \text{allocation\ contribution} = \sum_j \left( w_{j,p} C_{j,p} - w_{j,b} C_{j,b} \right)
\]

4. **Security selection contribution.** The return component generated by the manager's ability to select superior securities to represent markets. To calculate, multiply the weight of the market in the portfolio by the difference between the local returns for the market in the portfolio and in the benchmark and sum across all markets:

\[
\text{security\ selection\ contribution} = \sum_j w_{j,p} \left( R_{j,p,l} - R_{j,b,l} \right)
\]

5. **Yield component.** The cash flow component of the portfolio return. To calculate, multiply the percentage yield for the market by its weight in the portfolio and sum across all markets:

\[
\text{yield\ component} = \sum_j w_{j,p} I_{j,l}
\]

**Example: Return decomposition**

The following figure shows the performance of BC Fund, a U.S.-based fund, and its benchmark for calendar year 2010. BC invested only in Canadian and Mexican stocks. During 2010, the Canadian dollar and the Mexican peso depreciated by 2% and 10%, respectively, against the U.S. dollar. Assume that no dividends were paid. **Determine** the benchmark domestic return in addition to the fund's currency allocation, market allocation, security selection, and yield component effects.

**Performance of the BC Fund and Its Benchmark**

<table>
<thead>
<tr>
<th>Sector</th>
<th>BC Weight</th>
<th>Benchmark Weight</th>
<th>BC Local Return</th>
<th>Benchmark Local Return</th>
<th>BC U.S. $ Return</th>
<th>Benchmark U.S. $ Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>50%</td>
<td>80%</td>
<td>13.50%</td>
<td>15.00%</td>
<td>11.23%</td>
<td>12.70%</td>
</tr>
<tr>
<td>Mexico</td>
<td>50%</td>
<td>20%</td>
<td>22.00%</td>
<td>18.00%</td>
<td>9.80%</td>
<td>6.20%</td>
</tr>
</tbody>
</table>
Answer:

The following indicates the global performance attribution:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark domestic return</td>
<td>11.40%</td>
</tr>
<tr>
<td>Currency allocation</td>
<td>-3.03%</td>
</tr>
<tr>
<td>Market allocation</td>
<td>0.90%</td>
</tr>
<tr>
<td>Security allocation</td>
<td>1.25%</td>
</tr>
<tr>
<td>Yield return</td>
<td>0.00%</td>
</tr>
<tr>
<td>Portfolio return</td>
<td>10.52%</td>
</tr>
</tbody>
</table>

- The portfolio underperformed the benchmark (in base currency) by $10.52 - 11.40 = -0.88\%$.
- $-3.03\%$ is attributable to currency allocation. This is because the portfolio manager overweighted the underperforming currency (peso) as compared to the benchmark.
- $0.90\%$ is attributable to market allocation. This is because the manager overweighted the better-performing market in local currency (Mexico).
- $1.25\%$ is due to security selection, mainly due to superior return in Mexico (as compared to the benchmark).
- Because no dividends were paid, the yield is zero.

The following information summarizes the calculations.

**Benchmark Domestic Return**

The benchmark domestic return is the weight of each sector in the benchmark multiplied by the return of that sector in the domestic currency: $(0.8)(12.70\%) + (0.2)(6.20\%) = 11.4\%$.

**Portfolio Domestic Return**

The portfolio domestic return is the weight of each sector in the portfolio multiplied by the return of that sector in the domestic currency: $(0.5)(11.23\%) + (0.5)(9.8\%) = 10.52\%$.

**Excess Return Attribution for the Currency Allocation, Market Allocation, and Security Selection Effects**

<table>
<thead>
<tr>
<th>Sector</th>
<th>$C_{j,p}$</th>
<th>$C_{j,b}$</th>
<th>Currency Effect</th>
<th>Market Allocation</th>
<th>Security Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>-2.27%</td>
<td>-2.30%</td>
<td>0.71%</td>
<td>-4.50%</td>
<td>-0.75%</td>
</tr>
<tr>
<td>Mexico</td>
<td>-12.20%</td>
<td>-11.80%</td>
<td>-3.74%</td>
<td>5.40%</td>
<td>2.00%</td>
</tr>
<tr>
<td>Total</td>
<td>-3.03%</td>
<td>0.90%</td>
<td>1.25%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Currency Allocation Effect

Column 2 shows the currency effect for each sector in the portfolio (i.e., portfolio return\text{domestic} - portfolio return\text{local}):\[ C_{j,p} \text{ for Canada} = (R_{j,p,d} - R_{j,p,l}) = 11.23\% - 13.50\% = -2.27\% \]
\[ C_{j,p} \text{ for Mexico} = (R_{j,p,d} - R_{j,p,l}) = 9.80\% - 22.00\% = -12.20\% \]

Column 3 shows the currency effect for each sector in the benchmark (i.e., benchmark return\text{domestic} - benchmark return\text{local}):\[ C_{j,b} \text{ for Canada} = (R_{j,b,d} - R_{j,b,l}) = 12.70\% - 15.00\% = -2.30\% \]
\[ C_{j,b} \text{ for Mexico} = (R_{j,b,d} - R_{j,b,l}) = 6.20\% - 18.00\% = -11.80\% \]

Column 4 shows the currency allocation effect of each sector in the portfolio and benchmark:

\text{currency allocation effect for Canada} = (w_{j,p} C_{j,p} - w_{j,b} C_{j,b})
= 0.5(-2.27\%) - 0.8(-2.30\%) = 0.71\%

\text{currency allocation effect for Mexico} = (w_{j,p} C_{j,p} - w_{j,b} C_{j,b})
= 0.5(-12.20\%) - 0.2(-11.80\%)
= -3.74\%

\text{total currency allocation effect} = 0.71\% = (-3.74\%) = -3.03\%

Market Allocation Effect

Column 5 shows the market allocation effect (difference in weights \times local return):

\text{market allocation effect for Canada} = (w_{j,p} - w_{j,b})R_{j,b,l}
= (0.5 - 0.8)(15\%) = -4.50\%

\text{market allocation effect for Mexico} = (w_{j,p} - w_{j,b})R_{j,b,l}
= (0.5 - 0.2)(18\%) = 5.40\%

\text{total market allocation effect} = -4.50\% + 5.40\% = +0.90\%
Security Allocation Effect

Column 6 shows the security allocation (selection) effect (portfolio weight x difference in returns):

security selection for Canada = \( w_{j,p} (R_{j,p,t} - R_{j,b,t}) \)
\[ = 0.5(13.50\% - 15.00\%) = -0.75\% \]

security selection for Mexico = \( w_{j,p} (R_{j,p,t} - R_{j,b,t}) \)
\[ = 0.5(22.00\% - 18.00\%) = 2.00\% \]

total security selection effect = \(-0.75\% = 2.00\% = +1.25\%\)

Synopsis

The manager allocated 50% to Canadian stocks and 50% to Mexican stocks, while the benchmark weights were 80% to Canada and 20% to Mexico. Compared to the benchmark, the manager decided to increase Mexico’s weight and decrease Canada’s weight in anticipation of better performance by Mexican stocks as compared to Canadian stocks.

The market (sector) allocation effect is positive, so the manager’s bet was right—but only in terms of local returns. After taking the currency effects into account, the Canadian market outperformed the Mexican market.

Selection effect is positive for Mexico and negative for Canada. If this is a normal pattern over a number of years, we may be able to conclude that the manager has superior stock selection skills in the Mexican market but not in the Canadian market.

Active and Passive Currency Management

LOS 42.d: Explain active and passive currency management, relative to a global benchmark, and formulate appropriate strategies for hedging currency exposure.

Passive currency management has been defined in two ways, which are both flawed:

1. Fully hedging all currency exposures. This could be done with derivatives.

2. Allowing currency exposures to be determined by investment decisions. If the manager has no opinions on currency, the manager can select the best markets and investments, allowing those decisions to determine currency exposure.
The flaw in both of these approaches is that they do not consider the exposure of the manager’s benchmark to currency. Some benchmarks are constructed with currency always hedged, and others are not. Any deviation from the currency exposure of the benchmark is an **active currency management decision**. Passive currency management would require matching the currency exposures of the benchmark.

Another situation arises if a currency overlay manager is employed. In this case, the asset manager is not responsible for currency exposures and deviations from the benchmark. The asset manager should simply select the desired markets and assets. The overlay manager is then responsible for all currency decisions.

*Professor’s Note:* The CFA text includes a discussion of adjusting currency exposure by buying or selling currency forward. Because that is covered extensively in greater depth elsewhere, we are not repeating it here.

## Multi-Period Performance Attribution

**LOS 42.e:** Explain the difficulties in calculating a multi-period performance attribution and discuss various solutions.

To measure the return to active management, the difference in portfolio and benchmark returns is allocated amongst the various attributes (e.g., security selection, market allocation). For any single time period, the process is straightforward because any difference in returns can be attributed to active management. In fact, even the difference in total multi-period returns can be attributed to active management. The problem is that the multi-period *attribution* cannot be determined directly from the single-period attributions, or vice versa.

To see this, assume portfolio returns of 10% and 15% and benchmark returns of 9% and 11% over two successive time periods. The individual 1-period attributions to active management are 1% (10% − 9%) in the first period and 4% (15% − 11%) in the second period. This would appear to add to an overall return to active management of 5%. However, if we compare the 2-period returns for the benchmark and portfolio, we arrive at a different conclusion.

The 2-period return for the portfolio is 26.5% (= 1.10 × 1.15 − 1). For the same two periods, the benchmark return is 21% (1.09 × 1.11 − 1 = 20.99). The difference (5.5%) can be attributed to active management over the two periods, yet the simple sum of the individual 1-period active returns is 5%, and compounding them yields only 5.04% (1.01 × 1.04 − 1 = 0.0504).

The complication in measuring multiple-period active returns arises from the effects of changing values. Measuring the second period active return as the difference in portfolio
and benchmark returns for that period (15% – 11% = 4%) misses two important value considerations:

1. With no active management in the second period, the active return in the first period will compound at the benchmark return in the second period. Even if the manager pursues a pure indexing strategy in the second period, the value generated through active management in the first period should earn the benchmark return in the second period. This is value that would not have been realized had the manager not earned the active return in the first period.

2. The value of the portfolio at the end of the first period (the beginning value plus the return earned in the first period) will impact the measured active return in the second period. This can be seen by assuming the portfolio and benchmark values are equal at the beginning of the first period. If the portfolio active return is positive for the first period, the sizes of the benchmark and portfolio are different at the beginning of the second period. To separate out the increase in value over the second period, we must consider the value of the portfolio at the end of the first period.

To measure the overall return to active management, we use the following formula:

$$R_{A,2} = R_{a,1} (1 + R_{b,2}) + R_{a,2} (1 + R_{p,1})$$

where:

- $R_{A,2}$ = 2-period active return
- $R_{a,i}$ = active return in period $i$; $i = 1$ or 2
- $R_{b,2}$ = benchmark return in period 2
- $R_{p,1}$ = portfolio return in period 1

The first term in the equation, $R_{a,1} (1 + R_{b,2})$, is the active return on the portfolio in the first period multiplied by the return on the benchmark in the second period. It shows the value added by the manager’s actions in the first period. The active return in the first period will compound at least at the benchmark rate of return over the second period, even if the manager pursues a pure indexing strategy in that period.

The second term, $R_{a,2} (1 + R_{p,1})$, takes into account the manager’s active decisions in the second period. It is measured as the active return in the second period multiplied by the total return on the portfolio in the first period.

For our example, the 2-period return to active management is calculated as:

$$R_{A,2} = R_{a,1} (1 + R_{b,2}) + R_{a,2} (1 + R_{p,1})$$

$$= 1%(1.11) + 4%(1.10) = 1.1% + 4.4% = 5.5% = (26.5% - 21\%)$$

There are no multi-period considerations when we measure the return to active management for the first period (10% – 9% = 1%). Because we know the total 2-period return to active management is 5.5%, the true return to active management for the second period must be 4.5%.

Thus far we have made one assumption: the difference in portfolio and benchmark returns is due to active management. This is equivalent to assuming the active return is
generated by a single attribute or by a combination of attributes (e.g., security selection, market allocation, currency allocation) without attempting to value them individually. The analysis can be extended to separate out the effects of the individual attributes.

**Multi-Attribute Analysis**

The single-period contributions for each attribute are calculated as we saw in micro attribution analysis or global attribution analysis. Just as when we considered only a single attribute, however, adding or compounding the 1-period attribute contributions only approximates the overall contribution to each attribute for multiple periods.

Let’s assume we want to measure the security selection effect and the market allocation effect for multiple periods. You will recall that the security selection effect measures the manager’s ability to select superior securities to represent each sector (market) in the portfolio. It is calculated as the weight of each sector in the portfolio multiplied by the return for the sector in the portfolio minus the return for the sector in the benchmark, summed across all sectors:

\[
SSE = \sum_{i=1}^{n} w_{p,i}(R_{p,i} - R_{b,i})
\]

where:
- **SSE** = security selection effect
- **w_{p,i}** = weight of sector *i* in the portfolio
- **R_{p,i} - R_{b,i}** = portfolio return for sector *i* less benchmark return for sector *i*

The market allocation effect measures the manager’s ability to overweight outperforming sectors (markets) and underweight underperforming sectors. It is calculated as the difference between the weights of the sector in the portfolio and the benchmark multiplied by the return for the sector in the benchmark less the benchmark return, summed across all sectors: (Note: See following For the Exam.)

\[
MAE = \sum_{i=1}^{n} (w_{p,i} - w_{b,i})(R_{b,i} - R_{b})
\]

where:
- **MAE** = market allocation effect
- **w_{p,i} - w_{b,i}** = weight of sector *i* in the portfolio less its weight in the benchmark
- **R_{b,i} - R_{b}** = return for sector *i* in the benchmark less the benchmark return
For the Exam: You might have noticed that the market allocation effect as calculated in the 2012 Level III curriculum, Volume 6, page 224, is actually the pure sector allocation effect, as measured in micro attribution analysis on page 162 of Volume 6. When questioned about this, a CFA Institute representative responded that the two formulas measure the same thing and they yield the same answer. Actually, they yield the same total market allocation effect but different individual market allocation effects.

Using the market allocation formula on page 213 of Volume 6 and the weights and returns from the example on page 224 of Volume 6, the individual effects are 2% for Europe and 0% for Japan for a total of 2%:

\[
\begin{align*}
MAE_{\text{Europe}} &= (w_{p,\text{Europe}} - w_{b,\text{Europe}}) (R_{\text{Europe}}) \\
&= (0.60 - 0.50) \times 0.20 = 0.02 \\
MAE_{\text{Japan}} &= (w_{p,\text{Japan}} - w_{b,\text{Japan}}) (R_{\text{Japan}}) \\
&= (0.40 - 0.50) \times 0.00 = 0.00
\end{align*}
\]

The example on page 224 uses the pure sector allocation formula from page 162 to measure the market allocation effects, yielding 1% for Europe and 1% for Japan for a total of 2%. Note that in that example, the benchmark return \( (R_b) \) is the average of the European and Japanese market returns of 20% and 0%, respectively:

\[
\begin{align*}
SAE_{\text{Europe}} &= (w_{p,\text{Europe}} - w_{b,\text{Europe}}) (R_{\text{Europe}} - R_b) \\
&= (0.60 - 0.50) (0.20 - 0.10) = 0.01 \\
SAE_{\text{Japan}} &= (w_{p,\text{Japan}} - w_{b,\text{Japan}}) (R_{\text{Japan}} - R_b) \\
&= (0.40 - 0.50) (0.00 - 0.10) = 0.01
\end{align*}
\]

Thus, although the total market allocation effects are the same, the individual market allocation effects are different for the two formulas. As the LOS does not require calculations, however, this contradiction can probably be ignored for the exam.

As demonstrated previously with a single attribute, determining the multi-period attribute contributions is not a simple matter of adding or compounding their contributions for each period. Similar to our single attribute multi-period example, there are compounding and value effects that must be considered for each attribute when multiple periods are considered. Regardless of the number of attributes being measured or the number of periods, however, the total return to active management remains the final difference in the portfolio and benchmark returns.

In addition to adding or compounding the individual period contributions for each attribute, another possible and also incorrect method is maintaining the attributes’ proportional contributions. For example, if security selection contributes 75% of the active return in period 1 and market allocation 25%, we assume those contributions are the same in period 2. This method is not a recommended method either because it implicitly assumes consistency in the manager’s performance from period to period.
To more accurately assess the contribution of each factor, we must apply the same basic framework we used with a single attribute, namely:

1. Each attribute's contribution in the first period must be compounded at the benchmark rate of return over the second period.

2. Each attribute's contribution in the second period must be compounded with the portfolio return from the first period.

Let's return to the original example, but assume two attributes, security selection and market allocation. The portfolio returns are 10% and 15% and the benchmark returns are 9% and 11% for the same two periods. We will further assume we have already broken down the 1% active return in the first period (10% - 9% = 1%) into 0.70% to security selection and 0.30% to market allocation. The second period's 4% active return (15% - 11% = 4%) is broken down into 1.80% for security selection and 2.20% to market allocation. Keep in mind that the total active return for the two periods is 5.5% (= 26.5% - 21%).

**The Correct Method**

Remember, calculating the individual attributes' multi-period contributions must follow the same general process we used when we did not separate out the individual attributes:

1. Each attribute's contribution in the first period must be compounded at the benchmark rate of return over the second period.

2. Each attribute's contribution in the second period must be compounded with the portfolio return from the first period.

Start by calculating the 2-period security selection effect using the same formula we used when we did not separate out the individual attributes. First security selection:

\[
R_{SS,2} = R_{ss,1}(1 + R_{b,2}) + R_{ss,2}(1 + R_{p,1})
\]

where:
- \(R_{SS,2}\) = 2-period return to security selection
- \(R_{ss,i}\) = return to security selection in period \(i\)
- \(R_{b,2}\) = benchmark return in period 2
- \(R_{p,1}\) = portfolio return in period 1

\[
R_{SS,2} = 0.70\%(1.11) + 1.80\%(1.10)
\]

\[
= 0.77\% + 1.98\% = 2.75\%
\]
When we calculate the 2-period return to market allocation, we see that the 2-period contributions now add to the true 2-period return to active management of 5.5%:

\[ R_{MA,2} = R_{ma,1}(1 + R_{b,2}) + R_{ma,2}(1 + R_{p,1}) \]
\[ = 0.30\% (1.11) + 2.20\% (1.10) \]
\[ = 0.33\% + 2.42\% = 2.75\% \]

\[ R_{\text{active management},2} = R_{SS,2} + R_{MA,2} = 2.75\% + 2.75\% = 5.5\% \]

Several flawed methods are unfortunately used as well. The flawed methods include adding the individual attribute contributions, compounding the individual attribute contributions, and maintaining the same proportional contributions. These three incorrect methods produce the following results:

1. Adding individual attribute contributions:
   a. 2-period security selection = 0.70\% + 1.80\% = 2.50\%
   b. 2-period market allocation = 0.30\% + 2.20\% = 2.50\%
   c. Total 2-period return to active management:
      \[ 2.50\% + 2.50\% = 5.00\% \]
      \[ \approx 5.50\% \]

2. Compounding individual attribute contributions:
   a. 2-period security selection = (1.0070)(1.018) - 1 = 2.51\%
   b. 2-period market allocation = (1.0030)(1.022) - 1 = 2.507\%
   c. Total 2-period return to active management:
      \[ 2.51\% + 2.507\% = 5.017\% \]
      \[ \approx 5.50\% \]

3. Maintaining proportions of individual attribute contributions:
   a. The 2-period security selection effect: three steps:
      i. Determine the proportion of the active return in the first period attributable to security selection: 0.0070 / 0.01 = 70\%
      ii. Using the proportion from the first period, determine the amount of active return in the second period attributable to security selection: 70% of 4% = 2.80\%
      iii. 2-period security selection effect = 0.70\% + 2.80\% = 3.50\%
   b. The 2-period market allocation effect: three steps:
      i. Determine the proportion of the active return in the first period that can be attributed to market allocation: 0.0030 / 0.01 = 30\%
      ii. Using the proportion from the first period, determine the amount of active return in the second period attributable to market allocation: 30% of 4% = 1.20\%
      iii. 2-period market allocation effect = 0.30\% + 1.20\% = 1.50\%
   c. Total 2-period return to active management:
      \[ 3.50\% + 1.50\% = 5\% \]
      \[ \approx 5.50\% \]
For the Exam: The LOS asks you to explain and discuss the difficulties associated with estimating multi-period contributions and various methods for overcoming those difficulties. Therefore, although you can refer to the previous calculations for examples of the difficulties, be sure you know the following when you enter the exam room:

1. The total return to active management over multiple periods is the difference between compounded portfolio and benchmark returns.

2. Returns to individual attributes can be calculated for each individual period using the formulas we have seen for domestic and global attribution analysis.

3. The multiple-period return to active management for an individual attribute cannot be determined by adding the attribute’s contributions in each period.

4. The multiple-period return to active management for an individual attribute cannot be determined by compounding the attribute’s contributions in each period.

5. The multiple-period return to active management for an individual attribute cannot be determined by assuming it stays at the same proportion of the active return in each period.

6. Each attribute’s contribution in the first period must be compounded at the benchmark rate of return over the second period.

7. Each attribute’s contribution in the second period must be compounded with the portfolio return from the first period.

RISK MEASURES

LOS 42.f: Compare and interpret alternative measures of portfolio risk and risk-adjusted portfolio performance.

For the Exam: Note that the LOS asks you to compare and interpret, not calculate, the risk measures, but you should be ready to calculate the information ratio and the Sharpe measure. Also note how these risk measures are virtually identical to those presented in Topic Review 41, so any of the discussions about them in 41 would also be applied in a global context, when all data are presented in either local or domestic terms.
There are two widely used measures of risk in global performance evaluation.

**Standard Deviation**

Standard deviation measures the total or absolute risk of the portfolio. It is not measured relative to a benchmark. It measures the variability of the portfolio's return around its historical mean:

\[
\sigma = \sqrt{\frac{\sum (R_t - \bar{R})^2}{n-1}}
\]

where:
- \(R_t\) = return for period \(t\)
- \(\bar{R}\) = average portfolio return over \(n\) periods

The standard deviation for a period of less than one year can be annualized by multiplying by the square root of the number of subperiods in a year. For example, if the monthly standard deviation is 5%, multiply 5% by the square root of 12 for the annualized standard deviation.

**Tracking Error or Relative Risk**

\[
\text{SR}_t = R_t - R_{b,t} \quad \text{and} \quad \sigma_{SR} = \sqrt{\frac{\sum (\text{SR}_t - \text{SR}_{avg})^2}{n-1}}
\]

where:
- \(\text{SR}_t\) = surplus return (also called alpha or excess return) for period \(t\)
- \(R_t\) = portfolio return for period \(t\)
- \(R_{b,t}\) = benchmark return for period \(t\)
- \(\sigma_{SR}\) = standard deviation of surplus returns (a.k.a. tracking error)
- \(\text{SR}_{avg}\) = average surplus return

Obviously, fund sponsors prefer a positive surplus return. The variability of the surplus return, measured by its standard deviation, is an indication of the ability of the manager to consistently outperform the benchmark. The greater the standard deviation, however, the more variable the surplus return and the lower the sponsor’s confidence in the ability of the manager to be consistent in superior performance.

**Risk-adjusted performance** is typically measured by either the information ratio or the Sharpe ratio.

**Information Ratio**

The information ratio is the ratio of the average surplus return to its standard deviation (which is the tracking error just discussed):

\[
\text{information ratio} = \frac{\text{SR}}{\sigma_{SR}}
\]
It indicates the amount of risk undertaken (denominator) to achieve a certain level of return above the benchmark (numerator). An active manager makes specific cognitive bets to achieve a positive surplus return. The variability in the surplus return is a measure of the risk taken to achieve the surplus. The ratio computes the surplus return relative to the risk taken. A higher information ratio indicates better performance.

**Sharpe Ratio**

The Sharpe ratio compares the return above the risk-free rate (i.e., the risk premium) that the fund earned and the corresponding risk that the fund took (as measured by its standard deviation). A higher Sharpe ratio indicates superior performance.

\[
\text{Sharpe ratio} = \frac{\bar{R}_p - \bar{R}_F}{\sigma_p}
\]

where:
- \(\bar{R}_p\) = average return to the fund over the measurement period
- \(\bar{R}_F\) = average risk-free rate over the measurement period
- \(\sigma_p\) = standard deviation of the portfolio returns over the measurement period

In a global setting, it is appropriate to examine the Sharpe ratio of an investor’s global portfolio, but not the Sharpe ratio of the investor’s foreign assets only. The Sharpe ratio of the foreign assets only will be misleading because when the foreign assets are combined with the investor’s domestic assets there will be significant diversification effect. The standard deviation of the foreign assets only and resulting Sharpe ratio are misleading.

**RISK ALLOCATION AND BUDGETING IN GLOBAL PERFORMANCE EVALUATION**

**LOS 42.g: Explain the use of risk budgeting in global performance evaluation.**

Performance attribution assesses where managers add value. The client can use these attribution results to allocate funds to various managers. Allocating funds allocates the risk the client is taking by manager and is hence called risk budgeting.

The client can control and budget risk by assigning each manager a tracking error. If the client has less confidence in a manager, the client might assign a small tracking error that will effectively require the manager to manage the assets in ways similar to the manager’s benchmark. If the client has greater confidence in a manager and is willing to accept greater risk, the manager can be assigned a larger tracking error that will allow the manager to make greater deviations from the manager’s benchmark. The manager can do more active management and be less index like.
The total risk (standard deviation) of the portfolio will have two components:

1. **Absolute risk allocation** is driven by the standard deviation of the asset classes used. Choosing less risky asset classes will tend to reduce the riskiness of the client’s portfolio.

2. **Active risk allocation** is driven by the amount of deviation managers are allowed to take from their benchmarks.

Unfortunately, this is much more complicated when correlation is considered (but no further details are covered in the CFA material).

Another complication can be the difficulty of assessing the true return and risk of the managers:

- Past results can reflect skill or luck.
- Returns can be distorted by infrequently traded and priced assets.
- Option-like return patterns with skew distort risk measures such as standard deviation.
- Survivorship bias in both return and risk measures of a manager can arise if the manager only reports results of surviving (not terminated) portfolios under management. These are likely to be the higher return less risky portfolios of the manager.

**GLOBAL AND INTERNATIONAL BENCHMARKS**

**LOS 42.h:** Discuss the characteristics of alternative global and international benchmarks used in performance evaluation.

The performance of a portfolio manager is usually compared to a passive benchmark portfolio. The benchmark selected by the plan sponsors is usually consistent with the plan’s investment objective and may be specifically incorporated into the investment policy statement. Sometimes, existing and widely used indices are used as benchmarks. These may not be suitable for all portfolios, however, so some portfolios have custom benchmarks created specifically for performance evaluation.

Custom benchmarks should identify specific weights assigned to individual countries and/or sectors and specific industries within each country or sector. A currency-hedging component may also be present (if desired by the plan sponsor). The individual country weights may be based on the total market capitalization of the country’s publicly traded securities or another macroeconomic measure such as GDP.

Sometimes, benchmarks bypass country weights and assign weights to industries worldwide, irrespective of the companies’ countries of registration. This has become more popular with multiple listings of shares of large international corporations and expansion of world trade.
Sometimes, benchmarks are established purely on the basis of style, ignoring countries. For example, a small-cap growth manager may be assigned an international small-cap growth index as the benchmark. The key is to have a custom benchmark that accurately reflects the investment objectives of the portfolio.
KEY CONCEPTS

LOS 42.a

For a domestic portfolio, the return on the portfolio can be broken down into capital gains (price change) and cash flow yield (dividends or coupons):

\[ R_j = CG_j + CF_j \]

where:
- \( R_j \) = return on asset \( j \)
- \( CG_j \) = capital gain/loss on asset \( j \)
- \( CF_j \) = cash flow yield (dividend or coupon yield) for asset \( j \)

For a global portfolio, the equation must be modified to capture the effects of currency value fluctuations:

\[ R_{j,d} = CG_j + CF_j + C_j \]

where:
- \( R_{j,d} \) = return on asset \( j \) in the domestic (base) currency
- \( C_j \) = return due to currency movements = \( e_j(1 + CG_j + CF_j) \)
- \( e_j \) = percentage change in the value of currency \( j \)

LOS 42.b

We start our global performance attribution by defining the domestic return on the global portfolio as the sum of local capital gains, local income yields, and currency effects for all the markets in the portfolio:

\[ R_{p,d} = \sum_j w_{jp}CG_{j,l} + \sum_j w_{jp}I_{j,l} + \sum_j w_{jp}C_j \]

where:
- \( R_{p,d} \) = domestic return on the portfolio
- \( w_{jp} \) = weight of market \( j \) in the portfolio
- \( CG_{j,l} \) = capital gain for market \( j \) in the local currency
- \( I_{j,l} \) = income yield for market \( j \) in the local currency
- \( C_j \) = currency effect for market \( j \)

The capital gains component is the total percentage change in the value of the investment in the market as measured in the local (foreign) currency.

The income yield is the percentage cash flow (e.g., dividends, coupons), also measured in the local currency.
The currency effect for each market is the difference between the local and domestic returns caused by translating back into the domestic currency. The currency effect for market \( j \) is calculated as:

\[
C_j = e_j (1 + CG_j + I_j)
\]

where:
- \( C_j \) = currency effect for market \( j \)
- \( e_j \) = percentage change in the foreign currency \( j \) relative to the domestic currency
- \( CG_j \) = capital gain for market \( j \) in the local currency
- \( I_j \) = income yield for market \( j \) in the local currency

**LOS 42.c**

To determine whether the global portfolio manager was able to effectively allocate the portfolio among and within markets, we break out the components assuming the manager’s performance will be measured against a global index.

**Market allocation contribution.** In an attempt to generate extra return relative to the benchmark, the manager can choose to alter the weights of the global markets relative to their weights in the index.

\[
\text{market allocation contribution} = \sum_j \left( w_{j,p} - w_{j,b} \right) R_{j,b,l}
\]

where:
- \( w_{j,p} \) = weight of market \( j \) in the portfolio
- \( w_{j,b} \) = weight of market \( j \) in the benchmark
- \( \left( w_{j,p} - w_{j,b} \right) \) = amount by which the manager chose to over- or underweight market \( j \) relative to the benchmark
- \( R_{j,b,l} \) = return for market \( j \) in the benchmark in its local currency

**Currency allocation contribution** is the percentage increase or decrease in the value of the investment due solely to translating it back into the investor’s domestic currency due only to relative currency movements:

\[
\text{currency allocation contribution} = \sum_j \left( w_{j,p} C_{j,p} - w_{j,b} C_{j,b} \right)
\]

where:
- \( C_{j,p} \) = currency effect for market \( j \) in the portfolio
  \[
  = \left( R_{j,p,d} - R_{j,p,l} \right) = \text{domestic return for market } j \text{ in the portfolio minus the local return for market } j \text{ in the portfolio}
  \]
- \( C_{j,b} \) = currency effect for market \( j \) in the benchmark
  \[
  = \left( R_{j,b,d} - R_{j,b,l} \right) = \text{domestic return for market } j \text{ in the benchmark minus the local return for market } j \text{ in the benchmark}
  \]
Security selection contribution. The return component generated by the manager’s ability to select superior securities to represent markets.

\[ \text{security selection contribution} = \sum_j w_{j,p} (R_{j,p,l} - R_{j,b,l}) \]

**LOS 42.d**

Any strategy that produces currency exposures different from those of the benchmark is an active currency management strategy. Differences can arise through asset selection or through deliberately over- or underweighting the currencies themselves. When currency exposures are managed by a currency overlay manager, the portfolio manager’s performance is assessed net of currency movements.

The derivatives most commonly used for currency hedging are forward and futures contracts. The manager sells the foreign currency forward, in the amount of the invested principal, for the domestic currency. The manager is said to be short the foreign currency and long the domestic currency. To the extent that the value of the investment does not change, the manager has hedged the exposure to the currency.

**LOS 42.e**

- The total return to active management over multiple periods is the difference between compounded portfolio and benchmark returns.
- Returns to individual attributes can be calculated for each individual period using the formulas we have seen for domestic and global attribution analysis.
- The multiple-period return to active management for an individual attribute cannot be determined by adding the attribute’s contributions in each period.
- The multiple-period return to active management for an individual attribute cannot be determined by compounding the attribute’s contributions in each period.
- The multiple-period return to active management for an individual attribute cannot be determined by assuming it stays at the same proportion of the active return in each period.
- Each attribute’s contribution in the first period must be compounded at the benchmark rate of return over the second period.
- Each attribute’s contribution in the second period must be compounded with the portfolio return from the first period.

**LOS 42.f**

There are four generally accepted measures of risk in the context of global performance evaluation: standard deviation, tracking error, information ratio, and Sharpe ratio.
- Standard deviation.

Standard deviation measures the total risk of the portfolio. It is not measured relative to a benchmark. It measures the variability of the portfolio’s return around its historical mean.

\[ \sigma = \sqrt{\frac{\sum (R_t - \bar{R})^2}{n-1}} \]

where:
- \( R_t \) = return for period \( t \)
- \( \bar{R} \) = average portfolio return over \( n \) periods
• Tracking error.

\[ SR_t = R_t - R_{b,t} \text{ and } \sigma_{SR} = \sqrt{\frac{\sum (SR_t - SR_{avg})^2}{n-1}} \]

where:
- \( SR_t \) = surplus return (also called alpha or excess return) for period \( t \)
- \( R_t \) = portfolio return for period \( t \)
- \( R_{b,t} \) = benchmark return for period \( t \)
- \( \sigma_{SR} \) = standard deviation of surplus returns (a.k.a. tracking error)
- \( SR_{avg} \) = average surplus return

• Information ratio.

The information ratio is the ratio of the average surplus return to its standard deviation.

\[ \text{information ratio} = \frac{SR}{\sigma_{SR}} \]

• Sharpe ratio.

A higher Sharpe ratio indicates superior performance.

\[ \text{Sharpe ratio} = \frac{\bar{R}_p - R_F}{\sigma_p} \]

where:
- \( \bar{R}_p \) = average return to the fund over the measurement period
- \( R_F \) = average risk-free rate over the measurement period
- \( \sigma_p \) = standard deviation of the portfolio returns over the measurement period

LOS 42.g

Risk budgeting is the risk counterpart of performance attribution. Just as performance attribution tries to identify sources contributing to the portfolio's performance, risk budgeting is allocating varying amounts of risk among managers.

The overall risk of a portfolio has two major sources:

- **Sector risk**—the risk of individual sectors or countries. It is a measure of risk for a passive benchmark portfolio.
- **Selection risk**—the additional risk undertaken by the manager by deviating from the benchmark. The manager takes this additional risk to produce positive alphas for the sectors in the portfolio.

Typically, the investment policy statement of a portfolio specifies the risk allowances for the manager, effectively limiting the manager's ability to take risk. For example, the plan sponsor might limit the manager to benchmark tracking error of 5%.
LOS 42.h
The performance of a portfolio manager can sometimes be compared to an existing index. This may not be suitable for all portfolios, however, so some portfolio managers use custom benchmarks.

Custom benchmarks should identify specific weights assigned to individual countries and/or sectors and specific industries within each country or sector. A currency-hedging component may also be present. The individual country weights may be based on a macroeconomic measure such as GDP. Sometimes, benchmarks bypass country weights and assign weights to industries worldwide, irrespective of the companies’ countries of registration. Sometimes, benchmarks are established purely on the basis of style, ignoring countries.

The key is to have a custom benchmark that accurately reflects the investment objectives of the portfolio.
CONCEPT CHECKERS

1. Explain the importance of currency effect on a global portfolio return.

2. Mike Gill's international stock portfolio consisted of BMW and Cadbury. Gill, a U.S. investor, bought 1,000 shares of Cadbury at £3.65 and 200 shares of BMW at €33.58 on July 1, 2003. On July 31, 2003, the price of a Cadbury share was quoted at £3.85 and the price of a BMW share was quoted at €34.40. There was no dividend paid on either stock during the month. On July 1, 2003, the foreign exchange rates were $1.58/£ and $1.12/€. On July 31, 2003, the foreign exchange rates were $1.67/£ and $1.17/€. Calculate the portfolio's return in local and base currency and the effect of currency movement on the portfolio.

3. Rick Milo is the manager of portfolio G with the U.S. dollar as the base currency. The portfolio invests in three emerging markets: China (renminbi), Argentina (peso), and Indonesia (rupiah). The benchmark portfolio has 45% weight in China, 20% weight in Argentina, and 35% weight in Indonesia.

During the third quarter of 2003, the renminbi, peso, and rupiah appreciated against the U.S. dollar by 5%, 3%, and 1%, respectively. The following additional information is available about the portfolio and benchmark:

<table>
<thead>
<tr>
<th>Country</th>
<th>Weight</th>
<th>Local Currency Return</th>
<th>U.S. $ Return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Portfolio</td>
<td>Benchmark</td>
<td>Portfolio</td>
</tr>
<tr>
<td>China</td>
<td>50%</td>
<td>45%</td>
<td>6.50%</td>
</tr>
<tr>
<td>Argentina</td>
<td>10%</td>
<td>20%</td>
<td>12.00%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>40%</td>
<td>35%</td>
<td>1.00%</td>
</tr>
</tbody>
</table>
A. **Compute** the base currency return for portfolio G and the benchmark.

B. **Compute** the currency allocation effect for portfolio G.

C. **Compute** the market allocation effect for portfolio G.

D. **Compute** the security selection effect for portfolio G.

E. **Evaluate** the overall portfolio performance and **comment** on the strengths and weaknesses of the manager.
4. **Define** and **explain** three measures of risk in the context of global performance evaluation.

5. **Explain** the need for custom benchmarks for global performance evaluation.

6. A manager of an international portfolio uses country weights that are identical to the country weights in the benchmark. Based upon this information, which of the following statements is **most accurate**?
   
   A. Both the currency allocation effect and the market allocation effect are zero.  
   
   B. Neither the currency allocation effect nor the market allocation effect is zero.  
   
   C. The market allocation effect is zero, but the currency allocation effect may be nonzero.

7. Which of the following **most accurately** represents active currency management?
   
   A. A portfolio closely matches the benchmark, but neither is hedged against currency risk.  
   
   B. A portfolio manager sold a foreign currency forward contract in the amount invested in the foreign asset.  
   
   C. A portfolio that tracks the benchmark is not hedged against currency risk, but the benchmark is hedged.
8. Which of the following statements regarding measuring a manager’s multiple-period active return is least accurate?
   A. The multiple-period return to active management for an individual attribute cannot be determined by adding the attribute’s contributions in each period.
   B. The sum of the attribute contributions in each period (e.g., security selection, market allocation) must be the difference between the compounded portfolio and benchmark multiple-period returns.
   C. The multiple-period return to active management for an individual attribute cannot be determined by compounding the attribute’s contributions in each period.

9. In creating a global benchmark, the weights assigned to the markets of different countries can be based upon:
   A. either the market capitalizations or GDPs of the countries represented in the benchmark.
   B. the market capitalizations but not the GDPs of the countries represented in the benchmark.
   C. the GDPs but not the market capitalizations of the countries represented in the benchmark.

10. If the plan sponsor limits the manager of a portfolio to a benchmark tracking error of 10%, this would most likely be an example of:
    A. risk budgeting, and it would appear in the investment policy statement of a portfolio.
    B. risk budgeting, but it would not appear in the investment policy statement of a portfolio.
    C. performance attribution, and it would appear in the investment policy statement of a portfolio.
1. When a manager invests in a foreign security, he needs to consider not only the return on the investment in local currency, but also the impact of currency fluctuation on the return in the base (domestic) currency. For example, if an investment in a Mexican stock has a return of 15% in local currency and the peso devalues by 3% versus the U.S. dollar, the return in U.S. dollars will be lower by 3.45% \[= 0.03(1 + 0.15)\]. The lower return due to devaluation of the Mexican peso is called the currency effect. Hence, the manager must consider expectations of currency values while making international investment decisions.

2. Columns 1, 2, 3, and 4 show the name of the company, number of shares purchased, and price in local currency at the beginning and end of the month, respectively.

\[
\begin{array}{lcccccccc}
\text{Stock} & \# & \text{1-Jul Price} & \text{31-Jul Price} & \text{Return in Local Currency} & \text{1-Jul $/£,€} & \text{31-Jul $/£,€} & \text{1-Jul Value ($)} & \text{31-Jul Value($)} & \text{1-Jul Weight($)} \\
\hline
\text{BMW} & 200 & 33.58 & 34.40 & 2.44\% & 1.12 & 1.17 & 7,521.92 & 8,049.60 & 57\% \\
\text{Cadbury} & 1,000 & 3.65 & 3.85 & 5.48\% & 1.58 & 1.67 & 5,767.00 & 6,429.50 & 43\% \\
\hline
\text{Total} & & & & & & & 13,288.92 & 14,479.10 & 100\% \\
\end{array}
\]

Column 5 shows the return in local currency. Columns 6 and 7 show the value of the currencies at the beginning and end of the month. Columns 8 and 9 show the value of the portfolio at the beginning and end of the month. The return in local currency was 2.44% for BMW and 5.48% for Cadbury. Assigning weights based on the beginning U.S. dollar investment in the two stocks, we get the portfolio return of 3.75% in local currencies. The portfolio return in U.S. dollars is the appreciation of the portfolio value from 13,288.92 to 14,479.10 or 8.96% [i.e., the portfolio return in base (domestic) currency is 8.96%]. The difference in the two portfolio returns is 5.21% and is attributable to favorable currency movement for the portfolio.

3. The following table summarizes the results:

\[
\begin{array}{lccccccc}
\text{Country} & \text{Weight Portfolio} & \text{Currency Change} & \text{Local Currency Return} & \text{U.S. $ Return} & C_{jp} & C_{jb} & \text{Currency Effect} & \text{Market Allocation} & \text{Security Selection} \\
\hline
\text{China} & 50\% & 45\% & 5.00\% & 6.50\% & 5.50\% & 11.83\% & 10.78\% & 5.33\% & 5.28\% & 0.29\% & 0.28\% & 0.50\% \\
\text{Argentina} & 10\% & 20\% & 3.00\% & 12.00\% & 33.00\% & 15.36\% & 36.99\% & 3.36\% & 3.99\% & -0.46\% & -3.30\% & -2.10\% \\
\text{Indonesia} & 40\% & 35\% & 1.00\% & 1.00\% & -2.50\% & 2.01\% & -1.53\% & 1.01\% & 0.98\% & 0.06\% & -0.13\% & 1.40\% \\
\hline
\text{TOTAL} & 100\% & 100\% & 4.85\% & 8.20\% & 8.25\% & 11.71\% & & -0.11\% & -3.15\% & -0.20\% \\
\end{array}
\]

A. The U.S. dollar return for the portfolio and benchmark is 8.26% and 11.71%, respectively. The portfolio underperformed the benchmark by 3.46%.

Example: For portfolio G, \(R_{pd} = 0.50(11.83\%) + 0.10(15.36\%) + 0.40(2.01\%) = 5.92\% + 1.54\% + 0.80\% = 8.26\%\)
B. The currency allocation effect is -0.11%.

Example: For China, \( (w_{j,p} C_{j,p} - w_{j,b} C_{j,b}) = 0.5(5.33%) - 0.45(5.28%) = 0.289\%

C. The market allocation effect is -3.15%.

Example: For China, \( (w_{j,p} - w_{j,b}) R_{j,b,f} = (0.50 - 0.45)(5.5\%) = 0.275\%

D. The security selection effect is -0.20%.

Example: For China, \( w_{j,p} (R_{j,p,f} - R_{j,b,f}) = 0.50(6.50\% - 5.50\%) = 0.50\%

E. The portfolio underperformed the benchmark mostly due to market allocation effect of -3.15%. This was because the manager underweighted the best-performing sector, Argentina. The manager also had poor currency allocation effect and selection effect. The glaring difference is that the manager has positive currency and security selection effect in China and Indonesia, but that is offset by large negative currency and security selection effects in Argentina. If this was part of a normal pattern, it would seem that the manager’s strengths lie in the Chinese and Indonesian markets and not in the Argentinean market.

4. Three measures of risk:

A. Standard deviation is a measure of total risk. It computes the variability of portfolio returns around its historical mean. The standard deviation is not measured relative to a benchmark and is not comparable across portfolios because it measures absolute, rather than relative, risk.

B. Sharpe ratio is the ratio of the risk premium earned by the portfolio (portfolio return minus the risk-free rate) divided by the risk as measured by standard deviation. The Sharpe ratio is a benefit-cost ratio where the benefit of return is compared with the cost of the risk taken to achieve the return. A higher Sharpe ratio indicates a better risk-adjusted performance. The Sharpe ratio is not directly measured relative to a specific benchmark but compares returns to the risk-free rate.

C. Information ratio is the ratio of the surplus return earned by the portfolio (portfolio return minus benchmark return) divided by the tracking error, as measured by standard deviation of the surplus returns. The information ratio is measured relative to the benchmark. A higher information ratio indicates better risk-adjusted performance.

5. The performance of a portfolio manager is usually compared to a passive benchmark portfolio. The benchmark selected by the plan sponsors usually is consistent with the plan’s investment objective and may be specifically incorporated in the investment objective. Sometimes, existing and widely used indices are used as benchmarks. These may not be suitable for all portfolios due to defined objectives and/or constraints. As a result, some portfolios have specific custom benchmarks. Custom benchmarks should be designed to be consistent with the investment objective of the portfolio. Usually, the custom benchmark specifies the weights for each market in the benchmark. A currency-hedging component may also be present.

6. Because the country weights (market weights) are identical, the market allocation effect must be zero:

\[
\text{market allocation effect (MAE)} = \sum_{j=1}^{n} (w_{j,p} - w_{j,b}) \times R_{j,b,f}
\]

if \( w_{j,p} = w_{j,b} \Rightarrow \text{MAE} = 0 \)
The manager’s currency allocation effect is calculated as:

\[
\text{currency allocation effect (CAE)} = \sum_{j=1}^{n} \left( w_{j, p} C_{j, p} - w_{j, b} C_{j, b} \right)
\]

\(C_{j, p}\) and \(C_{j, b}\) are the currency effects for the portfolio and benchmark, respectively, and are determined by subtracting the local return from its respective domestic return. If the manager uses the same market weights as the benchmark, he has the same currency exposures as the benchmark. If he does not hedge any of the currency exposures and the returns for the sectors in the benchmark and portfolio are the same, the currency effects must be the same for the manager and the benchmark, and the currency allocation effect is zero.

If, on the other hand, the returns for the sectors (markets) in the portfolio are different from those in the benchmark, there may be a small currency allocation effect. For example, assume 10% and 12% local returns for the benchmark and portfolio, respectively. Further assume the foreign currency appreciates 2% relative to the domestic currency. The general form of the equation to calculate a domestic return and the domestic returns for the benchmark and portfolio are below:

\[
R_{D} = R_{L} + S + (R_{L})(S)
\]

\[
R_{D, B} = 0.10 + 0.02 + 0.10(0.02) = 0.1220\%
\]

\[
R_{D, P} = 0.12 + 0.02 + 0.12(0.02) = 0.1424\%
\]

where:
- \(R_{D}\) = domestic return for the benchmark (B) or the portfolio (P)
- \(R_{L}\) = local return for the benchmark (B) or the portfolio (P)
- \(S\) = percentage change in the value of the currency \(i\)

Note that the difference between the two domestic returns is 2.04% (\(= 14.24 - 12.20\)). The difference in the two local returns of 2% would be attributed to security selection and not to a currency allocation effect. We therefore remove the 2% from the difference in the domestic returns and are left with the difference in returns resulting solely from a currency effect:

\[
2.04\% - 2.0\% = 0.04\%
\]

Note that 0.04% is the cross product term consisting of the difference in the local returns multiplied by the change in the value of the currency:

\[
(0.12 - 0.10) \times 0.02 = 0.0004 = 0.04\% = 4 \text{ bps}
\]

Other than the 4 bps, the impact of the change in the value of the currency (i.e., the currency effect) is the same for the portfolio and the benchmark.
Professor's Note: Because the currency effects for the portfolio and the benchmark are usually so close, the overall currency allocation effect is sometimes estimated as the difference in weights multiplied by the percentage change (sj) in the value of the currency:

\[
\text{currency allocation effect} \approx \sum_j (w_{j,p} - w_{j,b})(s_j)
\]

7. C Active currency management is represented by any difference between the benchmark currency and the portfolio currency; thus, if the benchmark is hedged against currency risk but the portfolio is not, this is active currency management. Passive currency management is represented by a portfolio that is hedged against currency risk by using currency forward or futures contracts or a portfolio that closely matches the benchmark.

8. B Taking the difference in multi-period returns between the compounded portfolio and the benchmark returns will yield the total active return for the portfolio but will not tell us how the active return for each attribute was achieved. The active return for each attribute would be calculated using the following equation for a 2-period return analysis.

\[
R_{A,2} = R_{a,1} (1 + R_{b,2}) + R_{a,2} (1 + R_{p,1})
\]

where:
- \(R_{A,2}\) = 2-period active return
- \(R_{a,i}\) = active return in period \(i\)
- \(R_{b,2}\) = benchmark return in period 2
- \(R_{p,1}\) = portfolio return in period 1

The multi-period active return for each separate attribute would then be added together to get the total multi-period active return for the portfolio.

9. A The individual country weights may be based on the total market capitalization of the country's publicly traded securities or another macroeconomic measure such as GDP.

10. A This is an example of risk budgeting. Such guidelines are a part of the investment policy statement.
SELF-TEST: PERFORMANCE EVALUATION AND ATTRIBUTION

Use the following information for Questions 1 through 6.

Patty McDaniel and Peggy Peterson are consultants to Sigma Advisors. Sigma manages funds for wealthy individuals and small institutions. McDaniel and Peterson have been asked by Sigma to develop a plan to evaluate investment manager performance and to create customized benchmarks, when necessary.

As part of her service to Sigma Advisors, McDaniel creates a returns-based benchmark using monthly portfolio returns and the returns for large-cap value, large-cap growth, small-cap value, and small-cap growth indices over the past year. An algorithm is then used to determine the manager’s exposures to various styles. McDaniel uses this information to evaluate managers. She believes that this will help Sigma identify underperforming and outperforming managers.

Regarding the identification of underperforming managers, the null hypothesis is that the manager adds no value. McDaniel states that Sigma should avoid a Type I error, which, McDaniel continues, is failing to reject the null when it is false. Peterson adds that another danger for Sigma would be a Type II error, where Sigma would reject the null hypothesis when it is true. In both cases, McDaniel and Peterson agree that the decisions reached would be faulty.

Discussing returns-based style analysis further, McDaniel insists the model is purely statistical in nature, and one advantage to using this type of benchmark is that it is useful where the only information available is account returns. Peterson answers that a disadvantage to using this type of benchmark is that it is generally difficult to understand and not very intuitive.

As part of McDaniel’s and Peterson’s task, Sigma asks them to perform micro performance attribution on one of its managers, Frank Matson. Matson invests primarily in large-cap value stocks. Matson’s performance relative to the appropriate benchmark is shown below.

<table>
<thead>
<tr>
<th>Portfolio Sector</th>
<th>Portfolio Sector Weight</th>
<th>Benchmark Sector</th>
<th>Benchmark Sector Weight</th>
<th>Portfolio Sector Return</th>
<th>Benchmark Sector Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural</td>
<td>4.00%</td>
<td>6.00%</td>
<td>2.00%</td>
<td>-1.00%</td>
<td></td>
</tr>
<tr>
<td>Capital Goods</td>
<td>8.00%</td>
<td>9.00%</td>
<td>4.00%</td>
<td>-5.00%</td>
<td></td>
</tr>
<tr>
<td>Consumer Durables</td>
<td>32.00%</td>
<td>35.00%</td>
<td>2.00%</td>
<td>3.00%</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>6.00%</td>
<td>6.00%</td>
<td>8.00%</td>
<td>2.00%</td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>20.00%</td>
<td>18.00%</td>
<td>6.40%</td>
<td>4.00%</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>16.00%</td>
<td>16.00%</td>
<td>2.60%</td>
<td>-2.00%</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>12.00%</td>
<td>10.00%</td>
<td>4.00%</td>
<td>-2.00%</td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>2.00%</td>
<td>0.00%</td>
<td>0.20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.00%</td>
<td>100.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portfolio Plus Cash Return</td>
<td>2.90%</td>
<td>0.86%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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1. Regarding McDaniel's use of a returns-based benchmark, the characteristic that is most likely to make it invalid is that the typical returns-based style analysis:
   A. is not investable.
   B. is ambiguous.
   C. lacks statistical reliability.

2. Concerning McDaniel's and Peterson's statements about Type I and Type II errors:
   A. both are correct.
   B. both are incorrect.
   C. only one is correct.

3. Regarding their statements concerning the advantages and disadvantages of returns-based style analysis:
   A. both are correct.
   B. both are incorrect.
   C. only one is correct.

4. From the data in the table, does Matson demonstrate an ability to wisely allocate funds to the capital goods and/or financial sectors?
   A. Yes, but only in the capital goods sector.
   B. Yes, but only in the financial sector.
   C. Yes, in both capital goods and financial sectors.

5. Does Matson demonstrate an ability to select stocks in the consumer durables and/or technology sectors?
   A. Yes, in both technology and consumer durables sectors.
   B. Yes, but only in the technology sector.
   C. No, he does not demonstrate the ability to select stocks in either sector.

6. Does Matson demonstrate an ability to generate a positive return from selection/allocation interaction effects in the agricultural and/or utilities sectors?
   A. Yes, but only in the agricultural sector.
   B. Yes, in both agricultural and utilities sectors.
   C. Yes, but only in the utilities sector.

Use the following information for Questions 7 through 12.

John Willis and Mike Dunn are employees with Taylor Advisors. Taylor offers independent investment advice to institutional clients throughout the United States and Canada. Willis's and Dunn's primary responsibility is evaluating the performance of portfolio managers that Taylor's clients are considering. When necessary, they create customized benchmarks and use the Sharpe, Treynor, ex post alpha, and M² measures. These measures adjust a manager's return for the risk undertaken, where risk is defined as total using the standard deviation or as systematic using beta.

Willis and Dunn are preparing an analysis of the performance of the Jaguar and Theta mutual funds. Jaguar and Theta are being considered by the endowment of National University as an addition to its portfolio. Henry Roll is the portfolio manager for the National endowment. National's current endowment is well diversified, consisting of U.S. and international stocks and bonds, hedge funds, real estate investment trusts, and a small cash position necessary to meet next quarter's expenses. In addition to the Jaguar and Theta mutual funds under consideration, Roll is also considering adding individual bonds.
to National's portfolio because individual bonds have become increasingly more liquid. Willis believes that municipal bonds would be a good consideration because their after-tax return is often higher than that available from corporate bonds. Roll informs them that National is also considering adding BBB rated bonds as a small portion of their portfolio, but Dunn believes that this is probably not a good idea because, although he has not reviewed National's investment policy statement, endowments typically have a low ability and willingness to take risk because the endowment must meet the spending needs created by university operating budgets, student scholarships, and faculty salaries.

The most recent risk and return measures for both Jaguar and Theta are shown below. The minimum acceptable return (MAR) for National is the 5.0% spending rate on the endowment, which the endowment has determined using a geometric spending rule. The T-bill return over the same fiscal year was 4.5%. The return on the Wilshire 5000 was used as the market index. The Wilshire 5000 index had a return of 10% with a standard deviation of 21% and a beta of 1.0.

<table>
<thead>
<tr>
<th></th>
<th>Jaguar</th>
<th>Theta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>16.5%</td>
<td>15.9%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>38.1%</td>
<td>35.6%</td>
</tr>
<tr>
<td>Beta</td>
<td>0.8</td>
<td>1.25</td>
</tr>
<tr>
<td>Downside Deviation</td>
<td>14.9%</td>
<td>14.0%</td>
</tr>
</tbody>
</table>

Analyzing the results of their performance evaluation, Willis notices that the results demonstrate that the Jaguar portfolio is less diversified than the Theta portfolio. Dunn adds that the Theta portfolio would be a better addition to the National portfolio than the Jaguar fund.

7. Regarding Willis's and Dunn's comments concerning the addition of municipal and BBB bonds to National's portfolio:
   A. both are correct.
   B. both are incorrect.
   C. only one is correct.

8. The M-squared measure for the Jaguar fund is closest to:
   A. 8.10%.
   B. 11.11%.
   C. 6.70%.

9. The Sharpe ratio for the Theta fund is closest to:
   A. 0.15.
   B. 0.32.
   C. 2.31.

10. The Treynor ratio for the Theta fund is closest to:
    A. 31.5.
    B. 15.0.
    C. 9.1.
11. The ex post alpha for the Jaguar fund is closest to:
   A. 7.1%.
   B. 7.6%.
   C. 9.3%.

12. Regarding Willis's and Dunn's statements concerning the diversification and addition of the Jaguar and Theta funds to National's portfolio:
   A. both are correct.
   B. both are incorrect.
   C. only one is correct.
SELF-TEST ANSWERS: PERFORMANCE EVALUATION AND ATTRIBUTION

1. C McDaniels returns-based benchmark is likely not a valid benchmark because it is not statistically reliable. She uses only 12 data points (the monthly returns over the past year), and this is not enough data points to generate a statistically reliable model. Returns-based benchmarks are measurable, investable, and unambiguous.

2. B McDaniels is incorrect. Although the null hypothesis is stated correctly (the manager adds no value), McDaniels definition of a Type I error is incorrect. A Type I error is when the null hypothesis is rejected when it is true. Peterson is also incorrect. A Type II error is failure to reject the null when it is false.

3. C McDaniels is correct. One advantage to using a returns-based benchmark is that it is useful where the only information available is account returns. Peterson is incorrect. Returns-based benchmarks are generally easy to use and intuitive.

4. C To answer this question, we must first examine the return for the overall benchmark versus the return for the benchmark in both sectors. The overall return for the benchmark is given at 0.86%. The capital goods sector return in the benchmark was -5.00%. For the financial sector, it was 4.00%. Thus, relative to the overall benchmark return of 0.86%, the capital goods sector was an underperforming sector and the financial sector outperformed. Now determine whether Matson overweighted or underweighted each sector. He underweighted the weak capital goods sector (8.00% allocation for the manager versus 9.00% for the benchmark), and he overweighted the strong financial sector (20.00% allocation for the manager versus 18.00% for the benchmark). Because Matson underweighted a weak sector and he overweighted a strong sector, he made correct decisions for both.

No calculations are needed to reach the above conclusions. However, the sector allocation returns can be calculated by multiplying the difference between the portfolio and benchmark allocation by the difference in sector benchmark return and overall benchmark return for each sector. For the capital goods sector, it is (8.0% - 9.0%) x (-5.00% - 0.86%) = 0.0586%. For the financial sector, it is (20.0% - 18.0%) x (4.00% - 0.86%) = 0.0628%.

5. B To answer this question, examine the return for the manager against the return for the benchmark in each sector. Matson's return in the consumer durables sector was 2% versus 3% for the benchmark, so he did not outperform the benchmark for security selection in this sector. However, the return for the manager in the technology sector was 2.6% versus -2% for the benchmark, so he did outperform the benchmark for security selection in this sector.

No calculations are needed to reach the above conclusions. However, the within-sector allocation returns can be calculated by multiplying the difference between the portfolio and benchmark return in each sector by the benchmark's weight. For the consumer durables sector, it is (2.0% - 3.0%) x 35% = -0.35%. For the technology sector, it is (2.6% + 2.0%) x 16% = 0.736%.

6. B To answer this question, multiply the difference in weightings for the manager and the benchmark by the difference in returns for the manager and the benchmark in each sector. In the agricultural sector, this is (4% - 6%) x (-2% + 1%) = 0.02%. In the utilities sector, this is (12% - 10%) x (4% + 2%) = 0.12%.

7. B Willis is incorrect. Endowments are not taxable entities so the tax advantage of the municipal bonds is not a valid reason for the endowment to consider the municipal bonds. Dunn is incorrect. Endowments typically have a high ability and willingness to take risk because of
their infinite time horizon. It is also imprudent for Dunn to state whether an investment is appropriate for National until he has reviewed the investment policy statement.

8. B The M-squared measure for the Jaguar fund is 11.11%.

To calculate the M-squared ratio for Jaguar, use the following formula:

\[ M^2_p = R_F + \left( \frac{R_p - R_F}{\sigma_p} \right) \sigma_M \]

\[ M^2_p = 0.045 + \left( \frac{0.165 - 0.045}{0.381} \right) 0.21 = 0.1111 = 11.11\% \]

Comparing the 11.11% to the return on the market of 10%, the Jaguar fund has superior performance. The M-squared measure for the Theta fund is 11.22%, which indicates that the Theta fund has superior performance relative to both the market and Jaguar fund.

9. B The Sharpe ratio for Theta would be calculated as:

\[ S_p = \frac{\bar{R}_A - R_F}{\sigma_A} \]

\[ S_p = \frac{15.9 - 4.5}{35.6} = 0.32 \]

The Sharpe ratio for the Jaguar fund is 0.31, which indicates that the Theta fund has superior performance relative to the Jaguar fund.

10. C The Treynor ratio for Theta would be calculated as:

\[ T_p = \frac{\bar{R}_A - R_F}{\beta_A} \]

\[ T_p = \frac{15.9 - 4.5}{1.25} = 9.1 \]

The Treynor ratio for the Jaguar fund is 15.0, which indicates that the Jaguar fund has superior performance relative to the Theta fund.

11. B The ex post alpha for Jaguar would be calculated as:

\[ \hat{\alpha}_p = R_F + \beta_p \left( \hat{R}_M - R_F \right) \]

\[ \hat{R}_p = 0.045 + 0.8(0.165 - 0.045) = 8.90\% \]

\[ \alpha_p = R_{p,t} - \hat{R}_p \]

\[ \alpha_p = 0.165 - 0.0890 = 7.6\% \]

The ex post alpha for the Theta fund is 4.5%, which indicates that the Jaguar fund has superior performance relative to the Theta fund.

12. C Willis is correct. By the Sharpe ratio and M-squared measures, which use total risk (standard deviation), the Theta fund has superior performance. By the Treynor ratio and ex post alpha, which use systematic risk (beta), the Jaguar fund has superior performance. The discrepancy is because the Jaguar fund is poorly diversified. Dunn is incorrect. National's current endowment is well diversified and thus the appropriate measure of risk for additional investments would be beta. Because the Jaguar fund has a better Treynor ratio and ex post alpha, it is the better fund to add to the endowment.