2022 CFA®
Exam Prep

SchweserNotes™
Fixed Income and Equity

LEVEL III **BOOK 3**

KAPLAN SCHWESER

Book 3: Fixed Income and Equity

SchweserNotes™ 2022

Level III CFA®

KAPLAN SCHWESER

SCHWESERNOTES™ 2022 LEVEL III CFA® BOOK 3: FIXED INCOME AND EQUITY

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f. discuss how assets under management, position size, market liquidity, and portfolio turnover affect equity portfolio construction decisions.
g. evaluate the efficiency of a portfolio structure given its investment mandate.
h. discuss the long-only, long extension, long/short, and equitized market-neutral approaches to equity portfolio construction, including their risks, costs, and effects on potential alphas.

The following is a review of the Fixed-Income Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #11.

READING 11: OVERVIEW OF FIXED-INCOME PORTFOLIO MANAGEMENT

Study Session 5

EXAM FOCUS

This reading provides a good overview of issues covered in more detail in subsequent readings, so don't obsess about exact nuances of terminology. Take in what is said and move on to the rest of fixed income to see what we are going to do with these ideas and concepts. Do take the time to understand the model for projecting or decomposing bond return.

We make reference to historical results such as return, standard deviation, and correlation in this reading. They reflect results reported in the CFA reading. The numbers are to suggest typical relationships. They are not to be memorized and do not dictate what can happen in any specific period.

MODULE 11.1: ROLE OF FIXED INCOME

Video covering this content is available online.

LOS 11.a: Discuss roles of fixed-income securities in portfolios and how fixed-income mandates may be classified.

CFA® Program Curriculum, Volume 2, page 237

The fixed-income market is highly varied. It includes publicly traded securities such as bond and money market securities as well as nonpublic instruments such as loans and private placement securities. It varies by maturity and credit quality segments. There are structure differences such as straight bonds without embedded options, instruments with embedded prepayment options, variable coupon structures, and inflation adjustment features.

As an asset class used in a portfolio, fixed income may provide:

1. *Diversification*. In general, fixed income has low correlation to equity markets. Adding an asset class to an existing portfolio with a correlation of less than +1 improves its risk-adjusted return through diversification benefits. The lower the correlation, the greater the diversification benefit. Specific correlation numbers vary by time period and type of instrument used. For 2000 to 2019, the correlations of various fixed-income indexes to the S&P 500 equity index ranged from –0.30 for 10-year U.S. Treasury bonds to +0.63 for U.S. high-yield (credit-risky) bonds.

   Diversification can be achieved internally within the fixed-income asset class, primarily due to changes in credit spreads causing divergence in the performance of investment-grade securities versus credit-risky high-yield (below investment-grade) securities.

These correlations are not always stable over time. A particular problem is flight to quality. During periods of market stress, all lower-quality and riskier assets, including high-yield bonds and equities, tend to decline together (correlation approaching +1) as investors sell these assets and buy high-quality developed-market government bonds for safety. Thus, correlation of these government bonds to riskier assets declines during periods of stress and may be negative.

The volatility of bond market returns can also vary over time, increasing significantly for high-yield bonds in times of market crisis.

2. *Regular cash flow.* Most fixed income provides regular, predictable cash flow that investors can use to meet expected future obligations. This is convenient for an individual needing regular living expenses or specific periodic expenditures such as college tuition payments. Institutions such as insurance companies that must make periodic payments to policyholders could structure and dedicate a portfolio of bond assets to meet these payouts. Investors could also build a buy-and-hold laddered portfolio of bonds to provide regular cash flow. Buy and hold means no sales or trading are planned, and laddered means a somewhat equal amount of par comes due periodically. Implicit in this discussion is that there is no significant credit risk and that all payments will be made on the bonds.
3. *Inflation hedge.* While not the first thing most investors would think of, some types of bonds do provide forms of inflation protection. Standard fixed-coupon (nominal rate) bonds do not. For simplicity, assume the bonds are purchased at par so that initial yield is the coupon rate. The purchase yield and coupon reflect nominal compensation for an expected future rate of inflation and a real return above that rate of inflation. If inflation increases, the coupon cash flow is fixed and the investor suffers on an inflation-adjusted basis. Looked at another way, the yield a new investor would want increases and the price of the bond must decline.
   - Inflation-linked (also called real rate or real return) bonds provide direct protection for the effect of inflation. Like regular bonds, the coupon payment amount is the coupon rate × par. But unlike regular bonds, the par adjusts for inflation. If 1 million par is purchased and inflation is 5%, the par increases by 5% to 1.05 million. (For later comparison with floating-coupon bonds, assume the previous inflation rate was 3%, though this does not directly affect the calculations for the inflation-linked bond.) That leads the coupon payment amount to increase by 5% as well. For example, if the real rate were 0.5%, the first (annualized) coupon payment is 5,250 (1,050,000 × 0.005). This adjustment continues every period to compensate for cumulative inflation over the life of the bond. At expiration, inflation-adjusted par is paid to the investor. Thus, both coupon payments and par are inflation protected.
   - Floating-coupon (floating-rate) securities also provide inflation protection. The coupon rate is set by a formula such as LIBOR + 100 basis points. If inflation and LIBOR are initially 3.0% and 3.5%, the first (annual) coupon payment on 1 million par would be 45,000 [1,000,000 (0.035 + 0.01)]. If inflation then increases by 2% to 5.0%, it is likely LIBOR will also increase by 2% to 5.5% and the next coupon payment will increase to 65,000 [1,000,000 (0.055 + 0.01)]. No adjustment is made to the par amount. Thus, it is said the coupons are inflation protected but not the principal.

PROFESSOR'S NOTE

It is easy to misunderstand this material. In theory, both inflation-linked and floating-coupon securities provide full inflation protection but do so in different ways. Imagine fixed-coupon nominal rate (NR), inflation-linked, and floating-coupon bonds from the same issuer with the same maturity. In a fully efficient market, all three would be priced to reflect the same consensus expectations for inflation and have the same expected return. (Because they respond to inflation risk differently, there could be small differences.) If the actual rates of inflation turn out to higher (lower) than initial consensus expectations, the actual returns for the inflation linked and floating coupon would be superior (inferior) to the NR bond. Between the inflation linked and floating coupon, one or the other may end up being best depending on the actual path of future inflation. Notice in the earlier example with inflation increasing from 3% to 5% the par and coupon payment amount for the inflation-linked bond increased by 5% while the par of the floating coupon was unchanged, but the coupon payment amount went from 45,000 to 65,000, an increase of 44.4%.

The bottom line is to accept the conclusions as presented in the reading; they are correct. You can come back and develop spreadsheet models to test various scenarios after you have the charter. If you like bonds, it is fun to do so.

Fixed-Income Mandates

Fixed-income investment mandates can be classified into two major types: liability-based mandates and total return mandates.

Liability-based mandates are portfolio assets that are managed solely to meet expected future liability payouts. All asset cash flows are reinvested until paid out to meet the liabilities. This is often referred to as immunization. There are several forms and variations of **immunization**.

- **Cash-flow matching** is the simplest form of immunization. The assets are selected so that cash flows occur when and in the size needed to meet the liability payouts.
- **Duration matching** matches the duration of the assets and liabilities so the two will fluctuate in a similar way as interest rates change, such that their ending values will remain matched.
- **Contingent immunization** (CI) is a hybrid of active management and immunization. The portfolio is initially funded with more money than required to meet the future liability payouts. The present value of the assets (PVA) exceeds the present value of the liabilities (PVL). The difference is the surplus. As long as the surplus is positive, the portfolio can be managed in any way the manager believes will add value. If CI succeeds, the surplus will grow and the ultimate cost of CI will be less than that of initially immunizing. If the active management is unsuccessful and the surplus declines to zero, the portfolio must be immediately immunized and the ultimate cost of CI will be more than that of initial immunization but by a known amount.
- **Derivatives overlays**, involving the use of futures or swaps contracts, can be used to implement duration matching or contingent immunization strategies.

Total return mandates do not seek to fund future liabilities but may target an absolute rate of return or, more commonly, seek to equal or outperform (relative return versus) a benchmark. The key metrics to evaluate such portfolios are **active return** (portfolio return less return of the relevant benchmark, also called value added or alpha) and volatility of that active return (standard deviation of active return, also called **active risk**, **tracking error**, or **tracking risk**). Total return mandates include the following:

- **Pure indexing,** which attempts to replicate the performance of a bond index. It targets zero active return and risk. Unlike the equity market, the large number of

individual bonds in most indexes and their potential lack of liquidity makes literal duplication of the index (holding every issue in the same weight as in the index) impractical. Most pure bond indexing instead seeks to exactly match all the risk factors of the index (such as duration, credit or quality, sectors, and prepayment risks) while still allowing the manager some leeway on the individual bonds selected. The turnover (trading) in the portfolio should be low and similar to the turnover in the index.

- **Enhanced indexing** allows some additional flexibility in constructing the portfolio and seeks to add some modest active return. Typically, duration (interest rate risk) is still matched to the index, but some risk mismatches such as modest over- or underweighting of sectors and quality are allowed. Slightly higher portfolio turnover is likely.
- **Active management** allows much larger deviations from the risk factors of the index and seeks greater active return. Duration can also be mismatched and portfolio turnover can be much higher.

Fixed-Income Portfolio Measures

LOS 11.b: Describe fixed-income portfolio measures of risk and return as well as correlation characteristics.

CFA® Program Curriculum, Volume 2, page 247

PROFESSOR'S NOTE

This section reviews some fundamental definitions of fixed-income risk and return measures, almost all of which have been met at previous levels of the CFA program. Remember that the Level III exam will likely be less focused on the calculation of these measures than previous levels were and more focused on the interpretation and use of these measures in a portfolio management situation. Understanding what the measures are telling you is the key focus here.

Key bond risk and return measures are displayed here:

Name	Definition	Interpretation
Macaulay duration	Weighted average *time* to receive cash flows, where weights are the present value of the cash flows	A higher Macaulay duration means investors are waiting longer to receive cash flows and hence face higher price volatility when yields change.
Modified duration	Macaulay duration divided by one plus the periodic yield of the bond	This gives the approximate expected percentage change in bond price for a 1% change in yield. For example, a bond with a modified duration of 7 is expected to fall by approximately 7% when yields rise by 1%.
Effective duration	Sensitivity of a bond's price to a parallel shift change in a benchmark yield curve, based on directly modeling changes in prices due to changes in a benchmark curve	This gives the approximate expected percentage change in bond price for a 1% change in benchmark curve. Effective duration is used for complex bonds where cash flows are not certain, such as bonds with embedded options.
Key rate duration (or partial duration)	Sensitivity of a bond's price to a change in a benchmark yield *curve for a specific maturity, while other rates remain the same*	It helps to assess exposure to non parallel changes in yield curves, where different maturity rates move by different amounts. For example, a bond with a 10-year key rate duration of 7 is expected to fall by approximately 7% when 10-year benchmark yields rise by 1% *while all other maturity rates stay the same.*

Name	Definition	Interpretation
Empirical duration	A measure of interest rate sensitivity derived from regressing bond returns versus benchmark yield changes	This is the same interpretation as effective duration; however, it is based on past observed market behavior rather than derived through modeling.
Money duration (or dollar duration)	A measure of the monetary gain or loss expected due to a 1% change in yield, which is calculated as modified duration × market value	A higher money duration implies a larger absolute change in portfolio value (in currency terms) when yields change by 1%.
Price value of a basis point (PVBP) [or "dollar value of an 0.01" (DV01) or basis point value (BPV)]	Money duration × 0.0001	It measures the absolute change in portfolio value (in currency terms) when yields change by 1 basis point.
Convexity	The extent to which the bond's price behavior versus changes in yield is nonlinear (i.e., not a straight line). Convexity is positive for fixed-coupon bonds without embedded options.	Positive convexity implies that a bond price is expected to rise by *more* than that implied by duration alone when yields fall and fall by *less* than that implied by duration alone when yields rise.
Effective convexity	Measures the extent of a *nonlinear* relationship between a bond's price and changes in a benchmark yield curve, based on directly modeling changes in prices due to changes in a benchmark curve	Effective convexity is used for complex bonds where cash flows are not certain, such as bonds with embedded options.

Some key facts to consider include the following:

- Convexity is valuable to bondholders when yields are expected to change. This is because positive convexity, as just described, implies that a bond price is expected to rise by *more* than that implied by duration alone when yields fall and fall by *less* than that implied by duration alone when yields rise. Note that this will mean investors will pay higher prices for higher convexity bonds (and accept lower yields vs. yields of other less convex bonds).
- Convexity is often referred to as a second order measure—meaning that it measures how much the sensitivity of price versus yield *changes* as yields change. As a second order measure, it is approximately proportional to duration squared—in other words, a bond with a duration of 20 years will have approximately four times the convexity of a bond with a duration of 10 years (because 20 squared is four times 10 squared).
- Convexity is directly related to the *dispersion* of cash flows in time around the Macaulay duration of the bond. For a given Macaulay duration, the lowest convexity bond will be a zero-coupon bond with one cash flow at maturity.

Fixed-Income Portfolio Measures

When combining bonds together in a portfolio, the following apply:

- The Macaulay duration of a portfolio is the weighted average time to receive the cash flows of the portfolio. It is commonly estimated as the cash-weighed duration of the individual assets in the portfolio (note that this applies to all basic duration measures). For example, if 40% of a portfolio is invested in a bond with a duration of 10 and the remaining 60% of the portfolio is invested in a bond with a duration of 15, the portfolio duration is estimated as (0.4 × 10) + (0.6 × 15) = 13.
- The modified duration and convexity of a portfolio is estimated as the cash-weighted convexity of the individual assets in the portfolio, similar to the process for the Macaulay duration just described.
- The effective duration and effective convexity of a portfolio are calculated using the following formulas:

$$\text{effective duration} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{curve})(\text{PV}_0)}$$

$$\text{effective convexity} = \frac{(\text{PV}_-) + (\text{PV}_+) - 2(\text{PV}_0)}{(\Delta\text{curve})^2(\text{PV}_0)}$$

where:

PV_0 = current value of the portfolio

PV_- = value of portfolio when benchmark curve is shifted down

PV_+ = value of portfolio when benchmark curve is shifted up

Δcurve = change in benchmark curve

- **Spread duration** measures a portfolio's percentage sensitivity to a 1% change in *credit spreads*.
- **Duration times spread (DTS)** is equal to spread duration multiplied by the bonds' credit spread. This measure adjusts spread duration to give a higher sensitivity to spread changes when spreads themselves are higher. This adjustment reflects the empirically observed behavior that bonds with higher spreads are expected to have higher spread *changes* (i.e., spread changes tend to be proportional to current spread levels, rather than the same in absolute term across bonds with different spreads).

Fixed-income managers would use these measures just listed to actively manage a fixed-income portfolio as follows:

- A manager expecting interest rates to fall would increase the duration of their portfolio in order to increase the amount by which their bond prices rise. Conversely, a manager who expected rates to rise would lower the duration of their portfolio.
- A manager who expects credit spreads to narrow would increase the spread duration of their portfolio in order to increase the amount by which their bond price rises. They may also lower the credit rating of the bonds held in the portfolio. Conversely, a manager who expects spreads to widen would decrease the duration of their portfolio or increase the average credit rating of their holdings.

- A manager can use **relative value** techniques to rank individual bonds based on valuation, issuer characteristics, and technical market conditions, so that they can select the best bond to reflect their market view. For example, a manager who expects spreads to narrow can use relative value techniques to select the best bonds (according to their selection criteria) with a DTS greater than that of the benchmark.

Correlations Between Fixed-Income Sectors

Correlations between bonds in the same market are likely to be high due to the similar overarching macroeconomic conditions that apply to all bonds in the market.

Returns on investment-grade bonds with low credit risk are likely to be primarily driven by changes in the benchmark sovereign yield curve. High-yield bonds, however, are more likely to be affected by changes in spread than benchmark rates. There is likely a negative relationship between benchmark rates and spreads, because in poor economic conditions, interest rates will likely be low but credit spreads high (and vice versa). For this reason, high-yield securities are likely to exhibit higher correlations with equity.

Bond Liquidity

LOS 11.c: Describe bond market liquidity, including the differences among market sub-sectors, and discuss the effect of liquidity on fixed-income portfolio management.

CFA® Program Curriculum, Volume 2, page 252

Liquidity is the ability to make transactions in relatively large size, quickly, and with minimal deviation from the market price of the asset. In the bond market, the most recently issued (on-the-run) developed-market government bonds are likely to be quite liquid and other bonds may be quite illiquid. Those other bonds may trade virtually never or at very wide bid-ask spreads. Issues leading to illiquidity include:

- The very large number of bond issues, each of which can be quite small, compared to the smaller number of stock issues in the equity market. A single issuer can have dozens or more separate bonds outstanding. Each can be unique in terms of maturity, coupon, and call features. Each issuer's bonds are heterogeneous (different), unlike the stock of the issuer, which is homogeneous.Most issuers have one class of common stock (and perhaps none, one, or a few issues of preferred stock).
- Bonds usually trade over the counter, which increases the search cost to find a counterparty to any transaction. This also makes transactions less transparent (it is harder to find information on past price and volume of transactions). Bond liquidity is usually higher for recently issued bonds as dealers may have an inventory of those bonds on hand. As time passes, the bonds are likely to become held in portfolios of investors with no plans to trade the bonds. When the issuer puts out a new issue of similar remaining maturity to a previous issue, the older issue becomes off-the-run and its liquidity decreases. The less liquid issues normally trade at a higher yield to maturity, offering a liquidity premium. These liquidity premiums can vary widely depending on specific circumstances.

PROFESSOR'S NOTE

> Some authors refer to an illiquidity premium and others to a liquidity premium. They mean the same thing. The current Level III fixed-income readings call it a liquidity premium, meaning extra compensation in the form of higher yield for lack of liquidity. Remember that as liquidity and the ability to execute transactions at reasonable prices decrease, the liquidity (or illiquidity) premium and yield increase.

Liquidity varies widely by bond market subsector. Generally:

- Liquidity for on-the-run high-quality sovereign government debt is high and declines somewhat for older off-the-run issues. These sovereign government bonds are usually large in size, more homogeneous, and often used as benchmarks for pricing other bonds and as collateral in the repo market (an issue discussed later).
- Corporate bonds are far more varied in credit quality and size of issue. Liquidity typically declines with lower quality as the bonds become riskier and with smaller size of the issue. Size can be an important factor as it takes roughly the same commitment of resources to analyze a large or small issuer, but with smaller issuers it is more difficult to acquire a large holding for the portfolio. Small issuers may also be excluded from bond indexes.

Effects of Liquidity on Bond Portfolio Management

- *Pricing data*. Historically bonds trade over the counter with past price and value information not reported. This makes it difficult to find pricing information. Some countries have moved towards centralized collection and reporting of this trade information, increasing market transparency. In the absence of such reporting or with infrequent trading of a bond issue, pricing information may be based on out-of-date trade prices. Instead of using old prices, bond pricing is often based on **matrix pricing**. Information is gathered on recent trades of bonds with similar features (maturity, quality, and coupon). The YTM of those trades is used to calculate the inferred market price of similar bonds.
- *Portfolio construction*. Buy-and-hold investors have less need for liquidity as they have no plans to sell the bonds; thus, they may prefer to select less liquid bonds in exchange for higher yield. In contrast, active investors and traders will prefer more liquid bonds, reasoning their active management strategies will generate additional return and compensate for lower initial yield. Other investors who anticipate the possibility of needing to sell bonds before maturity to meet unexpected needs may tend to avoid less liquid bonds such as longer maturity and smaller issuers or private placements. The cost of crossing a bid-ask yield spread can be approximated as bond duration × (ask yield – bid yield). For example, a manager trading in a bond with a duration of 10 and a bid-ask spread of 20 bps would suffer costs of 10 × 0.002 = 0.02, or 2%, if they bought the bond at the ask and immediately sold the bond at the bid.
- The fact that most bond trading is done in dealer markets leads less liquid bonds to trade at higher bid-ask spreads. Dealers will reason that if they purchase such bonds, it will take longer to then resell them. Thus, dealers will widen the bid-ask to earn greater expected compensation for holding less liquid bonds in inventory.

Alternatives to Direct Investment in Bonds

PROFESSOR'S NOTE

There is no direct LOS on this next section, but you will recognize topics that are covered elsewhere, so we include a brief summary. These indirect investments are typically more liquid than the underlying bonds.

- Fixed-income exchange-traded funds (ETFs) replicate many sectors of the fixed-income market. The shares are listed on an exchange and therefore easily traded throughout the trading day and have high liquidity.
- Open-end mutual funds offer the ability to subscribe to and redeem fund units on a daily basis and provide diversification and economies of scale that smaller investors would not be able to achieve directly in bond markets.
- Derivatives include exchange-traded bond futures and options and OTC instruments such as interest rate swaps and total return swaps (TRS). Under a TRS, one party (the *total return receiver*) pays an interest rate plus a spread in return for the total return on a reference bond portfolio. An investor might prefer to receive the total return of a bond portfolio under a TRS because the contract will likely only require a relatively small amount of capital to be posted as collateral versus fully funding an ETF position. Drawbacks of using a TRS to access bond market returns include facing the counterparty risk of the total return payer, the rollover risk of renewing contracts when reaching maturity, and potential regulatory reform requiring higher collateral and increasing the costs of such contracts.

MODULE QUIZ 11.1

To best evaluate your performance, enter your quiz answers online.

1. A credit analyst is evaluating the potential for fixed-income securities to provide an inflation hedge. Which of the following types of securities protects both the bond coupon and notional principal amounts from inflation?
   A. Fixed-coupon bonds.
   B. Inflation-linked bonds.
   C. Floating-coupon bonds.
2. A fixed-income portfolio manager is seeking to outperform the Barclays Capital Aggregate Bond Index. Which of the following statements *most accurately* describes a pure indexing strategy for achieving the total-return mandate? Pure bond indexing:
   A. allows large deviations from the risk factors of the index and seeks a high active return.
   B. matches duration to the index, but some risk mismatches of sectors and quality are allowed.
   C. seeks to exactly match all the risk factors of the index while allowing the manager some leeway on the individual bonds selected.
3. Regarding the varying liquidity characteristics among bond market subsectors, which of the following bond issues would typically lead to higher levels of liquidity?
   A. Issuing a small corporate bond issue.
   B. Issuing on-the-run sovereign government debt.
   C. Issuing a corporate bond that is below investment grade.

MODULE 11.2: MODELING RETURN

Video covering this content is available online.

LOS 11.d: Describe and interpret a model for fixed-income returns.

CFA® Program Curriculum, Volume 2, page 257

Expected fixed-income return can be viewed as having five components. These components could be projected to calculate expected return or calculated after the fact

to decompose sources of return actually earned. The following example explains this approach and the required calculations. While it appears formidable in aggregate, it is a combination of simple time value of money calculations and bond math concepts covered at earlier levels. For a bond portfolio, it uses aggregate portfolio data and that aggregation is provided. Otherwise, there is too much weighted average calculating to be practical without access to spreadsheets.

EXAMPLE: **Expected return of a bond portfolio**

A fixed-income strategist wishes to forecast the expected return of a bond portfolio for the next year. She gathers the following information and assumes no reinvestment of cash flow:

Par value (notional principal) in millions	50
Average coupon rate of portfolio	3.0%
Coupon frequency	Semiannual
Horizon analysis	1 year
Average bond price of portfolio	101.500
Projected bond price in one year if yield curve is unchanged	102.419
Average bond convexity (C) of portfolio	28
Average bond duration (modified duration or MD) of portfolio	5.60
Expected average benchmark YTM change	–0.54%
Expected change in spread	–0.06%
Expected gains or losses versus investor's currency (for 40% of portfolio allocated to foreign bonds)	+3.925%

Projected return:

Component 1, **coupon income**:

annual coupon payment / current bond portfolio price = 3.0 / 101.50 = 2.956%

Because this example assumes no cash-flow reinvestment, it does not matter that the coupons are paid semiannually. With a 3.0% annual coupon rate, 1.50 will be received in 6 and 12 months for total coupons collected of 3.00 per 100 par. Collected coupon amount divided by initial price is the coupon income of the portfolio, sometimes referred to as current yield.

Component 2, **rolldown return**:

This is a projection of the bond prices in the portfolio assuming the yield curve is unchanged. For example, suppose the portfolio were made up only of a 7-year bond priced to yield 2.76% with a price of 101.50. Further assume the initial yield curve is upward sloping and the 6-year bond yields 2.56%. A bond pricing model could be used to project the price of the 7-year bond in one year when it is a 6-year bond priced at a 2.56% yield. (Note that this is not necessarily a simple analysis for a portfolio of bonds and would have to be done bond by bond and then aggregated. That is why it is a given value in the data provided). The rolldown return is calculated as follows:

(end of horizon period projected price – beginning price) / beginning price = (102.419 – 101.50) / 101.50 = 0.905%

Note that if the yield curve is flat and a bond is initially priced at a premium (discount) to par, the projected price at end of period will be lower (higher) than the start-of-period price as the bond's price is pulled to par at expiration. With a sloped yield curve, that may not always be true in the shorter run (before maturity). It is true that if the yield curve is upward (downward) sloping, the rolldown return will be higher (lower) than the start-of-period YTM because the bond will decline in

the remaining term to maturity over the horizon period and be priced at a lower (higher) YTM at the end of that period.

Components 1 and 2 are sometimes combined and called the **rolling yield**:

2.956 + 0.905 = 3.86%

Component 3, **expected price change due to change in benchmark yield (ΔY)**:

Let's assume the projected price based on rolldown of 102.419 is in fact an aggregate portfolio benchmark yield (YTM) of 2.56%. The analyst then projects a 54-basis-point decline in yields versus the 2.56% yield used in the rolldown calculation. Expected price change is calculated from the investor's expected change in benchmark yield using the portfolio's duration and convexity:

(–MD × ΔY) + (½ × C × ΔY2) = (–5.6 × –0.0054) + [½ × 28 × (–0.0054)2] = 0.03024 + 0.00041 = 3.065%

Notice that the convexity effect is very small and only adds 0.041% to the return. Convexity is a second-order effect and is often insignificant for option-free bonds unless the ΔY is very large. If the portfolio includes bonds with embedded options, then effective duration and effective convexity must be used. Floating-rate securities would also complicate the analysis, as their duration is low, but will still have a sensitivity to changes in spreads, as discussed next.

Component 4, **expected price change due to change in credit spreads (ΔS)**:

The analyst also projects a 6-basis-point narrowing of spreads over the investment horizon. This change in spread is assumed to flow through to change the bond's yield. The impact of this change in spread on the bond's price can be calculated in a similar way to the duration and convexity formula used in the previous component:

(–MD × ΔS) + (½ × C × ΔS2) = (–5.6 × –0.0006) + [½ × 28 × (–0.0006)2] = 0.00336 + 0.000005 = 0.337%

Component 5, **expected gains or losses versus investor's currency**:

The portfolio is invested 40% in foreign denominated bonds, and the investor expects the foreign currencies (weight to reflect portfolio exposures) to appreciate 3.925%, giving the portfolio an expected gain of 3.925% × 0.40 = 1.570%.

In summary, the projected bond return is the sum of these:

1. Coupon income: annual coupon amount / current bond price

   3.0 / 101.50 = 2.956%

2. Rolldown return: (projected ending bond price (BP) – beginning BP) / beginning BP; based on no change in the yield curve

   (102.419 – 101.50) / 101.50 = 0.905%

3. Price change due to investor's benchmark yield change predictions: (–MD × ΔY) + (½ × C × ΔY2)

   [–5.6 × (–0.0054)] + [½ × 28 × (–0.0054)2] = 3.065%

4. Price change due to investor's spread change predictions: (–MD × ΔS) + (½ × C × ΔS2)

   [–5.6 × (–0.0006)] + [½ × 28 × (–0.0006)2] = 0.337%

5. Currency gain or loss: projected change in value of foreign currencies weighted for exposure to the currency

   3.925% × 0.40 = 1.570% = expected total return for the year = 8.833%

Note the rolling yield = #1 + #2 = 2.956% + 0.905% = 3.86%.

Except for yield income, this analysis is based on projections. Rolldown assumes the yield curve is unchanged. But techniques for plotting the yield curve vary. Plotting is often done using on-the-run government bond yields, and then the curve is interpolated between those points. At times, the curve may be based on off-the-run government bond yields. Such bonds are more numerous, but the yields usually include a liquidity premium. Predicted price change is based on only duration and convexity projection. It does not include how individual bonds may shift in relative valuation. Credit losses and currency G/L are pure predictions.

PROFESSOR'S NOTE

Technically, spread duration should be used in the calculation for part 4, but our example follows the example as presented in the CFA curriculum. The assumption here seems to be that the spread duration of a fixed-coupon bond should be similar to the modified duration of the bond. While this is a fair approximation for a fixed-coupon bond, it is not a good assumption for floating-rate bonds where modified duration is likely to be low (because coupons move in line with benchmark rates), but spread duration is likely to be high (because increases in spread do not flow through to higher coupons). This is addressed more fully in a later reading on credit strategies. If given both effective duration and convexity and spread duration and convexity in a question, use effective duration for part 3 and spread measures for part 4.

This return decomposition is a framework that is used to analyze the returns from active strategies over the next two readings. This is a **very** important series of calculations!

MODULE 11.3: LEVERAGE AND TAX ISSUES

Video covering this content is available online.

LOS 11.e: Discuss the use of leverage, alternative methods for leveraging, and risks that leverage creates in fixed-income portfolios.

CFA® Program Curriculum, Volume 2, page 263

Leverage is a way to increase portfolio return and is particularly attractive in periods of lower interest rates (and expected return). (The return on the portfolio can also be called the return on investor's investment or equity in the portfolio.) As long as funds can be borrowed (B) at rates below the return earned on the investments made ($r_I > r_B$), leverage will enhance portfolio return. Leverage also increases the exposure of the portfolio to interest rate risk and loses if interest rates increase above the return on portfolio assets ($r_I < r_B$). Borrowing is normally done at shorter-term interest rates, and those costs can increase faster than return on assets if interest rates increase. Said another way, the asset duration normally exceeds the liability duration in a leveraged portfolio.

The leveraged portfolio's return (return on investor equity) can be calculated as:

r_p = portfolio return (amount) / portfolio equity

$r_I + [(V_B / V_E) \times (r_I - r_B)]$

where:
r_p = return on portfolio
r_I = return on invested assets
r_B = rate paid on borrowings
V_B = amount of leverage
V_E = amount of equity invested

There are multiple ways to achieve leverage.

Repurchase agreements (repos) are an explicit way to borrow funds that could be used for leveraging. A securities owner "sells" a security for cash and simultaneously agrees to "buy" it back at a specified future date. The repo is functionally a way to borrow money, and the assets are the collateral for the loan. The loan term is often overnight, though the repo could be renegotiated the next day at a new interest rate. Longer repo terms are also possible. The borrowing nature of the transaction is even more evident in

the details of the transaction. A securities dealer might enter an overnight $100,000,000 repo at a 2.5% repo rate. This means the dealer receives 100,000,000 and pays back 100,000,000 × [1 + (0.025 / 360)] the next day. (This is the normal calculation methodology for repo rates.)

The actual securities "sold" are not typically specified, and the money borrower can deliver any types previously agreed to. This is called general collateral. For example, any domestic government bonds can be delivered, and their market value must equal 102% of the repo amount, in this case $102 million. The 2% is a haircut amount and provides additional security to the money lender. The lender now holds collateral worth more than the funds lent. The collateral is returned the next day (for an overnight repo) when the loan is repaid. Other kinds of collateral can also be allowed to secure the loan, and the haircut would be larger for riskier and less liquid securities. In other words, the repo rate may not need to be adjusted based on the quality of the collateral because the amount of collateral is adjusted.

The repo can be bilateral with cash and collateral securities directly exchanged between the two counterparties or tri-party. Tri-party repos use an intermediate third party (usually a bank) who holds the underlying collateral for the two counterparties and records the exchange of ownership. That is less costly than actually exchanging ownership between the two counterparties.

The above repo is cash driven and any collateral (previously agreed to by the parties to the repo) can be used. Repos can also be security driven. In a security driven repo, the money lender wants to have temporary possession of specific collateral. They may need it for some hedging or arbitrage reason and could offer a lower repo rate in exchange for delivery of a specific security. The repo is now a form of securities lending (and will be discussed later).

Futures contracts also provide leverage. Futures contracts can be purchased and require only a small initial margin deposit. The contract price times multiplier is the full price of the contract and the quantity of the underlying security now controlled. In other words, buying a bond contract at a full price of $105,607 requires only a small margin deposit but provides the upside and downside of buying that full amount of underlying bonds. The amount of leverage achieved can be calculated as:

leverage = (notional value of contract − margin amount) / margin amount

Swap agreements also provide leverage. Entering a 10 million notional 5-year receive 4% fixed versus pay LIBOR swap is equivalent to buying 10 million of 5-year 4% bonds and borrowing 10 million at a floating rate of LIBOR. A receive-fixed swap increases the portfolio's exposure to the bond market and its duration with no explicit investment of funds. A receive-floating versus pay-fixed swap would have the opposite effect. Traditionally, swaps did not require posting of collateral and were largely unregulated and unreported; the 2008–09 financial crisis has led many swap users to settle swaps through a central clearinghouse, providing some of the benefits of standardization and exchange trading.

Securities lending, as mentioned earlier, is closely related to the repo market, but the motivations are different. Securities lending often supports short selling. Short selling means selling a security that is not owned and receiving immediate payment for the security. In many cases, the security must be immediately delivered, so the short seller must borrow the security from someone else (and later return the security). A bilateral

repo can be used to do this. The securities borrower specifies the desired security or securities to be received. The lender of the securities will specify the amount and types of collateral that the securities lender will receive back.

The lender of the securities can specify receiving cash in exchange for the securities lent. The securities lender can then invest the cash (which is typically greater than the value of the securities lent) to earn interest and compensation. The securities lender could also agree to accept back general, high-quality government bonds as collateral. Suppose the securities lender lends 10 million of a specific bond and receives back 10.5 million of various government bonds in exchange. The securities lender earns the interest on that collateral. If those earnings are higher than the fair compensation for the securities lent, a portion might be rebated to the securities borrower. The rebate rate equals:

rebate rate = collateral earnings rate – security lending rate

PROFESSOR'S NOTE

Think of it as I need 50 million of bond X, you have it and will lend it to me if I compensate you. You will take back as collateral some larger amount (say 105%) of cash or general (not specific) government securities. You can use that collateral to find another way to make some money, and if I really needed bond X, this could induce me to pay you other explicit fees. Obviously, this is a very specialized market used by a small number of large participants.

Unlike the repo market, security lending agreements are usually open ended. They do not have a specified maturity and continue until one counterparty requires settlement, reversing the transaction with return of the collateral. This can create additional risk if the other counterparty was not prepared to reverse his part of the transaction.

Ultimately, the earnings of the securities lender depend on how badly the securities borrower needs that specific collateral. If the need is high, the securities lender can demand an explicit fee. The securities lender can also demand more cash be posted as collateral or require more general collateral to be delivered. Either increases what the securities lender can earn.

Risks Created by Leverage

In addition to the obvious risk, if the costs of borrowing increase above the earnings on the portfolio assets, other risks are also created. If interest rates increase, the value of the leveraged portfolio and collateral will decline. This may induce money lenders to demand repayment and force liquidation of portfolio assets when they are down in value. This is referred to as a fire sale, selling under distressed conditions. If such liquidations are widespread, they can produce a vicious cycle as each round of sales drives down prices, leading other credit providers, repurchase participants, and securities lenders to demand repayment and/or stop lending.

Managing Taxable and Tax-Exempt Portfolios

LOS 11.f: Discuss differences in managing fixed-income portfolios for taxable and tax-exempt investors.

CFA® Program Curriculum, Volume 2, page 268

Both tax-exempt and taxable investors should seek the highest possible risk-adjusted return net of fees and transaction costs, consistent with their objectives and constraints.

This is more complex for taxable investors because taxes must also be taken into account to determine after-tax return and risk. Different types of tax issues arise and differ by tax jurisdiction around the world. The following are some examples:

- The two sources of bond return are usually taxed differently. Income may be taxed at a different rate from capital gains (price change). Both are usually taxed only when realized, but there are exceptions. For zero-coupon bonds, imputed income (increase towards par) may be taxed each year as income even though there is no cash flow.
- In general, capital gains are only taxed at sale and at a lower tax rate than for interest income. Gains on securities held for a longer period may be taxed at a lower rate than on securities held for a shorter period.
- Capital losses may only be allowed to be used to offset capital gains, but not other income sources. But if capital losses exceed gains, they may be carried forward to offset future realized gains. (In some cases, the realized losses can be carried back to reduce taxes already paid for a previous year, generating a tax reduction or refund on the current tax return.)
- It may be possible to invest some portions of the portfolio in tax-sheltered or tax-advantaged accounts.

Strategies to use in managing taxable accounts include:

- Realize capital losses to offset gains. This can include selective tax loss harvesting for partial sales when the investment was acquired at multiple prices.
- Extend holding periods to realize long-term, rather than short-term, capital gains.
- Extend holding periods to defer taxes.
- Consider differentials in income versus gain tax rates when selecting investments.

PROFESSOR'S NOTE

The above is just a listing of issues from earlier readings. Review the earlier material if it seems unfamiliar.

Taxation of investments in mutual funds and other collective investment funds varies by country. Income on the underlying assets is usually taxable to the fund investors when it is earned by the fund, regardless of whether the income is paid out or reinvested in the fund. However, the taxation of gains realized within the fund varies.

- Some countries use pass-through taxation of gains. The fund investor is taxed when the fund realizes the gain and that tax payment subsequently reduces taxes on gains when the investor sells the fund shares.
- Other countries use deferred taxation of the gains realized within the fund and instead tax the investor on all gains when the fund shares are sold.

In contrast, when a client hires a manager to manage the client's portfolio directly (a separately managed account) all income, gains, and losses in the portfolio are normally reported on the client's tax return and taxable to the client.

EXAMPLE: **Taxable vs. tax-exempt portfolios**

A manager must raise EUR5,000,000 to meet a client's need for funds. The client's portfolio is separately managed, and all tax issues are passed through and immediately taxable to the client. Income and capital gains tax rates are 38% and 15%, respectively. The manager is looking at two

bonds and will sell all of one or of the other. Both have market value of EUR5,000,000 and have the same remaining maturity, coupon, and credit quality. Any taxes owed due to the sale are to be ignored in the analysis and covered by other client funds. Bond A has a significant unrealized gain, while bond B has a significant unrealized loss. The manager believes the bonds are substantially identical except bond B has a slightly higher yield.

Select the bond the manager will sell and **explain** why if the investor is 1) taxable, or 2) tax-exempt.

Answer:

1. Taxable: Sell bond B to avoid realizing a gain and paying a tax now.
2. Tax-exempt: Sell bond A to retain bond B and its slightly better yield.

MODULE QUIZ 11.2, 11.3

To best evaluate your performance, enter your quiz answers online.

1. Suppose that a bond portfolio has 25 million in notional principal and an average annual coupon rate of 5%. The average bond duration of the portfolio is computed as 8, and the average convexity of the portfolio is 0.5. If an investor in this portfolio expects the average yield to be 0.35% with no change in spread, the expected portfolio price change due to the investor's forecast is *closest* to:
   A. –1.752%.
   B. –2.799%.
   C. –3.978%.
2. A credit investor is interested in using leverage in his portfolio to enhance return. Which of the following statements is *most correct* regarding the use of leverage and the risks that leverage creates when implemented in fixed-income portfolios?
   A. If interest rates increase, the value of the leveraged portfolio and collateral decline.
   B. Liability duration normally exceeds asset duration.
   C. As long as funds can be borrowed at rates above the return earned on the investments made, leverage will enhance portfolio return.
3. When managing fixed-income portfolios for taxable investors, which of the following strategies should *most likely* be applied?
   A. Realize capital gains to offset any losses.
   B. Shorten holding periods to realize long-term, rather than short-term, capital gains.
   C. Consider differentials in income versus gain tax rates when selecting investments.

KEY CONCEPTS

LOS 11.a

Fixed income as an asset class provides three major roles when added to an investment portfolio: diversification, regular cash flows, and inflation protection (in the form of floating-rate securities and inflation-linked securities).

There are two major classifications of fixed-income mandates: liability-based mandates, which invest to fund future liabilities, and total return mandates, which invest to track or beat a benchmark.

Types of liability-based mandates include cash-flow matching, duration matching, and contingent immunization strategies.

- Cash-flow matching funds liabilities with coupon and par amounts received on the dates the liabilities are paid.

- Duration matching matches asset and liability duration to achieve comparable results. Duration matching generally gives more flexibility in asset selection and, therefore, may meet the objective at a lower cost.
- Contingent immunization is a hybrid of active management with potential immunization. The portfolio must initially be overfunded and can be actively managed. If successful (unsuccessful), the surplus will grow (be lost) and the ultimate cost will end up being lower (higher) than from immunization.

Types of total return mandate include:

- Pure indexing, which exactly matches the holdings of the index.
- Enhanced indexing, which allows modest deviations (but matches duration to control interest rate risk).
- Active management, which does not restrict deviations versus the index and allows duration mismatches.

LOS 11.b

Bond risk and return measures include the following:

- Macaulay duration is the weighted average time to receive cash flows.
- Modified duration is the estimated percentage change in a bond price given a 1% change in yield [measured as Macaulay duration / (1 + the periodic yield of the bond)].
- Effective duration is the modeled estimated percentage change in a bond price given a 1% change in a benchmark curve. It is used for bonds with embedded options.
- Key rate duration (partial duration) is the estimated percentage change in a bond price given a 1% change in a key benchmark maturity yield while other yields remain the same.
- Empirical duration is the actual sensitivity of a bond's price relative to movements in a benchmark rate from a linear regression.
- Money duration (dollar duration) equals modified duration × market value. It gives a sense of size, as well as sensitivity.
- Price value of a basis point [DV01 or basis point value (BPV)] equals money duration × 0.0001. It measures the absolute currency sensitivity to a basis point move in rates.
- Convexity measures the curvature of the relationship of price and yield. More-convex bonds are expected to outperform less convex bonds when yields shift.
- Effective convexity models convexity when cash flows are not certain. It is used for bonds with embedded options.

Macaulay duration increases linearly with maturity.

Convexity is approximately proportional to duration squared.

Convexity is also directly related to the dispersion of cash flows in time around the Macaulay duration.

To aggregate duration and convexity measures for a portfolio of fixed-income assets, the cash-weighted average of the durations and convexities of the individual bonds is usually used.

Spread duration is the sensitivity of a bond's price to a unit change in spreads.

Duration times spread (DTS) = spread duration × credit spread. It reflects the fact that bonds with larger spreads tend to have larger movements in spread.

A manager who expects interest rates to rise (fall) will lower (increase) duration.

A manager who expects credit spreads to widen (narrow) will lower (increase) spread duration.

Relative value analysis involves the ranking of individual bonds according to fundamental value drivers in order to pick the best securities to express a top-down view on markets.

LOS 11.c

Liquidity in the bond market (ability to buy or sell on a timely basis at or near fair market value) is substantially lower than in equity markets.

Most bonds do not trade or trade infrequently after issuance (said to go "off-the-run").

The sheer number and variety of individual bond issues is immense.

The market is mostly over-the-counter with trade price and volume not reported.

Liquidity is highest for sovereign government, higher-quality, and most recently issued (on-the-run) bonds.

Smaller issues are generally less liquid.

Effects:

- Bond pricing data is more difficult to obtain.
- Portfolio managers have to choose between more-liquid bonds or less liquid bonds that may offer a liquidity premium.
- Derivatives and ETFs are generally more liquid and an alternative to direct investment in bonds.

LOS 11.d

Return can be projected (or actual return decomposed) as the sum of the following:

1. Coupon income: annual coupon amount / current bond price.
2. Rolldown return, assuming no change in yield curve: (projected ending bond price (BP) – beginning BP) / beginning BP.
3. Price change due to investor yield change predictions: (–MD × ΔY) + (½C × ΔY2).
4. Price change due to investor yield change predictions: (–MD × ΔS) + (½C × ΔS2).
5. Currency G/L: projected change in value of foreign currencies weighted for exposure to the currency.

Coupon income + rolldown return may be referred to as rolling yield.

LOS 11.e

- Leveraged portfolio return can be calculated as $r_I + [(V_B / V_E) \times (r_I - r_B)]$.
- If r_I exceeds (is below) r_B, the leverage enhances (reduces) portfolio return.
- Repurchase agreements (and securities lending), futures contracts, and swaps can all be used to leverage return.

- In addition to the detrimental effects if r_I is less than r_B, the lender of the funds can demand repayment, forcing liquidation of portfolio assets at fire sale prices, which can feed a financial crisis.

LOS 11.f

Taxes complicate portfolio management, as managers seeking to maximize return must consider the different tax effects of each portfolio decision.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 11.1

1. **B** Inflation-linked bonds provide direct protection for the effects of inflation. They protect coupon payments from inflation and adjust par (i.e., principal) for inflation. Floating-coupon securities also provide protection from change in inflation, but the adjustment mechanism is different and only affects the coupon. Fixed-coupon bonds do not protect coupons or principal from the effects of inflation. (LOS 11.a)

2. **C** Pure indexing attempts to replicate the performance of a bond index. It seeks to exactly match all of the risk factors of the index while still allowing the manager some leeway on the individual bonds selected. Enhanced indexing allows some additional flexibility in constructing the portfolio and seeks to add some modest active return. Active management allows much larger deviations from the risk factors of the index and seeks greater active return. (LOS 11.b)

3. **B** Liquidity for on-the-run high-quality sovereign government debt is high and declines somewhat for older off-the-run issues. These government bonds are usually large in size and have a high level of credit quality. Liquidity among corporate bonds typically declines with lower quality as the bonds become riskier and with the size of the issue (i.e., smaller issuers are less liquid). (LOS 11.c)

Module Quiz 11.2, 11.3

1. **B** Expected price change is calculated from the investor's expected change in yield using the portfolio's duration and convexity as follows: (–MD × Y) + (½C × Y2) = (–8 × 0.0035) + (½ × 0.5 × 0.00352) = –0.028 + 0.000003 = –2.7997%. Note that the expected change in spread is zero; hence, there is no impact on price from changes in spread. (Module 11.2, LOS 11.d)

2. **A** If interest rates increase, the value of the leveraged portfolio and collateral decline. As long as funds can be borrowed at rates *below* the return earned on the investments made, leverage will enhance portfolio return. Asset duration normally *exceeds* the liability duration in a leveraged portfolio. The other statements are false because a typical leverage transaction involves borrowing at lower shorter-term rates (and therefore in a liability with low duration) to invest at longer-term higher rates (and therefore in an asset with higher duration). (Module 11.2, LOS 11.d)

3. **C** Strategies to use when managing taxable accounts include:
   - Realize capital *losses* to offset *gains*.
   - *Extend* holding periods to realize long-term, rather than short-term, capital gains.

- Consider differentials in income versus gain tax rates when selecting investments.

  (Module 11.3, LOS 11.f)

The following is a review of the Fixed-Income Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #12.

READING 12: LIABILITY-DRIVEN AND INDEX-BASED STRATEGIES

Study Session 5

EXAM FOCUS

We now turn to the substantive discussion of liability-based and index-based fixed-income management approaches.

MODULE 12.1: LDI, BASICS

Video covering this content is available online.

LOS 12.a: Describe liability-driven investing.

CFA® Program Curriculum, Volume 2, page 284

Broadly speaking, **liability-driven investing** (LDI) is used when there are definable future liabilities to be paid from portfolio assets. It is classified as passive total return, but in this context, that does not mean nothing should be done—as many of these strategies require continual monitoring and adjustments. (In contrast, active management generally means managing to outperform a specified index or benchmark.) The specific LDI approach used depends on the nature of the liabilities. LDI is mostly used for institutional portfolios. There are some commonly used terms:

- **Asset-liability management** (ALM) means strategies that consider assets in relation to liabilities. It is appropriate when both the present value (PV) of the assets and liabilities change with changing interest rates.
- **Liability-driven investing** (LDI) or liability-based investing takes the liabilities as a given and manages the assets to meet those future liability values—for example, there is an insurance company or defined benefit (DB) pension plan that must fund future liability payouts. (Note that LDI is now being used in a more specific way than in the initial paragraph. The focus of this reading is on this more specific type of LDI investing, where the liabilities are taken as a given and the assets are managed in relation to those liabilities.)
- **Asset-driven investing** (ADI) takes the assets as a given and manages or adjusts the liabilities in relation to those assets. For example, a leasing company with specific types of floating- or fixed-rate financial assets may structure its liabilities to match the characteristics of those assets.

LDI can also apply to individuals, particularly when the goal is to accumulate sufficient funds to meet retirement. Consider a married individual who plans to retire in 12 years and is planning to use the value of his bond portfolio to fund the purchase of an annuity. He will reinvest any cash flows from the bonds and could also plan to add a regular amount to the bond position every year to meet the goal.

Four types of liabilities exist:

1. **Known future amount(s) and payout dates(s), called Type I**. The issuer of an option-free fixed-rate bond has this type of liability. We will see that these are the easiest type of liability to model.
2. **Known future amount(s) but uncertain payout dates(s), called Type II**. The issuer of a callable or putable bond has this type of liability. An insurance company selling term life insurance also fits here. The amount of payout is known, but the date of payout on any single policy is not. (However, actuaries can apply the law of large numbers to estimate likely payout amounts in any given period with considerable accuracy.)
3. **Uncertain future amount(s) but known payout dates(s), called Type III**. Floating rate instruments and real rate bonds such as Treasury Inflation Protection Securities (TIPS) fall in this category.
4. **Uncertain future amount(s) and uncertain payout dates(s), called Type IV**. Property and casualty as well as some DB plan liabilities fall in this category.

Simple duration (Macaulay or modified) is adequate to model Type I liabilities. The others require effective duration—modeled to reflect the initial shape of the yield curve plus assumed upward and downward shifts in the yield curve to estimate the potential amount and timing of liability payouts.

Immunizing a Single Liability

LOS 12.b: Evaluate strategies for managing a single liability.

CFA® Program Curriculum, Volume 2, page 287

Immunization is a fixed-income management process in which the portfolio is managed to minimize the variability of the rate of return earned over a specified time period. That means the future value (FV) of the portfolio can be confidently predicted, and if enough funds are invested initially, a known future liability can be funded.

Cash flow matching is the simplest but least flexible approach to immunizing. For a single liability, buy a zero-coupon bond with par and maturity matching the liability. With no cash flows to reinvest or bonds to sell, there is no cash flow or price risk. The bonds must also be default free.

Because a single liability is effectively a zero-coupon liability, its time to payment is also its Macaulay duration. Thus, a cash flow matched immunized portfolio will match the Macaulay durations of the assets and liabilities.

Macaulay duration is the weighted average time until the cash flows of an instrument are received. That is why Macaulay duration of a zero-coupon instrument is its maturity, but Macaulay duration of a non-zero-coupon instrument is less than its maturity. The weights are based on each cash flow's PV as a percentage of the total PV of the instrument's cash flows (the latter being the price of the instrument).

Macaulay duration is also a balance point where price and reinvestment risk offset each other:

- **Price risk** is the uncertainty of proceeds if a bond must be sold before maturity.
- **Reinvestment risk** is the uncertain FV of any cash flows received and reinvested before the end of the holding period.

If it is assumed interest rates change only once, immediately, in parallel fashion, and by a small amount, then:

- If rates increase, higher earnings from reinvesting all cash flows will offset a loss on price at the end of the horizon period.
- If rates decrease, lower earnings from reinvesting all cash flows will offset a gain on price at the end of the horizon period.

The unreasonable nature of the assumptions will be dealt with soon.

Modified duration is Macaulay duration divided by 1 plus the periodic interest rate used to compute the cash flow PVs:

- Modified duration is the (slightly) more accurate measure of immediate price change of the instrument.
- Macaulay duration is the (slightly) more appropriate measure of time for some immunization techniques.

Computing portfolio statistics: Portfolio yield (meaning YTM), duration, dispersion of cash flows, and convexity are commonly computed as weighted averages based on market value weighting of each holding in the portfolio. **For ALM, these average computations are less accurate than portfolio statistics computed directly from the portfolio's aggregate cash flows.**

PROFESSOR'S NOTE

There is no LOS or indication that you should try and make these portfolio statistic calculations. They are provided, and your challenge is to understand how to apply them in immunization situations. The actual process would require access to computer spreadsheet tools. The process is summarized here for those interested.

1. Project the time to receipt (starting with the nearest to most distant) of every portfolio cash flow.
2. Determine the aggregate portfolio cash flow in each period. The analysis uses six-month periods.
3. Determine the portfolio IRR that equates future cash flows with the current market value of the portfolio.
4. Use that IRR to determine the PV of each future cash flow from step 2. (The sum of those PVs will be the current portfolio market value.)
5. Calculate the PV weight (w) to apply to each payment as its PV (step 4) divided by the sum of the PVs.
6. For each cash flow, multiply its *(w)* by its time until receipt *(t)*. The sum of the *(w)(t)*s is the portfolio's Macaulay duration. Duration is normally expressed in years, so if the cash flow periods were in six-month increments, divide by 2 (two six-month periods in a year) for annual duration.
7. Portfolio dispersion is computed as the weighted average variance of when each cash flow is received around portfolio duration. (Remember, duration is just the weighted average of when all the cash flows are received).
8. Portfolio convexity can be computed by summing for each cash flow: *[(t)(t + 1)(w)]* and then divide this sum by $(1 + \text{portfolio } IRR_{\text{periodic}})^2$.

Here is what to focus on:

Portfolio statistics should be used for ALM work rather than traditional weighted average calculations based on each bond. The difference in the two approaches is determined by the shape of the yield curve:

- With a flat yield curve, there is no difference.

- In an upward-sloping yield curve, portfolio duration and IRR will be higher-than-average duration and YTM of the bonds because portfolio statistics reflect all cash flows (and return) to be received and the longer maturity bonds will impact the portfolio for a longer time.
- (Downward sloping curves are unusual and not discussed. In such a situation, you would build a spreadsheet and calculate all the numbers to see what happens. You cannot make such spreadsheet calculations on the exam.)

The goal of the immunized portfolio is to earn the initial portfolio IRR, not the average YTM of the bonds. Earning the IRR means the portfolio will grow to a sufficient FV to fund the liability.

PROFESSOR'S NOTE

Although we have just made the point that portfolio-level statistics based on aggregate portfolio cash flow and IRR should be used, be aware that it is not unusual to use simple weighted average date (such as YTM and duration) as approximations. That would add some error to the analysis.

The dispersion will be important because it is related to convexity and the convexity effect. Convexity matters because, when combined with modified duration, it provides a more accurate measure of estimated price change. Recall that %Δ in value = $(-\text{MD} \times \Delta Y) + (\frac{1}{2}C \times \Delta Y^2)$.

But more specifically, in relation to immunization:

$$\text{convexity} = \frac{\text{Macaulay duration}^2 + \text{Macaulay duration} + \text{dispersion}}{(1 + \text{periodic IRR})^2}$$

The dispersion and convexity will indicate the risk exposure of the immunization strategy to structural risk from shifts and twists in the yield curve.

Effects of Yield Curve Changes

Assume that the portfolio is being used to immunize a single liability (sometimes called a bullet) due in five years, the portfolio and liability D are initially matched at the 5.0 medium (M) duration of the liability, the initial value of the portfolio equals the discounted (at portfolio IRR) PV of the liability, and portfolio convexity exceeds convexity of the single cash flow liability. We can create an extreme situation to demonstrate the issues. Assume that the portfolio is made up of two bonds with a shorter (S) and longer (L) duration than the liability duration (M). This describes a barbell portfolio strategy, concentrating the assets in longer and shorter duration around the liability's single (bullet) duration.

If the yield curve shifts up or down in parallel fashion, the portfolio results will slightly exceed the amount required to pay the future liability. Duration matching alone would have led to meeting the future liability need, but the additional positive convexity of the assets will lead them to outperform duration results alone for large parallel shifts in the curve. (Recall the dispersion of cash flows and thus the convexity of the two-bond portfolio must exceed that of the single-point liability.)

- For a large parallel increase in the curve (Figure 12.1), the immediate decrease in portfolio value will be less than the decrease in the PVL due to the positive convexity effect. With the parallel increase, the new portfolio IRR will increase by

basically the same amount as the increase in discount rate for the PVL. In other words, the future rate of increase in A and L are still the same, but starting from a new PVA that is relatively higher than the PVL, the FVA will exceed the FVL.

- For a large parallel decrease in the curve (Figure 12.2), the immediate increase in portfolio value will exceed the increase in the PVL due to the positive convexity effect. With the parallel decrease, the new portfolio IRR will decrease by basically the same amount as the decrease in discount rate for the PVL. In other words, the future rate of increase in A and L are still the same, but starting from a new PVA that is relatively higher than the new PVL, the FVA will exceed the FVL.

Figure 12.1: Parallel Yield Shift Up

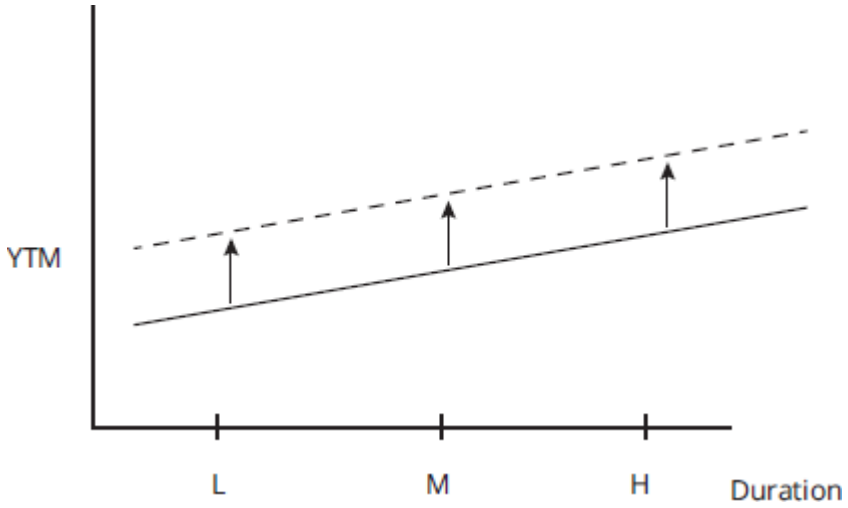
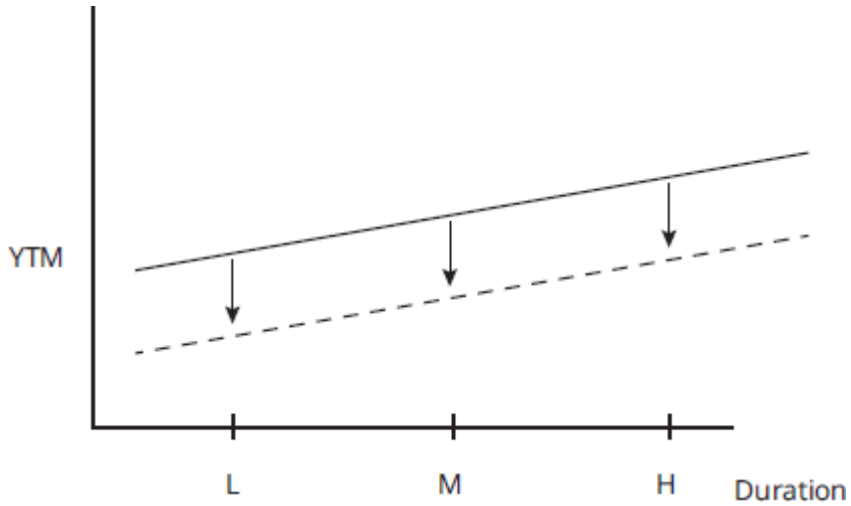


Figure 12.2: Parallel Yield Shift Down



The parallel shift analysis indicates that the duration (rather than cash flow) matching immunization strategy does have **structural risk**. The structural risk is due to creating portfolio duration with a different allocation of asset durations (L and H) versus the allocation of liability durations (M only). That can lead to differing performance of the assets and liabilities as the yield curve shifts. Fortunately, most interest rate changes can be described as roughly parallel, and by building the portfolio with an asset dispersion (hence, convexity) that exceeds the single liability payout date, the portfolio benefits from the structural risk.

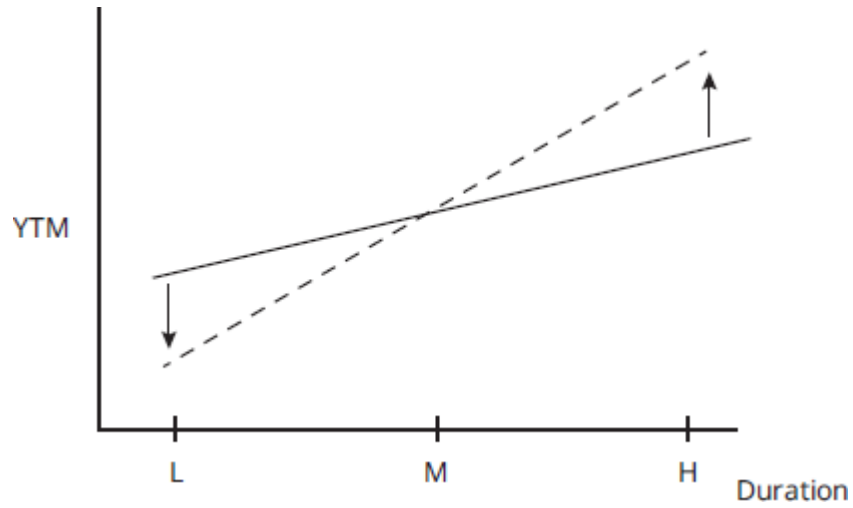
The parallel shift analysis:

- Indicates that immunization can be described as *zero replication*. A single zero-coupon bond could have been used for a no-risk, perfect cash flow match. The changes in portfolio value and IRR have replicated (or done better due to positive convexity) the changes in yield and value of that replicating zero-coupon bond. In general, if the change in portfolio IRR matches change in yield of the replicating zero, the risks for the strategy are low.
- Does not indicate the strategy is always structurally risk free. Other kinds of yield curve reshaping may or may not cause the strategy to fail in meeting the future payout. These other reshapings are discussed shortly.
- Does indicate the parallel shift assumption is sufficient to lead the strategy to succeed—but it is not a necessary assumption because the strategy may still be successful in other conditions. It is *sufficient,* but not *necessary*.
- Does not mean the strategy is buy and hold. Coupon-bearing bond duration declines more slowly than maturity, while the bullet liability duration will decline linearly with the approaching pay date. To maintain the immunization, the portfolio assets must be continually rebalanced to continually match portfolio to liability duration as time or market conditions change; otherwise, the strategy is at risk.

If the curve either steepens or flattens, the analysis becomes more complex and the structural risk increases. Assume for this discussion that rates do not change for the M duration liability, but move in roughly opposite directions for the L and H duration assets.

- Steepening twist (Figure 12.3): Yield L decreases while yield H increase relative to yield M. The portfolio market value will decrease because the decline in value of the longer duration bond will exceed the increase in the value of the shorter duration bond. PVL will be unchanged with no change in yield M. PVA is now below PVL. That, by itself, does not indicate the strategy will fail. If portfolio IRR increases sufficiently, the required FV might still be reached. (Recall that portfolio IRR would tend to increase above a single point M YTM with a steeper curve). This indicates that a steepening curve may create structural risk.

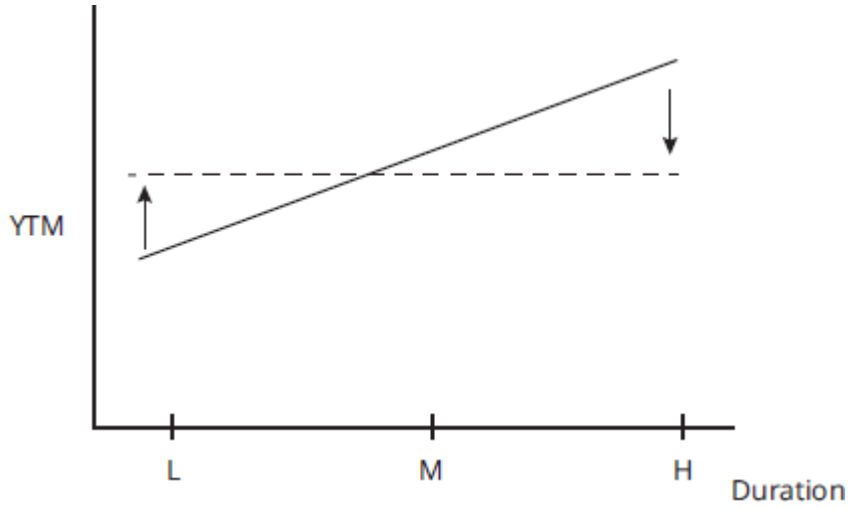
Figure 12.3: Steepening Twist



- Flattening twist (Figure 12.4): Yield L increases while yield H decrease relative to yield M. The portfolio market value will increase because the increase in value of the longer duration bond will exceed the decrease in the value of the shorter

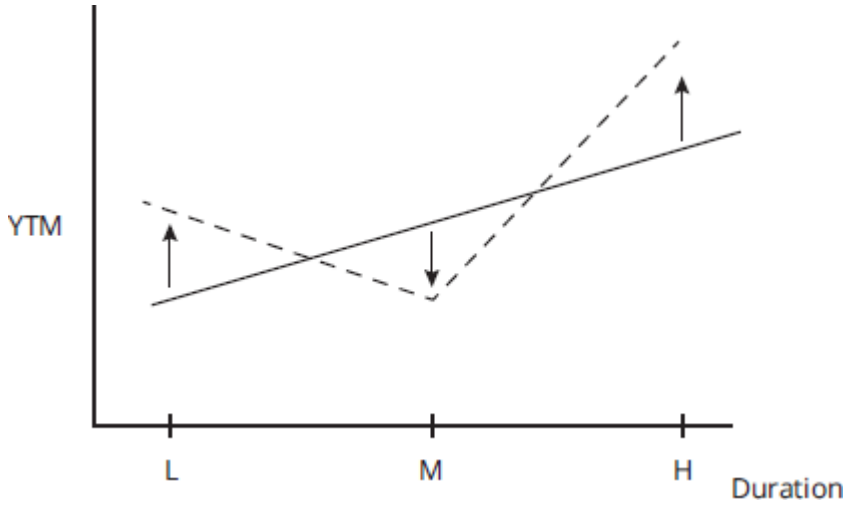
duration bond. PVL will be unchanged with no change in yield M. PVA is now above PVL. That, by itself, does not indicate the strategy will succeed. If portfolio IRR decreases sufficiently, the required FV of assets to meet the payout may not be reached. (Recall that portfolio IRR would tend to decrease below a single point M YTM with a flatter curve). This indicates that a flattening curve may create structural risk.

Figure 12.4: Flattening Twist



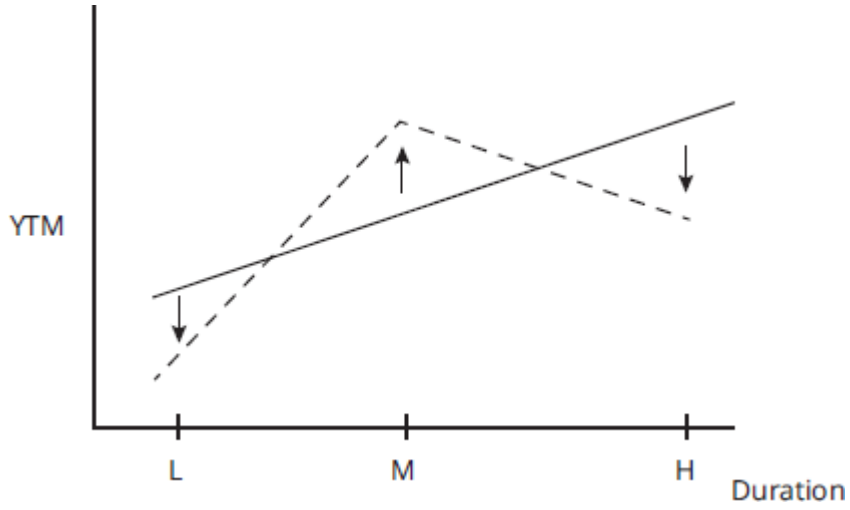
- Positive butterfly twist (Figure 12.5): Yield L and H increase while yield M decreases. The portfolio market value will decrease as both yield L and H increase. PVL will increase as yield M decreases. PVA is now below PVL. That is certainly detrimental, but it is possible the strategy could succeed if the portfolio IRR increases enough versus the decrease in liability discount rate. This indicates that the positive butterfly may create significant structural risk.

Figure 12.5: Positive Butterfly Twist



- Negative butterfly twist (Figure 12.6): Yield L and H decrease while yield M increases. The portfolio market value will increase as both yield L and H decrease. PVL will decrease as yield M increases. PVA is now clearly above PVL. That is certainly favorable, but does not guarantee the strategy will succeed if the portfolio IRR decreases too much in relation to the increase in liability discount rate. It again indicates the possibility of significant structural risk.

Figure 12.6: Negative Butterfly Twist



The risk in immunization is higher when the change in portfolio IRR does not match the change in yield of the replicating zero or is insufficient to fund the liability at the new level of rates. This structural risk can be reduced by reducing the dispersion of asset cash flows around the liability cash flow. This is not surprising because if you make dispersion 0, you have a zero-coupon bond and a perfect cash flow match to the single liability. Now, recall the earlier equation for determining convexity from duration and dispersion; reducing dispersion is directly related to reducing convexity. This leads to the rules for immunizing a single liability:

1. Initial portfolio market value (PVA) equals (or exceeds) PVL. (There are exceptions to this for more complex situations where the initial portfolio IRR differs from the initial discount rate of the liability.)
2. Portfolio Macaulay duration matches the due date of the liability ($D = D_L$).
3. Minimize portfolio convexity (to minimize dispersion of asset cash flows around the liability and reduce risk to curve reshaping).
4. Regularly rebalance the portfolio to maintain the duration match as time and yields change. (But also consider the tradeoff between higher transaction costs from more frequent rebalancing versus the risk of allowing durations to drift apart.)

PROFESSOR'S NOTE

It may seem strange to require minimizing convexity of assets when +C is good for immediate price change. But that ignores the real issue of immunization, failing to reach the FV needed to pay the liability.

Money duration: The first two conditions of immunization can be combined by matching money duration of the assets and liability. Money duration is the money change in value of the assets or liability for change in interest rates. It can be calculated as modified duration (MD) multiplied by the value of the item multiplied by a specified change in yield of the item. It is common to express it as **basis point value** (BPV):

$$BPV = MD \times V \times 0.0001 = \text{price value of a basis point}$$

BPV is also referred to as *price value of a basis point* (PVBP) or value of an 01, meaning a 1 BP change in rates.

Immunizing Multiple Liabilities

LOS 12.c: Compare strategies for a single liability and for multiple liabilities, including alternative means of implementation.

LOS 12.d: Describe construction, benefits, limitations, and risk–return characteristics of a laddered bond portfolio.

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Cash flow matching is the safest approach. In some cases, this may allow *accounting defeasance* where the assets are legally set aside and dedicated to meet the labilities—allowing both those assets and liabilities to be removed from the balance sheet of the organization responsible for paying the liability. The simplest cash flow match is to buy zero-coupon bonds in the amounts and due dates to meet each liability.

- Cash flow matching of a stream of liabilities may also be possible using coupon-bearing bonds. In concept, a bond is purchased due on and with par plus (+) final coupon to exactly fund the longest liability. Its earlier coupon payments can be used to partially meet the earlier liabilities. Then, in recursive fashion, the next-longest liability is funded by buying a bond due on and with par plus (+) final coupon to exactly fund that next-longest liability (after considering the coupon of the bond or bonds already purchased for the longer liability or liabilities).
- In practical terms, it is unlikely that the coupon-bearing bonds necessary for perfect cash flow matching will exist. A *cash-in-advance* constraint could be used, requiring the bond used to fund a specific liability to mature before the required payout date of the liability. This would expose the portfolio to reinvestment risk in an upward-sloping yield curve. The upward-sloping curve is anticipated to create reinvestment risk because as cash comes in to be reinvested for a short time period until payout, the reinvestment must be at the lower rates at the short end of the curve.

Laddered portfolios can be used in cash-flow matching multiple liabilities. A laddered portfolio has roughly equal par amounts purchased across different maturities. The same duration could also be achieved by concentrating all the holdings in a single middle duration (a bullet portfolio) or in a combination of shorter and longer duration holdings (a barbell portfolio). If all three portfolios have the same duration, they all have roughly the same price sensitivity to a parallel yield curve shift. The advantages of the laddered portfolio include the following:

1. The portfolio has regular liquidity, as some bonds come due each year. This is particularly significant if less liquid bonds such as corporates are used because the need to sell bonds at large bid-ask spreads to generate required cash flows is reduced. These near-to-maturity bonds would also be treated as less risky collateral and could be used to borrow at favorable interest rates.
2. There is broad diversification of cash flow across time and the yield curve and less concentrated exposure to nonparallel changes at specific maturities on the curve.
3. There is diversification between price risk on long-dated bonds and reinvestment risk on short-dated bonds. The bonds that mature each year can be reinvested at long-term, typically higher, rates, keeping the overall duration of the portfolio stable over time.

4. The laddered portfolio will have more convexity than the bullet, a benefit if there are large parallel shifts. Recall that convexity is directly related to the dispersion of cash flows across time. Note that the ladder, however, will not be as convex as a barbell portfolio.

- An alternative to building laddered bond portfolios with individual bonds is to use a laddered portfolio of **target-date** (fixed-maturity) bond ETFs. Each ETF has a designated year when it will mature and be paid off. It is passively managed to replicate the performance of a bond maturing in that year. For many investors, the ETF will offer cost advantages compared with purchasing individual bonds and have more liquidity if unanticipated sales are needed.
- Laddered portfolios do have some disadvantages. For some investors, an ongoing (no target date) passive index or active bond fund may be better. These ongoing funds are likely to be larger, provide greater diversification of credit risk, and be more liquid than directly investing in the underlying bonds.

Duration matching is a more flexible and generally practical approach to funding multiple liabilities. Like immunizing a single liability, there must be sufficient assets to fund the liability, and Macaulay durations of assets and liabilities (in this case, the average liability duration) must match. However, matching money durations is the more common approach. Money duration is more useful when initial amounts and discount rates of assets and liabilities differ. The rules for immunizing multiple liabilities become the following:

1. Initial portfolio market value (PVA) equals (or exceeds) PVL. (There are exceptions to this for some situations where the initial portfolio IRR differs from the initial discount rate of the liability.)
2. Portfolio and liability basis point values match ($BPV_A = BPV_L$).
3. Asset dispersion of cash flows and convexity exceed those of the liabilities. (But not by too much, in order to minimize structural risk exposure to curve reshaping).
4. Regularly rebalance the portfolio to maintain the BPV match of A and L as time and yields change.

EXAMPLE: **U.K. bond company**

A U.K.-based company has several option-free bond issues (liabilities) outstanding. The company would like to retire the bonds early, and has more than sufficient funds to do so. The company considers a bond tender offer (offer to repurchase the bonds from the public), but the bonds are widely distributed among buy-and-hold investors. The prices that would have to be paid are too high to make the tender desirable to the company.

The company could also establish a dedicated cash flow matched portfolio of U.K. government bonds and legally defease the bonds. In that case, both the company's bond liabilities and assets (the cash flow matching bond portfolio) could be removed from the company's balance sheet. The cost of the portfolio would be GBP475 million, and the company considers this too high.

The third alternative is to establish a duration matching portfolio; using high-quality corporate bonds, the cost will be less than for the government bond portfolio. While the portfolio will not qualify for defeasance, the company believes it will improve its credit rating and is the better choice.

The portfolio statistics for the company's liabilities and three proposed corporate bond portfolios are shown in the following table. All calculations are annualized and based on aggregate portfolio cash flows. Each portfolio is considered sufficient to pay the liabilities. Monetary amounts are in GBP:

Statistics	Company's Liabilities	Proposed Portfolios		
		A	B	C
Market value	457,780,900	Approximately 460,000,000		
Modified D	7.52	7.51	7.53	7.37
BPV	344,250	343,100	345,400	339,120
Convexity	45.12	35.14	46.29	65.97

1. **Select** the most appropriate portfolio (A, B, or C) to immunize the liabilities and **justify** your selection with *two* reasons.
2. If the company expects high volatility and the potential for very large parallel shifts in the yield curve, **select** the *one* other portfolio (A, B, or C) it would most likely consider and **explain** why.

Answers:

1. Portfolio B—because (1) its BPV closely matches, and (2) its convexity slightly exceeds that of the liabilities.
2. Portfolio C—while the BPV is not as good a match, it has much higher convexity, and this would increase return relative to change in liability values for large parallel shifts in the yield curve.

MODULE 12.2: MANAGING A DURATION GAP

Video covering this content is available online.

A **derivatives overlay** can be used to adjust the portfolio and maintain the duration match without the expense of adjusting the underlying assets. Futures contracts are often used.

In the United States, there are various Treasury futures contracts available based on the 30-year bond, as well as 2-, 5-, and 10-year Treasury notes. Each contract specifies a set of deliverable securities that the contract seller may deliver at contract expiration. The seller must deliver 100,000 par of a deliverable security [also called *most deliverable bond* or *cheapest to deliver* (CTD) bond]. The buyer must pay the seller the initial contract price multiplied by the conversion factor for that bond (CF_{CTD}) that the seller chooses to deliver. In recent years, an Ultra 10-year contract was developed that specifies a much narrower range of deliverable notes. The purpose of this was to limit the deliverable items to ones that have a duration much closer to that of the 10-year note. The issue of which bond the seller chooses to deliver is important because the duration of that CTD determines the duration (price volatility) of the contract—hence, its BPV. The exact calculation of contract BPV is complex (not covered by CFA material), but is approximately:

$$\text{futures BPV} \approx \frac{\text{BPV}_{CTD}}{\text{CF}_{CTD}}$$

Calculating the number of contracts required to adjust the portfolio assets is simply the desired change in BPV divided by the BPV of the contract:

$$N_f = \frac{\text{BPV of liability} - \text{BPV of current portfolio}}{\text{BPV of futures}}$$

EXAMPLE: **U.K. bond company revised**

Suppose the U.K.-based company seeking to immunize its bond liabilities had instead chosen to immunize only a portion of its debt. The company selected an asset portfolio with a BPV of 217,525 to

immunize a portion of the liabilities with a BPV of 217,512—a duration gap of only 13. After a modest increase in rates with a significant positive butterfly twist, the asset and liability BPVs are now 203,456 and 218,517 for a duration gap of 15,061.

Assume that there are government bond–based futures contracts based on 5- and 10-year notes, with features similar to U.S. Treasury–based futures contracts. Each contract specifies a range of deliverable government notes that the contract seller may select for delivery at contract expiration. Each deliverable note requires the seller to deliver 100,000 par and the buyer to pay initial contract price multiplied by the conversion factor for that bond (CF_{CTD}).

Figure 12.7: Characteristics of the CTD Note for the 5- and 10-Year Contracts; Per 100,000 Par

CTD Characteristics	5-Year Contract	10-Year Contract
YTM	1.71%	2.51%
Modified D	4.75	8.67
BPV of CTD	48.1650	86.7001
Conversion factor	0.9237	0.9169

1. **Determine** and **justify** if contracts will be bought or sold, assuming:
   i. the 5-year contract is used.
   ii. the 10-year contract is used.
2. **Calculate** contracts to use, assuming:
   i. the 5-year contract is used.
   ii. the 10-year contract is used.
3. If the liability duration is 8.99, **state** which contract is most likely to minimize structural risk based only on the information provided. You must choose either the 5 or 10 year, and not a combination of both. **Justify** your answer.

Answers:

1. To increase asset BPV to match liability BPV, buy contracts regardless of which contract is used.
2. i. Contract BPV ≈ 48.1650 / 0.9237 = 52.1436(218,517 – 203,456) / 52.1436 = buy 289 contracts
   ii. Contract BPV ≈ 86.7001 / 0.9169 = 94.5579(218,517 – 203,456) / 94.5579 = buy 159 contracts
3. The only available, relevant information is the liability duration. The 10-year contract is the better duration match. This closer match would likely minimize structural risk to nonparallel yield curve shifts.

PROFESSOR'S NOTE

You should be noticing that the PVA = PVL requirement is a bit of a misstatement. It will be true initially if the portfolio yield and liability discount rate are equal. Even then, it need not hold true after initiation, as the path of portfolio yield and liability discount rate can diverge. The strategy can still succeed if the changes in portfolio market value and yield track the path an immunizing, replicating zero-coupon bond could have followed. In other words, if the change in portfolio market value reflects a new portfolio yield, that will still reach the FVL desired. But even at initiation, PVA need not equal PVL if the portfolio yield and liability discount rate differ.

In practice, initially overfunding the portfolio with more market value than the strictly required PVA is common. If the surplus is significant, contingent immunization can be considered.

Contingent immunization (CI) is a hybrid active/passive strategy and requires a significant surplus. As long as that surplus is of sufficient size, the portfolio can be actively managed. At the extreme, assets could be invested in equity, commodities, real

estate, or any other assets. If the assets earn more than the initially available immunization rate, the surplus will grow, and can eventually be returned to the investor. If the strategy is unsuccessful, the surplus will shrink, and the portfolio must be immunized before the surplus declines below zero. For example:

- Invest the entire portfolio in stocks.
- Invest only the surplus in stocks or in long stock options. Use the balance of the assets to construct an immunized portfolio. This approach allows fewer funds for active management, but is in some ways safer because only the surplus amount is at risk of loss, and an immunized portfolio is already in place.
- Use active bond management techniques. Returning to the previous U.K. example that required buying 159 of the 10-year note contracts, the manager could overhedge or underhedge based on a view of interest rates. Consider the 159 contracts to be a 100% hedge.
  - If the manager believes rates will increase, underhedge (<100%) and the losses on the contracts will be reduced, improving portfolio performance and increasing the surplus.
  - If the manager believes rates will decrease, overhedge (>100%) and the gains on the contracts will be increased, improving portfolio performance and increasing the surplus.
  - Because the contract is based on 100,000 par, each 1/32 of change in price of 100 par will equate directly to a gain or loss on the contract of 31.25 [(1 / 32) × (100,000 / 100)].

CI approaches can be vulnerable to liquidity risk.

- If all of the assets (instead of just the surplus) are actively managed and the surplus declines, the assets must be quickly liquidated without further loss and converted to an immunizing portfolio before the surplus becomes negative.
- Even if only the surplus amount is actively managed, liquidity issues can still be a problem. If short option contracts were used, the downside risk is unlimited for calls and very large for puts (in excess of initial premiums received). Likewise, the potential losses on futures contracts are very large and could exceed the portfolio surplus.

MODULE QUIZ 12.1, 12.2

To best evaluate your performance, enter your quiz answers online.

1. A bond issuer is reviewing the four main categories of liabilities. He is interested in issuing a liability that can be managed easily and has known future amounts and payout dates. Which of the following types of liabilities *most likely* meets the issuer's demands?
   A. Callable bonds.
   B. Option-free fixed-rate bonds.
   C. Treasury inflation-protected securities.
2. An investor is looking to immunize a single liability, but is concerned with the impact from yield curve shifts and twists. When attempting to immunize this liability, which of the following rules should the investor apply?
   A. The portfolio Macaulay duration should match the due date of the liability.
   B. The dispersion of asset cash flows around the liability should be maximized.
   C. The present value of liabilities should exceed the initial portfolio market value.
3. Which of the following statements correctly describes contingent immunization?

A. It uses Treasury futures contracts to adjust the portfolio and maintain duration matching.
B. It constructs a portfolio of zero-coupon bonds that provide enough cash inflows to meet liabilities.
C. It uses active bond portfolio management, as long as the present value of assets exceeds the present value of liabilities.

4. A client at RBI Funds would like to build a laddered bond portfolio. In terms of the construction and advantages of a laddered portfolio, which of the following statements is *most correct*?
   A. With a laddered portfolio, the investor is diversified between price and reinvestment risk.
   B. A laddered portfolio has more reinvestment risk in any single year compared to a barbell portfolio.
   C. The more distributed cash flows of a ladder portfolio compared to a bullet portfolio will provide less convexity.

MODULE 12.3: ADVANCED STRATEGIES

Video covering this content is available online.

Pension funds can include complex Type IV liabilities where both the amount and timing of payouts may be uncertain.

PROFESSOR'S NOTE

We include a brief description of the complexities of projecting these liabilities. There is no direct LOS or questions for that issue. I suggest you briefly skim this note and move to the discussion of the various LDI strategies and issues.

Pension plan rules normally base benefit payouts on years of service, wages, and some multiplier. LDI strategies require estimates of those liabilities. Actuaries can develop models to estimate those liabilities based on the following: initial years of service by employees to the company (G), current wage rate (W_0), wage growth rate and future wages (w and W_T), the multiplier (m), additional years of work until retirement (T), a discount rate (r) related to risk (a high-quality corporate bond rate is normally used), and an estimate of how many years the benefit will be paid (Z).

The liability projection can then be based on the accumulated benefit obligation (ABO), which is a lower number and represents the legal liability if the plan were closed now or a higher projected benefit obligation (PBO) of what is actually expected to be paid in an ongoing plan. Unless the plan is terminating, the higher PBO is generally the more realistic number.

The risk characteristics of the liability must also be estimated. This is normally done by assuming equal upward and downward shifts in the yield curve (Δcurve) to generate a lower PV_+ of the liabilities if rates move up, and higher PV_- if rates move down around the initial PV_0 of the liabilities. Such data can then be used to infer effective duration (and convexity, though that formula is not covered).

$$\text{effective D} = \frac{PV_- - PV_+}{2 \times \Delta\text{curve} \times PV_0}$$

More complex analysis may be needed to incorporate changing yield curve shape and path dependency issues such as effect on interest rate levels and time to retirement.

Typically, it is assumed there is no reliable, consistent relationship between other portfolio assets such as equity in the portfolio and interest rates. Their value may be affected by changing interest rates, but not in the same predictable way as fixed-income assets. In such cases, the duration of those other plan assets is assumed to be zero.

LOS 12.e: Evaluate liability-based strategies under various interest rate scenarios and select a strategy to achieve a portfolio's objectives.

CFA® Program Curriculum, Volume 2, page 306

As an example, assume an ongoing DB pension plan has a PBO of USD2.57 billion. The effective duration has been modeled as 9.35. The BPV of the liabilities is:

$$2.57 \text{ billion} \times 9.35 \times 0.0001 = 2{,}402{,}950 \text{ BPV}_L$$

The plan assets of $3.07 billion are 60% equity and 40% bonds. The manager chooses to hold a laddered bond portfolio of 1-to-5-year Treasury and investment grade corporate bonds; his reasoning is that these can be used to fund nearer-term plan distributions. While there is no cash flow match, the bonds are highly liquid and can be sold to meet distributions. The duration of the bonds is only 2.85. The BPV of the assets is:

$$3.07 \text{ billion} \times 0.40 \times 2.85 \times 0.0001 = 349{,}980 \text{ BPV}_A$$

The duration gap is 2,402,950 – 349,980 = 2,052,970. The manager reasons he can use the Treasury bond contracts to eliminate the duration gap. The contract is based on 100,000 par. The CTD bond has a BPV of 128.98, duration of 13.53, and a conversion factor of 0.9436. The BPV of the contract is:

$$128.98 / 0.9436 = 136.6893 \text{ BPV}_{\text{futures}}$$

Assuming the manager has no view on interest rates, he could construct a 100% hedge to remove the duration gap. He will buy contracts to increase the asset duration:

$$N_f \text{ for 100\% hedge} = \frac{2{,}402{,}950 - 349{,}980}{136.6893} = 15{,}019 \text{ to buy}$$

Assume instead that the manager has discretion to overhedge or underhedge by 10%, and he believes that interest rates will decline. To profit by this, he will buy more contracts than required for a 100% hedge to set the asset duration above the liability duration. He will buy:

$$N_f \text{ for 110\% hedge} = 1.10 \times 15{,}019 = 16{,}521 \text{ to buy}$$

Now, assume instead that the manager believes that interest rates will increase. To profit by this, he will buy fewer contracts than required for a 100% hedge to set the asset duration below the liability duration. He would have bought:

$$N_f \text{ for 90\% hedge} = 0.90 \times 15{,}019 = 13{,}517 \text{ to buy}$$

Hedging with futures creates operational and practical risks. Margin must be posted and adjusted daily; that means all gains or losses on the contracts are posted in cash (or other securities) daily. Recall that each 1/32 change in price of the contract is a gain or loss on each contract of 31.25. If the hedge is successful, that G/L is an offset to changes in the value of the liability. But those are changes in unrealized value, not cash flow that must be posted in the margin account. In practice, these issues make 100% hedges rare in such situations. Partial hedges (< 100%) to reduce the duration gap are more common.

PROFESSOR'S NOTE

While not needed (and requiring data not provided in the discussion), the 1/32 value change of 31.25 per contract on an assumed starting par price and duration of 13.53 can be used to infer the change in rates needed to cause that percentage change in price: 31.25 / 100,000 =

−13.53 Δr, making the Δr only about 0.2 basis points. Clearly, the margin cash flow issues can be substantial on some 15,000 contracts with even modest changes in rates.

Interest rate swaps are another way to adjust the duration gap. As OTC instruments, they may avoid the margin cash flow issues of futures. Recall that a receive-fixed swap is equivalent to buying more bond assets and will increase portfolio duration; it has positive (+) duration. A pay-fixed swap will reduce duration; it has negative (−) duration. The swap's net duration is calculated as the difference between fixed- and floating-rate bonds that would replicate the swap's future coupon flows.

Assume a 10-year swap is available and the manager has discretion to hedge 30%–70% of the duration gap, with a 50% hedge considered a neutral or normal position. The duration gap in BPV is still 2,402,950 − 349,980 = 2,052,970 with asset duration too low. The durations of the replicating fixed and floating sides of the swap are 9.18 and 0.25. The BPVs per 100 notional for each side of the net swap duration are:

fixed-side BPV = 100 × 9.18 × 0.0001 = 0.0918

floating-side BPV = 100 × 0.25 × 0.0001 = 0.0025

net swap BPV = +0.0918 − 0.0025 = 0.0893

The notional swap principal (NP) required to close the duration gap for a 100% hedge is the duration gap in BPV divided by the swap BPV per 1 NP. Note that the BPVs are per 100 NP and must be divided by 100 for BPV per 1 NP.

Enter a receive-fixed swap to increase asset duration:

$$\text{NP} = \frac{2{,}052{,}970}{(0.0893 \,/\, 100)} = 2.3 \text{ billion for a 100\% hedge}$$

Assuming the manager expects rates to increase and given the hedging constraints, what hedge would be used?

With increasing rates expected the manager will leave asset duration as low as permitted for a 30% hedge. He will enter a receive-fixed swap of 0.3 × 2.30 = 0.69 billion NP.

Assuming the manager just entered the 30% hedge and now believes rates will decline, what will he do?

He will want to increase asset duration to the max allowed, a 70% hedge. He would want a receive-fixed swap of 0.7 × 2.30 = 1.61 billion NP. That will require an additional receive-fixed swap of 1.61 − 0.69 = 0.92 billion NP.

While historically swaps have not required margin posting, that has been an evolving issue. Many swaps now require periodic marking to market and posting of the gain or loss in margin or as a direct cash settlement. That reduces counterparty and credit risk, but introduces the same practical cash flow complications of exchange-traded futures.

An alternative to the swap is a swaption. The plan pays an initial premium for the right to enter a swap. The plan that needs to increase BPV of assets would purchase a receiver swaption, giving the plan the *right* to initiate a receive-fixed swap at a prespecified **swap fixed rate** (SFR); the swap's SFR may be called the *swaption strike rate*. The cost is limited to the initial premium paid. As time passes, comparing the SFR for new swaps (new SFR) to the SFR of the swaption determines if the swaption has value:

- If the new SFR declines, this right to receive a now above-market SFR has positive value and effectively increases the BPV of the assets. The value of the swaption is part of portfolio assets and increases the total value of plan assets.
- If the new SFR increases, this right to receive a now below-market SFR has no value, the swaption will not be exercised, and it would be allowed to expire worthless. Note that if a swap had been used instead of a swaption, the plan would suffer escalating losses on a receive-fixed swap.

EXAMPLE: **Swap vs. swaption hedges**

A U.S. pension plan has a 450,000 BPV duration gap with BPV of assets less than of liabilities. The plan uses a swap with a BPV per 100 notional of 0.2571 to construct a 50% hedge ratio. After setting up the 50% hedge, the manager forms the opinion that rates will increase, and would like to benefit if his view is correct, but be unaffected if he is wrong. The manager would be willing to adjust the hedge position by 15% to a 35% or 65% hedge. He checks and finds that both payer and receiver swaptions are available with a strike rate of 2.7%. The premiums for the payer and receiver swaptions are 55 and 75 basis points, respectively.

1. **State** the terms and **calculate** the notional principal of the 50% hedge ratio swap the manager would use.
2. **State** the terms and **calculate** the initial cost of the swaption the manager would buy or sell to adjust his hedge to a 35% hedge.
3. **Determine** the rate on new swaps and **state** whether new rates will have to be higher or lower than that rate to make exercising the swaption profitable.

Answers:

1. (450,000 × 0.50) / (0.2571 / 100) = 87.515 million NP of a receive-fixed swap.
2. 15% of the full hedge is (450,000 × 0.15) / (0.2571 / 100) = 26.254 million notional.

   The initial hedge is receive fixed, so to reduce the hedge, the manager will buy a payer swaption of 26.254 million NPl. The premium cost is 26.254 million × 0.0055 = 144,397.
3. If new SFRs are greater than the strike rate of 2.7%, the payer swaption and right to pay 2.7% is valuable and should be exercised.

PROFESSOR'S NOTE

This is hard material. You must know the terminology as well as be able to think clearly and logically to solve these questions.

Regarding Question 1, the assets have less BPV than the liabilities. If rates decline, the assets will increase less than the liabilities, and the plan will suffer. The correct swap is to receive fixed as that will increase duration and BPV of assets to reduce this loss if rates decline.

Regarding Question 2, if the manager wants the right to a smaller hedge position, he needs a pay-fixed swap to reduce his fixed inflow from the initial swap. Buying a payer swaption gives him the right to decide later if he wants to turn on the pay-fixed swap embedded in the swaption.

Regarding Question 3, economic logic dictates that his right to pay 2.7% and receive floating becomes valuable if new market conditions would require paying more than 2.7%. In that case, paying 2.7% is a bargain. The mechanics of how he captures this value are not covered, but there are a couple of possibilities: (1) He can exercise the swaption, pay the bargain SFR, and receive floating in this now higher interest rate environment. Of course, rates as well as the future floating rates received can change. (2) He could exercise the swaption and begin paying the 2.7% plus simultaneously enter into a new receive-fixed swap, receiving an SFR above the 2.7% he is paying. On each payment date, he will net the difference of 2.7% paid versus the higher SFR received for the life of the two swaps.

Note that the premium cost paid for the swaption is a sunk cost, and cannot be recovered. It does not affect the decision of whether the swaption is exercised. That premium is paid and gone regardless of whether the swaption is exercised.

The third alternative for the manager who needs to increase asset BPV is a swaption collar, which is a combination of buying one swaption and selling another.

- The manager would buy the receiver swaption to provide economic benefit if the SFR declines.
- To reduce the initial premium cost outlay, the manager sells a payer swaption. Note that this means the buyer of the payer swaption has the right to turn on a pay-fixed swap and the manager (seller) must accept that fixed rate. The buyer will do this if new SFRs exceed the payer swaption's strike rate. The sale of the payer swaption can limit the potential future benefits to the seller as the buyer will exercise and pay the SFR when rates increase (i.e., when unattractive to the seller of the swaption).

Choosing an Optimal Strategy

PROFESSOR'S NOTE

This material requires a solid understanding of terminology, swap diagrams, and the economic rationales of why swaptions are exercised. The discussion of *swaption seller* is tricky. The terms "payer swaption" and "receiver swaption" always refer to the fixed rate action of the *swaption buyer*. The *buyer of the payer swaption* will have positive value if new SFRs exceed the swaption strike rate the buyer would pay. That is negative value to the *seller of the payer swaption*, who must now accept and receive a below-market SFR.

But there is another issue here as well. The purpose of the hedge is to reduce risk. In this case, if rates go down, the assets—with lower BPV than the BPV of the liabilities—will increase in value less than the liabilities. In other words, hedging is to reduce or eliminate interest rate risk, which exists because no one can perfectly predict interest rates. But selecting the optimal hedge strategy will, as we'll see, require at least some ability to predict direction or magnitude of rate changes. Recognize that all three strategies work and reduce interest rate risk. But if you want optimal strategy, you need to predict interest rates to at least some degree.

The choice of optimal strategy will depend on the manager's view of interest rates. Consider the DB plan with a duration gap and a need to increase asset duration. In other words, the plan is currently at risk if interest rates decline because the assets would increase less than the liabilities increase, and the plan surplus would decline. The manager has three swap-based hedging choices:

1. Enter a receive-fixed swap versus pay MRR.
2. Buy a receiver swaption.
3. Enter a zero-cost collar composed of buying the receiver swaption and selling a payer swaption.

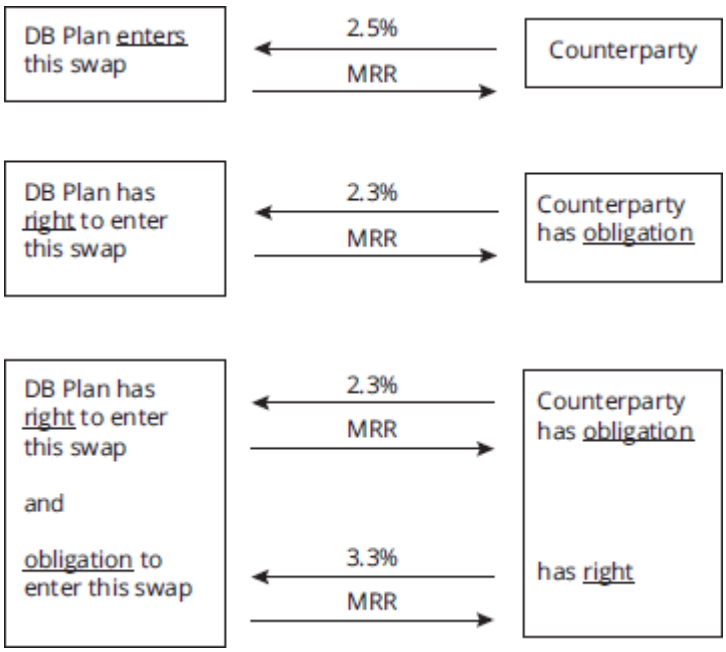
The swap notionals and payment frequency are the same. All floating payments are MRR. After consulting with the sponsor and the sponsor's accountants, the manager is instructed that all gain or loss on swaptions will be captured and reported on the sponsor's financial statements. In other words, she can evaluate the swaptions as if they are marketable securities for decision-making purposes. She is directed that she must use one of the hedges because the duration gap is too large and too risky to the plan surplus. All the hedges have the same effect on the duration gap. She cannot be unhedged. She gathers the following additional data:

	Premium Cost
2.5% fixed-rate swap	None
2.3% receiver swaption	75 bp
3.3% payer swaption	75 bp

The receive 2.5% SFR swap is optimal if the *manager expects the new SFR will be at or below 2.5%*.

- This is equivalent to buying 2.5% fixed-rate bonds (financed by borrowing at MRR), increasing asset duration and BPV. The plan will benefit from the decline in rates.
- Buying the 2.3% receiver swaption is suboptimal because there is an initial cost, and the 2.3% fixed rate received by the plan is lower.
- The collar (buy the 2.3% receiver swaption; sell the 3.3% payer swaption) is suboptimal because the 2.3% fixed rate received by the plan is lower. The payer swaption buyer has no rational reason to exercise his right with the new SFR below 3.3%.

Figure 12.8: Comparing Swap-Related Strategies



The collar is optimal if the *manager expects the new SFR will be above 2.5% but below 3.3%*.

- The collar (buy the 2.3% receiver swaption and sell the 3.3% payer swaption) has no intrinsic value, which is the best choice.
  - The right to receive 2.3% when rates are above 2.5% has no value.
  - The payer swaption buyer has no rational reason to exercise his right with new SFRs below 3.3%.
- The other hedges have negative value or zero value with an up-front cost.
  - The swap of receive 2.5% will have negative value when SFRs are above 2.5%.

- The receiver swaption (right to receive 2.3%) has no value when new SFRs are above 2.5% and required an initial cost.

Buying the 2.3% receiver swaption is *optimal at some level of new SFRs above 3.3%*.

- The 2.3% receiver swaption has no intrinsic value with new SFRs above 3.3%. But there was an initial premium cost. This is the best case at some level of SFRs above 3.3%.
- The receive 2.5% swap has increasing negative value as new SFRs increase above 3.3%.
- The collar also begins to have increasing negative value as new SFRs increase above 3.3%.
  - The receive 2.3% swaption has no value.
  - The 3.3% payer swaption increases in value as SFRs increase above 3.3%, and this is negative value to the seller (the plan).
  - As SFRs increase, that negative value will at some point exceed the initial cost of the receiver swaption, and the receiver swaption would become optimal.
  - The breakeven rate to make the payer swaption optimal is above 3.3%.

PROFESSOR'S NOTE

Fortunately, the method of calculating breakeven above 3.3% is not even covered. We do not plan to respond to requests for, "But I just want to see how to do it."

MODULE 12.4: RISKS

LOS 12.f: Explain risks associated with managing a portfolio against a liability structure.

Video covering this content is available online.

CFA® Program Curriculum, Volume 2, page 330

- Hedge amounts are approximations based on assumed durations and ignore convexity. Convexity matters for large-rate movements.
- Duration assumes parallel shifts in the curve.
- Twists in the yield curve can create substantial structural risk, and immunization may fail to replicate the immunizing zero-coupon bond. Setting asset convexity (somewhat) higher than liability convexity creates net positive convexity (C of assets exceeds C of liabilities) while limiting the dispersion of asset cash flows in relation to liability flows to minimize structural risk.
- Model risk can be significant in some cases. See the earlier discussion of assumptions required to estimate DB plan liabilities, effective duration, and BPV.
- Measurement error when weighted average characteristics of the portfolio assets and liabilities are used instead of portfolio statistics based on portfolio cash flows and yield (IRR).
- Futures BPV calculations are based on an assumed CTD bond. That bond can change, changing the futures duration and BPV. Also, a more accurate estimate of futures BPV should adjust for accrued interest discounted at short-term rates (because accrued interest paid is recouped on the next coupon payment date).

- Portfolio yield and liability discount rate may differ, reflecting different risk levels. This creates spread risk (i.e., the risk the asset and liability discount rates and their PVs may shift in unexpected ways). Here are a few examples.
  - The liability discount rate may reflect corporate debt rates and assets government bond rates. Using Treasury contracts introduces this same potential spread risk.
  - Use of Treasury rates introduces a more subtle risk. The Treasury market is highly liquid and more likely to reflect frequent price change. That is reflected in higher reported volatility of Treasury rates. By definition, *higher volatility* means a higher rate of change in Treasury rates compared to other rates, (i.e., nonparallel shifts).
  - Using swaps also creates spread risk as swap rates directly reflect the MRR market.
- Traditionally, OTC derivatives have counterparty risk. The move toward requiring collateral reduces the counterparty risk, but creates cash flow risk. Counterparties must be prepared to meet the demands to post cash or other collateral. The same risks already exist for exchange-traded futures.
- Asset liquidity risk exists if positions cannot be quickly adjusted with reasonable transaction costs.

MODULE QUIZ 12.3, 12.4

To best evaluate your performance, enter your quiz answers online.

1. Assume that the BPV duration gap of a defined benefit pension plan is equal to $300,000. The pension fund manager would like to hedge 100% of this duration gap with a 10-year swap. The manager finds that the duration of the fixed side of the swap is 8.25 and the duration of the floating side of the swap is 0.5. What is the notional swap principal required to fully close the duration gap?
   A. $125 million.
   B. $387 million.
   C. $495 million.
2. A risk analyst is discussing the risks associated with managing a bond portfolio against a liability structure. She makes three statements regarding liability-driven investment risks. Which of her statements is *most likely* an indicator of spread risk?
   A. "Bond positions cannot be adjusted with reasonable transaction costs in a timely manner."
   B. "Hedge calculations are approximated based on only the duration of the assets and liabilities."
   C. "The liability discount rate may reflect corporate debt rates, and the asset discount rate may reflect government bond yields."

MODULE 12.5: INDEX-BASED INVESTING

Video covering this content is available online.

LOS 12.g: Discuss bond indexes and the challenges of managing a fixed-income portfolio to mimic the characteristics of a bond index.

CFA® Program Curriculum, Volume 2, page 334

Many bond indexes exist—providing varying exposures to duration, credit, and other risk factors. Investing in a bond market index fund provides low cost diversification and an alternative to active fixed-income management. Their goal is to minimize tracking error.

Tracking error also called *tracking risk* or *active risk*. It is the standard deviation of the portfolio's active return (portfolio return – benchmark return).

The **pure index** or **full replication approach** requires holding all the securities and weighting them as in the index. **Enhanced indexing** matches all the primary risk exposures of the index, but not all the holdings. The goal is more efficient tracking of the index by avoiding some of the overly costly transactions required for pure indexing.

Indexing for bonds is more difficult than for equity:

- Fixed-income markets are much larger, more bond issues are outstanding, and the characteristics of individual bonds vary widely. This generally makes full replication impractical.
- Any one issuer may have multiple bond issues outstanding. They may differ substantially in liquidity, making it appropriate to concentrate positions in the less-costly to trade, liquid issues.
- Most bond trading is done OTC through dealers, unlike stock traded on exchanges. Capital requirements have increased for dealers post-2008. The higher capital cost has reduced dealers' willingness to hold large bond inventories and increased the bid-ask spread charged by dealers. The result is that bond market liquidity has declined.
- Most individual bond issues do not trade in any given year. Many transactions that do occur are not publicly reported, making reliable price and volume data more difficult to obtain. This also leads to valuation challenges in existing portfolios. Bond pricing for nontrade securities is based on **matrix** or **evaluated pricing**. The price of similar, traded bonds is captured and used to calculate YTM. That YTM is then used to infer the price of nontraded bonds. The more unusual the features of a bond, the more difficult it is to find an appropriate traded bond to use as the basis of such pricing.
- Bond index composition and characteristics can change fairly quickly as new bonds are issued and old bonds approach maturity or change in credit quality and other characteristics.

Matching the primary risk characteristics of the bond index is generally more practical than full replication. Matching primary risk factors includes:

- Matching modified duration (MD) to minimize tracking error due to parallel shifts in the yield curve. For bonds with embedded options, effective duration must be used instead:

  $$\%\Delta \text{ value} = -\text{MD } \Delta y$$

- Matching key rate durations to minimize tracking error due to nonparallel changes in the yield curve. There are multiple key rate durations, and each simulates the expected change in value if one single point on the yield curve shifts. For example, the price change if five-year rates shift is as follows:

  $$\%\Delta \text{ value} = -\text{MD}_{\text{key rate n}}\, \Delta y_n$$

- Match weighting exposure to the various bond sector and quality ratings of the index. For nongovernment securities, it is useful to distinguish price change due to a general change in rates (i.e., government bond yields) from spread change. MD measures change due to the general change in rates, and spread duration measures

how the nongovernment bonds perform relative to government bonds when (credit) spread changes:

$$MD = \text{Macaulay duration} / (1 + YTM_{periodic})$$

$$\%\Delta \text{ value} = -MD\ \Delta y$$

$$\%\Delta \text{ relative value} = -D_S\ \Delta s$$

$$\text{spread} = y_{\text{higher yield}} - y_{\text{government}}$$

- Matching sector/coupon/maturity cell weights of the index. For example, if the index is 1.7% in A-rated corporates of 2–3 duration, match that weight. When there are bonds with embedded options such as callable or mortgage-backed securities, match these weighting exposures as well. Doing so means effective duration and convexity will be matched.
- Matching issuer exposure weights to control for specific event risk affecting only that issuer, such as bankruptcy.

Another method of minimizing yield curve risk is matching **present value distribution of cash flows**. The following example demonstrates this and its relationship to bond price, duration, and key rate durations. They are all interrelated. The example is for a 4.0% semiannual pay three-year bond trading at par (4% YTM):

4.0% semiannual pay 3-year bond priced at 4% YTM*			w = PV as % of total PV	Duration contribution = (t)(w)
Cash flow due in time *t*	Amount	PV		
0.5	2.00	1.9608	0.0196	0.0098
1	2.00	1.9223	0.0192	0.0192
1.5	2.00	1.8846	0.0188	0.0283
2	2.00	1.8477	0.0185	0.0370
2.5	2.00	1.8115	0.0181	0.0453
3	102.00	90.5731	0.9057	2.7172
		100.0000	**1.0000**	**2.8567**
* for a periodic discount rate of:		2.00%		

- List the cash flows by six-month period (t). If there were embedded options, the cash flows would be the best estimates of amount and when the cash would be received.
- The bond's price is the discounted PV of its future cash flows using a 4%/2 semiannual periodic discount rate.
- Each weight (w) is computed as that PV as a percentage of total PV (the price).
- Each (t)(w) is the cash flow's contribution to duration and a key rate duration. The sum of the duration contributions (key rates) is the bond's duration.
- Matching the *w* of portfolio to the *w* of the index will also match their (t)(w). This matching of present value distribution of cash flows is also matching the duration contributions and key rate durations. These actions minimize exposure risk from changes in shape of the yield curve. They also match total duration and convexity.

The goal of matching all the risk factors is to minimize tracking error while avoiding some of the expense of full replication.

Alternative Methods of Obtaining Passive Bond Market Exposure

Passive index replication provides diversifying exposure to the fixed-income market without the expense of active management. As discussed earlier, the nature of the fixed-income markets generally makes full replication impractical. Enhanced indexing provides one acceptable alternative. **Stratified sampling** (**cell matching**) can be used to implement enhanced indexing. The manager first determines the most significant characteristics that need to be matched. For example, the manager could divide the index into three duration and sector groupings:

Index	Duration		
	1–5	5–10	10–15
Treasury	5.1%		
Corporate			
ABS			

In the cell grid for the index, only the data for 1–5 duration Treasuries is shown. To cell match, the manager will also hold 5.1% in bonds with these characteristics, but need not use all of the same bonds as in the index to do so. The manager will also need to collect and match the weights for the other eight cells.

Cell matching can incorporate **environmental, social, and corporate governance** (ESG) or socially responsible investing restrictions. ESG may prohibit or explicitly require securities with specific characteristics. For example, bonds of high carbon emission industries are prohibited, and bonds of clean energy industries are desired. The manager will seek to do both while still matching cell weights.

Relevant techniques to reduce the expense of pure indexing or add value include:

- Reducing fund expenses, including transaction costs.
- Overweighting undervalued and underweighting overvalued: securities, sectors, and portions of the yield curve; while still matching overall index characteristics. The basic principle is to avoid areas of spread widening and favor areas of spread narrowing.
- Over (under)weighting callable bonds for their typically higher yield, when interest rate volatility is expected to be low (high) and impact of the call feature on price (and effective duration) is more (less) predictable.

LOS 12.h: Compare alternative methods for establishing bond market exposure passively.

CFA® Program Curriculum, Volume 2, page 340

Indirect exposure is an alternative to investing directly in bonds through full or enhanced indexing. Indirect exposure can be gained with funds or synthetically through derivative strategies. These indirect approaches usually avoid the higher initial costs of directly trading in bonds, but incur ongoing expenses and other possible risks.

Bond index **mutual funds** may be particularly well suited for smaller investors. They provide broad market exposure with one investment and economies of scale. Aggregating the capital of many investors typically gives these funds access to more securities at better prices.

Open-ended fund shares can be redeemed or purchased at **net asset value** (NAV) once per day. However, such funds charge ongoing management fees and may also charge fees at purchase (front load) or sale (back load). Unlike bonds, they do not typically mature, plus the holdings and income stream change over time.

Exchange-traded funds (ETFs) provide some advantages in that the shares trade continuously on exchanges and investors can buy or sell continuously, rather than once per day. The typical investor cannot purchase or redeem shares directly with the fund. However, **authorized participants** can redeem shares in kind with a pro rata distribution of the underlying fund assets. Those participants can also assemble a package of the underlying fund assets and trade them to the fund in exchange for new shares of the fund. This redemption and purchase in kind (with fund assets instead of cash) creates an arbitrage mechanism between the open-market price of fund shares and NAV. That benefits all investors in the fund. However, the arbitrage mechanism is less effective than in the equity market due to the illiquidity of many underlying bond assets; they are simply harder to buy or sell at the expected fair price.

Total return swaps (TRS): The manager enters a swap to receive a desired bond market index total return (both income and price change) in exchange for paying MRR + spread. TRS are equivalent to buying the index and borrowing the funds needed for purchase at MRR + spread. If the index has a negative return in a given period, the index receiver pays that return to the index payer to replicate the loss in value that would have occurred if the index receiver had actually invested in the index:

- If not fully collateralized, the TRS is effectively a leveraged investment in the index.
  - The user does not directly own the underlying securities. The TRS replicates the underlying return, but there is counterparty (credit) risk if the dealer cannot perform his side of the transaction.

Bond Benchmark Selection

LOS 12.i: Discuss criteria for selecting a benchmark and justify the selection of a benchmark.

CFA® Program Curriculum, Volume 2, page 344

Benchmark selection begins with defining the client's objectives and constraints, then determining the strategic asset allocation that will meet these requirements. The manager may be given tactical discretion to vary those asset class exposures.

Selecting suitable bond indexes can be more complicated than for equity. Here are examples:

- In a static (no changes) bond portfolio, duration will decline as the bonds age.
- New bond issuance may cause the characteristics of the index selected as a benchmark to change over time. For example, issuers may shift to shorter or longer security issuance, making a given index no longer appropriate for a given investor's desired duration.

- Value-weighted indexes give the greatest weight to the largest issuers, which may lead to the "bums problem." A bum is a less creditworthy issuer. There is often a negative correlation between amount of bonds issued and creditworthiness of the issuer; thus, the less creditworthy issuers tend to become an increasing percentage of the index.

A bond investor could start by defining the desired interest rate (duration) risk and sector exposures. That could lead to a custom index (instead of a broad market index) of desired sub-exposures, such as 50% in 5-to-10-year Treasuries and 50% in 1-to-3-year investment grade corporates as a benchmark. (See **credit barbell** in the next paragraph).

Smart beta rules could be used. This means identifying relatively simple, definable rules that can be followed to add value. The custom index explained previously is one such example, and is called a **credit barbell**. Longer-term Treasuries (with no credit or spread risk) are used to give the portfolio the desired duration exposure. Shorter-term corporate securities are used to add additional spread return. Those shorter-term securities will be less vulnerable to relative price underperformance if spreads widen.

MODULE QUIZ 12.5

To best evaluate your performance, enter your quiz answers online.

1. Using a full replication approach for bond indexing may be impractical, given the large size of the bond market and the varying characteristics of individual bonds. Instead, it may be easier to match the primary risk characteristics of the selected bond index. When reviewing specific risk characteristics, the risk factor that minimizes tracking error due to nonparallel shifts in the yield curve is associated with matching:
   A. modified duration.
   B. key rate durations.
   C. issuer exposure weights.
2. A bond portfolio manager is looking to gain passive exposure to the bond market. Which of the following approaches would allow the manager to receive the return from a desired bond market index in exchange for paying MRR plus a spread?
   A. Total return swap.
   B. Exchange-traded funds (ETFs).
   C. Exchange-traded derivatives.
3. Which of the following statements regarding fixed-income benchmarks is *most likely* false?
   A. If a static bond index is used as a benchmark, the duration will remain the same as the bonds age.
   B. New bond issuance may cause the characteristics of the selected benchmark to change over time.
   C. Issuers may shift to shorter or longer security issuances, making a given benchmark no longer appropriate for a given investor.

KEY CONCEPTS

LOS 12.a

- Liability-driven investing is a form of asset-liability management (ALM) that manages the assets in relation to the characteristics of the liabilities. This is easier when the future liability payouts are known in amount and timing. The liabilities are essentially the benchmark for making decisions.
- Asset-driven investing is a less common form of ALM and adjusts the liabilities in relation to the characteristics of the assets.

LOS 12.b

Immunization can be used to fund liabilities with a high degree of certainty. The assets are dedicated to this purpose and all cash flows are reinvested until needed for payout.

Cash flow matching is without risk, assuming there are no defaults. Bonds are bought and held in sufficient amount and pay date to meet the liabilities. It is the most restrictive strategy, and so typically costs more (has lowest return).

Duration matching achieves similar results, but is less restrictive in the assets selected. Matching Macaulay duration of the assets to liabilities balances the exposure between price and reinvestment risk. Duration and other portfolio statistics should be based on portfolio yield (IRR). To immunize a single-period liability:

- Initial PVA equals (or exceeds) PVL. (There are exceptions to this for more complex situations where initial portfolio IRR differs from initial discount rate of the liability.)
- Match Macaulay durations ($D_A = D_L$).
- Minimize portfolio convexity.
- Rebalance the portfolio to maintain the duration match.

Immunization (duration matching) issues include the following:

- The assets have greater convexity than the single date liability; therefore, the portfolio benefits from large parallel shifts but is at risk from curve twists (nonparallel shifts). Minimizing convexity minimizes this structural risk.
- Immunization can be interpreted as zero replication, meaning a successful immunization will replicate the price and yield path of a zero-coupon bond that could have been used for a perfect cash flow match immunization.

LOS 12.c

Multiple liabilities can be cash flow matched with a portfolio of zero-coupon bonds or coupon-bearing bonds whose cash flows (P&I) most closely match the liability payouts. Duration matching can be done by matching the BPV of the assets and liabilities. The rules are as follows:

1. Initial PVA equals (or exceeds) PVL (see the caveat given under single liability rules).
2. $BPV_A = BPV_L$
3. Asset dispersion of cash flows and convexity exceed those of the liabilities. (But not by too much, in order to minimize structural risk exposure to curve reshaping).
4. Regularly rebalance the portfolio to maintain the BPV match.

Derivatives are often used to adjust the BPV of the assets and hedge or partially hedge the duration gap:

- Buying (selling) futures or receive (pay) fixed swaps increases (decreases) asset duration and BPV.
- Futures BPV $\approx BPV_{CTD} / CF_{CTD}$
  - BPV = MD × V × 0.0001
- N_f = (BPV of liability − BPV of current portfolio) / BPV of futures.

- NP for swap = (BPV of liability − BPV of current portfolio) / BPV of 1 NP for the swap.
  - BPV_{swap} is the difference in BPV of fixed and floating side.

Contingent immunization (CI) requires the portfolio be overfunded with a positive surplus (PVA > PVL). If the surplus is positive, the portfolio can be actively managed (not immunized):

- If active management is successful, the return will exceed the initially available immunization rate, the surplus will grow, and ultimate cost of the strategy will be less than immunizing.
- If active management fails, the surplus will decline to zero and the portfolio must be immunized. The ultimate cost will exceed that of immunizing.

LOS 12.d

Laddered portfolios:

- Laddered portfolios can be useful in cash flow matching multiple liabilities.
- Provide diversification across the yield curve and natural liquidity as a portion of the bonds come due each year. In an upward sloping yield curve, this can also be desirable as each maturing bond is rolled over into the longest (and highest yielding) maturity used in the ladder.
- Have more convexity than a bullet portfolio because their cash flows are more distributed.
- Could be constructed with a sequence of target-date ETFs as an alternative to individual bonds.

LOS 12.e

A 100% hedge eliminates the duration gap (matches BPV of assets and liabilities). In the normal scenario of $BPV_A < BPV_L$, a manager who expects interest rates to:

- Increase will reduce the hedge size, leaving the BPV of assets less than of a fully hedged duration gap. Leaving the BPV of assets at a lower level means they will decline in value less as interest rates increase.
- Decrease will increase the hedge size, increasing the BPV of assets above that of a fully hedged duration gap. Increasing the BPV of assets means they will increase in value more as interest rates decrease.

Regarding the three swap methods of reducing a negative duration gap (increase BPV of assets):

- Entering a receive-fixed swap is generally optimal if interest rates in the future are below the swap's SFR.
- Using a zero-cost collar (buy receiver swaption and sell payer swaption) is generally optimal if interest rates in the future are moderately higher (i.e., between the swap and payer swaption SFRs).
- Buying a receiver swaption is generally optimal if interest rates in the future exceed the payer swaption SFR by some amount.

LOS 12.f

Risks include:

- Hedge amounts are approximations based on assumed durations and ignore convexity.
- Duration assumes parallel shifts in the curve.
- Twists in the yield curve can create structural risk (risk due to curve reshaping).
- Multiple assumptions (model risk) are required to model the characteristics of complex liabilities, such as those in DB plans.
- Measurement error issues occur when weighted average characteristics are used instead of portfolio statistics based on portfolio yield (IRR).
- Futures base calculations are approximations based on an assumed CTD bond, and that CTD can change.
- Spread risk exists if the relationship between asset yield and liability discount rate changes.
- Traditionally, OTC derivatives have counterparty risk.
- Cash flow risk for exchange-traded and OTC derivatives requiring cash settlement of gain/loss or margin.
- Asset liquidity risk if positions cannot be quickly adjusted at near fair market value.

LOS 12.g

Bond index funds offer low cost diversification. Their goal is to minimize tracking error. But there are challenges (compared to equity):

- A much larger number of bond issues with diverse characteristics exists. This generally makes full replication impractical.
- Liquidity has declined post-2008, is often low, and varies by bond issue.
- Trading is OTC, and dealers have become less able to supply liquidity.
- Most individual bonds rarely trade, and price must be estimated based on matrix pricing.
- Bond index composition and characteristics can change.

Enhanced indexing matches the primary risk factors of the index. To minimize tracking error:

- Match modified duration—and effective duration if there are option features.
- Match key rate durations.
- Match weighting exposure to the various bond sectors, quality ratings, issuers, and all other material factors. Cell matching is a common technique used to do this.

LOS 12.h

Passive bond market exposure can be achieved with:

- A separately managed account that replicates the index.
- Index mutual funds, either open ended or ETFs.
- Synthetic strategies, such as receiving a bond index return under a total return swap.

LOS 12.i

Determine the client's objectives and constraints before finalizing the strategic asset allocation. Then, select a bond index that matches the objectives and constraints as well

as the desired asset class characteristics. Selecting a suitable index is complicated by:

- The possible decline in index duration as the bonds age.
- The changing characteristics of many indexes over time as the holdings change.
- The "bums problem" in value-weighted indexes as the largest issuers become a greater percentage of the index, but large issuance is often associated with increasing leverage and declining credit quality.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 12.1, 12.2

1. **B** Type I liabilities have known future amounts and payout dates. The issuer of an option-free fixed-rate bond has this type of liability. These are the easiest to manage liabilities because their sensitivity to interest rate movements can be modeled using modified duration. Callable bonds have known future amounts, but uncertain payout dates (Type II). Real rate bonds, such as Treasury inflation-protected securities, have uncertain future amounts, but known payout dates (Type III). (Module 12.1, LOS 12.a, 12.b)

2. **A** Rules for immunizing a single liability include the following:
   - Initial portfolio market value (PVA) equals (or exceeds) PVL.
   - Portfolio Macaulay duration matches the due date of the liability (DA = DL).
   - Minimize portfolio convexity (to minimize dispersion of asset cash flows around the liability and reduce risk to curve reshaping).

   (Module 12.1, LOS 12.b)

3. **C** Contingent immunization is a hybrid active/passive strategy. It requires initially overfunding the portfolio with more assets than needed to immunize and meet the future liability. As long as that surplus is of sufficient size, the portfolio can be actively managed. A derivatives overlay uses Treasury futures contracts to adjust the portfolio. Cash flow matching creates a portfolio of zero-coupon bonds to match cash inflows with cash outflows. (Module 12.2, LOS 12.b)

4. **A** With a laddered portfolio, the investor is diversified between price and reinvestment risk. Some bonds mature each year and can be reinvested if rates are high. This creates a form of dollar cost averaging over time. The ladder has less reinvestment risk in any single year versus the barbell (or bullet). The more distributed cash flows of the ladder compared to the bullet will provide greater convexity—benefiting performance for large changes in rates. (Module 12.1, LOS 12.d)

Module Quiz 12.3, 12.4

1. **B** The basis point values (BPVs) per 100 notional for each side of the swap and the net swap duration are computed as:

   fixed-side BPV = 100 × 8.25 × 0.0001 = 0.0825

   floating-side BPV = 100 × 0.5 × 0.0001 = 0.005

   net swap BPV = +0.0825 − 0.005 = 0.0775

The notional swap principal required to close the duration gap for a 100% hedge is the duration gap in BPV divided by the swap BPV per 1 NP.

NP = $300,000 / (0.0775 / 100) = $387 million

Note that the case never said if BPV of assets or liability is larger. Thus, we can compute the size of the swap, as asked, but not if it is a pay- or receive-fixed swap. (Module 12.3, LOS 12.e)

2. **C** An example of spread risk occurs when the portfolio yield and liability discount rate differ, which reflects different risk levels. If the spread between the two rates changes, the change in rates of the two cannot match; their present values may not change in the expected ways. Using only duration will ignore convexity, which will result in some error. Not being able to adjust positions with reasonable transaction costs is an example of asset liquidity risk. (Module 12.4, LOS 12.f)

Module Quiz 12.5

1. **B** Matching key rate durations minimizes tracking error due to nonparallel twists in the yield curve. Matching modified duration minimizes tracking error due to parallel shifts in the yield curve. Matching issuer exposure weights controls for specific event risk that affects only that issuer, such as bankruptcy. (LOS 12.e)
2. **A** In a total return swap, a manager enters a swap to receive a desired bond market index total return (both income and price change) in exchange for paying MRR + spread. If the index has a negative return in a given period, the index receiver pays that return to the index payer to replicate the loss in value that would have occurred if the index receiver had actually invested in the index. (LOS 12.h)
3. **A** In a static (no changes) bond portfolio, duration will decline as the bonds age. New bond issuance may cause the characteristics of the selected benchmark to change over time. Issuers may shift to shorter or longer security issuance, making a given index no longer appropriate for a given investor. (LOS 12.i)

The following is a review of the Fixed-Income Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #13.

READING 13: YIELD CURVE STRATEGIES

Study Session 6

EXAM FOCUS

We now turn our attention to methods for adding value by positioning portfolio exposures along the yield curve. You will see many concepts already discussed, such as bullet versus ladder versus barbell, adjusting convexity, and PVBP (which a previous reading referred to as BPV). Think of this as positioning on a credit risk-free government yield curve to add value. The next reading will extend these ideas to focus on adding value through credit risk decisions.

MODULE 13.1: YIELD CURVE DYNAMICS, TRADES FOR A STATIC YIELD CURVE

Video covering this content is available online.

LOS 13.a: Describe the factors affecting fixed-income portfolio returns due to a change in benchmark yields.

CFA® Program Curriculum, Volume 3, page 5

Active management requires the investment manager to have a view of how the yield curve will behave over time. If the manager acts on this view, is correct, and the view was not already reflected in security prices, the actions can add value to the portfolio's performance.

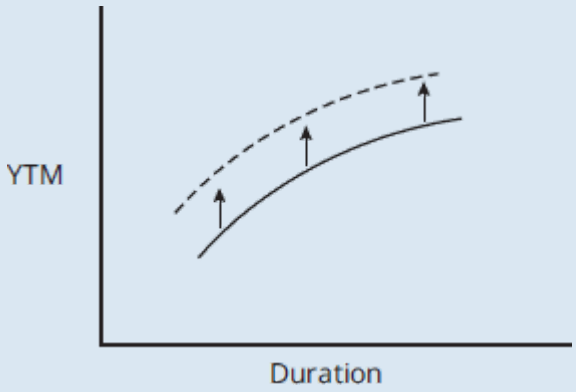
A yield curve plots the yield of a certain type of fixed-income security as a function of its maturity. Yield curves are most typically plotted for credit risk-free government bonds to act as a benchmark for other, riskier, types of fixed-income securities. The "yield" could be yield to maturity (YTM), spot rates, or even forward rates. For our purposes, the yield will be YTM unless clearly indicated otherwise. Thus, in the United States, the typical benchmark yield curve will be for YTM as a function of maturity for U.S. Treasury securities.

While the concept of a yield curve is straightforward, its generation involves modeling and assumptions that are often not straightforward. Plugging gaps in maturity through the use of interpolation (i.e., averaging nearby available yields), differences in accounting or regulatory rules, and the choice of which existing bonds to use to construct the yield curve can affect the resulting curve. Yield curves are often constructed using more-liquid, more-recently issued on-the-run securities. The use of all securities, including less liquid off-the-run securities, would lead to a higher yield curve due to the liquidity premium.

Yield curves are generally not stable but change over time. To determine how to profit from expected changes in the yield curve, it is helpful to view yield curve changes as resulting from three sources, which are a change in the following:

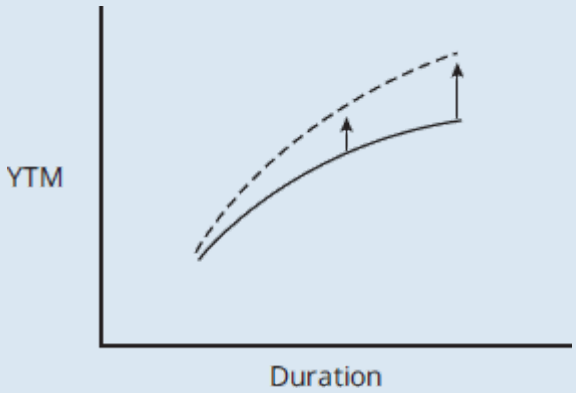
1. *Level*. This is a parallel shift where all yields shift up (or down) by the same amount.

EXAMPLE: **An upward parallel shift**



2. *Slope*. The slope is where the curve becomes flatter or steeper (a "twist").

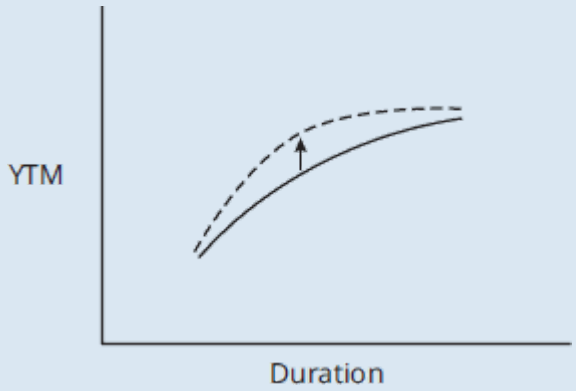
EXAMPLE: **A steepening**



The slope of a curve can be measured by subtracting a short-term yield from a long-term yield. If this difference increases, then the curve is steepening.

3. *Curvature*. This is where the curve becomes more or less curved (a "butterfly movement").

EXAMPLE: **Increased curvature**



The curvature of the yield curve is measured through the butterfly spread:

butterfly spread = –(short-term yield) + (2 × medium-term yield) – long-term yield

If the butterfly spread is increasing, then medium-term yields are rising relative to short-term and long-term yields and the curvature of the yield curve is increasing.

In reality, most changes in the curve involve more than one source. However, by far the most important yield curve change in explaining changes in bond prices is a parallel shift in rates.

Recall from a previous reading, Overview of Fixed-Income Portfolio Management, the five-step return decomposition process:

1. Coupon income = annual coupon amount / current bond price
2. Rolldown return = (projected bond price (BP) assuming no yield curve change – beginning BP) / beginning BP
3. Price change due to investor yield change predictions: $(-MD \times \Delta Y) + (\frac{1}{2}C \times \Delta Y2)$
4. Price change due to investor spread change predictions: $(-MD \times \Delta S) + (\frac{1}{2}C \times \Delta S2)$
5. Currency G/L: projected change in value of foreign currencies weighted for exposure to the currency

The impact of changes in the benchmark yield curve (ΔY) is captured in part 3 of the process just listed. Recall also some key facts regarding duration and convexity that we stated in an earlier reading but will be relevant in this reading also:

- Part 3 of the return decomposition shows that bonds with higher convexity outperform similar bonds with lower convexity in periods of high interest rate volatility (ΔY). This will likely lead to bonds with higher convexity trading at a premium and consequently offering lower yield to maturity.
- The higher the dispersion of cash flows in time around a bond's modified duration, the higher the convexity of the bond. This means that barbell portfolios, with highly dispersed cash flows, will have a higher convexity than bullet portfolios with the same duration.

EXAMPLE: **Barbell vs. bullet**

Consider the following hypothetical U.K. government bonds:

Maturity	Coupon	Modified Duration	Convexity
2y	2.25%	1.86	5.2
10y	0.25%	9.52	104.8
20y	1.25%	16.23	292.8

Portfolio 1 is a bullet portfolio with 100% weight in the 10-year bond. Portfolio 2 is a barbell portfolio with 46.68% weight in the 2-year bond and 53.32% weight in the 20-year bond.

Calculate the change in values of portfolios 1 and 2 if the yield curve undergoes a parallel shift up of 50 basis points.

Answer:

Using part 3 of the return decomposition process, the following are calculated:

price change of the 2-year bond = $(-1.86 \times 0.005) + (\frac{1}{2} \times 5.2 \times 0.0052) = -0.0092$ or –0.92%

price change of the 10-year bond = $(-9.52 \times 0.005) + (\frac{1}{2} \times 104.8 \times 0.0052) = -0.0463$ or –4.63%

price change of the 20-year bond = (–16.23 × 0.005) + (½ × 292.8 × 0.0052) = –0.0775 or –7.75%

price change of portfolio 1 = –4.63% because it is 100% invested in the 10-year bond

price change of portfolio 2 = (0.4668 × –0.92%) + (0.5332 × –7.75%) = –4.56%

Note how the higher convexity of portfolio 2 (barbell) causes outperformance versus the lower convexity of portfolio 1 (bullet). Note also that the weight of portfolio 2 has been deliberately chosen to set portfolio 2's duration to be equal to that of portfolio 1, because (0.4668 × 1.86) + (0.5332 × 16.23) = 9.52.

Yield Curve Strategies

We now turn our attention to the trades an active manager can make to earn excess returns based on their view on the shape and level of the yield curve.

Static Yield Curve

LOS 13.b: Formulate a portfolio positioning strategy given forward interest rates and an interest rate view that coincides with the market view.

CFA® Program Curriculum, Volume 3, page 13

An active manager can earn excess return from the view that an upward-sloping yield curve will remain unchanged over time by either increasing maturity (and therefore also increasing duration) to earn higher yields or introducing leverage into the portfolio to magnify returns.

Cash-based static yield curve strategies include the following:

- **Buy and hold.** Extend the duration of the portfolio to be longer than that of the benchmark in order to earn higher returns, primarily through higher coupon income on longer-dated bonds. The buy-and-hold nature of the strategy keeps portfolio turnover and associated trading costs low.
- **Rolling down the yield curve.** This strategy is based on the fact that, as time passes, the bond's remaining maturity and duration decrease. In an upward-sloping curve, that means its yield will decline as time passes. It differs from buy and hold in that the manager aims to earn excess return from both higher coupon income and rolldown return from the bond's price changing over time. The manager will look to find a bond positioned next to a relatively steep portion on the curve such that as time passes and its yield declines, the bond will offer the greatest increase in price. Then, after the yield declines, the manager sells the bond and rolls out the curve to repeat the process by buying another bond at the end of a steep segment of the curve.
- **Repo carry trade.** A carry trade is just another form of leverage. Return is enhanced by borrowing at a lower rate to invest the funds in an asset that will generate a higher rate of return. In a stable upward-sloping curve, borrow at lower shorter-term rates to invest at higher longer-term rates.

Derivatives-based static yield curve strategies include the following:

- **Long futures positions.** Futures contracts provide implicit leverage into fixed-income positions because investors are required only to fund margin payments to open positions, which are usually a small fraction of the exposure gained through the futures contract.

- **Receive-fixed swap.** By receiving the fixed leg and paying the floating leg [a short-term market reference rate (MRR)] under an interest rate swap, the active manager can synthetically increase the duration of the portfolio. Recall from the derivatives material of the curriculum that the fixed leg of the swap carries the most duration because it is analogous to a fixed-coupon bond. A manager that receives the fixed leg increases their portfolio duration. They expect to earn the swap carry of the swap fixed rate – MRR, while also earning the profits and losses from marking the swap to market over time.

PROFESSOR'S NOTE

LIBOR was for a long time the benchmark floating rate for interest rate derivatives. This rate is now being phased out and replaced by different market reference rates (MRR) in different markets across the world (usually secured overnight interbank funding rates). So, instead of seeing LIBOR underlying interest rate derivatives, expect to see MRR in the future.

Note that the curriculum reading here revisits material that we saw in the liability-driven investing and derivative sections of the curriculum. As a reminder, the BPV of a treasury futures contract is related to the BPV of the underlying cheapest-to-deliver (CTD) bond through the conversion factor (CF) of the CTD as follows:

$$\text{futures BPV} = \frac{\text{BPV}_{\text{CTD}}}{\text{CF}_{\text{CTD}}}$$

Then the number of futures contracts to go long = target BPV / futures BPV.

EXAMPLE: **Extending duration (bond vs. swap)**

An active manager has the view that the yield curve will remain static over the next six months. They are considering two different trades to exploit this view by extending the duration of the portfolio.

Trade A: Purchase a 10-year 3% semiannual coupon U.K. Treasury bond currently yielding 2.5%, priced at 104.3998.

Trade B: Enter a 10-year semiannual receive-fixed swap at 3%. Current floating MRR is 0.5%.

For a six-month horizon, a £50 million par value position, and a 25 bps fall in both treasury yields and swap rates, **calculate**:

1. The coupon income and price appreciation for trade A. Break the price appreciation down into rolldown and the change in price due to the change in rates.
2. The swap carry and MTM gain/loss on the swap.

Answers:

1. Coupon income for the bond in trade A = 0.03 / 2 × £50,000,000 = £750,000

   Price of bond in six months: **19** N; **2.25** / 2 = 1.125 I / Y; 3 / 2 = 1.5 PMT; 100 FV; CPT PV: 106.3828

   Hence, the price appreciation for £50,000,000 par = (106.3828 – 104.3998) / 100 × £50,000,000 = £991,500.

   (Note that the price is a "percentage of par" quote. We divide the price by 100 here to scale down to £1 of par; then we multiply by £50 million to scale up to the full size of the bond).

   In order to break the price appreciation into rolldown and impact of yield change, we price the bond in six months' time at its original yield (note that we are assuming here that the yield curve between 10 and 9.5 years is flat).

   Price of bond in six months with unchanged yield: **19** N; **2.5**/2 = 1.25 I/Y; 3/2 = 1.5 PMT; 100 FV; CPT PV: 104.2048

   price appreciation due to rolldown = (104.2048 – 104.3998) / 100 × £50,000,000 = –£97,500

   price appreciation due to yield change = (106.3828 – 104.2048) / 100 × £50,000,000 = £1,089,000

2. Swap carry = fixed-leg income – floating-leg outflow = [(0.03 – 0.005) / 2] × £50,000,000 = £625,000

   In order to value the swap in six months' time, we view the swap as two separate bonds: the receive fixed position is viewed as a long position in a 3% fixed-coupon bond, and the pay floating position is viewed as a short position in a floating-rate note (FRN).

   Value of £1 of par of the fixed leg in six months' time after fair swap rates have fallen by 25 bps: 19 N; 2.75 / 2 = 1.375 I/Y; 0.03 / 2 = 0.015 PMT; 1 FV; CPT PV: £1.020776346

   value of fixed-leg side = 1.020776346 × £50,000,000 = £51,038,817

   The floating side can be viewed as an FRN, which at a payment date will reset to par. Hence, the value of the swap in 6 months' time = £51,038,817 – £50,000,000 = £1,038,817.

MODULE QUIZ 13.1

To best evaluate your performance, enter your quiz answers online.

1. Portfolio A is a bullet portfolio, portfolio B is a barbell portfolio, and both are invested in risk-free government securities with the same portfolio modified duration. Under which of the following yield curve changes will portfolio B outperform portfolio A?
   A. A downward shift in yields only.
   B. An upward shift in yields only.
   C. Both a downward and an upward shift in yields.
2. A manager that expects a stable yield curve environment is likely to consider which of the following trades to profit from this view?
   A. Receive-fixed swap.
   B. Pay-fixed swap.
   C. Reverse repo carry trade.
3. Which of the following yield curve scenarios is the major risk to a manager engaging in a buy-and-hold strategy?
   A. A parallel shift up in yields.
   B. An inversion from a normal upward-sloping yield curve to a downward-sloping yield curve due to falling long-term rates.
   C. Yield curve remains unchanged.

MODULE 13.2: TRADES FOR A DYNAMIC YIELD CURVE

Video covering this content is available online.

LOS 13.c: Formulate a portfolio positioning strategy given forward interest rates and an interest rate view that diverges from the market view in terms of rate level, slope, and shape.

CFA® Program Curriculum, Volume 3, page 13

We now consider the scenarios where the manager has a view that the yield curve will change level, slope, or curvature. Note that the view that rates will fall is a *bullish* view, because this means fixed-income security prices will rise. Conversely, the view that interest rates will rise more than expected is a *bearish* view.

Divergent Rate Level View

An active manager can earn excess return from a bullish view that the benchmark yield curve will shift down by *increasing* the duration of their portfolio. Conversely, a manager with the bearish view that the yield curve will shift up would *lower* the duration of their portfolio.

Managers could use cash bonds, interest rate swaps, or futures contracts to alter the duration of the portfolio as follows:

Strategy	Increase Duration	Decrease Duration
Cash bond	Overweight longer-dated bonds	Short sell bonds/overweight shorter-dated bonds
Swap	Receive fixed	Pay fixed
Futures	Long contracts	Short contracts

Recall the three hypothetical U.K. government bonds used in a previous example:

Maturity	Coupon	Modified Duration	Convexity
2y	2.25%	1.86	5.2
10y	0.25%	9.52	104.8
20y	1.25%	16.23	292.8

A benchmark consisting of an equal weight in the three bonds would have a duration of (1.86 + 9.52 + 16.23) / 3 = 9.203 and a convexity of (5.2 + 104.8 + 292.8) / 3 = 134.3.

A manager expecting rates to rise could take an overweight position of 50% in the 2-year bond and 25% in both the 10-year and 20-year bonds. The portfolio would have a duration of (0.50 × 1.86) + (0.25 × 9.52) + (0.25 × 16.23) = 7.368 and a convexity of (0.50 × 5.2) + (0.25 × 104.8) + (0.25 × 292.8) = 102.0.

Now, if we assume that the manager's view was correct and that there is an immediate 40 bps increase in rates, we can use step 3 of the return decomposition process to calculate the change in price for both the benchmark and the portfolio:

price change of the benchmark = (−9.203 × 0.004) + (½ × 134.3 × 0.0042) = −0.0357 or −3.57%

price change of the portfolio = (−7.368 × 0.004) + (½ × 102.0 × 0.0042) = −0.02866 or −2.87%

The manager correctly lowered the duration before a shift up in the level of the yield curve, leading to excess return of −2.87% − (−3.57%) = 0.7%.

Note that the manager could have achieved the same outcome through combining the benchmark portfolio with a pay-fixed swap with a modified duration of −8.354. The size of the swap required can be calculated here using basis point value (BPV) (recall that BPV = market value × modified duration × 0.0001).

BPV of benchmark = $100 million × 9.202 × 0.0001 = $92,020

target portfolio BPV = $100 million × 7.366 × 0.0001 = $73,660

Hence, the pay-fixed swap must have a BPV of $73,660 − $92,020 = −$18,360.

Using a swap with a duration given as −8.354, we use a notional principal (NP) that solves −8.354 × NP × 0.0001 = −$18,360. We can then solve for NP = −$18,360 / (−8.354 × 0.0001) = $21,977,496.

Divergent Yield Curve Slope View

Due to the inverse relationship between rates and bond prices, an active manager that expects a change in the *shape* of the yield curve should buy bonds with rates that are expected to fall relative to the rest of the curve (because prices will rise) and short sell bonds with rates that are expected to rise relative to the rest of the curve (because prices will fall).

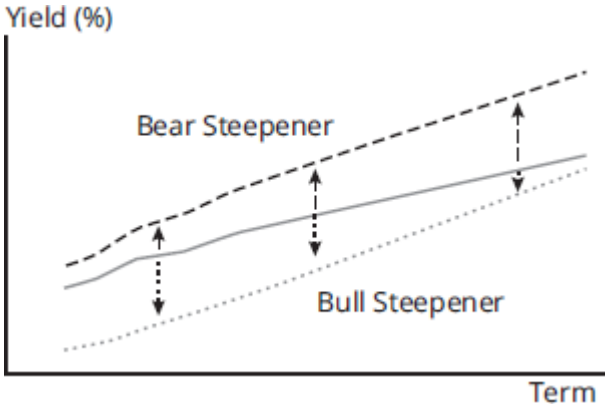
Therefore, a manager expecting a steepening curve, where long-term rates are rising and short-term rates are falling, should short sell long-dated bonds and buy short-dated bonds. Conversely, a manager expecting a flattening curve where short-term rates are rising and long-term rates are falling should buy long-dated bonds and short sell short-dated bonds.

A manager might expect a change in the *level* of yields to occur simultaneously alongside a change in slope. Recall that a manager expecting a fall in the level of rates is referred to as bullish, and a manager expecting a rise in the level of rates is referred to as bearish. A bullish manager would position their overall portfolio duration to be positive, such that the portfolio increases in value as rates fall. A bearish manager would position their overall portfolio duration to be negative, such that the portfolio increases in value as rates rise. A manager that does not expect a change in the level of the curve would likely position their portfolio as duration neutral.

A **bull steepener** is the view that short-term rates will fall by more than long-term rates. This might occur when central banks cut short-term rates during an economic contraction.

A **bear steepener** is the view that long-term rates will rise by more than short-term rates. This might occur when central banks keep short-term rates too low for too long, increasing longer-term inflation expectations and the required return on longer-term bonds.

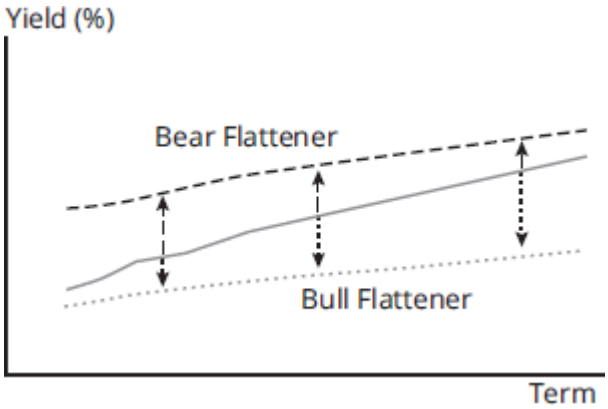
Figure 13.1: Steepening Yield Curve



A **bear flattener** is the view that short-term rates will rise by more than long-term rates. This might occur when central banks begin to raise short-term rates in response to rising inflation expectations.

A **bull flattener** is the view that long-term rates will fall by more than short-term rates. This might occur when there is a flight to quality in uncertain markets as investors sell risky assets and purchase risk-free benchmark securities.

Figure 13.2: Flattening Yield Curve



A summary of these curve changes and the associated strategies are displayed here:

View	Portfolio Duration	Short-Term Bonds	Long-Term Bonds
Steepener (no change in level)	Zero	Buy	Short sell
Bear steepener	Negative		
Bull steepener	Positive		
Flattener (no change in level)	Zero	Short sell	Buy
Bear flattener	Negative		
Bull flattener	Positive		

PROFESSOR'S NOTE

It is very difficult to digest this sort of information without picturing what is happening. Do not try to rote learn tables like the one here, but think logically about the definition of each view and how the manager should buy bonds where rates are falling relative to the rest of the market and sell bonds where rates are falling relative to the rest of the market. This, combined with maintaining a positive duration in a bull market and a negative duration in a bear market, unlocks the table without the need for memorization.

EXAMPLE: **Bull steepening**

A portfolio manager expects the yield curve to steepen and has collated the following information on government bonds:

Maturity	Coupon	Modified Duration	Convexity
2y	2.25%	1.86	5.2
20y	0.25%	9.52	104.8

The manager wishes to take a long position with market value of £100 million and an appropriately sized short position in order to take advantage of their view. They currently do not expect a change in the general level of rates.

1. **Describe** the trades the manager should make to profit from their view.
2. **Calculate** the total profit or loss of the portfolio if there is an immediate 20 bps decline in 2-year yields and 20 bp rise in 10-year yields.
3. **Discuss** how the manager would adjust the portfolio positions should they subsequently decide the yield curve will undergo a bull steepener (no calculations required).

Answers:

1. To profit from the view that the yield curve is going to steepen, the manager should buy short-dated bonds (2-year maturity) and short sell long-dated bonds (10-year maturity). It is stated that the manager wishes to take a long position with market value of £100 million. This implies a BPV of the long position in short-dated bonds of £100,000,000 × 1.86 × 0.0001 = £18,600.

   Since the manager has no view on change in the level of rates, they should remain duration neutral. Hence, the BPV of the short position in the 10-year bonds must equal –£18,600 to cancel out the BPV of the long position in 2-year bonds. This means we require a market value for the short position in 10-year bonds (MVs) such that MVs × 9.52 × 0.0001 = –£18,600. This implies MVs = –£18,600 / (9.52 × 0.0001) = –£19,537,815.

2. We can use step 3 of the return decomposition process to calculate the change in price for both bonds:

   price change of the 2-year bond = (–1.86 × –0.002) + (½ × 5.2 × 0.0022) = 0.0037304 or 0.37304%

   resulting gain = 0.0037304 × £100 million = £373,040

   price change of the 10-year bond = (–9.52 × 0.002) + (½ × 104.8 × 0.0022) = –0.01883 or –1.883%

   resulting gain = –0.01883 × –£19,537,815 = £367,897

   total increase in portfolio value = £373,040 + £367,897 = £740,937

3. If the manager believes the next yield curve change will be a bull steepener, then they believe that the steepening of the curve is going to take place in a generally falling-rate environment.

   The manager should adjust the portfolio to have a positive duration in order to profit from rates generally falling. This can be done by adding more to the long position in the 2-year bond or short selling less of the position in the 10-year bond.

Divergent Yield Curve Shape View—Change in Curvature

If a manager has the view that the curvature of the yield curve is likely to change, they can profit from this view by combining long and short positions in bullets and barbells (referred to as a **butterfly strategy**). Note that the bullet is referred to as the body and the barbell referred to as the wings in this trade.

If the manager believes that curvature will *increase*, they think that medium-term rates will rise relative to short- and long-term rates. In this scenario, the manager should short sell a medium-term bullet and buy a barbell ("short the body and long the wings"). Conversely, if the manager believes that curvature will *decrease*, they think that medium-term rates will fall relative to short- and long-term rates. In this scenario, the manager should buy a medium-term bullet and short sell a barbell ("long the body and short the wings").

Recall that the curvature of the yield curve can be measured through the butterfly spread:

butterfly spread = –(short-term yield) + (2 × medium-term yield) – long-term yield

An increase in the butterfly spread implies that medium-term rates are rising relative to short- and long-term rates, and, hence, curvature is increasing. Conversely, a fall in the butterfly spread implies that curvature is decreasing.

Recall also that an increase in curvature is referred to as a negative butterfly twist. A manager with a negative butterfly view expects the curvature of the yield curve to increase.

Note that while butterfly strategies are constructed to be duration neutral, they will not be convexity neutral due to the barbell having a higher convexity than the bullet.

PROFESSOR'S NOTE

This is a real minefield because a negative butterfly twist corresponds to an increase in the butterfly spread! Given this is fixed income, we shouldn't be surprised to see an inverse relationship; however, we need to tread very carefully when presented with information on curvature on the exam. A tip to remembering the negative/positive twist idea is to think that the curve actually "frowns" more after a negative butterfly twist (due to the increased curvature). A positive butterfly twist causes the curve to "frown" less—or even smile in a positive way!

EXAMPLE: **Butterfly strategy**

Recall the following three hypothetical U.K. bonds:

Maturity	Coupon	Modified Duration	Convexity
2y	2.25%	1.86	5.2
10y	0.25%	9.52	104.8
20y	1.25%	16.23	292.8

A manager wishes to construct a portfolio to profit from a positive butterfly view. They wish to set the total market value of any long position in the portfolio to £100 million, and they wish the wings of the trade to be of equal market value.

1. **Explain** how a manager should construct a duration neutral portfolio. **Show** your calculations.
2. **Calculate** the profit on the portfolio if 2- and 20-year yields rise by 10 bps and the 10-year yield falls by 25 bps.
3. **Discuss** the convexity exposure of the resulting portfolio and the impact on portfolio performance, should the manager's view be correct (note that no calculations are required for this part).

Answers:

1. A positive butterfly view implies the manager thinks that short-term and long-term rates will rise relative to intermediate rates. The manager should short sell the 2-year and 20-year bonds (the "wings") and buy the 10-year bonds (the "body").

   If the manager wishes to take a long position of value £100 million, this implies a BPV from the 10-year bond of £100 million × 9.52 × 0.0001 = £95,200. It is stated in the question that the manager wishes the wings to have equal market value, MVw. In order to be duration neutral, we require the total BPV of the short wings to equal the BPV of the long body:

   (MVw × 1.86 × 0.0001) + (MVw × 16.23 × 0.001) = £95,200

   Solving for MVw:

   0.000186MVw + 0.001623MVw = £95,200

   0.001809MVw = £95,200

   = >MVw = £95,200 / 0.001809 = £52,625,760

   Hence, the manager should buy £100 million of the 10-year bond and short sell £52,625,760 of both the 2-year and the 20-year bond.

2. We can use step 3 of the return decomposition process to calculate the change in price for each bond:

   price change of the 2-year bond = (−1.86 × 0.001) + (½ × 5.2 × 0.0012) = −0.001857 or −0.1857%

   resulting p/l = −0.001857 × −£52,625,760 = £97,747

   price change of the 10-year bond = (−9.52 × −0.0025) + (½ × 104.8 × −0.00252) = 0.0241275 or 2.41275%

   resulting p/l = 0.0241275 × −£100,000,000 = £2,412,750

   price change of the 20-year bond = (−16.23 × 0.001) + (½ × 292.8 × 0.0012) = −0.0160836 or −1.60836%

resulting p/l = −0.0160836 × −£52,625,760 = £846,412

total increase in portfolio value = £97,747 + £2,412,750 + £846,412 = £3,356,909

3. The portfolio is short a high convexity barbell and long a lower convexity bullet. This implies that the overall portfolio is short convexity, which will decrease portfolio performance when yields move. (Note that if we summed the convexity adjustments from part 2, we would see that the convexity effect of the bullet is in fact larger than that of the short wings. However, this is due to the fact that medium-term rates moved by more than the short-term and long-term rates. If medium-term rates had moved by the same amount as the short-term and long-term rates, the overall impact of convexity would have been negative.)

MODULE QUIZ 13.2

To best evaluate your performance, enter your quiz answers online.

1. Which of the following trades is *most likely* to be executed by a manager that expects a downward shift in yields?
   A. Enter a pay-floating swap.
   B. Enter a receive-floating swap.
   C. A short futures position.
2. A manager positions their portfolio to have a negative overall duration with long positions in short-term bonds and short positions in long-term bonds. Which of the following yield curve changes is the manager *most likely* anticipating?
   A. Bear flattener.
   B. Bear steepener.
   C. Bull flattener.
3. A manager who buys the wings and sells the body in a butterfly trade is *most likely* expecting:
   A. a decrease in curvature.
   B. the butterfly spread to decrease.
   C. a negative butterfly twist.

MODULE 13.3: YIELD CURVE VOLATILITY STRATEGIES, KEY RATE DURATION

Video covering this content is available online.

LOS 13.d: Formulate a portfolio positioning strategy based upon expected changes in interest rate volatility.

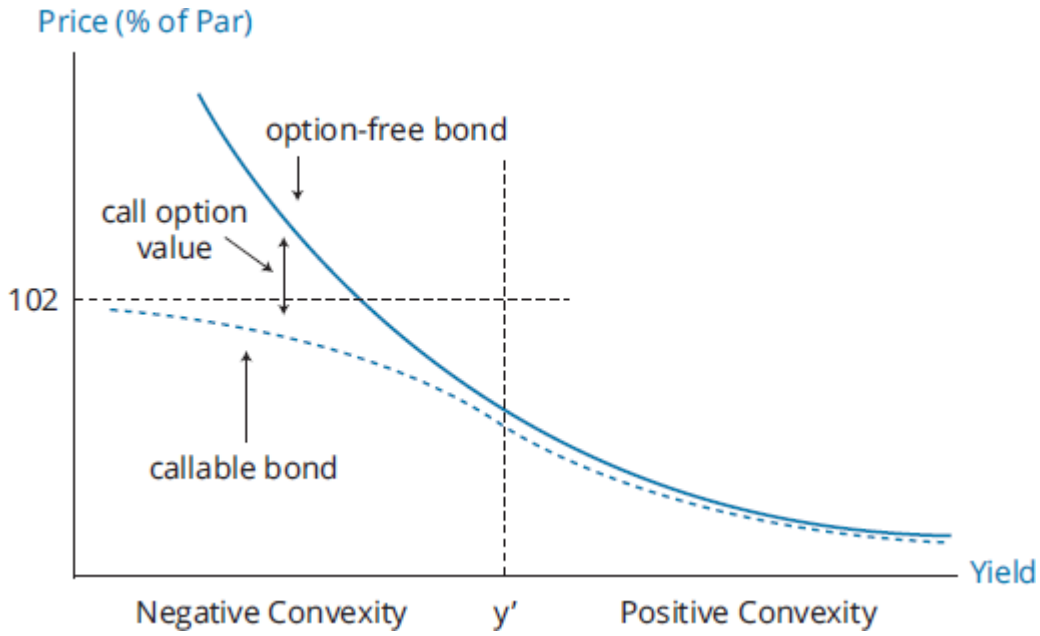
CFA® Program Curriculum, Volume 3, page 31

We now turn our attention to bonds with embedded options and stand-alone option strategies in fixed-income markets.

In the underlying bond markets, the major types of bonds with embedded options are callable bonds and putable bonds.

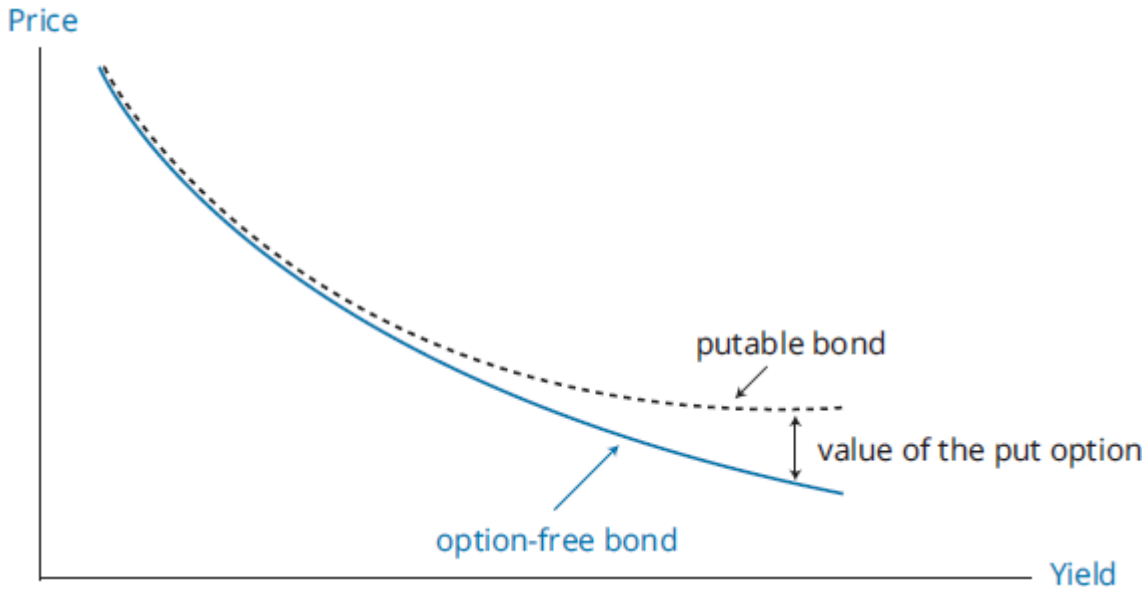
A **callable** bond gives the issuer the right to buy the bond back from the investor before maturity. It can be viewed as a combination of an option-free bond and a short call option, because this call has been granted to the issuer. The embedded short call option becomes more valuable as yields fall and underlying bond prices rise. This leads to negative convexity for callable bonds at low yields, as their prices will rise at a slower pace than option-free bonds due to the increase in the value of the call option.

Figure 13.3: Callable Bond



A **putable** bond gives the investor the right to sell the bond back to the issuer before maturity. It can be viewed as a combination of an option-free bond and a long put option because this put is owned by the investor. The embedded long put option becomes more valuable as yields rise and underlying bond prices fall. This leads to a floor underneath putable bond prices at high yields, as their prices fall at a slower pace than option-free bonds due to the increase in the value of the put option.

Figure 13.4: Putable Bond



Recall that bonds with embedded options should be analyzed using *effective* duration and convexity measures, which incorporate the impact on the cash flows of changes in the benchmark yield in their calculation. Note that Macaulay duration/convexity and modified duration/convexity measures cannot be used for bonds with embedded options because they do not account for the uncertainty of the bond's cash flows due to the exercise of the embedded option.

The formulas for effective duration and convexity were stated in an earlier reading but are reprinted here for convenience:

$$\text{effective duration} = \frac{(PV_-) - (PV_+)}{2(\Delta\text{curve})(PV_0)}$$

$$\text{effective convexity} = \frac{(PV_-) + (PV_+) - 2(PV_0)}{(\Delta\text{curve})^2 (PV_0)}$$

where:
PV0 = current value of the portfolio
PV– = value of portfolio when benchmark curve is shifted down
PV+ = value of portfolio when benchmark curve is shifted up
Δcurve = change in benchmark curve

A general rule for bonds with embedded options that is useful to keep in mind is that the option always *lowers* the duration of the otherwise option-free bond. This is because the short call and long put positions move inversely to the underlying bond (when the bond falls, the option position value increases and vice versa).

In the derivatives markets, the three major types of options available are options on bond prices, options on bond futures, and swaptions.

Adding **call options on either a bond price or a bond futures contract** will *increase* the duration of a fixed-income portfolio because the calls will increase in value as yields fall and bond prices rise. They also *increase* the convexity of the portfolio due to the convex relationship between prices and yields.

Adding **put options on either a bond price or a bond futures contract** will *decrease* the duration of a fixed-income portfolio because the puts will increase in value as yields rise and bond prices fall. They also lower the convexity of the overall portfolio due to the floor that the put options place under the portfolio, which causes the portfolio to move in a straighter line versus yields than the equivalent option-free bond.

PROFESSOR'S NOTE

The fact that adding puts to a fixed-income portfolio lowers convexity can be seen from the behavior of the putable bond in Figure 13.4 when yields are high and the put option is valuable. Remember that a straight line has zero convexity—by placing a floor under the value of the portfolio, the chart shows that the putable bond begins to move in a straight line sooner than the option-free bond as yields rise and, hence, has less convexity. This is a technical point and does seem to assume that the put option is in the money; however, the curriculum does not choose to elaborate on these ideas and simply states that adding puts on a bond price or bond futures lowers the duration and convexity of a portfolio.

Swaptions can also be used to alter the duration and convexity of a fixed-income portfolio.

A **payer swaption** gives the holder the right to enter a pay-fixed swap. This becomes valuable as rates rise; hence, a payer swaption *decreases* the duration and convexity of the portfolio (similar to the impact of a long put on a bond price as described previously).

A **receiver swaption** gives the holder the right to enter a receive-fixed swap. This becomes valuable as rates fall; hence, a receiver swaption *increases* the duration and

convexity of the portfolio (similar to the impact of a long call on a bond price as described previously).

A summary of the different types of options and their impact on portfolio duration and convexity is displayed here:

Strategy	Impact on Duration	Impact on Convexity
Long call on bond prices/bond futures prices	Increase	Increase
Long put on bond prices/bond futures prices	Decrease	Decrease
Long payer swaption	Decrease	Decrease
Long receiver swaption	Increase	Increase

Key Rate Duration

LOS 13.e: Evaluate a portfolio's sensitivity using key rate durations of the portfolio and its benchmark.

CFA® Program Curriculum, Volume 3, page 36

Recall that **key rate duration** (or partial duration) measures the sensitivity of a portfolio to a movement in a key maturity rate *while other rates remain constant*. Note that the sum of key rate durations for a portfolio will equal the effective duration of the portfolio because this sum represents the aggregate sensitivity of the portfolio to a move in all maturity yields at the same time (i.e., a parallel shift in the yield curve).

Key rate duration is used to identify which maturities a manager's portfolio has most sensitivity to and, in doing so, allows us to assess the manager's exposure to nonparallel changes in the yield curve (slope/curvature). Recall that this is not possible under modified or effective duration measures, which assume a parallel shift in yield curves.

A manager with a high positive key rate duration at a particular maturity has the view that this maturity rate is going to fall. Conversely, a manager with a high negative key rate duration at a particular maturity has the view that this maturity rate is going to rise.

Key rate duration can be calculated as follows:

$$\text{KeyRateDur} = -\frac{\text{change in portfolio value}}{\text{portfolio value} \times \text{change in key rate}}$$

PROFESSOR'S NOTE

When dealing with zero-coupon bonds, an easy way to get to key rate duration is to take the modified duration of each zero-coupon bond and multiply by its weight in the portfolio. This scales the bond's sensitivity to changes in rates down to represent the portfolio's sensitivity to a unit change in the key rate. Note that this would not work for coupon-paying bonds because part of their modified duration would come from cash flows that occur at other maturities (i.e., the coupons before maturity).

EXAMPLE: **Key rate duration**

An active fixed-income portfolio manager takes the following positions in the zero-coupon bonds displayed below:

Maturity	Annualized Yield	Position ($m)
2	2%	250
10	3%	–50
20	5%	100

The manager's benchmark is equally weighted across the three zero-coupon bonds.

1. **Calculate** the key rate durations and overall modified durations for both the manager and the benchmark.
2. **Determine** the most likely view of the manager on the next change in yield curve level, slope, and curvature.

Answers:

1. First, compute the modified durations of the zero-coupon bonds through the relationship:

   modified duration = Macaulay duration / (1 + yield)

   Using the fact that the Macaulay duration of a zero-coupon bond is its maturity, the following are calculated:

   modified duration of 2-year bond = 2 / (1.02) = 1.961

   modified duration of 10-year bond = 10 / (1.03) = 9.7087

   modified duration of 20-year bond = 20 / (1.05) = 19.0476

   Next, calculate the key rate duration of the portfolio by multiplying each zero-coupon bond by its weight in the portfolio:

   2-year key rate duration = 1.961 × (250 / 300) = 1.634

   10-year key rate duration = 9.7087 × (−50 / 300) = −1.618

   20-year key rate duration = 19.0476 × (100 / 300) = 6.349

   total portfolio modified duration = 1.634 – 1.618 + 6.349 = 6.365

   Doing the same for the benchmark gives the following:

   2-year key rate duration 1.961 × (100 / 300) = 0.654

   10-year key rate duration = 9.7087 × (100 / 300) = 3.236

   20-year key rate duration = 19.0476 × (100 / 300) = 6.349

   total benchmark modified duration = 0.654 + 3.236 + 6.349 = 10.239

2. Summarizing the result derived in part 1 results in the following:

Maturity	Portfolio	Index	Active Position (Difference)
2-year key rate duration	1.634	0.654	0.980
10-year key rate duration	–1.618	3.236	–4.854
20-year key rate duration	6.349	6.349	0.000
Overall modified duration	6.365	10.239	–3.874

   At the overall portfolio level, the manager has a negative active duration of –3.875. This implies that the manager is bearish (i.e., believes that rates are generally going to rise).

   From a slope perspective, the manager has a positive active exposure to short-term rates (0.980) but a zero active exposure to long-term rates (0.000). This suggests that the manager expects short-term rates to rise by *less* than long-term rates (i.e., the curve is going to steepen).

   The manager also has a significant negative exposure to medium-term rates and overall a positive exposure to short-term and long-term rates. This implies that the manager has a negative butterfly view, where they expect medium-term rates to rise by more than short-term and long-term rates.

Overall, this manager is positioned for a combination of a negative butterfly and a bear steepener.

MODULE QUIZ 13.3

To best evaluate your performance, enter your quiz answers online.

1. Given otherwise similar bond characteristics, a manager who is expecting an upward shift in rates is *least likely* to invest in:
   A. a callable bond.
   B. a putable bond.
   C. an option-free bond.
2. Which of the following positions would *most likely* be established by a manager expecting a downward shift in yields?
   A. Short a receiver swaption.
   B. Long a payer swaption.
   C. Long a call option on bond futures contracts.
3. A manager has created active key rate durations of 3, –0.5, and –3 at the 10-year, 20-year, and 30-year maturities, respectively, using only derivatives to create the active exposures. Which of the following derivatives positions is the manager *most likely* using?
   A. Receive-fixed 10-year swap, short 20-year futures, and pay-fixed 30-year swap.
   B. Pay-fixed 10-year swap, short 20-year futures, and receive-fixed 30-year swap.
   C. Short 10-year futures, long 20-year futures, and receive-fixed 30-year swap.

MODULE 13.4: ACTIVE MANAGEMENT ACROSS CURRENCIES, EVALUATING YIELD CURVE STRATEGIES

Video covering this content is available online.

LOS 13.f: Discuss yield curve strategies across currencies.

CFA® Program Curriculum, Volume 3, page 38

Unhedged Foreign Bond Position

A manager who invests in a foreign currency bond will earn the return of the bond in the foreign currency, *R*FC, alongside returns due to changes in the exchange rate, *R*FX. These two return components compound together to give a total domestic return, *R*DC, given by the following:

$$RDC = (1 + RFC)(1 + RFX) - 1$$

A manager with several different foreign exposures should calculate the domestic returns, *R*DC, individually for each foreign market, then weight these returns according to each foreign market's weight in the portfolio.

PROFESSOR'S NOTE

This equation mirrors the approach in the currency management reading in derivatives. Recall that the *R*FX return here **must** be calculated as the change in the FX quote, with the domestic currency as the variable (price) currency and the foreign currency as the fixed (base) currency (referred to as a direct quote). This is required because the investor's domestic returns are driven by how much one unit of the foreign currency is worth in terms of their own domestic currency, which is what a direct quote displays. If this direct quote rises, the investor profits from an appreciating foreign currency and *R*FX will be positive. If this direct quote falls, the investor suffers losses from a depreciating foreign currency and *R*FX will be negative.

For example, if we had a U.K. portfolio manager investing in a Japanese bond, the domestic currency would be GBP and the foreign currency would be JPY. To calculate *R*FX, we need to look at how the GBP/JPY (i.e., direct quote) quote has moved. The question might state that the JPY/GBP rate was 150 at the start of the period and 125 at the end of the period—this quote is the wrong way around for our purposes. We need to invert this quote and observe that the GBP/JPY quote at the start of the period was 1 / 150 = 0.006667 and ended the period at 1 / 125 = 0.0080. Then *R*FX can then be calculated as (0.0080 – 0.006667) / 0.006667 = 20%. The U.K. manager has benefited from their JPY strengthening during the period—we can see this most easily from the GBP/JPY rate moving up during the period.

The Hedging Decision

EXAMPLE: **Unhedged foreign bond investment**

An Australian portfolio manager invests in a 2-year zero-coupon U.S. Treasury bond for one year. Details of the transaction are as follows:

- The U.S. bond is initially trading at a price of 96.374.
- The USD/AUD exchange rate was 0.90 at the start of the year and 0.80 at the end of the year.
- The U.S. bond ends the year at a price of 99.939.

Calculate the return of the investor in domestic currency terms.

Answer:

The foreign currency return of the U.S. Treasury bond, *R*FC, is the return in the local U.S. market, ignoring any currency effects:

RFC = (99.939 – 96.374) / 96.374 = 3.70%

The domestic currency here is AUD and the foreign currency is USD. In order to calculate *R*FX, the impact of foreign exchange, we need to calculate the percentage change in the AUD/USD exchange rate, with the domestic currency as the variable currency. The quotes in the question, therefore, need to be inverted before calculations:

Opening AUD/USD = 1 / 0.90 = 1.1111

Closing AUD/USD = 1 / 0.80 = 1.2500

Now we can calculate *R*FX as RFX = (1.2500 – 1.1111) / 1.1111 = 12.5%.

The domestic return of the USD assets is therefore (1.037) × (1.125) – 1 = 16.66%.

A manager may choose to hedge their foreign currency exposure by selling the foreign currency forward, thereby locking in an exchange rate to convert the foreign funds back to their domestic currency.

Recall the fundamental no-arbitrage principal of **covered interest rate parity (CIRP),** which implies that, in efficient markets, a manager that hedges a foreign currency by selling the foreign currency forward should *not* earn excess returns. CIRP states that high interest rate currencies should trade at a forward *discount*, so that when a manager sells high interest rate currencies forward to remove currency risk, the forward discount offsets the interest rate differential earned from holding the higher interest rate currency. CIRP means that the manager fails to earn an overall higher return in their hedged foreign bond, instead only earning their *domestic* risk-free rate.

Recall that, according to CIRP, the fair forward rate is related to the spot rate by adjusting for interest rate differentials over the period of length *T* as follows:

$$\text{forward rate} = \text{spot rate} \times \frac{\left(1 + r_{DC}\right)^{T}}{\left(1 + r_{FC}\right)^{T}}$$

Notice how the foreign, fixed currency appears on the base of this relationship, just as it does for the currency quote itself.

EXAMPLE: **The hedging decision**

Following on from the previous example, assume the manager actually holds the U.S. bond for two years to its maturity when it redeems at par. Recall the following formation:

- The original price of the U.S. 2-year zero-coupon bond was 96.374.
- The original USD/AUD exchange rate was 0.80 at initiation of the trade.

An equivalent 2-year zero-coupon Australian government bond was yielding 5% at the initiation of the trade.

1. **Calculate** the fair 2-year forward rate.
2. **Demonstrate** that the manager would earn their domestic risk-free rate if they used this forward rate to hedge their USD foreign currency exposure. **Show** your workings.

Answers:

1. The domestic risk-free rate implied by the 2-year zero-coupon Australian is 5%. The foreign risk-free rate based on the price of the U.S. Treasury is (100 / 96.374)(1/2) – 1 = 1.864%.

   Using the covered interest rate parity formula, the fair 2-year AUD/USD forward rate is as follows [note that we continue to work in direct quotes (DC/FC) here]:

$$\text{forward rate} = \text{spot rate} \times \frac{\left(1 + r_{DC}\right)^{T}}{\left(1 + r_{FC}\right)^{T}} = \frac{1}{0.80} \times \frac{\left(1.05\right)^{2}}{\left(1.01864\right)^{2}} = 1.328$$

2. To hedge their receipt of USD 100 in two years' time, the manager should sell USD 100 forward at the fair forward rate of AUD/USD 1.328 and receive in return 100 × 1.328 = AUD 132.8.

   The original AUD cost of the U.S. bond was 96.374 / 0.80 = 120.4675.

   Therefore, the annualized domestic return to the Australian investor is (132.8 / 120.4675)(1/2) – 1 = 5.0%.

   This is the same annualized return as the domestic risk-free Australian government bond, as required by covered interest rate parity.

PROFESSOR'S NOTE

Note that the interest rate differential in the USD market here was actually negative: USD yield – AUD yield = 1.864% – 5% = –3.1%. Here, covered interest rate parity implies that the higher-yielding AUD will be at a forward discount and the lower-yielding USD will be at a forward premium.

The forward rate of 1.328 AUD/USD is higher than the spot AUD/USD rate of 1.25 by an annualized (1.328 / 1.25)(1/2) – 1 = 3.1%. This is indeed a premium on the USD (don't forget that if the quote is higher, it is the base currency that is stronger).

Observe how, in this case, the premium on the low interest rate currency offsets the lower interest rate earned in the foreign market, causing the investor to earn their domestic risk-free rate.

If the manager chooses *not* to hedge, they will earn a domestic return that depends on the actual movement of exchange rates over their investment horizon. The theory of **uncovered interest rate parity (UIRP)** states that high interest rate currencies should *actually* depreciate over time, such that all *unhedged* investors earn the same return, regardless of which currency they hold. This theory implies that spot rates should move toward the original forward rates set by CIRP. UIRP tends *not* to hold—high interest rate currencies on average tend *not* to depreciate over time according to their interest rate

differential versus other currencies, which means the forward rate is not an unbiased predictor of future spot rates (called **forward rate bias**). This forward rate bias can be exploited by executing a carry trade, described later in this chapter.

PROFESSOR'S NOTE

In the example just listed, **uncovered** interest parity would forecast that the actual AUD/USD spot rate in two years' time should turn out to be 1.328, (i.e., the original forward rate set by **covered** interest rate parity). This does not tend to happen. In practice, the exchange rate tends to move from 1.25 today to some value between 1.25 and 1.328 in two years' time, but doesn't on average move all the way to the original forward rate. In other words, high interest rate currencies tend not to weaken as implied by their forward discount, which means the carry trade can earn excess returns.

Hedging Foreign Coupon-Paying Bonds

Now, let us consider an Australian investor who wishes to hedge their exposure to a *coupon-paying* U.S. Treasury bond.

In order to hedge their foreign USD exposure, the Australian investor must lock in a rate at the outset, which they can periodically exchange the regular foreign USD coupon payments received from the U.S. bond for domestic AUD over the life of the bond. They can achieve this by entering into a **fixed-fixed cross-currency swap**, agreeing to pay USD and receive AUD over the life of the swap. Note that the fixed-fixed cross-currency swap also involves an exchange of principal amounts at the start and the end of the swap's life, which can be used to finance the initial purchase of the foreign U.S. bond and convert back the foreign USD par proceeds in domestic AUD at maturity.

Assume that the current USD/AUD rate is 0.80 and that the manager wishes to hedge an investment in USD 100 million par of a 10-year U.S. Treasury bond currently trading at par. The manager enters into a fixed-fixed cross-currency swap to pay-fixed USD and receive-fixed AUD with principal sizes of USD 100 million and 100 million / 0.80 = AUD 125 million.

Position	At Initiation	Periodic Semiannual Payments for Next 10 Years	At the End
U.S. Treasury Bond	Pay out USD 100 million to purchase the U.S. bond	Receive-fixed USD bond coupon	Receive USD 100 million par at maturity of bond
Fixed-Fixed Cross-Currency Swap	Receive USD 100 million and pay AUD 125 million in exchange of principal amounts	Pay-fixed USD leg Receive-fixed AUD leg	Pay USD 100 million and receive AUD 125 million in exchange of principal amounts
Net Flow	*Pay AUD 125 million principal outflow*	*Receive-fixed AUD payment*	*Receive AUD 125 million principal inflow*

As can be seen from the net flow box, the resulting exposure for the Australian manager is the same as investing in a domestic Australian bond. This is analogous to the scenario with the zero-coupon bond—if parity relations hold, a manager that hedges a foreign exposure will earn their domestic return on the hedged position.

The pay USD, receive AUD fixed-fixed cross-currency swap just described is, in practice, generated through a combination of the three underlying swaps (swaps A, B, and C) listed here:

Swap	Description	Interest Paid	Interest Received	Principal Exchange at Outset	Principal Exchange at End
A	USD interest rate swap	USD Fixed	USD Floating	None	None
B	AUD interest rate swap	AUD Floating	AUD Fixed	None	None
C	Cross-currency basis swap	USD Floating	AUD Floating	Receive in USD principal, pay out AUD principal	Pay out USD principal, receive in AUD principal

The rationale is as follows:

- The fixed-fixed legs (pay USD, receive AUD) are provided by swaps A and B.
- The floating legs of swaps A and B cancel with the floating legs of the cross-currency basis swap, swap C.
- The cross-currency basis swap, swap C, provides the exchange of principal amounts required to fund the investment in foreign U.S. bonds and convert the principal proceeds back into domestic AUD at the end.

PROFESSOR'S NOTE

We first met cross-currency basis swaps in the derivatives section of the curriculum. Recall that they are an exchange of floating rates in different currencies with an exchange of principal amounts at the outset and the end. A good rule of thumb regarding the direction of the principal payments is to think of the floating leg paid out as an interest rate paid on funds borrowed through the swap. In this case, we are paying out USD Floating; hence, we must be using the swap to borrow USD at the start (receive USD principal in) and repay this USD principal at the end (pay USD principal out).

Recall also that covered interest rate parity can be breached in cross-currency basis swaps due to an adjustment to the non-U.S. interest leg referred to as basis. If the basis is negative, this implies that the non-U.S. floating leg is below the fair rate implied by covered interest rate parity. This means that borrowers of U.S. funds through cross-currency basis swaps, like our Australian investor here, are willing to receive a lower interest rate on their domestic currency in order to borrow USD through the swap.

The decomposition of the fixed-fixed cross-currency swap into the three swaps gives an insight into ways an active manager might express an active view on interest rates or currencies. For example, if the manager chose not to initiate swap A, this would leave them with a fixed USD coupon coming in from the bond and a floating USD payment going out under swap C. Hence, the manager would be net receiving fixed and paying floating in USD and will therefore profit if USD rates fall (think: positive duration). Note, however, that currency is still fully hedged under the cross-currency swap.

Unhedged Cross-Currency Trade: The Carry Trade

To conclude this section on currency, we shall consider a classic *unhedged* cross-currency trade: the **carry trade**. The carry trade involves borrowing in a low interest rate currency and depositing in a high interest rate currency. The manager faces the risk

that the high interest rate currency weakens and can also take a view on the relative yield curve changes in the two currencies by borrowing and depositing over different maturities, as per the example here.

EXAMPLE: **INR carry trade**

A manager is considering executing a carry trade with a 1-year horizon through borrowing U.S. dollars (USD) and investing in short-term Indian rupee (INR) securities. Details of the trade are as follows:

- The manager will borrow at the 1-year USD rate of 1%.
- The manager will roll 90-day INR securities, which currently offer a rate of 5% on an annualized basis.
- The current INR/USD spot rate is 70.
    1. **Calculate** the approximate return from the carry trade if interest rates and exchange rates remain stable over the year.
    2. **Calculate** the return from the carry trade based on if short-term 90-day INR rates evolve to be 5%, 6%, 4%, and 3% over the coming year, and the final INR exchange rate is 85.

Answers:

1. Foreign returns from rolling the INR securities every 90 days for a year = $(1 + 0.05 / 4)4 - 1 = 5.1\%$.

   The cost of funds in USD for 1 year = 1%.

   With no change in exchange rates, there are no profits/losses from currency exposure; hence, total return = 5.1% – 1% = 4.1%.

2. Foreign returns from rolling the INR securities every 90 days for a year

   $= (1 + 0.05 / 4) \times (1 + 0.06 / 4) \times (1 + 0.04 / 4) \times (1 + 0.03 / 4) - 1 = 4.6\%$.

   The cost of funds in USD for 1 year = 1%.

   In order to measure the foreign exchange impact, we need to look at the percentage change in the value of the INR, since this is the currency the manager is depositing in. Hence, we need to look at the change in the USD/INR quote where the INR is the base currency. This quote started the year at 1 / 70 = 0.014286 and ends the year at 1 / 85 = 0.011765. Therefore, the p/l from fx is calculated as (0.011765 / 0.014286) – 1 = –17.6%.

   The total p/l from the carry trade = 4.6% – 1.0% – 17.6% = –14.0%.

PROFESSOR'S NOTE

While we said earlier that forward rate bias means that the carry trade can, on average, earn excess returns, it appears here that the major risk of the carry trade has crystallized in this example. A significant depreciation in the high interest rate currency has wiped out the interest rate differential many times over and caused significant losses. It is likely this trade occurred in a time of flight to quality in a market crisis, where the carry trade can suffer significant losses.

Note that swap can also be used to profit from an active cross-currency view. Generally, a manager would use swaps to:

- Receive floating in markets where they expect floating rates to rise, and pay floating in markets where they expect rates to fall.
- Receive fixed in markets where they expect rates to fall and pay fixed in markets where they expect rates to rise.
- The manager would also be subject to foreign exchange risk. They should be careful to ensure that expected currency movements do not wipe out or exceed the expected interest rate advantage (as per the example just listed).

PROFESSOR'S NOTE

This is simply a basic duration comment. If we keep in mind that we wish to extend duration (receive fixed) when rates are expected to fall and lower duration (receive floating) when rates are expected to rise, with an exam question, logic should prevail.

A Framework for Evaluating Yield Curve Strategies

LOS 13.g: Evaluate the expected return and risks of a yield curve strategy.

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Recall the five-step return decomposition process:

1. Coupon income = annual coupon amount / current bond price
2. Rolldown return = [projected bond price (BP) assuming no yield curve change – beginning BP] / beginning BP
3. Price change due to investor yield change predictions: $(-MD \times \Delta Y) + (\frac{1}{2}C \times \Delta Y2)$
4. Price change due to investor spread change predictions: $(-MD \times \Delta S) + (\frac{1}{2}C \times \Delta S2)$
5. Currency G/L: projected change in value of foreign currencies weighted for exposure to the currency

Steps 1–3 and 5 have been central to the discussions in this chapter (step 4 is considered in the next reading on credit strategies). This reading concludes with some applications of steps 1–3 and 5 of the process just listed.

PROFESSOR'S NOTE

There is nothing new here that we have not already seen in the chapter, and the examples in the curriculum become quite repetitive. It is really just an exercise in tying all of the information together in a scenario analysis. The important thing here is that this is likely how this material will be actually tested. We present one example for reference.

EXAMPLE: CAD bullet vs. barbell

A U.S.-based portfolio manager is considering investing in Canadian zero-coupon bonds. The manager collates the following information relating to the expected performance of a bullet portfolio relative to a barbell portfolio over the next year.

	Bullet	Barbell
Average bond price	96.75	97
Expected average price in 1 year assuming stable yield curve	98.75	98.95
Expected effective portfolio duration	4.89	4.92
Expected portfolio convexity	28.5	43
Expected change in CAD bond yields	0.25%	0.25%
Expected change in CAD versus USD	–0.50%	–0.50%

1. **Calculate** the expected return from the bullet and barbell portfolios over the next year.
2. **Discuss** reasons for the difference in performance of the bullet and barbell portfolios.

Answers:

1. Using the five-part return decomposition process:

   Step 1: Coupon income

Since all bonds are zero-coupon bonds, there is no coupon yield for either the bullet or the barbell portfolios.

Step 2: Rolldown return

Bullet: (98.75 – 96.75) / 96.75 = 2.067%

Barbell: (98.95 – 97) / 97 = 2.010%

Step 3: Impact of changes in yield

Bullet: Price change = (–4.89 × 0.0025) + (0.5 × 28.5 × 0.00252) = –0.01214 or –1.214%

Barbell: Price change = (–4.92 × 0.0025) + (0.5 × 43 × 0.00252) = –0.01217 or –1.217%

Step 4: Impact of changes in spread

There is no information regarding changes in spread, so we assume this is zero for both the bullet and barbell.

Step 5: Impact of currency

Steps 1–3 have given us the foreign market returns in CAD. We can compound this with the expected currency return of –0.50% to get the expected domestic returns in USD.

Bullet: (1 + 0.02067 – 0.01214) × (1 – 0.005) –1 = 0.0035 or 0.35%

Barbell: (1 + 0.02010 – 0.01217) × (1 – 0.005) –1 = 0.0029 or 0.29%

2. The bullet outperforms the barbell by 6 bps. This primarily comes from the higher expected rolldown return of the bullet bond versus the two bonds that make up the barbell. It must be the case that the bullet bond lies on a steeper part of the yield curve than the average of the two bonds that make up the barbell leading to a slightly larger fall in yield and a slightly higher rolldown return for the bullet.

PROFESSOR'S NOTE

Notice that step 5 here compounds currency return on the domestic return of the bond, whereas in the first example of this return decomposition process given in an earlier reading, we simply added step 5 to the other components. So which is correct? Given that the section in this chapter that delves into detail on currency uses a multiplicative approach as just listed, we would recommend using the multiplicative approach. Chances are, though, that given the earlier example simply adds step 5, it is unlikely that examiners could actually mark this approach wrong if it were used in the exam.

MODULE QUIZ 13.4

To best evaluate your performance, enter your quiz answers online.

1. A U.S. investor buys a zero-coupon 1-year European bond denominated in EUR for EUR 99.01. At the same time, the 1-year U.S. interest rate is 3%. The manager chooses to hedge currency exposure through selling EUR forward against USD. If covered interest rate parity holds, the manager will:
   A. sell EUR at a 2% premium against USD.
   B. sell USD at a 2% premium against EUR.
   C. buy USD at a 2% discount against EUR.
2. Excess returns from the unhedged carry trade imply that which of the following parity relationships is not holding?
   A. Covered interest rate parity only.
   B. Uncovered interest rate parity only.
   C. Both covered and uncovered interest rate parity.
3. A manager believes a foreign yield curve will undergo a bull steepening, while their higher-yielding domestic yield curve will remain stable and upward sloping. In order to maximize carry benefits according to their view, the manager should:
   A. pay-fixed in foreign currency, receive-fixed in domestic currency.
   B. pay-fixed in foreign market, receive-floating in domestic currency.
   C. pay-floating in foreign currency, receive-fixed in domestic currency.
4. A manager constructs a barbell portfolio using a 60% position in bond A and a 40% position in bond B, details of which are displayed here:

Bond	Maturity	Coupon	Modified Duration	Convexity
A	2y	2.25%	1.86	5.2
B	10y	0.25%	9.52	104.8

If a bear flattening occurs through a 50 bps rise in the 2-year rate and a 30 bps rise in the 10-year rate, the change in price of the portfolio will be *closest* to:

A. –1.68%.
B. –1.71%.
C. –1.97%.

KEY CONCEPTS

LOS 13.a

The three primary yield curve changes are changes in:

- Level, as measured by a parallel shift in yields across the curve.
- Slope, as measured by long-term yields – short-term yields.
- Curvature, as measured by the butterfly spread:

  – (short-term yield) + (2 × medium-term yield) – long-term yield

The five-step return decomposition process can be used to analyze the impact of changes in the yield curve on fixed-income securities:

1. Coupon income = annual coupon amount / current bond price
2. Rolldown return = [projected bond price (BP) assuming no yield curve change – beginning BP] / beginning BP
3. Price change due to investor yield change predictions: (–MD × ΔY) + (½C × ΔY2)
4. Price change due to investor spread change predictions: (–MD × ΔS) + (½C × ΔS2)
5. Currency G/L: projected change in value of foreign currencies weighted for exposure to the currency

The impact of changes in the benchmark yield curve (ΔY) is captured in part 3 of the process.

LOS 13.b

Active Strategies When the (Upward-Sloping) Yield Curve Is Expected to Be Stable

- Buy and hold—extend duration to get higher yields.
- Rolling down the yield curve—weight the portfolio highest for securities at the long end of the steepest yield curve segments, which maximizes price gains on securities from declines in yield as time passes.
- Repo carry trade—buy a long-term bond using short-term repo financing.
- Long futures—increase the leverage of the portfolio through futures contracts.
- Receive-fixed swap—earn the swap carry of swap fixed rate – MRR.

LOS 13.c

Change in Yield Curve Level

A manager expecting a parallel shift down (up) in yields should increase (decrease) the duration of the portfolio.

Strategies to alter the duration of a portfolio are as follows:

Strategy	Increase Duration	Decrease Duration
Cash bond	Overweight longer-dated bonds	Short sell bonds/overweight shorter-dated bonds
Swap	Receive fixed	Pay fixed
Futures	Long contracts	Short contracts

Change in Slope

- Steepening curve: short sell long-dated bonds and buy short-dated bonds.
- Flattening curve: buy long-dated bonds and short sell short-dated bonds.

A manager with no view on overall level of yields should structure the trades just listed to be duration neutral. If a manager is bullish (bearish) on the yield level, they should position the portfolio to have positive (negative) duration.

Change in Curvature

- Increasing curvature (negative butterfly twist): short sell bullet (body), buy barbell (wings)
- Decreasing curvature (positive butterfly): short sell barbell (wings), buy bullet (body)

A manager with no view on overall level of yields should structure the trades just listed to be duration neutral. If a manager is bullish (bearish) on the yield level, they should position the portfolio to have positive (negative) duration.

LOS 13.d

A callable bond (option-free bond and short call option) will rise at a slower rate than an option-free bond as yields fall (exhibiting negative convexity).

A putable bond (option-free bond and long put option) will fall at a slower rate than an option-free bond as yields rise.

Option strategies:

Strategy	Impact on Duration	Impact on Convexity
Long call on bond prices/bond futures prices	Increase	Increase
Long put on bond prices/bond futures prices	Decrease	Decrease
Long payer swaption	Decrease	Decrease
Long receiver swaption	Increase	Increase

LOS 13.e

Key rate duration (or partial duration) measures the sensitivity of a portfolio to a movement in a key maturity rate *while other rates remain constant.*

$$\text{KeyRateDur} = \frac{\text{change in portfolio value}}{\text{portfolio value} \times \text{change in key rate}}$$

A high positive (negative) key rate duration at a specific maturity implies that the portfolio will outperform if this maturity rate falls (rises) relative to other maturities.

LOS 13.f

The domestic return of a foreign bond with a foreign currency return, *R*FC, and a return from the DC/FC exchange rate of *R*FX is as follows:

$$RDC = (1 + RFC)(1 + RFX) - 1$$

In efficient markets, covered interest rate parity means that high interest rate currencies trade at a forward discount. This means that a hedged foreign bond position cannot earn excess returns because any interest rate advantage of the foreign bond is offset by the forward discount. Hence, a hedged foreign bond investor earns their domestic interest rate.

An unhedged manager in a foreign bond will earn the foreign currency return of the bond and any appreciation/depreciation of the foreign currency over the investment horizon (as per the formula just listed). Uncovered interest rate parity theorizes that high interest rate currencies should actually weaken over time. This theory tends not to hold and allows the unhedged manager to earn excess returns from the carry trade (borrow in a low interest rate currency, deposit in a high interest rate currency).

A manager wishing to hedge exposure to a foreign coupon-paying bond should enter a fixed-fixed cross-currency swap as the foreign currency payer and domestic currency receiver.

LOS 13.g

The five-step return decomposition process from LOS 13.a can be used to assess the relative performance of different portfolios under different yield curve change scenarios.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 13.1

1. **C** Portfolio B, being a barbell portfolio, will have higher convexity than portfolio A, the bullet portfolio. Higher convexity bonds benefit from falling less in price when yields rise and rising more in price when yields fall. (LOS 13.a)

2. **A** A manager that expects a stable yield curve should increase risk to enhance returns by either extending the duration of the portfolio or using leverage. A receive-fixed swap will increase the duration of the portfolio and enhance returns. Answer B is incorrect because a pay-fixed swap would lower the duration of the portfolio. Answer C is incorrect because a reverse repo is a form of lending—a manager wishing to increase leverage should enter a repo carry trade, which is a form of collateralized borrowing. (LOS 13.b)

3. **A** A manager that is engaging in a buy-and-hold strategy is extending the duration of their portfolio in order to enhance returns when they forecast that the yield curve will not change. The risk to this strategy is that yields do move and rise, causing prices to fall. Answer B is incorrect because if the curve inverts and longer-term rates fall, the manager's bond prices will rise and they will outperform. Answer C is incorrect because the manager will successfully enhance returns as

anticipated if the yield curve remains stable due to higher returns on higher duration bonds. (LOS 13.b)

Module Quiz 13.2

1. **A** A manager that expects a shift down in rates should increase the duration of their portfolio order to magnify price rises in their portfolio. Entering a receive-fixed (and pay-floating) swap will increase the duration of the portfolio. The other answers are incorrect because they will lower the duration of the portfolio. (LOS 13.c)

2. **B** The negative overall duration of the manager implies that they expect rates to rise; hence, this is a bearish trade (i.e., we expect fixed-income prices generally to fall). The fact that the manager is long short-term bonds implies that they expect short-term yields to rise by less than long-term rates. Similarly, the fact that the manager is short long-term bonds suggests that they expect longer-term yields to rise by more than short-term rates. This implies that the manager expects the curve to steepen. (LOS 13.c)

3. **C** A manager that is long the wings (short-term and medium-term bonds) and short the body (medium-term bonds) will outperform if medium-term rates increase relative to short-term and long-term rates. This would be an increase in curvature and a corresponding rise in the butterfly spread (recall the butterfly spread = – short-term rate + (2 × medium-term rate) – long-term rate). This increase in curvature is referred to as a negative butterfly twist. (LOS 13.c)

Module Quiz 13.3

1. **C** An upward shift in yields will cause option-free bonds to fall more than bonds with embedded options. The putable bond will fall by less than an option-free bond because the embedded long put option will increase in value and place a floor beneath the bond price. A callable bond will fall by less than an option-free bond because the embedded short call option will decrease in value, which will partially offset losses on the underlying bond. (LOS 13.d)

2. **C** Answer A is incorrect because receiver swaptions are profitable when rates fall because the holder can choose to exercise their right to receive a relatively high rate after the rate move. Answer B is incorrect because payer swaptions are profitable when rates rise because the holder can choose to pay a relatively low rate; however, in the scenario expected by the manager, they would expire worthless. Answer C is the correct option—as rates fall, bond futures prices will rise and a call on futures will increase in value. (LOS 13.d)

3. **A** A manager should use receive-fixed to increase duration and pay-fixed to lower duration. Buying futures increases duration and selling futures decreases duration. Note that there are other ways of altering the duration of the portfolio, but Answer A is the only option that corresponds with the active positions of the manager. (LOS 13.e)

Module Quiz 13.4

1. **C** The foreign EUR interest rate implied by the zero-coupon bond price is (100 / 99.01) – 1 = 0.01 or 1%. Covered interest rate parity states that high interest rate

currencies will be at a forward discount. Here, the USD interest rate is 3% and, hence, is the high interest rate currency. Covered interest rate parity states that the USD will trade at a 2% discount to EUR in the forward market. (LOS 13.f)

2. **B** In order for the unhedged carry trade to earn excess profits, uncovered interest rate parity, which states that high interest rate currencies depreciate, must not hold. Covered interest rate parity relates to establishing a fair forward rate, which is not relevant for an unhedged carry trade. (LOS 13.f)

3. **C** A bull steepener occurs when rates fall and short-term rates fall faster than long-term rates. In order to maximize carry benefit, the manager should pay the foreign floating rate that is expected to fall by more than longer-term rates and receive the higher longer-term fixed domestic rate that is expected to remain stable. (LOS 13.f)

4. **A** Using the third step of the five-step return decomposition process, the following can be calculated:

   Price change of the 2-year bond = (−1.86 × 0.005) + (½ × 5.2 × 0.0052) = −0.0092 or −0.92%

   Price change of the 10-year bond = (−9.52 × 0.003) + (½ × 104.8 × 0.0032) = −0.0281 or −2.81%

   Hence, the performance of the barbell portfolio = (0.6 × −0.92%) + (0.4 × −2.81%) = −1.68%

   (LOS 13.g)

The following is a review of the Fixed-Income Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #14.

READING 14: FIXED-INCOME ACTIVE MANAGEMENT: CREDIT STRATEGIES

Study Session 6

EXAM FOCUS

This reading turns our attention to ways to earn excess return versus a benchmark by altering exposure to credit-risky positions. Recall the five-step return decomposition process introduced and applied repetitively in the previous two readings—this reading focuses on step 4 of the process, which is the impact of changes in credit spreads. The reading begins with a discussion of the different types of spread used by fixed-income analysts—make sure you are comfortable with each type and that you can perform basic interpolation of benchmark yields based on maturity. After a discussion of bottom-up versus top-down techniques, there is a large section on using underlying bonds or CDS derivatives to express views on spreads, and another application of the five-step return decomposition to attribute any excess return of the portfolio versus the benchmark.

MODULE 14.1: CREDIT RISK AND CREDIT SPREAD

Video covering this content is available online.

LOS 14.a: Describe risk considerations for spread-based fixed-income portfolios.

CFA® Program Curriculum, Volume 3, page 60

A **spread** is defined as the excess return of a bond over a comparable benchmark security, which compensates investors for risks inherent in the bond that are not inherent in the benchmark. The two major risks that spreads primarily represent are credit risk (the risk the issuer fails to make payment as promised) and liquidity risk (the risk the investor is not able to trade in the security at a reasonable price). This reading focuses on credit risk and the associated credit spread of fixed-income securities.

The two crucial components of credit risk are as follows:

- **Probability of default (POD)**. This is the chance that the issuer fails to make payments on its obligation when due, usually expressed on an annualized basis.
- **Loss given default (LGD)** (or **loss severity**). This is the proportion of investment lost if a default occurs. It is calculated as 1 – recovery rate (RR), where *RR* is the percentage of exposure recovered in default.

Note that the total expected credit losses from a credit-risky security are equal to the sum of POD × LGD for all periods scaled up by the expected exposure at the time of default. The present value of these expected losses is called the credit valuation adjustment (CVA) and represents the discount that the credit-risky instrument should

trade below an equivalent risk-free security in order to compensate investors for their expected credit losses.

Note that while an analyst will be interested in forecasting expected losses, a starting point for analysis is the historical realized percentage of value lost to default, referred to as the **credit loss rate**.

In terms of calculating the credit spread, a simplified approach is to assume that investors need to earn their periodic expected loss of POD × LGD:

$$\text{credit spread} \approx \text{POD} \times \text{LGD}$$

EXAMPLE: **Credit spread, POD, and LGD**

A credit analyst notes that an issuer has first lien bonds outstanding with a spread of 1.5%. The historical recovery rate for similar first lien bonds is 50%. The issuer is preparing to issue second lien bonds. The historical recovery rate of similar second lien bonds is 40%.

Calculate the fair credit spread for the second lien bonds.

Answer:

Solve for the POD for the issuer implied by the first lien bonds:

$$\text{spread} = \text{POD} \times \text{LGD}$$

$$\text{POD} = \text{spread} / \text{LGD} = 1.5\% / (1 - 0.50) = 3\%$$

Then, use this relationship again to find the fair credit spread for the second lien bonds:

$$\text{spread} = \text{POD} \times \text{LGD} = 3\% \times (1 - 0.4) = 1.8\%$$

PROFESSOR'S NOTE

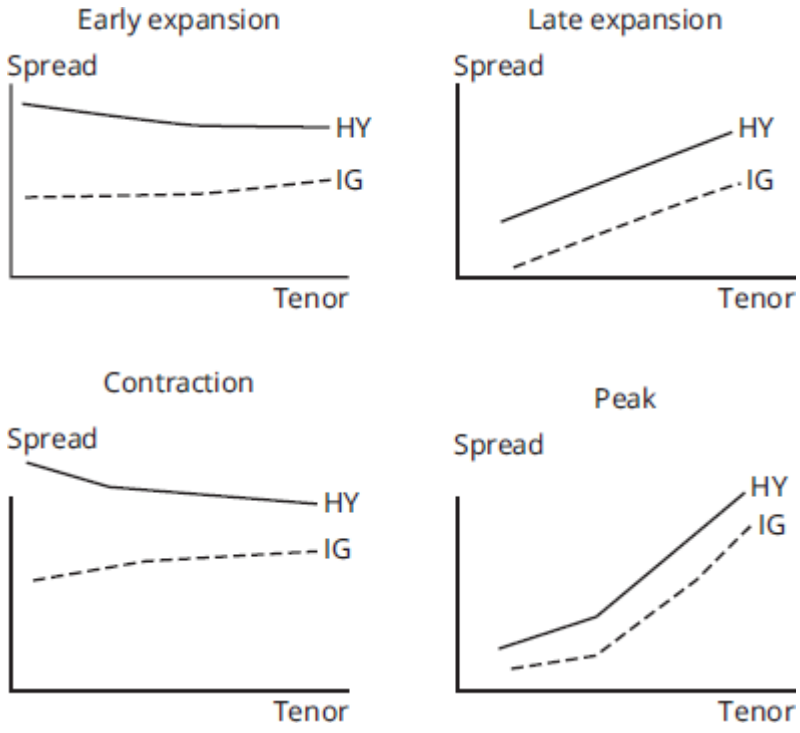
"Lien" here is a legal term referring to the ranking of claim on collateral for a borrowing.

Recall that credit-risky securities are divided into high-quality *investment grade (IG)* (rated BBB and above) and *high yield (HY)*, or *speculative* (rated BB or below). Actual defaults in IG bonds are extremely rare; however, there remains the risk of a ratings downgrade, called a **credit migration**. For lower-quality bonds, default risk becomes a more significant risk than the risk of credit migration.

A plot of credit spreads versus maturity for a particular type of bonds is called the **credit spread curve**. An upward-sloping curve implies that POD is more likely in the long term versus the short term. A flat curve suggests that defaults are equally likely across maturities. The shape of the credit curve is primarily driven by changes in credit conditions over the **credit cycle**, summarized in the following table:

	Stage of Economic Cycle			
	Early Expansion (Recovery)	Late Expansion	Peak	Contraction (Recession)
Corporate defaults	Peak	Falling	Stable	Rising
Credit spread level	Stable	Falling	Rising	Peak
Credit spread slope	IG: Stable HY: Inverted	Upward sloping for both IG and HY	Upward sloping for both IG and HY	IG: Flat HY: Inverted

Figure 14.1: Economic Cycle



The major difference between IG and HY credit curves over the credit cycle is the inversion of the HY curve in an economic downturn, reflecting the fact that near-term POD and downgrade risk for HY names is elevated. Generally, HY securities experience sharper changes in level and slope over the cycle than IG-rated securities.

It has already been observed in a previous reading that risk-free rates and spreads often move in opposite directions (i.e., are negatively correlated). For example, strong economic conditions often lead to increasing benchmark risk-free rates as investors sell risk-free securities to move into riskier assets. However, at the same time, there is a decreasing risk of default and narrowing credit spreads. For lower-quality securities, the narrowing of spreads is likely to have a significant impact on price and result in a sensitivity to changes in risk-free benchmark rates that is *lower* than that predicted by modified duration. Conversely, weaker economic conditions often lead to decreasing risk-free rates but increasing risk of default and wider spreads. Once again, spreads moving in the opposite direction to benchmark yields will dampen the sensitivity of the low-quality bond's price versus changes in benchmark rates.

For example, consider a HY bond yielding 6% versus a Treasury of a similar maturity yielding 2%. The spread of the bond over the benchmark is 6% – 2% = 4%. Assume the bond is a 5-year bond with a modified duration of 4.4. Let's assume that a contraction in economic activity occurs and there is a flight to quality, forcing down the risk-free benchmark yield to 1%. Modified duration would imply that the bond should rise by 4.4%. However, let's assume that the credit spread widens due to the downturn to 5%. This implies a new yield of the bond of 1% + 5% = 6%. The yield of the bond hasn't changed; hence, the price of the bond will not have changed. The observed sensitivity of this bond to changes in benchmark rates is 0, a lot lower than the modified duration of 4.4.

This effect is captured in differences between analytical (i.e., modified) and *empirical* duration. **Empirical duration** is based on regression of market data of actual bond price returns and benchmark rate changes. Since the actual bond price is driven by both spreads and benchmark rates, empirical duration will be *lower* than analytical duration for low-quality securities.

MODULE QUIZ 14.1

To best evaluate your performance, enter your quiz answers online.

1. At the peak of the economic cycle, the credit spread curve is *most likely*:
   A. rising and upward sloping.
   B. falling and downward sloping.
   C. rising and downward sloping.
2. Which of the following credit spread curves is *most likely* to invert during a recession?
   A. Both the IG curve and the HY curve.
   B. The IG curve only.
   C. The HY curve only.
3. Relative to its analytical duration, the empirical duration for a HY issuer is likely to be:
   A. lower.
   B. similar.
   C. higher.

MODULE 14.2: CREDIT SPREAD MEASURES

Video covering this content is available online.

LOS 14.b: Discuss the advantages and disadvantages of credit spread measures for spread-based fixed-income portfolios, and explain why option-adjusted spread is considered the most appropriate measure.

CFA® Program Curriculum, Volume 3, page 69

Fixed-Rate Bond Credit Spread Measures

The simplest measure of spread, the **yield spread** (or **benchmark spread**) of a bond is defined as the bond's YTM minus the YTM of the closest maturity on-the-run government bond.

The ***g-spread*** of a bond is defined as the bond's YTM minus an interpolated YTM of the two adjacent maturity on-the-run government bonds. The interpolation process is designed to estimate a government benchmark YTM that matches the maturity of the bond exactly and is demonstrated in the following example.

EXAMPLE: **Yield spread and *g*-spread**

A credit analyst collates the following information regarding a corporate bond and two adjacent maturity on-the-run government benchmark securities:

	Maturity (Years)	Coupon	Yield	ModDur
Corporate bond	12	4.30%	4.5%	11.1
Government	10	2.75%	3.0%	9.2
Government	20	5.25%	5.0%	17.5

1. **Calculate** the yield spread and *g*-spread for the corporate bond.
2. **Calculate**, using both the yield spread and the *g*-spread, the estimated change in price of the corporate bond under the following scenario:
   - The corporate bond's spread and the 10-year government bond yield remain unchanged.
   - The 20-year government bond yield falls by 10 bps.

Answers:

1. The yield spread of the corporate bond is its yield minus the nearest dated government bond yield (in this case, the 10-year government bond). Hence, the yield spread = 4.5% – 3.0% = 1.5%.

   To calculate the *g*-spread, we must interpolate the two adjacent government bond YTMs to estimate a 12-year government bond YTM. We do this by calculating the weights that would need to be held in the 10-year and 20-year bonds in order to have an average maturity of 12 years (i.e., the same as the corporate bond's maturity).

   Assuming a weight of *w* in the 20-year bond and a weight, therefore, of (1 – w) in the 10-year bond, we need to solve for *w* such that:

   $12 = (1 - w) \times 10 + (w \times 20)$

   $12 = 10 - 10w + 20w$

   $2 = 10w$

   $w = 0.2$

   Hence, a portfolio with 20% in the 20-year bond and 80% in the 10-year bond will have the same average maturity as the 12-year corporate bond. Such a portfolio would have a YTM of (0.8 × 3%) + (0.2 × 5%) = 3.4%. This is the benchmark government YTM for the *g*-spread.

   Hence, the *g*-spread of the corporate bond = 4.5% – 3.4% = 1.1%.

   PROFESSOR'S NOTE

   The interpolation process used in this example is used multiple times in this reading. It is important that you know how to perform this process. It is worth noting that if the adjacent government securities have maturities *S* (shorter) and *L* (longer) versus the target maturity *M*, then to quickly calculate the weight in the longer-dated benchmark bond, we can use the following ratio:

   (M – S) / (L – S)

   For example, in this case, S = 10, M = 12, and L = 20, so we could calculate that the weight in the 20-year government bond should be (12 – 10) / (20 – 10) = 2 / 10 = 0.2.

   We will use this more direct method for interpolation throughout the rest of this chapter.

2. Based on yield spread, the corporate bond's YTM is equal to the 10-year government bond YTM plus the yield spread. Since neither of these are expected to change, the yield of the bond is not expected to change; therefore, the price of the bond is not expected to change.

   The only change expected is a 10 bps fall in the 20-year government bond YTM from 5% to 4.9%. Using the same maturity weights as before, this implies that the interpolated 12-year government YTM will change to (0.8 × 3.0%) + (0.2 × 4.9%) = 3.38%.

If the *g*-spread remains at 1.1%, this implies that the corporate bond yield will move to 3.38% + 1.1% = 4.48%. This implies a change in the corporate bond YTM of 4.48% – 4.5% = –0.02%. With a modified duration of 11.1, the expected price change of the bond is –11.1 × –0.02% = 0.222%.

The ***i*-spread (interpolated spread)** of a bond is defined as the bond's YTM minus the maturity interpolated swap fixed rate. The advantage of the *i*-spread is that it is based on a tradeable derivative that can be used to hedge duration or measure carry returns (i.e., measure the difference between the long-term fixed leg and the shorter-term floating leg).

The **asset swap spread (ASW)** is defined as the bond's fixed *coupon* minus the maturity interpolated swap fixed rate. This represents the spread that the bond is offering over the *floating* market reference rate (MRR) over its life (assuming the bond is trading close to par). For example, if a manager purchases a corporate bond close to par with a coupon of 6%, when the equivalent maturity swap fixed leg is 4%, the ASW is 6% – 4% = 2%. The manager could earn this 2% as a fixed spread above floating MRR by buying the bond and entering a pay-fixed swap. The net periodic receipt of the manager from this combination of the bond and the swap would be +6% bond coupon – 4% swap fixed leg + MRR swap floating leg = MRR + 2%.

EXAMPLE: ***i*-spread and ASW**

Recall the bonds from the previous example:

	Maturity (Years)	Coupon	Yield	ModDur
Corporate bond	12	4.30%	4.5%	11.1
Government	10	2.75%	3.0%	9.2
Government	20	5.25%	5.0%	17.5

Ten- and twenty-year swap spreads over similar maturity government bond YTMs are 20 bps and 30 bps, respectively.

Calculate the *i*-spread and the ASW for the corporate bond.

Answer:

The 10-year swap fixed rate = 3.0% + 0.2% = 3.2%.

The 20-year swap fixed rate = 5.0% + 0.3% = 5.3%.

We can use the same weights in the previous example to interpolate between the 10- and 20-year maturities to estimate the 12-year maturity, namely 20% in the 20-year maturity and 80% in the 10-year maturity.

The interpolated 12-year swap fixed rate = 0.8 × (3.2%) + 0.2 × (5.3%) = 3.62%.

The *i*-spread = corporate YTM – interpolated swap fixed rate = 4.50% – 3.62% = 0.88%.

The ASW = corporate bond coupon – interpolated swap fixed rate = 4.30% – 3.62% = 0.68%.

Recall that a YTM is a non-simple average of the spot rates that apply to the different cash flows of a bond. Similarly, a swap fixed rate is a non-simple average of the expected floating MRR rates over the life of the swap. The use of YTMs and swap fixed rates to derive spreads, therefore, ignores *how* spot rates change over different maturities (called the term structure of spot rates).

In order to respect the term structure of spot rates when calculating spreads, we turn to the **zero-volatility spread (*z*-spread)**. The *z*-spread uses a trial-and-error calculation to determine a single spread that, when added to risk-free spot rates, discounts the bond's future cash flows back to its current market value.

Later in this reading, we will be looking at excess returns from active trading of credit default swap (CDS) contracts. Recall that under such a contract, there is a protection buyer who makes a regular payment to the protection seller and, in return, receives a payment should a credit event occur on a reference bond. The protection buyer pays a standardized fixed coupon adjusted by an up-front payment/receipt to reflect the fair value of the protection, known as the **CDS spread**. This CDS spread should, in theory, be equal to the *z*-spread that is earned on the underlying bond, since both are essentially a risk premium paid to the party facing the credit risk of the bond. However, differences between the CDS spread and the *z*-spread can occur due to technical reasons, such as the underlying bond price trading away from par, accrued interest on the underlying bond, and idiosyncratic features of the CDS protection. The **CDS basis** is defined as the CDS spread minus the *z*-spread. This is a useful measure for those trading CDS contracts.

None of the spread measures introduced so far in this reading (yield spread, *g*-spread, *i*-spread, ASW, or *z*-spread) are appropriate for measuring the credit/liquidity risk of a bond with an embedded option.

The **option adjusted spread (OAS)** is the only spread measure appropriate for assessing the credit/liquidity risk of bonds with embedded options. It uses an assumption of interest rate volatility to build an interest rate tree of possible paths for forward risk-free interest rates. Future cash flows are adjusted for the optionality of the bond along each path (i.e., to reflect whether the option would be exercised). The OAS is then a trial-and-error calculation to determine a single spread that, when added to every node of the interest rate tree of risk-free rates, discounts the bond's adjusted future cash flows back to its current market value. By adjusting the cash flows of the bond to reflect expected interest rate volatility, the uncertainty of the cash flows due to the optionality of the bond has been removed, and the resulting OAS, therefore, does *not* include any impact of the option on the spread. The OAS measures the spread that is earned for facing the credit and liquidity risk of the issuer—the impact of the option has been removed from the spread.

The OAS is the best measure for consistent comparison of the spreads on bonds with embedded options (e.g., callable, putable) and bonds without embedded options.

PROFESSOR'S NOTE

Take care here—it would be better to call the OAS the option **removed** spread because the process of calculating it removes the impact of the option. You will not be required to calculate the OAS for the exam. However, you must keep an eye out for bonds that have a significantly different OAS to other spreads—this implies there is an embedded option in the bond and OAS **must** be used to compare the bond against other bonds. Take the hint here—OAS is best!

Floating-Rate Note Credit Spread Measures

A floating-rate note (FRN) pays a periodic coupon equal to a floating market reference rate (MRR) plus a fixed **quoted margin (QM)**. For example, a corporate FRN might pay MRR + 50 bps.

This coupon will change in line with change in MRR, so when benchmark interest rates rise, the coupon of the bond also rises and, therefore, the price of the bond will not fall like the price of a fixed-coupon bond would fall. This means that FRNs have lower rate duration, EffRateDur (i.e., price sensitivity to changes in benchmark yields), than fixed-coupon bonds.

Note, however, that the 50 bps QM is *fixed*. This means that if the credit quality of the issuer declines, leading to credit spreads widening, the corporate FRN *will* fall in price. Hence, the FRN will likely have an effective spread duration, EffSpreadDur, significantly higher that its rate duration. The required return of investors *above* the current MRR is called the **discount margin (DM)**. In the example just listed, if the DM is above 50 bps due to deteriorating credit conditions, the FRN will trade below par. If the DM falls below 50 bps due to improving credit conditions, the FRN will trade above par. When DM = QM, the FRN will trade at or close to par because the coupon paid is expected to be equal to the required return of investors. Note that in the calculation of the DM, the expected future coupons are based on the *current period's* MRR + QM, and the discount rate applied to these coupons is the *current period's* MRR + DM. As such, the calculation of DM assumes that the MRR is not expected to change over the life of the FRN (i.e., it assumes a flat MRR curve and does not reflect the term structure of the MRR).

PROFESSOR'S NOTE

DM is playing the role of yield here, and QM is playing the role of coupon. Think: Low coupon bonds trade below par (and vice versa).

The rate duration and spread duration of an FRN are given by the following formulas:

$$\text{EffRateDur}_{\text{FRN}} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{MRR})(\text{PV}_0)}$$

$$\text{EffSpreadDur}_{\text{FRN}} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{DM})(\text{PV}_0)}$$

where:
PV0 = current value of the portfolio
PV– = value of portfolio when benchmark curve is shifted down
PV+ = value of portfolio when benchmark curve is shifted up
ΔMRR = change in benchmark curve
ΔDM = change in DM

PROFESSOR'S NOTE

Notice that these formulas are applications of the general effective duration formula introduced in an earlier reading. The difference is that Δcurve on the denominator has been replaced by the change in the rate (MRR) or spread (DM) against which we wish to measure price sensitivity.

EXAMPLE: Discount margin

A 1-year FRN pays 3-month MRR + 1.25% on a quarterly basis. The current MRR is 0.55% and is assumed to stay constant over time, and the discount margin is 1.55%.

1. **State** whether the FRN will be trading below, equal to, or above par. **Justify** your response.
2. **Calculate** the value of $1 million of par of the FRN.

Answers:

1. The FRN will trade *below* par. The DM of 1.55% is above the QM of 1.25%, which implies that investors require a higher margin above the MRR than that being paid by the FRN. This will cause the bond to trade below par because the future overall discount rate applied to bond cash flows will be higher than the coupon paid.
2. Assuming that the MRR doesn't change, the bond will pay a quarterly coupon of (MRR + QM) / 4 = (0.55% + 1.25%) / 4 = 0.45%. For a par amount of $1 million, this represents a $4,500 payment every quarter, along with par of $1 million paid in one year's time.

   The quarterly discount rate to apply to these cash flows is equal to (MRR + DM) / 4 = (0.55% + 1.55%) / 4 = 0.525%.

   Therefore, the value of $1 million of par is calculated as follows:

$$\begin{aligned}\text{value} &= \frac{\$4{,}500}{(1.00525)} + \frac{\$4{,}500}{(1.00525)^2} + \frac{\$4{,}500}{(1.00525)^3} + \frac{\$1{,}004{,}500}{(1.00525)^4} \\ &= \$997{,}039\end{aligned}$$

As we have said, a drawback of the discount margin is that it assumes the MRR stays constant at its current level over the life of the bond, which effectively assumes that the term structure of interest rates is flat. The **zero-discount margin (Z-DM)** addresses this drawback by incorporating the term structure of interest rates into its calculation. The derivation of the Z-DM is similar to that of the DM; however, future coupon rates are equal to the relevant *MRR forward rate* plus the QM, and discount rates are equal to the *relevant spot MRR plus the Z-DM.* By respecting the term structure of MRR, the Z-DM is playing a similar role to floating-rate securities that the *z*-spread played to fixed-coupon bonds.

Note that the Z-DM will depend on the path of forward MRRs—if the MRR curve is upward sloping, the calculation of the Z-DM will use *higher* MRR spot rates for longer maturities when discounting cash flows, which will cause the Z-DM to be *lower* than the DM (which assumes the MRR remains unchanged in its calculation).

The Impact of Spreads on Portfolio Return

Recall from a previous reading, Overview of Fixed-Income Portfolio Management, the five-step return decomposition process:

1. Coupon income = annual coupon amount / current bond price
2. Rolldown return = (projected bond price (BP) assuming no yield curve change – beginning BP) / beginning BP
3. Price change due to investor yield change predictions: (–MD × ΔY) + (½C × ΔY2)
4. Price change due to investor spread change predictions: (–MD × ΔS) + (½C × ΔS2)
5. Currency G/L: projected change in value of foreign currencies weighted for exposure to the currency

While step 4 of this process captures the impact of changes in spread on a manager's returns, steps 1–3 are also important in explaining the excess return of corporate bonds versus benchmark securities, as demonstrated in the following example:

EXAMPLE: **Corporate vs. government bond rolldown**

A manager collates the following information regarding a corporate bond and a benchmark government security with a similar maturity:

	Maturity	Coupon	YTM
Corporate bond	5	4.00%	2.25%
Government	4.5	2.00%	1.20%

Both bonds have a semiannual coupon. **Calculate** the annualized excess rolling yield earned by the manager if they hold the corporate bond versus if they hold the government bond over the next six months.

Answer:

Pricing the corporate bond produces the following:

Starting price: 10 N; 2.25 / 2 = 1.125 I / Y; 2 PMT; 100FV; CPT PV: 108.232

Price in 6 months: 9 N, CPT PV: 107.450

Hence, 6-month coupon yield = (0.5 × 4) / 108.232 = 1.849%

6-month rolldown return = (107.450 / 108.232) – 1 = –0.723%

Total annualized rolling yield = (1.849% – 0.723%) × 2 = 2.25%

Doing the same for the government bond results in the following:

Starting price: 9 N; 1.2 / 2 = 0.6 I / Y; 1 PMT; 100 FV; CPT PV: 103.494

Price in 6 months: 8 N, CPT PV: 103.115

Hence, 6-month coupon yield = (0.5 × 2) / 103.494 = 0.966%

6-month rolldown return = (103.115 / 103.494) – 1 = –0.366%

Total annualized rolling yield = (0.966% – 0.366%) × 2 = 1.20%

The annualized excess rolling yield of the corporate bond = 2.25% – 1.20% = 1.05%

When applying step 4 of the return decomposition process, credit managers focus on the sensitivity of the bond's price with respect to changes in yield *spread* rather than changes in benchmark yields. This is achieved through using **effective spread duration (EffSpreadDur)** and **effective spread convexity (EffSpreadCon)**, which play the same price sensitivity roles with regard to changes in spread as effective duration and effective convexity do with benchmark yields.

The effective spread duration and effective spread convexity of a portfolio are calculated using the following formulas:

$$\text{effective spread duration} = \frac{(PV_-) - (PV_+)}{2(\Delta\text{spread})(PV_0)}$$

$$\text{effective spread convexity} = \frac{(PV_-) + (PV_+) - 2(PV_0)}{(\Delta\text{spread})^2 (PV_0)}$$

where:

PV0 = current value of the portfolio

PV– = value of portfolio when benchmark curve is shifted down

PV+ = value of portfolio when benchmark curve is shifted up

Δspread = change in spread

Using these spread-specific sensitivity measures, the calculation of step 4 of the return decomposition process becomes:

$$\%\Delta\text{price} = (-\text{EffSpreadDur} \times \Delta\text{spread}) + (\tfrac{1}{2} \times \text{EffSpreadCon} \times \Delta\text{spread}^2)$$

"Δspread" here is typically defined as the change in the *OAS*.

PROFESSOR'S NOTE

All these formulas are analogous to the effective duration and convexity measures based on yield curve changes with which we are already very familiar. Also remember our conclusion about the different types of spread—OAS is best for comparing valuations across different types of bonds.

A practical observation regarding changes in spread is that it tends to be proportional to the spread itself rather than an absolute measure. Put simply, we would expect greater *changes* in spread for bonds with higher spread levels than we would for bonds with lower spread levels.

This proportionate relationship between spread change and spread level is captured through measuring the **duration times spread (DTS)** of a bond portfolio, approximately defined as follows:

$$\text{DTS} \approx \text{EffSpreadDur} \times \text{spread}$$

PROFESSOR'S NOTE

We can multiply DTS through by an expected proportional change in index (i.e., average) OAS in order to derive the expected basis point change in portfolio value (in the other direction). To see why, consider how DTS × % change in index OAS = EffSpreadDur × spread × % change in index OAS. The second two terms in this expression represent the expected spread change for the bond, assuming the proportionate change in spread for the bond is the same as the proportionate change in spread for the index. The first term represents the price sensitivity relative to this change in spread as usual. The following example demonstrates this idea.

EXAMPLE: **DTS**

A portfolio manager collates the following information regarding their two-bond portfolio:

Issuer	OAS (bps)	EffSpreadDur	Weight
A-rated	180	9.0	70%
C-rated	400	9.5	30%

The current benchmark index OAS is 200 bps. **Calculate**:

1. The DTS of the portfolio.
2. The expected change in the value of the portfolio for a 20 bps increase in benchmark spread.

Answers:

1. DTS of the A-rated bond = 9.0 × 180 = 1,620
   DTS of the C-rated bond = 9.5 × 400 = 3,800
   Hence, the DTS of the portfolio = (0.70 × 1,620) + (0.30 × 3,800) = 2,274
2. The proportionate expected index spread widening is 20 / 200 = 10%.

We can multiply the DTS of the portfolio through by this proportionate change in spreads to calculate the expected basis point *fall* in the value of the portfolio: 2,274 × 0.1 = 227.4 bps.

The portfolio is expected to fall in value by 227.4 bps.

Excess Spread

The goal of any active manager is to earn excess return over fair market returns by finding mispriced securities. In the case of a fixed-income manager, they want to earn **excess spread**—spread in excess of the fair spread for suffering credit losses. If we view the credit losses as both changes in market value due to widening spread (EffSpreadDur × Δspread) and expected credit losses (POD × LGD), then the annualized excess spread of the manager becomes the following:

expected excess spread = spread – (EffSpreadDur × Δspread) – (POD × LGD)

PROFESSOR'S NOTE

This is an unannualized excess return over a specific holding period. If inputs are given as annualized figures, they need to be de-annualized to match the holding period. We are going to use this equation many times later in this reading to analyze the source of the manager's excess return. It's an important one!

EXAMPLE: **Excess spread**

A credit analyst collects the following information regarding a corporate bond:

- Effective spread duration: 4.5 years
- Current credit spread: 250 bps
- 1.5% annualized expected: POD
- Expected loss severity: 55%
- Expected credit spread in six-months' time: 270 bps

Evaluate the valuation of this corporate bond based on the estimates of the credit analyst and the bond's expected excess spread over a six-month holding period.

Answer:

expected excess spread over the next 6 months = spread – (EffSpreadDur × Δspread) – (POD × LGD) = (0.025 × 0.5) – (4.5 × (0.027 – 0.025)) – ((0.015 × 0.5) × 0.55) = –0.000625 or –6.25 bps

The bond is expected to earn a negative excess return over the next six months and is therefore currently *overvalued*.

PROFESSOR'S NOTE

The units of this equation are a bit of a minefield. There are decimals, basis points, and whole number percentages all going on at the same time and this often causes concern to students. Best advice when unsure about which units we should work in is to use decimals for everything. While the numbers may be small, their decimal value is their true size. If you put decimals in, you will get decimals out (as in this example).

MODULE QUIZ 14.2

To best evaluate your performance, enter your quiz answers online.

1. A manager is calculating spread measures for a 12-year corporate bond using on-the-run Treasury bonds with 10 years and 15 years to maturity. In an upward-sloping yield curve environment, the manager will calculate a yield spread that is:
   A. lower than the *g*-spread.

B. equal to the *g*-spread.
C. higher than the *g*-spread.

2. For a corporate fixed-coupon bond trading below par, the *i*-spread will be:
   A. lower than the ASW.
   B. equal to the ASW.
   C. higher than the ASW.
3. A manager holds £1,000,000 face value in each of bonds X and Y. Bond X is priced at 102 with accrued interest of 1.0 per 100 par and an OAS of 120 basis points. Bond Y is priced at 94 with accrued interest of 1.5 per 100 par and an OAS of 140 basis points. The OAS of the portfolio is *most likely*:
   A. below 130 bps.
   B. equal to 130 bps.
   C. above 130 bps.
4. During an economic recovery, the Z-DM for an FRN is *most likely*:
   A. lower than the DM.
   B. equal to the DM.
   C. higher than the DM.

MODULE 14.3: BOTTOM-UP AND TOP-DOWN CREDIT STRATEGIES

Video covering this content is available online.

LOS 14.c: Discuss bottom-up approaches to credit strategies.

CFA® Program Curriculum, Volume 3, page 84

Bottom-Up Credit Strategies

Bottom-up managers engage in individual security selection to attempt to earn excess return. Focus here is on finding the best issuer or individual bond investment (rather than focusing on best macro environment as a top-down manager would do).

The bottom-up manager starts by identifying the universe of bonds relevant to their mandate, then divides that universe into sectors such as industry and/or geography.

The manager then looks for relative misvaluation within each sector to determine individual securities to select.

Fundamentally, this credit analysis is an assessment of the likelihood of the issuer making scheduled principal and interest payments as they come due. Factors to consider here include the following:

- Operating history and competitive position of the issuer within its industry.
- Relevant financial ratios relating to profitability (e.g., EBITDA/total assets), leverage (e.g., debt/equity), and coverage ratios (e.g., EBITDA/interest).

Credit Risk Models

There are two major categories of credit risk models: **structural** models and **reduced form** models.

Structural models assume POD to be driven by the likelihood of the future value of the assets of a borrower falling below the threshold that would trigger default. These models are often referred to as “distance to default” models because the models are assessing how far away from defaulting an issuer currently is in terms of the volatility of their assets. Estimates for the volatility of the issuer’s asset often come from equity market

data such as market capitalization and equity price volatility. Examples of structural models include Moody's Expected Default Frequency (EDF) and Bloomberg's Default Risk (DRSK) models, which provide daily estimates of POD and implied fair credit spreads.

Reduced form models look for relationships between macroeconomic conditions and the individual characteristics of a borrower, such as financial ratios, to infer **default intensity** (or periodic POD) for a bond issuer. This default intensity and estimated LGD can then be used to estimate the fair credit spread of the bond.

An example of a reduced form model is **Altman's *z*-score**, which uses key financial ratios of companies as inputs to a regression-based equation, the output of which is used to classify the issuer in terms of likelihood of subsequent default. The *z*-score is calculated as follows:

$$z\text{-score model} = (1.2 \times A) + (1.4 \times B) + (3.3 \times C) + (0.6 \times D) + (0.999 \times E)$$

where:

A = working capital / total assets

B = retained earnings / total assets

C = EBIT / total assets

D = market value of equity / total liabilities

E = sales / total assets

The interpretation of the *z*-score is as follows:

z-score > 3.0 ð low chance of default

1.8 ≤ *z*-score ≤ 3.0 ð some risk of default

z-score < 1.8 ð likely to default

PROFESSOR'S NOTE

A natural question to ask upon sight of a model like this is, "Do I have to memorize this?" While everything in the curriculum is examinable, it is noted that curriculum examples give the Altman model in the question body. This suggests that memorization of this should not be a first priority. Instead, focus on using the model given a list of components of the inputs and the model itself and interpreting the resulting z-score according to the bands just stated.

Bottom-Up Relative Value Analysis

The expected excess spread calculation introduced in the previous section can be used in a relative value analysis across different bonds to assess which bond would be the most attractive in a specific assumed spread change scenario. As a reminder, the expected excess spread is given by the following:

$$\text{expected excess spread} = \text{spread} - (\text{EffSpreadDur} \times \Delta\text{spread}) - (\text{POD} \times \text{LGD})$$

Given a set of assumptions for changes in spread, POD, and LGD, the bond with the highest expected excess spread is considered to offer the best relative value.

The analyst should be careful to note any structural differences between the types of bonds being analyzed—for example, embedded options or seniority on capital structure. Liquidity is also an important concern because this will also affect the spreads offered by

fixed-income securities. It should also be considered how other corporate events such as merger and acquisition activities impact spreads.

Credit spread curves can also be used for relative value analysis, as demonstrated in the following example:

EXAMPLE: **Relative value analysis using spread curves**

A corporate issuer has the option-free bonds outstanding displayed below:

Maturity (yr)	Coupon	YTM
2	0.5%	0.9%
5	2.0%	1.5%
15	3.5%	3.5%

On-the-run benchmark bonds have the following yields:

Maturity (yr)	YTM
2	0.2%
5	0.8%
10	2.0%
30	4.0%

The company plans on issuing a new bond with maturity of 10 years. Expectations are that the new bond will offer 5 bps more than the credit spread derived from interpolating the existing credit spread curve for the issuer.

Calculate the fair credit spread for the new 10-year bond issue.

Answer:

In order to derive a fair 10-year credit spread from the existing credit spread curve, we interpolate credit spreads of the two adjacent maturity credit spreads—namely the 5-year and 15-year maturities.

The 5-year credit spread is easily calculated from the data as 1.5% – 0.8% = 0.7%.

In order to calculate the 15-year credit spread, we need a 15-year benchmark yield. Since there is no 15-year benchmark yield given, we need to interpolate the two adjacent maturities benchmark YTMs, namely the 10-year maturity and the 30-year maturity. Recall from an earlier example, for the adjacent maturities *S* (shorter) and *L* (longer) versus the target maturity *M* to quickly calculate the weight in the longer-dated maturity, we can use the ratio (M – S) / (L – S). Here, M = 15, S = 10, and L = 30; hence, weight in the 30-year maturity = (15 – 10) / (30 – 10) = 25%, and weight in the 10-year maturity = 75%.

Therefore, the interpolated 15-year benchmark YTM = (0.75 × 2.0%) + (0.25 × 4.0%) = 2.5%.

The 15-year credit spread is then calculated as 3.5% – 2.5% = 1.0%.

Now we can interpolate between the 5-year and 15-year maturity credit spreads to find the 10-year credit spread:

- Weight in the 15-year maturity = (10 – 5) / (15 – 5) = 50%. Weight in the 5-year maturity is therefore 50%.
- The interpolated 10-year credit spread plus the new issue premium of 5 bps

  = (0.5 × 0.7%) + (0.5 × 1.0%) + 0.05% = 0.90%.

Top-Down Credit Strategies

LOS 14.d: Discuss top-down approaches to credit strategies.

The top-down approach focuses on macro factors that are likely to affect the credit portfolio. Relevant factors include strength of economic growth and corporate profits. Stronger growth and profits are associated with decreasing spreads and suggest moving down in credit quality for greater relative price gains. Top-down managers may use this relationship to identify when to focus on HY versus IG.

Top-down can also be used to identify sectors of the market most likely to improve (or deteriorate), and the manager can overweight (or underweight) those sectors. This analysis could also be used by the bottom-up manager to identify sectors for more-targeted individual security analysis.

Top-down analysis may focus on historical patterns such as the credit cycle and credit spread changes. The credit cycle refers to variations in real economic growth and default rates. The two are negatively correlated in general, though it is not a perfect relationship.

The default rate and spreads are also highly correlated, so the manager must generally be able to anticipate the next change in economic conditions to add value. For example, suppose real growth is very low, defaults are high, and OAS for HY bonds is well above average; there is no particular opportunity because the high spread is compensation for high default losses. But if the manager has insight that the economy and growth rate are going to improve, it is an opportune time to move into HY.

The top-down manager would likely vary the portfolio's average credit rating upward to a higher (or downward to a lower) rating in anticipation of weaker (or stronger) than consensus expectations for economic growth. The manager should consider how the portfolio's average quality is calculated. Often, a numeric sequence is assigned to each rating (e.g., AAA = 1, AA+ = 2, AA = 3, AA– = 4). The portfolio's market value weighted average rating is then calculated. This approach can understate exposure to credit risk because default rates and losses tend to increase rapidly as the rating declines. Other more weighted scales assign a number that increases much more rapidly than 1, 2, 3, 4 as credit rating declines (e.g., 1, 10, 20, 40 is used by Moody's). Portfolio averages of a weighted scale will show that exposure to credit risk increases at a faster than linear rate, as bond ratings decline.

As seen before in this reading, portfolio average OAS and spread duration are also calculated based on market value weighted average. A higher spread indicates that the portfolio has greater exposure to credit-risky assets. To reflect the empirical observation that assets with higher spreads exhibit higher spread changes, DTS should be used as per the example earlier.

Note that the excess spread equation introduced earlier can also be applied to a class of bond such as rating or sector in order to establish the most attractive macro area to invest. The manager could also use top-down analysis to form a view on changes in the shape of the credit curve for a particular sector or class of bonds.

Factor-Based Credit Strategies

Active fixed-income managers are increasingly deploying strategies that use style-based factors, similar to their counterparts in active equity portfolio management. Four factors that have been identified as offering a risk premium in corporate bond investing are as follows:

1. *Carry*. The expected return if conditions remain unchanged over time, measured by the OAS.
2. *Defensive*. Empirical observation that lower-risk assets offer higher *risk-adjusted* returns than higher risk assets.
3. *Momentum*. Bonds that have recently outperformed (underperformed) go on to outperform (underperform) in the future.
4. *Value*. Low market value versus fundamental value (or equivalently high excess return).

These factors are analogous to factors identified in equity markets, with some technical adjustments. However, they do provide diversification against common equity or credit-based risk premiums and are not fully explained by traditional risk exposures or mispricing.

Environmental, Social, and Governance (ESG) Factors

Similar techniques for ESG investing are used in fixed income as they are in other asset classes, namely:

- Negative **screening** to exclude industries, companies, or sovereigns with poor ESG records.
- Use of **ESG ratings** to target issuers with favorable ESG characteristics. ESG ratings play a similar role to credit ratings in that they attempt to classify investments based on key underlying features. ESG ratings tend to be more diverse than credit ratings; however, there is a positive relationship between the two due to (1) companies with poor ESG records being more likely to suffer financial distress and (2) credit rating agencies starting to incorporate ESG factors into credit ratings.
- Investing to *directly fund* ESG-specific initiatives. For example, **green bonds** are bonds issued to raise finances for projects that reduce air pollution, improve recycling, promote environmental remediation (i.e., reduce contamination of the environment), and improve the sustainability of building construction. Such bonds have shown very strong demand from investors in recent years.

MODULE QUIZ 14.3

To best evaluate your performance, enter your quiz answers online.

1. Altman's z-score model is specified as follows:

   z-score model = (1.2 × A) + (1.4 × B) + (3.3 × C) + (0.6 × D) + (0.999 × E)

   where:

   A = working capital / total assets

   B = retained earnings / total assets

   C = EBIT / total assets

   D = market value of equity / total liabilities

   E = sales / total assets

   A corporate issuer has sales of $2,000, total assets of $3,500, working capital of $2,100, retained earnings of $1,900, EBIT of $600, total liabilities of $1,200, and the market value of the company's equity is $3,000. The Altman's z-score for this company implies that the issuer has:

   A. low default risk.
   B. some risk of default.
   C. high default risk.

2. An analyst is using a structural model to assess the credit risk of a corporate issuer. Which of the following changes to the inputs of the model will *most likely* decrease the probability of default of the issuer?
   A. A decrease in the interest coverage ratio of the issuer.
   B. A decrease in the volatility of the issuer's share price.
   C. An increase in the leverage ratio of the issuer.
3. A credit analyst collates the following information regarding two corporate issuers:

Rating	EffSpreadDur	YTM	OAS (bps)	POD	Recovery Rate
A	6	3.5%	150	0.25%	40%
B	8	6.0%	300	3.00%	40%

   The manager expects spreads to widen by 15%. Based on excess spread, which of the following statements is accurate?
   A. The A-rated bond is more attractive than the B-rated bond.
   B. The A-rated bond and B-rated bond are both of similar attractiveness from a valuation perspective.
   C. The A-rated bond is less attractive than the B-rated bond.
4. Which of the following fixed-income risk factors suggests that low duration bonds should have higher risk-adjusted returns?
   A. Carry.
   B. Defensive.
   C. Value.

MODULE 14.4: LIQUIDITY AND TAIL RISK

Video covering this content is available online.

LOS 14.e: Discuss liquidity risk in credit markets and how liquidity risk can be managed in a credit portfolio.

CFA® Program Curriculum, Volume 3, page 99

Liquidity Risk

Liquidity levels in fixed-income markets range from extremely high for large issues of on-the-run (i.e., most-recently issued) bonds in developed market sovereign debt to very low for smaller corporate off-the-run securities, which may not even trade at all during a typical trading day. For illiquid bonds that trade infrequently, **matrix pricing** (or **evaluated pricing**) is often used, which estimates fair value through reference to the yields and prices of similar actively traded and government securities.

The bond market has historically been a dealer-quoted OTC market, although electronic trading and liquid ETF products are gaining in prominence. For bonds with an active quote, transaction costs can be measured through the effective spread, which measures the cost of paying above the midpoint of a spread as a buyer or receiving a price below the midpoint of a spread as a seller.

effective spread for a buy order = trade size × (trade price – midquote)

effective spread for a sell order = trade size × (midquote – trade price)

where:

midquote = (bid + ask) / 2

Transaction costs can also be measured through referencing market prices and volumes reported into the TRACE (Trade Reporting and Compliance Engine) system for U.S. corporate bonds.

To manage liquidity risk, managers can:

- Use more-liquid on-the-run securities for shorter-term strategies and less liquid securities for longer-term strategies.
- Use liquid fixed-income alternatives such as credit default swaps (CDS) (discussed in depth later in this reading) or exchange-traded funds (ETFs). Fixed-income ETFs have become increasingly popular in fixed income in recent years. While ETFs are traded by investors in the secondary market on an exchange, the creation and cancellation of ETF shares is a process that happens directly between an institutional investor with special status (referred to as the **authorized participant**) and the ETF manager, meaning that the end investors in the ETF never have to directly buy or sell the bonds underlying the ETF. ETFs never mature, nor do they have a duration that drifts lower over time (unless they are target maturity ETFs that aim to mature on a specified date).
- Use asset swaps to hedge exposure on illiquid bonds over the time it takes to transact. For example, a manager wishing to sell a large illiquid holding over a long period of time could enter a pay-fixed asset swap to hedge the fixed-coupon income received on the corporate bond. As the trade in the underlying bond is slowly executed, the swap should be concurrently unwound.

Tail Risk

LOS 14.f: Describe how to assess and manage tail risk in credit portfolios.

CFA® Program Curriculum, Volume 3, page 101

"Tail risk" refers to the risk of losses due to infrequent but high negative impact events.

Value at risk (VaR) is a measure of minimum expected loss occurring in a given time frame with a specified probability. For example, if the 1% daily VaR of a portfolio is $7 million, this means that there is a 1% chance that the portfolio could lose $7 million (or more) on any given trading day.

The VaR is a percentile in a return distribution—for example, if the 1% daily VaR is $7 million, we know that the probability of observing a loss of $7 million or worse on any given day is 1%, and the probability of not suffering this loss is 99%.

PROFESSOR'S NOTE

Think of VaR as the loss at the point of the return distribution where the tail (say bottom 1% of returns) begins.

There are three common methods used to derive the return distribution from which VaR is estimated:

1. **Parametric method.** This assumes returns are normal and uses the parameters (mean and standard deviation) to calculate the loss at a given percentile of the distribution. Recall that for a normal distribution, we identify the 5th percentile as 1.65 standard deviations below the mean and the 1st percentile as 2.33 standard deviations below the mean. The advantage of the parametric VaR method is that it

is simple to apply. The disadvantage is that it does not perform well for portfolios with non-normal distribution, such as those containing options.

2. **Historical simulation.** This applies historical movements in key risk factors (movements in rates, spreads, etc.) to the existing portfolio in order to generate a return distribution. The advantage of this historical VaR is that it uses actual market data and can handle portfolios with non-normal returns. The disadvantage is that it is heavily dependent on the historical sample used, and this history may not be a guide to the future.
3. **Monte Carlo analysis.** This generates return distribution through random simulations from a user-defined model. The advantage is that the user-defined model has the flexibility to incorporate non-normal distributions. The disadvantage is that there is high model risk (i.e., the VaR is highly dependent on model assumptions being sound).

An example of the parametric method applied to fixed-rate bonds follows.

> EXAMPLE: **Fixed-rate bond VaR**
>
> A fixed-income manager holds $100 million par of a 15-year bond with a coupon of 2%, yield of 3%, and a modified duration of 12. If daily yield volatility is assumed to be 1.5%, what is the VaR for the position at 99% confidence (1% in the tail) for one month (assuming 20 trading days in the month and normally distributed yields)?
>
> **Answer:**
>
> First, scale up the daily yield volatility to 20-day volatility by multiplying the square root of 20 (recall that variance scales up with time; therefore, standard deviation, which is the square root of variance, scales up by multiplying through by the square root of time). Hence, the 20-day yield volatility is $1.5\% \times \sqrt{20} = 6.708\%.$ This is a proportionate measure; hence, a single standard deviation move in yields = 0.06708 × 3% = 0.2012%. The 99% confidence level for yield changes, which corresponds to the 1% VaR for the portfolio value, is 2.33 × 0.2012% = 46.9 bps.
>
> The impact on the portfolio of a 46.9 bps move is –12 × 0.469% = –5.63%. Given a portfolio value of $100 million, this implies a 20-day 1% VaR of $5.63 million.

VaR as a tail risk measure has the following drawbacks:

- Tail events tend to be more frequent and more severe than VaR forecasts.
- It fails to capture changes in correlation and liquidity during times of market stress.
- It fails to quantify the expected loss during a tail event.

Several extensions of VaR exist that are aimed at addressing these drawbacks:

- **Conditional value at risk (CVaR)** is the expected loss *given the portfolio is experiencing a loss in the tail*. It is a measure of the average loss in the tail and addresses the third drawback listed previously.
- **Incremental VaR (IVaR)** (or **partial VaR**) measures the change in VaR from adding or removing a position in a portfolio.
- **Relative VaR** measures the VaR of a portfolio's returns relative to a benchmark. It can be used to assess the minimum underperformance of an active manager relative to their benchmark in a given time frame with a specified probability.

When performing risk analysis, estimates for the volatility of benchmark rates can be taken from the implied volatility of option-based derivative contracts such as swaptions,

while credit models can derive expected spread volatility from CDS and equity market prices.

Risk analysis should extend beyond quantitative estimates of loss to consider the consequences of experiencing large losses in times of stress. For example, managers using leverage should model the impact of margin calls, managers of DB plan assets should consider the ability of plan sponsors to meet extra contributions, and treasurers of banks should assess their ability to meet regulatory reserves in times of stress.

MODULE QUIZ 14.4

To best evaluate your performance, enter your quiz answers online.

1. An active credit manager has a holding in a 5% coupon corporate bond, the size of which is 10 times the average daily trading volume according to historical TRACE data. In order to manage the interest rate risk of liquidating this position, the manager should enter:
   A. a pay-fixed swap and unwind the swap over time as the bond is sold.
   B. a pay-fixed swap and unwind the swap once the bond is fully sold.
   C. a receive-fixed swap and unwind the swap over time as the bond is sold.
2. An active credit manager can *best* assess the impact on the risk profile of a portfolio by increasing or decreasing an active position in the portfolio through using:
   A. relative VaR.
   B. incremental VaR.
   C. conditional VaR.

MODULE 14.5: CREDIT DEFAULT SWAPS AND SYNTHETIC STRATEGIES

Video covering this content is available online.

LOS 14.g: Discuss the use of credit default swap strategies in active fixed-income portfolio management.

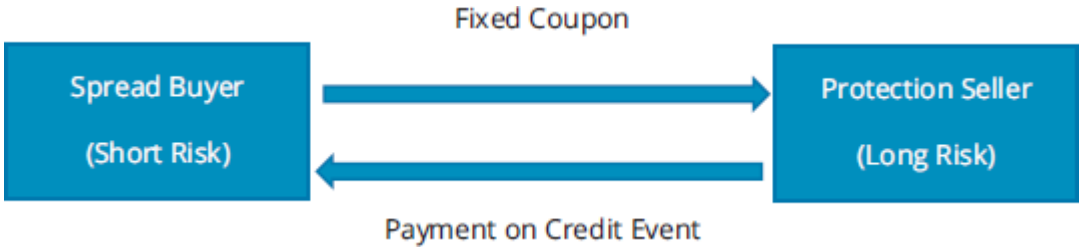
CFA® Program Curriculum, Volume 3, page 104

Synthetic Credit Strategies

A credit default swap (CDS) is a derivatives contract that involves two parties—a protection buyer and a protection seller.

The protection buyer pays a regular fixed coupon to the protection seller periodically over the life of the contract in return for a payment upon a prespecified credit event on a reference issuer (or issuers). The protection seller suffers losses if a credit event occurs and is, therefore, referred to as being long risk (i.e., they face the credit risk of the reference issuer). The size of the CDS is specified at the outset and referred to as the notional principal.

Figure 14.2: CDS Mechanics



The fixed coupon paid periodically by the protection buyer is standardized to 1% for investment-grade (IG) issuers and 5% for high-yield (HY) issuers for operational reasons, since standardizing the regular payment in this way makes settlement and clearing of contracts more straightforward. It is important to note that this standardized coupon is *not* the fair premium that should be regularly paid by the protection buyer (referred to as the **CDS spread**) for the credit protection based on credit pricing models. If the fair CDS spread is above the standardized fixed coupon, the protection buyer needs to make an up-front premium payment to the protection seller at initiation of the contract. Conversely, if the fair CDS spread is below the standardized fixed coupon, the protection buyer will receive an up-front premium payment from the protection seller.

The upfront payment is calculated as follows:

Scenario	Upfront Premium
CDS spread = fixed coupon	None
CDS spread > fixed coupon	[(CDS spread – fixed coupon) × $\text{EffSpreadDur}_{\text{CDS}}$] paid to protection seller
CDS spread < fixed coupon	[(fixed coupon – CDS spread) × $\text{EffSpreadDur}_{\text{CDS}}$] paid to protection buyer

The up-front premium is used to approximate the price quotation of the CDS contract as a percentage of notional amount as follows:

$$\text{CDS price} \approx 1 + [(\text{fixed coupon} - \text{CDS spread}) \times \text{EffSpreadDurCDS}]$$

This pricing convention conforms with the usual inverse price/yield relationship seen in fixed income because, when CDS spreads rise, the CDS price will fall and vice versa.

PROFESSOR'S NOTE

When it comes to the up-front premium, rather than rote learning these formulas, focus on the intuition that if the protection buyer pays a fixed coupon that is less than what is fair (the CDS spread), then they need to top up what they pay to the protection seller. The difference between the CDS spread and the fixed coupon is multiplied through by the effective spread duration of the CDS to incorporate the percentage impact on value of this difference, which gives us the up-front premium. With regard to the CDS price formula, note this is simply adjusting "1," which represents 100% of par, for the up-front premium to create an inverse relationship between CDS prices and spreads. For higher-quality issuers, the CDS spread will be lower than the fixed coupon and the CDS price will be above par. For lower-quality issuers, the CDS spread will be higher than the fixed coupon and the CDS price will be below par.

EXAMPLE: **CDS price and price changes**

A manager purchases protection on a high-yield reference obligation using a 5-year CDS contract with a CDS spread of 5.5% and an effective spread duration of 4.5.

Calculate:

1. The up-front premium and the price of the CDS.
2. The mark-to-market gain or loss to the protection buyer if the CDS spread immediately falls to 5.4%.

Answers:

1. The reference obligation is a high-yield bond; hence, the fixed coupon on this contract will be 5%. The fair CDS spread of 5.5% is greater than the fixed coupon; hence, the protection buyer is going to have to pay an up-front premium equal to the following:

up-front premium = (CDS spread – fixed coupon) × EffSpreadDur = (0.055 – 0.05) × 4.5 = 0.0225 or 2.25%

The CDS price = 1 + [(fixed coupon – CDS spread) × EffSpreadDur] = 1 + [(0.05 – 0.055) × 4.5] = 0.9775 or 97.75%. Note that the quick way to derive the CDS price is to notice that the CDS spread is higher than the fixed coupon; hence, we deduct the up-front premium from par.

2. The price impact of a change in spread = –ΔCDS spread × EffSpreadDur = –(5.40% – 5.50%) × 4.5 = 0.45%. Note that the protection buyer would suffer a mark-to-market loss here of 0.45% due to the fall in spread.

PROFESSOR'S NOTE

Here, spreads have narrowed and hence the protection buyer is suffering losses. The protection buyer can be viewed as synthetically short the reference issuers bond (this is the reason they are called "short risk")—if spreads widen (and prices fall), they profit.

CDS contracts can reference an individual issuer (single name) or an index of names (index-based). For example, the Markit CDX North American Investment Grade Index comprises 125 equally weighted CDS contracts. Payer (receiver) options also exist on CDS contracts where the option holder pays a premium for the right to buy (sell) protection on a CDX index on a future date. The holder of a payer CDS option profits if fair CDS spreads are above the CDS strike at expiry. The holder of a receiver CDS option profits if fair CDS spreads are below the CDS strike at expiry.

Active CDS strategies include CDS long-short strategies and CDS curve trades.

A **CDS long-short strategy** involves buying protection on issuers, where credit spreads are expected to widen relative to other issuers, while simultaneously selling protection on issuers, where credit spreads are expected to narrow relative to other issuers.

EXAMPLE: **CDS long-short strategy**

A manager wishes to increase exposure to XYZ Corp and decrease exposure to ABC Corp in their credit portfolio. Details of CDS contracts on the two companies are displayed here:

	Tenor (Years)	CDS Spread (bps)	EffSpreadDur
ABC Corp	5	220	4.59
XYZ Corp	5	240	4.62

Describe the appropriate long-short CDS trade to meet the manager's objectives. **Calculate** the manager's return if ABC Corp spreads widen by 15 bps and XYZ Corp spreads narrow by 20 bps, based on $15 million notional principal for each contract.

Answer:

The manager should sell protection on XYZ Corp to increase exposure to XYZ Corp and profit if spreads narrow; they should buy protection on ABC Corp to decrease exposure to ABC Corp and profit if spreads widen.

Profits from ABC Corp's spread widening = $15,000,000 × 0.0015 × 4.59 = $103,275.

Profits from XYZ Corp's spread narrowing = $15,000,000 × 0.002 × 4.62 = $138,600.

Total profit/loss from the trade = $103,275 + $138,600 = $241,875.

PROFESSOR'S NOTE

Keep in mind the risk side of the contract— to increase exposure, we increase risk and sell protection. When we sell protection, we profit if spreads fall, just as if we were long the

bonds of the issuer.

The CDS curve is a plot of CDS spreads versus maturity for a reference entity or index. An active manager can use **CDS curve trades** to profit on their view on changes in the CDS curve through buying protection at maturities where CDS spreads are expected to rise relative to other maturities and selling protection at maturities where spreads are expected to fall relative to other maturities.

EXAMPLE: **Duration-neutral CDS curve flattener**

An active credit manager expects the upward-sloping CDS curve for high-yield U.S. issuers to flatten. Details of the 5-year and 10-year CDS index contracts are displayed here:

Issuer	Tenor (Years)	CDS Spread (bps)	EffSpreadDur
HY CDS index	5	410	4.78
HY CDS index	10	490	9.18

1. **Describe** the appropriate long-short CDS to profit from the manager's view, assuming they wish to remain duration neutral and hold a $5,000,000 notional position in the 5-year contract.
2. **Calculate** the investor's return if 5-year spreads fall by 5 bps and 10-year spreads fall by 20 bps.

Answers:

1. The manager expects a flattening CDS curve; hence, they expect the 10-year CDS spread to fall relative to the 5-year CDS spread. The manager should, therefore, buy protection in the 5-year contract and sell protection in the 10-year contract.

   It is stated that the manager wishes to hold a notional principal of $5 million in the 5-year contract. The BPV of this position = notional principal × EffSpreadDur × 0.0001 = $5 million × 4.780 × 0.0001 = $2,390.

   In order to remain duration neutral, we require the position in the 10-year contract to have the same BPV as the position in the 5-year contract. Hence, the notional principal in the 10-year position must satisfy notional principal × 9.18 × 0.0001 = $2,390. Solving for the notional principal in the 10-year contract gives notional principal = $2,390 / (9.18 × 0.0001) = $2,603,486.
2. The manager has bought protection in the 5-year contract. Losses for a 5 bps fall in spread = –5 × $2,390 = –$11,950.

   The manager has sold protection in the 10-year contract. Gains for a 20 bps fall in spread = 20 × $2,390 = $47,800.

   The total profit/loss = $47,800 – $11,950 = $35,850.

Credit Spread Curve Strategies

LOS 14.h: Discuss various portfolio positioning strategies that managers can use to implement a specific credit spread view.

CFA® Program Curriculum, Volume 3, page 110

This section turns our attention to the strategies that active managers can employ to profit from a view on the shape or level of the credit spread curve.

Static Credit Spread Curve Strategies

A manager who believes that the current credit spread curve will remain unchanged can earn excess return in the cash market through either lowering the average credit rating of

their bond portfolio or increasing the spread duration of the portfolio by buying and holding longer-dated bonds.

PROFESSOR'S NOTE

These two strategies are analogous to two of the strategies seen in an earlier yield curve reading for a static benchmark yield curve. There, the manager could increase risk through leverage (the equivalent strategy here is to increase risk through lowering the credit rating of the portfolio) or through a buy-and-hold strategy using higher-returning longer-dated bonds.

EXAMPLE: **Credit spread curve buy-and-hold strategy for static credit curve**

An active credit manager collates the following data regarding the bonds of a corporate issuer and comparable government benchmark bonds. All coupons are semiannual, and all government securities listed are trading at par.

	Corporate Bonds			
Maturity (Years)	Coupon	YTM	Price	Govt. Par Yields
5	2.00%	2.00%	100.0000	0.50%
10	2.40%	2.30%	100.8888	0.80%
15	3.10%	2.90%	102.4187	1.10%

The manager expects a stable credit spread curve over the next six months and consequently takes an overweight position of $10 million face value of the 15-year corporate bond versus the 10-year corporate bond in order to extend the credit duration of the portfolio.

1. **Calculate** the incremental coupon income and rolldown price appreciation earned by the manager from extending the credit duration of the portfolio.
2. **Determine** the attribution of this incremental return to benchmark yield versus credit spread. **Show** your calculations.

Answers:

1. First, solve for the incremental coupon income generated from overweighting the 15-year corporate bond versus the 10-year corporate bond over the next six months.

   total incremental coupon = [(15-year corporate coupon – 10-year corporate coupon) / 2] × $10 million

   = [(0.031 – 0.024) / 2] × $10 million = $35,000

   Next, we need to calculate price appreciation due to rolling down the static curve. To price the bonds in six months' time with a static yield curve, we use interpolation of the existing data to estimate the YTM of the corporate bonds and the benchmark government bonds after six months have passed.

   #### PROFESSOR'S NOTE

   Recall that if the adjacent securities have maturities S (shorter) and L (longer) versus the target maturity M, then to quickly calculate the weight in the longer-dated bond, we can use the ratio (M – S) / (L – S). Here, when interpolating to get the 9.5-year yield (M) from the existing 5-year (S) and 10-year (L) yields, we have a weight in the 10-year security of (9.5 – 5) / (10 – 5) = 0.9 and therefore a weight in the 5-year security of 0.1. These are the same weights for the 15-year and 10-year yields, respectively, when interpolating for the 14.5-year yield.

   The interpolated 9.5-year corporate yield = (0.9 × 2.3%) + (0.1 × 2.0%) = 2.27%.

   Price of 10-year corporate bond in six months' time (with 9.5 years to go): 19 N; 2.27 / 2 = 1.135 I / Y; 2.4 / 2 = 1.2 PMT; 100 FV; CPT PV: 101.1053

   Recall that the original price of the 10-year corporate bond was given as 100.8888.

Hence, the absolute rolldown return of the 10-year bond = [(101.1053 – 100.8888) / 100] × $10 million = $21,650.

The interpolated 14.5-year corporate yield = (0.9 × 2.9%) + (0.1 × 2.3%) = 2.84%.

Price of 15-year corporate bond in six months' time (with 14.5 years to go): 29 N; 2.84 / 2 = 1.42 I / Y; 3.1 / 2 = 1.55 PMT; 100 FV; CPT PV: 103.0726

Recall that the original price of the 15-year corporate bond was given as 102.4187.

Hence, the absolute rolldown return of the 15-year bond = [(103.0726 – 102.4187) / 100] × $10 million = $65,390.

Hence, the total incremental rolldown return due to price appreciation is $65,390 – $21,650 = $43,740.

Therefore, the total incremental return earned from overweighting the 15-year bond versus the 10-year bond is $35,000 + $43,740 = $78,740.

2. Recall that the incremental coupon income from part 1 was $35,000.

   To attribute this extra coupon into an extra benchmark coupon versus an extra coupon related to credit, we calculate the incremental coupon earned from the government bond as [(15-year govt. coupon – 10-year govt. coupon) / 2] × $10 million = [(0.011 – 0.008) / 2] × $10 million = $15,000.

   Hence, the incremental coupon coming from the credit spread = $35,000 – $15,000 = $20,000.

   In order to attribute the incremental rolldown price appreciation to changes in benchmark yield versus credit spread, we first need to assess the change in credit spread due to the 10-year and 15-year bonds rolling down the credit curve.

   Using the same methodology as part 1, we interpolate the yields of the government securities as follows:

   interpolated 9.5-year government yield = (0.9 × 0.80%) + (0.1 × 0.50%) = 0.77%

   interpolated 14.5-year government yield = (0.9 × 1.10%) + (0.1 × 0.80%) = 1.07%

   We now analyze the change in *g*-spread (corp. YTM – govt. YTM) over the six months:

Bond	Corp. YTM	Govt. YTM	*g*-Spread
10-year at initiation	2.30%	0.80%	1.50%
9.5-year in six months' time	2.27%	0.77%	1.50%
Change over the six months	**–0.03%**	**–0.03%**	**0.00%**
15-year at initiation	2.90%	1.10%	1.80%
14.5-year in six months' time	2.84%	1.07%	1.77%
Change over the six months	**–0.06%**	**–0.03%**	**–0.03%**

   Recall from part 1 that the total rolldown return of the 10-year corporate bond is $21,650.

   The table here shows that this rolldown return came from a 0.03% fall in corporate bond yield, which was all attributable to the change in the government YTM.

   Recall from part 1 that the total rolldown return of the 15-year corporate bond is $65,390.

   The table here shows that this rolldown return came from a 0.06% fall in corporate bond yield, which is split evenly between a 0.03% fall in govt. YTM and a 0.03% fall in *g*-spread. Therefore, half the rolldown return ($65,390 / 2 = $32,695) is attributable to changes in benchmark yields, and the other half ($32,695) is attributable to changes in credit spread.

Price appreciation due to rolldown return is summarized in the following table (figures in $):

Bond	Total Rolldown Return	Attributed To	
		Benchmark Yields	Credit Spreads
10-year	21,650	21,650	0
15-year	65,390	32,695	32,695
Incremental (15-yr – 10-yr)	43,740	11,045	32,695

Total incremental return from holding the 15-year bond over holding the 10-year bond = total incremental coupon income + total incremental rolldown return = $35,000 + $43,740 = $78,740.

Incremental return from credit spreads = incremental coupon from credit spreads + incremental rolldown return from credit spreads = $20,000 + $32,695 = $52,695.

A manager expecting a static curve can also use CDS contracts to profit from this view. The manager may increase risk by selling protection on lower credit quality issuers or extend duration through selling protection on longer-dated CDS contracts.

EXAMPLE: **CDS strategy for a static credit spread curve**

A manager expects a static credit spread curve over the next 12 months and plans to increase the spread duration of the portfolio in order to enhance returns. They collect the following information regarding CDS contracts on a domestic HY index:

Reference Obligation	Tenor (Years)	CDS Spread (bps)	EffSpreadDur
HY index	5	450	4.8
HY index	10	550	8.9

The manager takes the appropriate position in $50 million notional of the 10-year CDS. Assume annual coupon payments and a 9-year effective spread duration of 8.1.

1. **State** whether the manager should buy or sell protection in the 10-year CDS.
2. **Calculate** the total coupon income and rolldown return from the position in the 10-year CDS.

Answers:

1. The manager wishes to extend the duration of the portfolio. They should take a long-risk position in the longer-dated 10-year CDS through selling protection.
2. Being a high-yield reference obligation, the fixed coupon on the CDS will be 5%. The manager will therefore receive 0.05 × $50,000,000 = $2,500,000 coupon income during the year.

   To calculate the rolldown return, we need to calculate the price of the 10-year CDS in 1 year's time when it has rolled down the curve to become a 9-year CDS. To find the 9-year CDS spread, we interpolate using the original 5-year and 10-year CDS spreads. Here, S = 5, L = 10, and M = 9; hence, the weight in the longer 10-year maturity = (9 – 5) / (10 – 5) = 0.8.

   Then the 9-year interpolated CDS spread = (0.8 × 550) + (0.2 × 450) = 530 bps.

   opening price of 10-year CDS

   = 1 + (fixed coupon – CDS spread) × EffSpreadDur

   = 1 + (0.05 – 0.055) × 8.9

   = $0.9555

   The price of the 10-year CDS in one year's time on becoming a 9-year CDS = 1 + (0.05 – 0.053) × 8.1 = $0.9757.

   The manager is long risk (sold protection); therefore, they profit as CDS spreads fall and prices rise. Profit from price appreciation = ($0.9757 – $0.9555) × $50,000,000 = $1,010,000.

   The total return = coupon income + price appreciation = $2,500,000 + $1,010,000 = $3,510,000.

PROFESSOR'S NOTE

There was an important step toward the end of the last example where we used the change in price of the CDS contract to calculate overall P/L. We stated that the manager sold protection, was long risk, and therefore benefitted if spreads fell and prices rose. *When calculating profit or loss from change in CDS price, view the long risk position as being like a long bond position—it profits if prices rise and spreads fall*. It is important for this and subsequent examples that this is clear. The following is a useful summary:

	Profit if CDS Spreads	Profit if CDS Prices
Sell protection (long risk)	Fall	Rise
Buy protection (short risk)	Rise	Fall

Dynamic Credit Spread Curve Strategies

Recall from the opening section in this chapter that the credit cycle is a key driver of the credit spread curve. A summary of the appropriate strategies for an economic slowdown or economic recovery are displayed in the following table:

		Strategy	
Economic Stage	**Typical Curve Feature**	**Cash**	**CDS**
Economic recovery	HY spreads narrow more than IG spreads	Buy HY bonds Sell IG bonds	Sell HY protection Buy IG protection
	HY credit curve steepens	Buy short-term HY bonds Sell long-term HY bonds	Sell short-term HY protection Buy long-term HY protection
Economic slowdown	HY spreads widen more than IG spreads	Buy IG bonds Sell HY bonds	Sell IG protection Buy HY protection
	HY credit curve flattens/inverts	Buy long-term HY bonds Sell short-term HY bonds	Sell long-term HY protection Buy short-term HY protection

EXAMPLE: **Dynamic credit curve cash strategy—economic slowdown**

An active credit manager collects the following information on three corporate bonds in their investment universe:

Rating	Current OAS	Expected Loss (POD × LGD)	EffSpreadDur
A	1.30%	0.09%	6.00
BBB	1.72%	0.39%	6.60
BB	2.60%	0.79%	5.90

The manager's benchmark is equally weighted across the three zero-coupon bonds. The manager is expecting an economic slowdown causing divergence in the changes of HY spreads relative to IG spreads over the next 12 months. The manager intends to take a 100% long position in a single bond and a 100% short position in a single bond to profit from this view.

1. **Describe** the trades the manager should make to profit from their credit spread curve view.

2. **Calculate** the excess spread of the portfolio and the benchmark under an economic slowdown where both OAS and expected loss increase by 40% for IG bonds and 80% for HY bonds.

Answers:

1. In an economic slowdown, HY spreads will likely widen by more than IG spreads. The manager should therefore sell HY bonds and buy IG bonds (think: flight to quality). Their portfolio should therefore be positioned 100% long the A-rated bond and 100% short the BB-rated bond.
2. Recall the excess spread of an investment is given by this formula:

   expected excess spread = spread – (EffSpreadDur × Δspread) – (POD × LGD)

   Applying this to the three bonds with the stated changes in spread and yield gives the following:

   excess spread of A-rated bond = 0.013 – [6 × (0.4 × 0.013)] – (0.0009 × 1.4) = –0.01946 or –1.946%

   excess spread of BBB-rated bond = 0.0172 – [6.60 × (0.4 × 0.0172)] – (0.0039 × 1.4) = –0.03367 or –3.367%

   excess spread of BB-rated bond = 0.026 – [5.90 × (0.8 × 0.026)] – (0.0079 × 1.8) = –0.11094 or –11.094%

   excess spread of the equally weighted benchmark = (–1.946% – 3.367% – 11.094%) / 3 = –5.47%

   excess spread of the active portfolio = (+1 × –1.946%) + (–1 × –11.094%) = 9.15%

EXAMPLE: **Dynamic credit curve synthetic strategy—economic slowdown**

A credit analyst collates the following information regarding CDS contracts on an IG index and a HY index:

Reference Obligation	Tenor (Years)	CDS Spread (bps)	EffSpreadDur
IG index	5	100	4.65
HY index	5	250	4.63

The manager is expecting an economic slowdown causing divergence in the changes of HY spreads relative to IG spreads over the next 12 months. The estimated spread durations of the IG index and HY index in 12 months' time are 3.85 and 3.82, respectively. The manager intends to invest in a long-short CDS trade with notional of $50 million in each of the contracts listed to profit from this view.

1. **Describe** the trades the manager should make to profit from their credit spread curve view.
2. **Calculate** the total return of the strategy under an economic slowdown where CDS spreads increase by 40% for the IG index and 80% for the HY index.

Answers:

1. In an economic slowdown, HY spreads will likely widen by more than IG spreads. The manager should therefore buy protection on the HY index and sell protection on the IG index (think: flight to quality).
2. The total return of the portfolio will consist of coupon paid/received and price appreciation.

   The manager will pay a 5% coupon to buy the HY protection and receive a 1% coupon for selling the IG protection. Net coupon outflow = $50 million × (0.05 – 0.01) = $2 million.

   In order to calculate price appreciation, we need to calculate the price of the CDS contracts at initiation and after 12 months. We will use this formula:

   CDS price ≈ 1 + [(fixed coupon – CDS spread) × EffSpreadDurCDS]

   We also recall once again that the standardized coupon on a CDS contract is 1% for IG and 5% for HY.

price of the IG index CDS at initiation = 1 + (0.01 – 0.01) × 4.65 = 1

price of the IG index CDS after 12 months = 1 + [0.01 – (0.01 × 1.4)] × 3.85 = 0.9846

The manager has sold protection on the IG index and is therefore long risk: they benefit from rising prices. Therefore, p/l from selling IG protection = $50 million × (0.9846 – 1) = –$770,000.

price of the HY index CDS at initiation = 1 + (0.05 – 0.025) × 4.63 = 1.11575

price of the IG index CDS after 12 months = 1 + [0.05 – (0.025 × 1.8)] × 3.82 = 1.0191

The manager has bought protection on the HY index and is therefore short risk: they benefit from falling prices. Therefore, p/l from buying HY protection = $50,000,000 × (1.11575 – 1.0191) = $4,832,500.

total p/l from price appreciation = –$770,000 + $4,832,500 = $4,062,500

Subtracting the premium outflow gives a total p/l of $4,062,500 – $2,000,000 = $2,062,500.

MODULE QUIZ 14.5

To best evaluate your performance, enter your quiz answers online.

1. A CDS contract on a HY issuer has a CDS spread of 4.7% and effective spread duration of 4.5. The up-front premium on $10 million notional of this contract is:
   A. $135,000 and paid to the protection seller.
   B. $135,000 and paid to the protection buyer.
   C. $1,665,000 and paid to the protection seller.
2. An active credit manager expecting a stable credit curve is *least likely* to:
   A. sell protection in longer-dated CDS contracts.
   B. buy protection in shorter-dated CDS contracts.
   C. lower the credit rating of the portfolio.
3. An active credit manager who is expecting an economic recovery should *most likely*:
   A. lower exposure to HY securities.
   B. use CDS contracts to sell short-dated protection and buy long-dated protection.
   C. use CDS contracts to buy protection on HY issuers and sell protection on IG issuers.
4. An active credit manager decides to overweight exposure to an investment-grade company using $10 million notional of CDS contracts with tenor of 5 years, a CDS spread of 150 basis points, and a spread duration of 4.5. Three months later, the CDS spread is 120 basis points and the spread duration is 4.25. The profit from the CDS trade is *closest* to:
   A. $100,000.
   B. $140,000.
   C. $240,000.

MODULE 14.6: GLOBAL CREDIT STRATEGIES, STRUCTURED CREDIT, AND FIXED-INCOME ANALYTICS

Video covering this content is available online.

LOS 14.i: Discuss considerations in constructing and managing portfolios across international credit markets.

CFA® Program Curriculum, Volume 3, page 120

Global Credit Strategies

A manager engaging in cross-border credit strategies has the following considerations when constructing their portfolio:

- Attempts to diversify through investing in different sectors (e.g., sovereign issuers vs. corporate issuers) in an emerging market that is heavily reliant upon a dominant industry or commodity export may yield little success, as all securities are likely to perform in a similar way.
- Significant sector differences may exist, even between developed markets. For example, a far higher proportion of the U.S. fixed-income market is related to mortgage and other asset-backed securities than are other developed markets.
- Differences in accounting standards across markets may affect the liquidity, profitability, and solvency ratios used in credit analysis.
- Differences in the magnitude and timing of the credit cycle across countries often present opportunities in yields, exchange rates, and credit spread curves.

Recall from an earlier reading that the domestic return of a foreign market investment can be calculated as follows:

$$RDC = (1 + RFC)(1 + RFX) - 1$$

where:
RDC = domestic return
RFC = foreign currency (local market) return
RFX = appreciation/depreciation of foreign currency versus domestic currency

EXAMPLE: **Cross-border credit strategy**

A U.S.-based active credit manager has the view that an economic recovery will see European credit outperform U.S. credit over the next 12 months. They identify the following CDS contract based on a European HY index:

Reference Obligation	Tenor (Years)	CDS Spread (bps)	EffSpreadDur
EUR HY index	5	450	4.55

Calculate the price return (ignoring coupon) of the appropriate position in the above CDS contract if the European credit spreads fall by 20% and the EUR strengthens against the USD by 2%.

Answer:

Note that the high-yield index will have a standardized fixed coupon of 5%.

The initial price of the CDS = 1 + (0.05 – 0.045) × 4.55 = 1.02275.

After the fall in spreads, the new price of the CDS = 1 + [0.05 – (0.045 × 0.8)] × 4.55 = 1.0637.

Hence, the foreign price return, *R*FC = (1.0637 – 1.02275) / 1.02275 = 0.04 or 4%.

Given an expected appreciation of the foreign currency of 2%, the domestic return of the U.S. investor is calculated as (1.04) × (1.02) – 1 = 0.0608 or 6.08%.

Managers investing in emerging markets often begin their credit analysis by assessing the willingness and ability of the government to meet their sovereign debt payments. Considerations here include the following:

- **Institutional considerations**. Consider the enforcement of property rights, contract law, and the level of political stability in the country. Geopolitical risk such as trade wars or conflicts, plus ESG factors, are also important.

- **Economic profile**. Tax revenues from economic activity, plus the level of debt and annual deficit as a percentage of GDP, all directly affect the ability of a country to meet its debt payments.
- **Exchange rate regime**. Fixed exchange rate regimes limit the flexibility and effectiveness of monetary policy. From a sovereign credit risk perspective, high external (foreign) debt/GDP implies a higher chance of financial distress, while a low currency reserves/GDP ratio suggests potential liquidity issues.

Investors in emerging market corporate bonds also need to consider the level of control/influence the government may exert on the running of business and the "sovereign ceiling" set by the government, whereby corporations are usually not assigned higher-quality credit ratings than the sovereign credit rating of their domicile.

Liquidity risk is a key concern for investors in emerging market bonds because often a relatively small number of bonds trade on a regular basis, resulting in investors demanding a liquidity premium. Currency risk is also a key concern for investors. The higher yields available in emerging markets could be interpreted under uncovered interest rate parity as a sign that the currency is expected to depreciate. However, as discussed in a previous reading, uncovered interest rate parity is not a theory that always holds, meaning that investors could earn excess returns from an international carry trade (called the forward rate bias).

Structured Credit

LOS 14.j: Describe the use of structured financial instruments as an alternative to corporate bonds in credit portfolios.

CFA® Program Curriculum, Volume 3, page 124

Structured credit instruments allow investors to purchase securities that are backed by debt-based collateral, such as a pool of mortgages or commercial loans.

There are two primary reasons for an investor to invest in structured credit:

1. The structured instrument issues different *tranches* of security, each with a different risk profile, allowing the investor to create risk exposures not available through investing directly in the collateral. For example, with credit tranching, credit losses in the underlying collateral will flow to the most junior tranche first. The most senior tranche will, therefore, have the lowest credit risk and receive the highest credit rating. Investors that are not be able to invest in the collateral due to their credit rating being too low will be able to invest in the higher-rated senior tranches of the structured product. Structured products that offer such tranching features include the following:
    - Collateralized debt obligations (CDOs)—with general debt obligations as collateral.
    - Collateralized loan obligations (CLOs)—with leveraged loans (i.e., loans to non-investment-grade companies) as collateral.
2. The structured instrument offers *exposure* to collateral that the investor cannot access directly. Examples include the following:
    - Mortgage-backed securities (MBSs) backed by mortgages.
    - Asset-backed securities (ABSs) backed by credit card, auto, or other types of loan.
    - Covered bonds—senior debt obligations of a commercial bank backed by a pool of mortgages or loans made by the bank. The investor here has recourse to the other asset of the bank should the bank fail to make payments on the covered bond (this is not the case for other

types of structured products that are issued by an off-balance sheet special purpose vehicle (SPV) with no recourse to the original lender of the collateral loans). This, along with the fact that a lender would substitute nonperforming loans in the collateral, makes the credit risk of a covered bond lower than that of other structured products.

PROFESSOR'S NOTE

Remember that Level III is all about application in an investment scenario rather than forensic focus on technical detail. Expect questions to test the understanding of how/why a manager would use these products in certain situations. For example, a manager expecting an economic recovery would sell senior tranches and buy junior tranches in anticipation of lower credit quality assets outperforming higher credit quality assets (just in the same way that a credit manager would lower the credit rating of their portfolio before an economic recovery in order to outperform).

Fixed-Income Analytics

LOS 14.k: Describe key inputs, outputs, and considerations in using analytical tools to manage fixed-income portfolios.

CFA® Program Curriculum, Volume 3, page 126

Fixed-income analytical tools perform important operational and investment tasks for a fixed-income investment manager. They comprise three major parts: inputs, user-defined parameters, and outputs.

- **Inputs** include portfolio position data, relevant market data (prices/yields, exchange rates, volatilities, etc.), credit and ESG ratings, and index data subscriptions for benchmarking purposes.
- **User-defined parameters** comprise models for term structure, risk (e.g., VaR), scenario analysis, and filters to include or exclude bonds by sector or ESG rating. The time horizon of the manager is also an important user-defined parameter, as is the overall objective of the manager (e.g., total return vs. liability-driven).
- **Outputs** include a summary of portfolio positions and risk exposures versus the benchmark index, position selection and portfolio construction tools, risk and scenario analysis, and trading and cash management tools.

The investment manager should consider the accuracy of model inputs, the appropriateness of assumption in the user-defined models, and how the outputs relate to the manager's overall objectives.

MODULE QUIZ 14.6

To best evaluate your performance, enter your quiz answers online.

1. An active credit manager has exposure to two emerging markets, market A and market B, with the following economic profiles:

	Country A	Country B
Foreign debt/GDP	100%	60%
Budget deficit/GDP	4%	6%
Currency reserves/GDP	12%	21%

Based on these ratios, if the manager wishes to invest in the country with the greatest fiscal stability, they should increase exposure to:

A. country A and reduce exposure to country B due to the relative budget deficit/GDP ratios.
B. country B and reduce exposure to country A due to the relative foreign debt/GDP ratios.
C. country B and reduce exposure to country A due to the relative currency reserves/GDP ratios.

2. After recent central bank actions, an active credit manager expects an economic recovery and a strong rebound in residential housing prices. The portfolio position *most appropriate* to profit from this view is to sell:
   A. the BB-rated tranche of a credit card ABS and buy the AA-rated tranche of the same structured product.
   B. the AA-rated tranche of a CDO and buy the BB-rated tranche of the same structured product.
   C. the AA tranche of an MBS and buy the BB tranche of the same structure product.
3. A manager performing risk analytics on their portfolio of MBS securities is *most likely* to increase the future value output of their portfolio relative to similar option-free bond holding through making which of the following input changes?
   A. A downward parallel shift in the yield curve.
   B. An increase in interest rate volatility.
   C. A decrease in interest rate volatility.

KEY CONCEPTS

LOS 14.a

The two primary components of credit risk are probability of default (POD), usually expressed as an annualized probability, and loss given default (LGD) or loss severity calculated as 1 – recovery rate (RR). The credit valuation adjustment (CVA) of a credit-risky bond is the present value of expected credit losses, calculated as the sum of (POD × LGD × expected exposure) across the life of the bond. The credit-risky bond's fair value is equal to an equivalent risk-free bond's value minus the CVA.

The following is a simple approach to estimating the fair credit spread for the next period:

$$\text{spread} \approx \text{POD} \times \text{LGD}$$

A plot of credit spreads versus maturity for a class of bonds is called the credit spread curve. This curve is largely driven by the credit cycle linked to the general level of economic activity as follows:

	Stage of Economic Cycle			
	Early Expansion (Recovery)	Late Expansion	Peak	Contraction (Recession)
Corporate defaults	Peak	Falling	Stable	Rising
Credit spread level	Stable	Falling	Rising	Peak
Credit spread slope	IG: Stable HY: Inverted	Upward sloping for both IG and HY	Upward sloping for both IG and HY	IG: Flat HY: Inverted

Empirical duration is based on regression of market data of actual bond price returns and benchmark rate changes. Since the actual bond price is driven by both spreads and

benchmark rates, empirical duration will be lower than analytical duration for low-quality securities.

LOS 14.b

Fixed-Rate Bond Credit-Spread Measures

yield spread (benchmark spread) = bond's YTM – YTM of closest maturity on-the-run government bond

g-spread = bond's YTM – interpolated YTM of the two adjacent maturity on-the-run government bonds

i-spread (interpolated spread) = bond's YTM – the maturity interpolated swap fixed rate

asset swap spread (ASW) = bond's fixed *coupon* – the maturity interpolated swap fixed rate

zero-volatility spread (*z*-spread) = bond's spread over risk-free *spot rates*

The CDS spread is the fair value of the protection bought under a CDS contract, expressed as a periodic percentage of notional exposure.

CDS basis = CDS spread – *z*-spread

The option adjusted spread (OAS) is a bond's spread over an interest rate tree of potential future risk-free forward-rate paths. The OAS removes the impact of options on the spread and should be used to compare across different types of bond.

Floating-Rate Note (FRN) Credit-Spread Measures

Quoted margin (QM) is the fixed margin above a floating market reference rate (MRR) making up an FRN coupon.

Discount margin (DM) is the constant spread above the current MRR rate offered by an FRN.

If DM is less (greater) than QM, then the FRN will trade above (below) par.

The rate duration and spread duration of an FRN are given by the following:

$$\text{EffRateDur}_{\text{FRN}} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{MRR})(\text{PV}_0)}$$

$$\text{EffSpreadDur}_{\text{FRN}} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{DM})(\text{PV}_0)}$$

Zero-discount margin (Z-DM) is the constant spread above the current term structure of MRR rates offered by an FRN.

The Impact of Spreads on Portfolio Return

The effective spread duration and effective spread convexity of a portfolio are calculated using the following formulas:

$$\text{effective spread duration} = \frac{(PV_-) - (PV_+)}{2(\Delta\text{spread})(PV_0)}$$

$$\text{effective spread convexity} = \frac{(PV_-) + (PV_+) - 2(PV_0)}{(\Delta\text{spread})^2 (PV_0)}$$

The sensitivity of a bond portfolio to changes in spread is given by:

%Δ price = (–EffSpreadDur × Δspread) + (½ × EffSpreadCon × Δspread2)

where Δ*spread* is typically defined as the change in the **OAS**.

The duration times spread (DTS) of a bond portfolio respects the fact that spread changes tend to be proportional to spread size, and is approximately defined as follows:

DTS ≈ EffSpreadDur × spread

The annualized excess return over credit losses expected from a bond portfolio is defined as the *excess spread* and calculated as follows:

expected excess spread = spread – (EffSpreadDur × Δspread) – (POD × LGD)

LOS 14.c

Bottom-up credit strategies aim to identify the most attractive individual bond investments by focusing on the operating history of the borrower and key financial ratios.

Credit-risk models used on a bottom-up basis can be structural or reduced form. Structural models assess the probability of default as the probability of the assets of the borrower falling below the value of their liabilities. Reduced form models assess probability of default and the impact of credit losses through modeling the relationship between macroeconomic variables and the characteristic of the borrower.

An example of a reduced form model is the Altman's *z*-score, which maps key financial ratios to a *z*-score using linear regression. A *z*-score greater than 3 implies a low chance of default. A *z*-score between 1.8 and 3 indicates some chance of default, while a score below 1.8 indicates that default is likely.

LOS 14.d

Top-down credit strategies focus on macroeconomic factors that are likely to affect the credit portfolio. Managers attempt to form views on the timing of the credit cycle, lowering the credit rating of the portfolio prior to good economic conditions and increasing the credit rating of the portfolio prior to poor economic conditions.

Factor-based credit strategies focus on identifying factors in fixed-income securities that are rewarded with a risk premium. Four factors that have been identified are carry, defensive, momentum, and value.

ESG techniques in fixed income include negative screening, use of ESG ratings, and direct funding of ESG initiatives such as green bonds.

LOS 14.e

Fixed income has historically been an OTC market with low liquidity in off-the-run, smaller, emerging market corporate issues and higher liquidity for on-the-run, larger, developed market sovereign issues.

Transaction costs can be measured through the effective spread:

effective spread for a buy order = trade size × (trade price – midquote)

effective spread for a sell order = trade size × (midquote – trade price)

where:

midquote = (bid + ask) / 2

LOS 14.f

Value at risk (VaR) is a measure of minimum expected loss occurring in a given time frame with a specified probability.

The three common methods used to generate distributions for VaR calculations are the parametric method, which uses the parameters of the normal distribution; the historical method; and Monte Carlo simulation.

Extensions of VaR include the following:

- Conditional value at risk (CVaR) is the expected loss *given the portfolio is experiencing a loss in the tail.*
- Incremental VaR (IVaR) (or partial VaR) measures the change in VaR from adding or removing a position in a portfolio.
- Relative VaR measures the VaR of a portfolio's returns relative to a benchmark.

LOS 14.g

Under a credit default swap (CDS), a protection buyer pays a regular fixed coupon to the protection seller periodically over the life of the contract in return for a payment on a prespecified credit event on a reference issuer (or issuers).

If the fair value of the protection (the CDS spread) is different from the fixed coupon paid, then an up-front premium is paid/received by the protection buyer, as follows:

Scenario	Upfront Premium
CDS spread = fixed coupon	None
CDS spread > fixed coupon	[(CDS spread – fixed coupon) × $\text{EffSpreadDur}_{\text{CDS}}$] paid to protection seller
CDS spread < fixed coupon	[(fixed coupon – CDS spread) × $\text{EffSpreadDur}_{\text{CDS}}$] paid to protection buyer

The CDS price as a percentage of par is quoted as follows:

CDS price ≈ 1 + [(fixed coupon – CDS spread) × EffSpreadDurCDS]

A *CDS long-short strategy* involves buying protection on issuers where credit spreads are expected to widen relative to other issuers, while simultaneously selling protection on issuers where credit spreads are expected to narrow relative to other issuers.

A *CDS curve trade* involves buying protection at maturities where CDS spreads are expected to rise relative to other maturities and selling protection at maturities where

spreads are expected to fall relative to other maturities.

LOS 14.h

Static credit spread curve strategies when the (upward-sloping) credit spread curve is expected to be stable include the following:

- Lower the credit quality of the portfolio or extend the spread duration of the portfolio.
- Sell protection on lower-quality credit issuers or sell protection over longer maturities.

Dynamic credit spread curve strategies when the credit spread curve is expected to change include the following:

		Strategy	
Economic Stage	**Typical Curve Feature**	**Cash**	**CDS**
Economic recovery	HY spreads narrow more than IG spreads	Buy HY bonds Sell IG bonds	Sell HY protection Buy IG protection
	HY credit curve steepens	Buy short-term HY bonds Sell long-term HY bonds	Sell short-term HY protection Buy long-term HY protection
Economic slowdown	HY spreads widen more than IG spreads	Buy IG bonds Sell HY bonds	Sell IG protection Buy HY protection
	HY credit curve flattens/inverts	Buy long-term HY bonds Sell short-term HY bonds	Sell long-term HY protection Buy short-term HY protection

LOS 14.i

A manager engaging in cross-border credit strategies should consider whether foreign market reliance on an industry or commodity export limits diversification, any significant sector weight differences between markets, differences in accounting standards, and difference in the magnitude and timing of credit cycles between countries.

The domestic return of a foreign credit investment is given by the following:

$$RDC = (1 + RFC)(1 + RFX) - 1$$

Investors in emerging markets should consider institutional factors such as political stability and enforcement of the law, the economic profile of the country, and the exchange rate regime.

LOS 14.j

Structured credit instruments allow managers to access collateral they could not access directly (ABS, MBS, covered bonds), allow managers to tailor their risk exposure through the tranching of securities (CDO, CLO), or both.

LOS 14.k

Fixed-income analytical tools comprise three major parts: inputs (positions, market data, ratings, and index data), user-defined parameters (models, time horizon, and objectives), and outputs (risk summaries, portfolio construction, trading, and cash management tools).

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 14.1

1. **A** At the peak of the economic cycle, lower defaults and increased profitability cause short-term credit spreads to remain low. Longer-term credit spreads will likely increase due to higher leverage, increased inflation expectations over the longer term, and the pricing in of higher defaults when a contraction begins. The curve will likely be rising and upward sloping in this stage of the economic cycle. (LOS 14.a)

2. **C** While the IG credit spread curve is likely to flatten during periods of economic downturn, it is only the HY curve that typically inverts (i.e., becomes downward sloping), due to the high level of defaults in the short term for HY issuers. (LOS 14.a)

3. **A** Analytical duration measures the theoretical sensitivity of a bond's price to a unit move in benchmark rates (think: modified duration). Empirical duration is derived through regressing a bond's actual returns relative to movements in benchmark rates. As benchmark rates rise in good economic times, credit spreads tend to fall (and vice versa in bad economic times). This inverse relationship between benchmark rates and spreads will cause bond yields to move by less than benchmark rates; hence, the bond price will empirically be less sensitive to changes in rates than analytical duration implies. Therefore, empirical duration will be lower than analytical duration. (LOS 14.a)

Module Quiz 14.2

1. **C** The yield spread compares the YTM of the 12-year corporate bond to the nearest maturity on-the-run Treasury YTM. In this case, the nearest maturity is the 10-year maturity. The *g*-spread compares the YTM of the corporate bond to the 12-year interpolated government YTM using the 10- and 15-year maturity treasuries. Given that the yield curve is upward sloping, the 12-year interpolated Treasury YTM will be higher than the 10-year government YTM. This implies that the *g*-spread will be lower than the yield spread. (LOS 14.b)

2. **C** The *i*-spread is defined as the corporate YTM minus an interpolated swap rate. The asset swap spread (ASW) is defined as the bond's coupon minus the interpolated swap rate. Since the bond is trading below par, the YTM of the bond will be higher than its coupon; hence, the *i*-spread will be higher than the ASW. (LOS 14.b)

3. **A** First, solve for the market value of bonds X and Y:

   market value of bond X = £1,000,000 × (1.02 + 0.01) = £1,030,000

   market value of bond Y = £1,000,000 × (0.94 + 0.015) = £955,000

   Therefore, the total portfolio value = £1,030,000 + £955,000 = £1,985,000.

   The weight of bond X = £1,030,000 / £1,985,000 = 0.51889.

   The weight of bond Y = 0.48111.

Given that we can see that bond X has a higher weight than bond Y in the portfolio, we will have a higher weight in the 120 bps bond than in the 140 bps bond; hence, the portfolio OAS will be less than 130 bps.

For completeness, the OAS of the portfolio = (0.51889 × 120) + (0.48111 × 140) = 129.6 bps. (LOS 14.b)

4. **A** The DM assumes that the yield curve is flat because it is the constant margin above the current MRR that is required by investors. The Z-DM reflects the term structure of the MRR curve in that it reflects the constant return in excess of MRR spot rates that is required by investors. In an upward-sloping MMR curve environment, the MRR spot rates will be higher than the current MRR as maturity increases, and so the Z-DM will be lower than the DM. (LOS 14.b)

Module Quiz 14.3

1. **A** First, we calculate the inputs to the Altman model:

   A = working capital / total assets = $2,100 / $3,500 = 0.60

   B = retained earnings / total assets = $1,900 / $3,500 = 0.54

   C = EBIT / total assets = $600 / $3,500 = 0.17

   D = market value of equity / total liabilities = $3,000 / $1,200 = 2.5

   E = sales / total assets = $2,000 / $3,500 = 0.57

   Using these inputs in the model, we calculate the following *z*-score:

   z-score model = (1.2 × 0.60) + (1.4 × 0.54) + (3.3 × 0.17) + (0.6 × 2.5) + (0.999 × 0.57) = 4.11

   This *z*-score of 4.11 is above the threshold of 3, so we are required to label the company as low default risk. (LOS 14.c)

2. **B** Under structural models, the probability of default is measured by how far the assets of the issuer are away from a level that would trigger a default in terms of standard deviations. A decrease in the interest coverage ratio and increase in leverage both imply the issuer has a lower ability to service its debt and, therefore, is closer to default and has a higher POD. A fall in the volatility (i.e., standard deviation) of equity will imply a fall in the standard deviation of the issuer's assets, which will increase the distance to default (in terms of standard deviations) and, therefore, lower the POD of the issuer. (LOS 14.c)

3. **A** Excess spread is calculated using this formula:

   expected excess spread = spread – (EffSpreadDur × Δspread) – (POD × LGD)

   Given a 15% increase in spreads:

   excess spread for A-rated bond = 0.015 – [6 × (0.15 × 0.015)] – [0.0025 × (1 – 0.4)] = 0%

excess spread for B-rated bond = 0.03 – [8 × (0.15 × 0.03)] – [0.03 × (1 – 0.4)] = –0.024 or –2.4%

With a higher excess spread, the A-rated bond offers a more attractive valuation than the B-rated bond. (LOS 14.c)

4. **B** The carry factor represents returns earned from holding fixed-income securities over time. The value factor represents returns available from investing in bonds with a low value relative to their fundamental value. The defensive factor suggests that risk-adjusted returns for less risky securities are superior to those of higher risk (longer duration) securities. (LOS 14.d)

Module Quiz 14.4

1. **A** It will take a significant amount of time to carefully liquidate such a large position. In the meantime, the manager should hedge the interest rate exposure of the fixed-coupon received on the bond by paying fixed under an interest rate swap. As the bond is sold over time, the swap should be unwound to match the remaining bond position. (LOS 14.e)
2. **B** Incremental VaR measures the impact of changing positions in the portfolio on overall VaR. Relative VaR measures VaR relative to a benchmark index, and conditional VaR measures the average loss given we are in the tail of the distribution. (LOS 14.f)

Module Quiz 14.5

1. **B** The up-front premium is calculated as follows:

   upfront premium = (fixed coupon – CDS spread) × EffSpreadDur × notional

   The standardized fixed coupon for a HY reference obligation is 5%. Hence, the up-front premium = (0.05 – 0.047) × 4.5 × $10,000,000 = $135,000. Since the fixed coupon that is actually paid is higher than the fair CDS spread, this up-front premium is paid from the protection seller to the protection buyer. (LOS 14.g)

2. **B** Managers expecting a static credit spread curve should enhance the return of the portfolio through lowering the credit rating of the portfolio (buy HY bonds, sell HY protection) or extending the spread duration of the portfolio (buy longer-dated bonds, sell longer-dated CDS contracts). (LOS 14.h)
3. **B** An economic recovery is likely to see HY spreads fall by more than IG spreads and credit curves steepening. A manager should therefore sell protection on HY issues versus buying protection on IG issuers or increase exposure to HY securities in order to benefit from HY bonds outperforming IG bonds. To profit from the steepening curve, they should sell short-term protection and buy longer-term protection. (LOS 14.h)
4. **C** The CDS contract is on an IG issuer; hence, the standardized fixed coupon is 1%.

   initial price of the CDS = 1 + [(0.01 – 0.015) × 4.5] = 0.9775

   price of the CDS after 3 months = 1 + [(0.01 – 0.012) × 4.25] = 0.9915

Since the manager wishes to overweight exposure to the issuer, they will sell protection to take a long risk position. A long risk position wins when prices rise.

profit from price appreciation = (0.9915 – 0.9775) × $10,000,000 = $140,000

coupon income = 0.01 × $10,000,000 = $100,000

total profit = $240,000

(LOS 14.h)

Module Quiz 14.6

1. **A** If the manager wishes to invest in countries with the greatest fiscal stability, they should invest in countries with the lowest budget deficit/GDP ratios, since this ratio indicates how much borrowing the country needs to make each year to meet its spending requirements. The foreign debt/GDP ratio is used to assess external leverage, and the currency reserves/GDP ratio is used to assess the liquidity position of the countries. (LOS 14.i)
2. **C** In anticipation of an economic rebound, managers should lower the credit quality of investments since high-yield spreads will likely contract by more than IG spreads. The manager can incorporate their view on a housing market recovery by using MBS securities. (LOS 14.j)
3. **C** MBS securities contain a prepayment option held by the mortgage borrowers. This option, like a call option on a bond, will become more valuable as interest rate volatility increases. Since the prepayment option lies with the borrowers, the MBS securities have an embedded short position in the prepayment option. The MBS security will become more valuable if volatility assumptions fall and the embedded short prepayment option value falls. (LOS 14.k)

TOPIC QUIZ: FIXED-INCOME PORTFOLIO MANAGEMENT

You have now finished the Fixed-Income Portfolio Management topic section. On your Schweser online dashboard, you can find a Topic Quiz that will provide immediate feedback on how effective your study of this material has been. The test is best taken timed; allow three minutes per question. Topic Quizzes are more exam-like than typical QBank questions or module quiz questions. A score less than 70% suggests that additional review of the topic is needed.

The following is a review of the Equity Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #15.

READING 15: OVERVIEW OF EQUITY PORTFOLIO MANAGEMENT

Study Session 7

EXAM FOCUS

These introductory readings cover the role of equity in the portfolio, common approaches to equity investing, and shareholder engagement.

MODULE 15.1: EQUITY INVESTMENT ROLES

Video covering this content is available online.

LOS 15.a: Describe the roles of equities in the overall portfolio.

CFA® Program Curriculum, Volume 3, page 147

Within the overall investment portfolio, equity securities play several beneficial roles. These roles include capital appreciation, dividend income, diversification, and the potential to hedge inflation.

Capital Appreciation

The main driver of long-term equity returns is capital (or price) appreciation. Capital appreciation results from investing in companies that are experiencing growth in cash flows, revenues, and/or earnings. These companies range from small technology companies that are focused on growth opportunities to large, well-established companies that are focused on value-added acquisitions and minimizing costs.

In the last 50 years, equity returns on average have been higher than bonds and bills. In general, equities tend to outperform other major asset classes during periods of strong economic growth, and underperform during periods of weak economic growth.

Dividend income: This is an important component of equity return. When companies generate excess cash flows, they can decide to either reinvest those cash flows in value-added projects or distribute them to investors in the form of *dividends*. Well-established companies often pay dividends to investors and those dividends may increase over time. However, dividend payments are not guaranteed to increase or even continue into the future. Typical recent annual dividend yields have been 1%–3%. Dividend yield tends to be more stable than return due to price change.

Diversification: Equity securities offer diversification benefits due to less than perfect (i.e., less than +1.0) correlation with other asset classes. When assets are less than perfectly correlated, portfolio standard deviation will be lower than the weighted sum of the individual asset standard deviations.

However, the risk reduction is not constant. During a financial crisis correlations tend to increase, limiting the diversification benefit. In addition, asset class standard deviations

could increase, further reducing the expected reduction in portfolio risk.

Inflation hedge: In some cases, individual equities or equity sectors may provide a hedge against inflation. A company that can charge its customers more when input costs increase (due to inflation), can provide an inflation hedge by increasing to cash flow and earnings as prices increase. Commodity-producing companies (e.g., oil producer) may also benefit directly from commodity price increases.

The general record for equities as an inflation hedge is mixed. Studies generally show positive correlation between equity real returns and inflation, but the relationship varies over time and by country. Other studies show that equities and inflation become negatively correlated during periods of hyperinflation. In addition, equity prices are typically a leading economic indicator while inflation is a lagging economic indicator; also suggesting a less than perfect correlation between equity return and inflation.

Client Investment Considerations

The decision to include equities or the kinds of equities to include in a portfolio also depends on client investment considerations as outlined in the investment policy statement (IPS). Clients with a high risk tolerance may prefer growth-oriented companies, while clients with a low risk tolerance may prefer stable, well-established companies that pay dividends.

Client constraints may include environmental, social, and governance (ESG) considerations and religious beliefs. Portfolio managers can address these constraints using the following:

- **Negative screening** (i.e., exclusionary screening), which excludes companies or sectors that do not meet client standards.
- **Positive screening** (i.e., best-in-class screening), which seeks to uncover companies or sectors that rank most favorably with clients.
- **Thematic investing**, which screens equities based on a specific theme, such as climate change. A related approach is **impact investing**, which aims to meet investor objectives by becoming more actively engaged with company matters and/or directly investing in company projects.

Equity Investment Segmentation

LOS 15.b: Describe how an equity manager's investment universe can be segmented.

CFA® Program Curriculum, Volume 3, page 153

The three main **segmentation** approaches include size and style, geography, and economic activity. Using these approaches provides a better understanding of how equity investments integrate into the overall portfolio and enhance diversification benefits.

Size and Style

- Size, typically measured by market capitalization, can be categorized by large-cap, mid-cap, or small-cap companies.
- Style can be categorized by growth or value companies, or a mix of these two styles (sometimes referred to as *blend* or *core*). Investment style can be determined by

analyzing company metrics, such as price-to-earnings ratios, price-to-book ratios, dividend yield, and earnings and/or book value growth.

A style box can be used to rank (or *score*) companies or portfolios among these metrics. An example is shown in Figure 15.1.

Figure 15.1: Equity Investment Style Box

		Style		
		Value	**Blend**	**Growth**
Size	**Large**	Large-cap value	Large-cap blend	Large-cap growth
	Medium	Mid-cap value	Mid-cap blend	Mid-cap growth
	Small	Small-cap value	Small-cap blend	Small-cap growth

It may be beneficial for portfolio managers to analyze exactly where each company falls within the nine size/style boxes (e.g., create a scatterplot of each investment within an equity index). For example, when comparing two equities within the large-cap value box, a scatterplot may reveal that one of these companies has a higher market cap and is solidly valued while the other may be closer to medium-cap and a blend investment style. Managers can also break the nine boxes into additional equity style classifications such as micro-cap growth.

Advantages to segmenting by size and style include:

- Portfolio managers can better address client investment considerations in terms of risk and return characteristics.
- The potential for greater diversification benefits by investing across different sectors or industries.
- The ability to construct relevant benchmarks for funds that invest in a specific size/style category.
- The ability to analyze how company characteristics change over time. For example, as a small-cap growth company matures it may move into the mid-cap or large-cap categories and shift towards blended from pure growth.

The last advantage is also a disadvantage in that the categories are not stable over time.

Geography

This approach categorizes international markets by stage of economic development, such as developed markets, emerging markets, and frontier markets. Examples for each economic development stage include the following:

- *Developed markets*: United States, United Kingdom, Germany, Australia, and Japan.
- *Emerging markets*: Brazil, Russia, India, China, and South Africa.
- *Frontier markets*: Argentina, Estonia, Nigeria, Jordan, and Vietnam.

The main advantage to geographic segmentation is that investors with significant domestic market exposure can better understand how to diversify across international markets. One disadvantage to this approach is that investing in international equity markets may subject investors to currency risk. Another disadvantage is an overestimation of the diversification benefit. For example, a domestic investor from a developed market purchases stock in large companies in a foreign market to diversify.

But the companies may have already diversified their business internationally and may even derive much of their income from the investor's country.

Economic Activity

This approach groups companies into sectors or industries by applying either a market-oriented or a production-oriented approach. A *market-oriented approach* segments companies by markets served, how products are used by consumers, and how cash flows are generated. A *production-oriented approach* segments companies by products manufactured and inputs required during the production process. Note that applying either approach may lead to slightly different classifications. For example, a market-oriented approach may classify a coal company in the energy sector, while a production-oriented approach may classify that same company in the basic materials sector.

The four primary classification structures for segmenting companies by economic activity are:

- Global Industry Classification Standard (GICS).
- Industrial Classification Benchmark (ICB).
- Thomson Reuters Business Classification (TRBC).
- Russell Global Sectors Classification (RGS).

The GICS applies a market-oriented approach, while the remaining structures apply a production-oriented approach. Each of these structures starts with a broad sector/industry classification and then divides further by subsector/sub-industry. As an example, consider the segmentation method shown in Figure 15.2 for the GICS Consumer Staples sector.

Figure 15.2: GICS Classification Example

Sector	**Consumer Staples**
Industry Group	Food, Beverage, and Tobacco
Industry	Beverages
Sub-Industry	Soft Drinks

PROFESSOR'S NOTE

The four classification structures differ on their application of sector versus industry. For example, GICS, TRBC, and RGS refer to their top level as sectors and then subdivide into industries. In contrast, ICB starts with industries and then subdivides into sectors.

An advantage to economic activity segmentation is that it allows portfolio managers to analyze, compare, and construct performance benchmarks based on specific sectors/industries. In addition, diversification benefits are enhanced when investments span different sectors/industries. The main disadvantage to this approach is that some companies, especially larger firms, may have business operations that are not easily assigned to one specific sector or industry.

Equity Indices and Benchmarks

Equity market indices and equity portfolio benchmarks can be constructed based on a combination of size/style and geographic segmentation. For example, the MSCI Europe Large Cap Value Index and the MSCI China Small Cap Index combine elements from both

size/style and geographic classifications. Economic activity can also be used to subdivide equity indices by sector or industry. For example, the MSCI World Energy Index and the S&P Global Natural Resources Index track global companies categorized by sector/industry. Equity indices can also track unique client considerations, such as ESG practices.

MODULE QUIZ 15.1

To best evaluate your performance, enter your quiz answers online.

1. Equities typically offer diversification benefits when combined with other major asset classes in a portfolio. Discuss *two* reasons an economic crisis may affect the risk reduction archived through diversification.
2. Assume an investor is segmenting the equity investment universe by economic activity. Describe *two* advantages for applying this segmentation approach.

MODULE 15.2: PORTFOLIO INCOME AND COSTS, SHAREHOLDER ENGAGEMENT, PASSIVE/ACTIVE MANAGEMENT

Video covering this content is available online.

LOS 15.c: Describe the types of income and costs associated with owning and managing an equity portfolio and their potential effects on portfolio performance.

CFA® Program Curriculum, Volume 3, page 159

There are several ways to earn (current) income from an equity portfolio.

Dividend income is the most obvious and often the largest. One additional consideration is how the dividends are taxed; they may be subject to income and/or withholding tax. Note that investors with a growth-oriented focus are less likely to seek portfolio income from dividends.

Some companies pay an **optional stock dividend**, which allows investors to choose between cash payments or stock dividends (i.e., new shares). This "option" between cash and stock dividends has value for the investor and can even be sold to another investor to immediately monetize the "option." On occasion some companies pay a **special dividend**, a one-time cash payment to investors (as opposed to the more typical periodic regular dividend).

Securities lending is another way to generate current income. Securities lending is often part of short selling. A short sale is the sale of a security that is not owned. To make the short sale, the seller must typically borrow the security in order to deliver it to the buyer when the short sale is made. The lender of the security is typically paid a fee and may also receive collateral or cash on which they can also earn a return. The lender also receives back the security lent at a future date. Securities lending is not unusual in index funds large institutional portfolios such as pension funds and endowments.

Security or **stock lending** does introduce additional issues. Short selling (like any sale) tends to drive down the securities price, which is not particularly beneficial to the lender (who still owns) the security. This is more likely to concern an active manager who expects their holdings to outperform, as opposed to a passive index fund manager. The lender must also be concerned with the quality of the borrower and the borrower's

ability to return the securities. The borrower must also compensate the lender for any dividend payments that occur during the period of the loan. The lender generally loses the right to vote the shares during the period of the loan.

Lenders typically collect a small fee, in the range of 0.2%–0.5% annually for developed markets. This fee can increase substantially for emerging market stock loans or stocks that are in high demand for borrowing, known as *specials*. As mentioned, lenders can also earn extra income by reinvesting the borrower's posted cash collateral. However, this reinvestment would be subject to various risks, such as market, credit, and operational risk. The reinvestment is likely to incur costs such as administration costs to keep track of everything.

Additional income strategies include:

- Writing options (i.e., selling options) to earn option premiums. A **covered call** strategy involves writing a call option on a stock owned. The writer then loses the upside of the security if the price increases above the strike price. Another option strategy is a **cash-covered put** (also known as a cash-secured put). This involves selling a put option on stock and setting aside sufficient cash equivalents to pay for the stock if the put option buyer exercises their right. The risk to the seller is the put buyer will only exercise the right if the stock declines in value.
- **Dividend capture** where an investor buys a stock right before its ex-dividend date, holds that stock through the ex-dividend date (entitling the investor to receive the dividend payment), and then sells the stock. The strategy is premised on and will be profitable if the stock price declines by less than the amount of the dividend. Theory says the stock should decline by the dividend amount but stock movements may differ from expectations given market forces (e.g., supply and demand) and/or income tax considerations.

Equity portfolios also incur fees and costs. These include:

- **Management** and **performance (incentive)** fees.
- **Administration** fees.
- **Marketing** and **distribution** fees.
- **Trading** costs.
- **Investment strategy** costs.

Management fees (i.e., ad valorem fees) compensate the manager and pay research and analysis, computer hardware and software, compliance, and processing trades. These fees are typically based on a percentage of assets under management and are due at regular time intervals (e.g., annually). The management fees vary and are usually higher for actively managed portfolios due to higher levels of investment analysis and portfolio turnover.

Some managers also earn **performance fees** (i.e., **incentive fees**) when the portfolio outperforms a stated return objective. These fees are more common for hedge funds and alternative managers. For example, suppose a portfolio exceeds a threshold return, the manager may earn a performance fee in the range of 10%–20% based on any capital appreciation above the threshold. Incentive fees are often one sided; the manager shares in outperformance but is not penalized for underperformance.

To protect an investor from paying for performance twice, there may be a **high-water mark**. For example, assume a hedge fund earns a performance fee for outperforming its

return objective and then the portfolio declines in value. The manager will only earn an incentive fee on future appreciation above the previous level that was already compensated for.

PROFESSOR'S NOTE

We are about to briefly discuss various types of fees and costs associated with equity (and other) assets. Managers may charge one management fee that covers all of these. In other cases the manager may break out some or all of these and present them as separate fees. Other managers may not provide some of these services and a separate third party provides and charges for them. The bottom line is that services are not free and must be paid for. The way the bill is presented varies and investors need to consider all the costs in total.

Portfolios may be subject to **administration fees** associated with corporate activities, such as measuring risk/return and voting on company issues. The manager may include these services in the basic management fee; however, if these functions are conducted by external parties, administration fees will likely be separate from management fees. Additional administrative type fees include the following:

- *Custody fees*: charged for having a custodian hold assets independent of the portfolio manager.
- *Depository fees*: charged to assist custodians with segregating portfolio assets and for verifying portfolio compliance with investment limits, such as leverage and cash requirements.
- *Registration fees*: charged for registering ownership of mutual fund shares.

Some firms also charge separate **marketing** and **distribution** fees to cover:

- Employing marketing, sales, and client services teams.
- Advertising investment products and services.
- Sponsoring and presenting at relevant conferences.
- Developing and distributing marketing materials (e.g., brochures).
- Fees from online platforms that offer multiple fund options (i.e., platform fees).
- Sales commissions from financial intermediary services (e.g., financial planners or brokers).

Trading costs (i.e., transaction costs) refer to costs associated with buying and selling securities. These transaction costs can be either explicit or implicit. *Explicit costs* include broker commissions, stock exchange fees, and taxes. *Implicit costs* include bid-ask spreads, price impact from the transaction, and delay costs (i.e., slippage costs) from not completing an entire trade due to illiquidity.

Investment strategy costs are an implicit cost related to the chosen investment strategy. As mentioned earlier, actively managed funds that require more investment analysis and transactions will have higher fees/costs than passively managed funds. However passive funds like index funds may be subject to hidden costs from *predatory trading*. This additional cost stems from predatory traders purchasing (selling) shares that are soon to be added (removed) from an equity index. These transactions will create price impact costs for the fund and a profit for the predatory trader.

Strategies may demand or provide liquidity. For example, momentum strategies tend to demand liquidity by buying shares in an increasing market and selling shares in a decreasing market. This is likely to create high market impact costs. Contrarian

strategies are the opposite and tend to supply liquidity by buying shares in a decreasing market and selling shares in an increasing market. This is likely to create low market impact costs. Passive index replication strategies are likely to fall in the middle.

Shareholder Engagement

LOS 15.d: Describe the potential benefits of shareholder engagement and the role an equity manager might play in shareholder engagement.

CFA® Program Curriculum, Volume 3, page 164

Shareholder engagement refers to investors and managers interacting with companies in ways to potentially favorably impact the stock price. Engagement also benefits the company with improved corporate governance. Engagement includes participating in calls with the company and/or voting on corporate issues at general meetings (i.e., general assemblies). Such meetings may discuss:

- *Corporate strategy*: Company objectives, constraints, growth opportunities, and resources. Additional items may include company research, culture, products, competitive environment, and sustainability. Prioritizing stakeholder interests and balancing short-term obligations with long-term goals may also be items of interest for shareholders.
- *Capital allocation*: Selection process for new projects that add value, and strategy for potential mergers and acquisitions. Shareholders may also be interested in capital expenditures, use of leverage, payment of dividends, and equity financing.
- *Corporate governance*: Internal controls and functions of the company's audit and risk committees. Additional items include how the company manages regulatory and political risks.
- *Compensation structures*: Top management remuneration, incentives, and alignment with shareholder interests. Larger shareholders may influence future compensation structures.
- *Composition of the board of directors*: The board's experience, competence, diversity, culture, and effectiveness. Additional items include succession planning to address departing board members.

Shareholder engagement is not free because it requires an investment of time and resources.

- Active managers are more likely to do so in order to influence the company in ways they expect will improve performance.
- Passive managers are more likely to focus on minimizing these costs for themselves and for the companies they invest in.
- Larger investors can more easily absorb these costs as they spread the costs over a large amount of assets.
- Successful engagement benefits all shareholders, including "free riders." Free riders do not engage but reap the same benefit from any increase in the stock price.
- Engagement can also be used to address nonfinancial concerns (e.g., ESG issues), though such benefits may be harder to quantify.
- Other stakeholders such as employees, customers, creditors, regulators, and governments are also impacted by shareholder engagement outcomes. After

engagement activities, these stakeholders may have more or less influence on a given company. For example, decisions to reduce company costs may impact employee compensation. The act of shareholder engagement can also be influenced by external factors, such as academic research or media coverage.

Beyond the issues of time, cost, and free riders; shareholder engagement has other limitations. Engagement may:

- Focus on short-term goals such as increasing cash flows or stock prices at the expense of the company's long-term goals.
- Lead to the acquisition of material, nonpublic information; increasing the risk of insider trading.
- Create potential conflicts of interest. For instance, an engaged portfolio manager may support company management because the management also invests in the manager's fund.

Equity managers play a key role in engagement and may assign specific employees responsibility for this task. Firms may also consult with outside experts for advice on shareholder voting and monitoring corporate governance issues. Some countries set legal and regulatory requirements and require firms to establish written documentation for how to meet these obligations.

Activist investing takes engagement even further. Activist investors may:

- Propose shareholder resolutions and launch media campaigns to influence the vote.
- Seek representation on the company's board of directors.
- Launch proxy fights to achieve their goals. A proxy fight means seeking to persuade other shareholders to support their proposals.

Active/Passive Management for Equity Portfolios

LOS 15.e: Describe rationales for equity investment across the passive–active spectrum.

CFA® Program Curriculum, Volume 3, page 168

Passive investors seek to replicate an equity market index or benchmark. Active managers seek to outperform the benchmark and add value. While the distinction seems clear, the reality is strategies may blur this distinction, such as closely track the index with limited deviations allowed to add some value. Active investing is riskier as the manager could also underperform the benchmark. Rationales for shifting to active management include:

- Confidence the manager has the expert knowledge and skill to add value.
- Client preferences—unless enough investors are interested, the manager will not be able to attract enough funds to cover the costs of active investing. Growth strategies are often seen as more likely to benefit from active management while value style may be more passive.
  - Managers must also manage the investor's expectations for what to reasonably expect from the strategy; investors with unreasonable expectations are more likely to become dissatisfied.

  - However, strategies that become too popular can also be a problem. Too much capital flowing in may make it harder to find opportunities to add value.
  - Managers must also select an appropriate benchmark that investors will be interested in. The benchmark should contain a broad range of underlying equities with sufficient liquidity to support active management. Narrow limited benchmarks don't give the manager much room to deviate and are likely to support a more passive approach.
- Mandates from clients to invest in certain companies (e.g., ESG considerations) may require a more active approach as the manager may need to use screening and other techniques to meet the mandates.

The results of active management are less certain and the costs are higher. Active management is also subject to other potential risks:

- *Reputation risk* results from violations of rules, regulations, client agreements, or moral principles.
- *Key person risk* results from individuals who are essential to the success of the fund leaving the investment firm.
- *Higher portfolio turnover* which can lead to higher tax burdens. Active funds could be structured to limit tax consequences, but the techniques used to do this can themselves be costly and risky. Managers who use such techniques need additional knowledge to navigate the applicable tax regulations, which of course vary by country and situation.

MODULE QUIZ 15.2

To best evaluate your performance, enter your quiz answers online.

1. **Explain** why actively managed portfolios are typically subject to higher fees and costs than passively managed portfolios.

2. **Explain** how shareholder engagement can benefit investors who are not actively involved in company issues.

3. **Identify** two disadvantages of shareholder engagement activities.

4. A client is concerned with low fees, seeks substantial value added versus their benchmark, has numerous ESG restrictions, and has selected a narrowly defined benchmark made up of large companies. Based on the client's concerns, **explain** *two* reasons the client should favor a passive approach and *two* reasons the client should favor an active approach.

5. Compared to passively managed funds, active funds tend to have higher research and trading costs. **Identify** and **describe** *two* additional types of risk for active managers and investors.

KEY CONCEPTS

LOS 15.a

The roles of equities in a portfolio include capital appreciation, dividend income, diversification benefits, and the potential to hedge inflation.

The allocation to equity must be consistent with the client's investment objectives and constraints. For investors with environmental, social, and governance (ESG)

considerations, portfolio managers may apply negative or positive screening approaches to select appropriate companies or use thematic or impact investing techniques.

LOS 15.b

The equity investment universe can be segmented by:

- Size (market capitalization) and style (growth, value, or blended).
- Geographic segmentation (which includes developed markets, emerging markets, and frontier markets).
- Economic activity segmentation by sectors or industries. Classification can be based on a market-oriented or a production-oriented approach.
- Or combinations of the previous can be used.

LOS 15.c

Income can be generated from:

- Dividends, mostly in the form of regular dividends received.
- Lending securities for a fee and earning funds on cash collateral received.
- Writing options for the premium received.
- Dividend capture through buying a stock just before and selling it just after it goes ex-dividend.

Managers typically charge regular and some charge performance-based management fees. Some managers cover all services in the management fee. Others also charge additional fees for specific additional services, or coordinate with third-party providers who provide and charge fees for specific services. The bottom line is to determine the total fees regardless of how they are broken down.

Other costs to consider are:

- Transaction and trading costs, which may be explicit or implicit.
- Strategy costs—generally active strategies will have higher cost. Passive strategies may incur hidden costs such as predatory pricing when others anticipate and trade ahead of the passive investor.
- Liquidity demands—momentum strategies that buy in up or sell in down markets demand liquidity and typically pay high market impact costs. Contrarian strategies are the opposite.

LOS 15.d

Shareholder engagement refers to shareholders and managers seeking to influence the companies they invest in through calls and/or shareholder voting. Engagement benefits the company with improved corporate governance. It may benefit shareholders through higher stock price. Free riders who don't incur the costs of engagement also benefit.

Activist investors take this further and propose resolutions to be voted on and seek the support of others or engage in proxy fights to achieve their goals.

LOS 15.e

Equity portfolios are often characterized as being actively or passively managed. However, in practice, portfolios may exhibit characteristics from both investment strategies. Rationales for equity portfolios to span across the passive–active spectrum

include manager confidence, client preferences, benchmark selection, client mandates, active management costs/risks, and taxes.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 15.1

1. Risk reduction is likely to be less than expected.
   - The correlations are likely to move upward towards 1.0.
   - The volatility of the assets is likely to increase.

   (LOS 15.a)

2.
   - It allows portfolio managers to analyze, compare, and construct performance benchmarks based on specific sectors or industries.
   - Diversification benefits are enhanced when investing across sectors or industries.

   (LOS 15.b)

Module Quiz 15.2

1. Such funds require more investment analysis and portfolio turnover than passively managed funds. (LOS 15.c)

2. They can earn a free ride, benefiting from the activities of others to increase the stock price without the time and cost of engagement. (LOS 15.d)

3. (1) The cost and time commitment from shareholders and management, (2) the desire to influence cash flows or stock prices in the short term, at the expense of long-term goals, (3) the potential for insider trading violations, and (4) the potential for conflicts of interest. (LOS 15.d)

4. Passive: (1) Passive managers can charge lower fees; (2) The narrowly defined benchmark of presumably efficient large cap stocks is not going to provide the opportunity for active managers to find ways to add value.

   Active: (1) Active management is required to meet the desired value added; (2) The ESG restrictions will require an active manager who uses various screening and other techniques to simultaneously meet this constraint *and* the overall objectives. This client sounds highly unrealistic in their objectives, but that was not the question asked. (LOS 15.e)

5.
   - Reputation risk results from violations to rules, regulations, client agreements, or moral principles.
   - Key person risk results from essential individuals leaving the investment firm.

   (LOS 15.e)

The following is a review of the Equity Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #16.

READING 16: PASSIVE EQUITY INVESTING

Study Session 7

EXAM FOCUS

This is the second of four equity readings. The first one is an introduction, the current reading discusses passive management, and the last two discuss active equity portfolio management. This reading starts by covering benchmarks and methods used in constructing indexes along with index rebalancing and reconstitution. The reading then shifts to discussing different approaches to investing passively (e.g., pooled investments such as ETFs). The focus then shifts to the construction of passively managed portfolios from full replication to optimization. The reading ends with a discussion on tracking error and attribution analysis.

MODULE 16.1: BENCHMARKS

Video covering this content is available online.

LOS 16.a: Discuss considerations in choosing a benchmark for a passively managed equity portfolio.

CFA® Program Curriculum, Volume 3, page 177

An equity index used as a benchmark for equity investment strategies must be (1) rules-based, (2) transparent, and (3) investable.

Rules-based: The rules for including and excluding stocks in the portfolio, the weighting scheme, and the rebalancing frequency must be consistent, objective, and predictable so investors can replicate the investment performance of the index.

Transparent: The rules underlying the index are public, clearly stated, and understandable to investors.

Investable: Investors can replicate the return and risk performance of the index.

Considerations in choosing a benchmark include (1) determining the desired market and risk exposures, and (2) identifying the methods used in constructing and maintaining the index.

Market and Risk Exposures

The choice of portfolio exposure includes the choice of which markets to invest in as well as the various risks the portfolio will be exposed to. Overall, these choices depend on the investor's risk and return objectives and portfolio constraints identified in the investment policy statement.

Some examples of **market exposure** choices are:

- Choosing between broad market exposure and focused exposure to certain sectors.
- Choosing between domestic or international exposure.
- Choosing among developed, emerging, or frontier markets.

The **risk factor exposure** of a passive portfolio refers to the expected sensitivity of portfolio returns to various risk factors. Recall that a multifactor model of returns uses multiple risk factors, while the CAPM is based on a single-factor market risk. Examples of risk factors used in portfolio construction include market risk (beta), firm size, style (e.g., growth vs. value), and prior returns (momentum). Other factors considered include the liquidity, volatility, and firm "quality." We examine portfolio risk factors in greater detail later in this review.

Identifying the Methods Used in Constructing and Maintaining an Index

The construction of an index starts with the method of identifying stocks to include; this method can be **exhaustive** (every stock in a defined universe; e.g., the CRSP U.S. Total Market Index) or **selective** (a subset of stocks within a universe; e.g., the S&P 500 Index or the Dow Jones Industrial Average [DJIA]).

Methods of index-weighting include (1) market-cap weighting, (2) price weighting, (3) equal weighting, and (4) fundamental weighting.

Market-cap weighting refers to weighting each portfolio stock by its total market capitalization as a percentage of the total capitalization of all the stocks in the index. The market portfolio in the CAPM and many indexes, such as the S&P 500, are market-cap weighted. The most common market-cap weighting method in practice is based on each stock's free-floating shares (i.e., outstanding shares that are not closely held and, therefore, available for trading by market participants).

Price weighting refers to weighting each portfolio stock by its price. This can be achieved with a portfolio that holds an equal number of shares of each index stock, which gives stocks with higher share prices larger index weights. The DJIA is an example of a price-weighted index.

Equal weighting refers to investing equal amounts in each portfolio stock. Equal weighting reduces concentration risk, especially compared to market-cap weighting for the large-cap segment where capitalizations vary widely. For example, the weight of the five largest firms in the S&P 500 Index in 2018 was greater than the weight of the 250 smallest firms in the index. Equal weighting also reduces changes in sector exposures as market prices change compared to market-cap weighting. Equal weighting is factor-indifferent; it randomizes factor mispricing and, because of its small-cap bias relative to market-cap weighting, returns are more volatile than for market-cap weighting. Equal weighting can produce marginally better returns before transaction costs when stock prices vary around their intrinsic values.

Fundamental weighting refers to weighting index stocks by their proportions of the total index value of a fundamental factor, such as sales, income, or dividends. For example, a stock of a firm that pays 3% of all the dividends paid by index companies will have a 3% weight in a dividend-weighted index.

Stock concentration is a key concern in the selection of the appropriate index. Concentration can be captured using the concept of "effective number of stocks," which

can be measured using the **Herfindahl-Hirschman index** (HHI). HHI is the sum of the squared weights of the individual stocks in the portfolio:

$$\text{HHI} = \sum_{i=1}^{n} w_i^2$$

where:
n = number of stocks in the portfolio
w_i = weight of stock *i*

HHI ranges from $\frac{1}{n}$ (an equally weighted portfolio) to 1 (a single stock portfolio), so as HHI increases, concentration risk increases.

The *effective number* of stocks is the reciprocal of the HHI:

$$\text{effective number of stocks} = \frac{1}{\text{HHI}}$$

For example, a market-cap weighted index with 500 stocks might have an HHI of 0.01 and, therefore, an effective number of stocks of $\frac{1}{0.01} = 100$. The fact that 100 is less than the number of stocks in the portfolio reflects the disproportionate effect of the largest capitalization stocks in the index. An *equal weighted* index of 500 stocks would have an HHI of 0.002 and an effective number of stocks of $\frac{1}{0.002} = 500$.

Rebalancing is the process of adjusting portfolio weights as index weightings change. For an equal weighted index, portfolio weights are no longer equal as soon as prices change. Price-weighted index weights change in response to stock splits and stock dividends. Market-cap-weighted portfolio weights require rebalancing when index firms issue new shares or repurchase shares in a significant amount. Rebalancing incurs trading costs (and possibly tax costs) and will decrease returns. To reduce such costs, rebalancing is often done only periodically, often quarterly.

Reconstitution is the process of removing and replacing stocks that no longer fit the desired market exposure of an index. For example, if a small-cap stock's capitalization increases, it may become a mid-cap stock and have to be removed from and possibly replaced in a small-cap index. Reconstitution will also reduce index portfolio returns as trading costs are incurred.

Two practices are used to reduce trading costs associated with migration of a stock between indexes on reconstitution dates. **Buffering** refers to the practice of establishing a threshold level for the change in a firm's capitalization rank that must be met before moving it from one index to another on a reconstitution date. Consider a large-cap index comprising the stocks of the 200 largest firms in a market and a mid-cap index of the next 300 stocks in capitalization rank. If a firm in the mid-cap index increases in capitalization so that it is one of the largest 200 firms, it is not actually moved into the large-cap index until its rank increases beyond the *buffer zone*—for example, until it has reached the size rank of 150 or higher at the next reconstitution date.

An alternative method of reducing the transaction costs of stock migration among indexes is termed **packeting**. With packeting, when a mid-cap company's capitalization increases so that it qualifies as large-cap stock, half of the portfolio position is moved to the large-cap index on the reconstitution date. If the stock still meets the criteria for inclusion in the large-cap index at the next reconstitution date, the remainder of the position is moved from the mid-cap to the large-cap index.

LOS 16.b: Compare passive factor-based strategies to market-capitalization-weighted indexing.

CFA® Program Curriculum, Volume 3, page 188

The CAPM is a single-factor model in which the only risk factor that drives returns is the return on the market portfolio, and the risk of individual securities is measured by their beta (market risk). Multifactor models consider multiple risk factors, and returns on individual securities are the result of their exposures to, and the returns to, these risk factors. Fama and French (2015) identify five risk factors that can be used to explain the variation in (total) returns across equity securities. These five factors are:

- Market risk (based on beta, standardized covariance of returns with the return on the market).
- Firm size (market value of equity).
- Book-to-market value (shareholders' equity divided by market value of equity).
- Operating profitability (operating income divided by beginning shareholders' equity).
- Investment intensity (growth rate of total assets).

Indexes with a high exposure to a specific risk factor are created to allow investors to augment or replace a market-cap-weighted index based on their beliefs about future returns to the various risk factors. Available indexes with greater or less exposure to a factor than broad-based index funds are typically structured as **exchange-traded funds** (ETFs).

Factor-weighted portfolios are rules-based, so they have lower operating costs than traditional actively managed funds but typically have higher costs than large-cap-weighted index funds. Factor-based index funds themselves are considered passive, as they are rules-based and typically transparent and replicable. However, emphasizing some factors and de-emphasizing others relative to the overall market portfolio is a form of active portfolio management.

Returns-oriented indexes and strategies include the following:

- Momentum-based indexes typically overweight stocks that have outperformed a benchmark index over the most recent period of a specified length.
- Dividend yield strategies often overweight stocks with relatively high dividends, or dividend growth rates.
- Fundamental-weighted index strategies are based on company fundamentals such as dividends, sales, and income.

Passive factor-based strategies frequently involve an element of active decision-making by altering the risk factor exposures and exploiting out-of-favor factors in an attempt to increase returns relative to a market-cap-weighted portfolio. Decisions regarding factor selection, weighting, and rebalancing tend to be transparent, allowing other investors to mimic the strategy. This can reduce or eliminate the opportunity for higher returns. The buy-sell actions of investors may move prices and reduce or eliminate the opportunity for increased factor returns.

There are three types of passive factor-based strategies: (1) return oriented, (2) risk oriented, and (3) diversification oriented.

Return-oriented strategies include dividend yield, momentum, and fundamentally weighted strategies, as noted previously.

Risk-oriented strategies include volatility weighting (where the weights are the inverse of price volatility) and minimum-variance investing (using the traditional Markowitz framework), where portfolios are selected that minimize portfolio variance, subject to constraints (such as maximum or minimum sector or country weights). The advantages of risk-oriented strategies are that they are simple and provide risk reduction. However, they are based on past return data, and as such may not reflect future conditions and outcomes.

Diversification-oriented strategies include equally weighted portfolios (as discussed previously) and maximum diversification strategies (achieved by maximizing the ratio of the weighted average volatility of the individual stocks to the portfolio volatility).

Passive factor-based strategies often use multiple benchmarks, including both factor-based and market-cap-weighted indexes, which can increase tracking error.

The advantage of passive factor-based investing is that it is typically less costly than active management but still allows for different factor exposures based on the investor's view of future factor returns. A disadvantage is that, relative to passive cap-weighted investing, management fees and trading commissions are typically higher.

MODULE QUIZ 16.1

To best evaluate your performance, enter your quiz answers online.

1. Which of the following is a necessary characteristic for an equity index to have in order to use it as a benchmark for a passively managed equity portfolio?
   A. Selective.
   B. Investable.
   C. Flexible.
2. A small-cap, high P/E factor-based investment strategy is *best* classified as:
   A. risk oriented.
   B. return oriented.
   C. diversification oriented.

MODULE 16.2: APPROACHES TO PASSIVE INVESTING

Video covering this content is available online.

LOS 16.c: Compare different approaches to passive equity investing.

CFA® Program Curriculum, Volume 3, page 191

Three common approaches to passive equity investing involve the use of (1) pooled investments, (2) derivatives-based strategies, and (3) separately managed index-based portfolios.

Pooled investments include open-end mutual funds and ETFs. The advantages of open-end mutual funds are low transaction costs and the convenience of the fund structure. The advantages of ETFs are that they trade intraday (not just at market close each day) and they do not have to sell stocks in response to shareholder redemption requests. This eliminates taxable gains from portfolio stock sales that shareholders are exposed to with open-end mutual funds. The disadvantages include higher transaction costs from

commissions and the bid-ask spread, as well as possible illiquidity in some ETF secondary markets.

Derivatives-based strategies use derivatives (options, futures, and swap contracts) to recreate the risk/return performance of an index. Derivative positions used to adjust the existing portfolio risk and return exposures may be called *overlay positions*, reflecting that they are used to modify the underlying portfolio positions. *Completion overlays* can move the portfolio back to the risk exposure of the index, for example, by adjusting the portfolio's beta to match the index beta. *Rebalancing overlays* can efficiently and cheaply match the reconstitution of the index as securities are added and dropped. *Currency overlays* adjust the foreign exchange risk of portfolio holdings denominated in a foreign currency.

Advantages of using equity index derivatives (options, futures, and swaps) over cash-based portfolio construction techniques are that derivatives:

- Can be used to quickly adjust a portfolio's factor exposures at low cost.
- Trade in liquid markets.
- Make it easy to leverage the portfolio.

Disadvantages include:

- Derivative positions have finite expirations, so they must be rolled over at or near expiration.
- Some contracts have position limits.
- Specialty portfolio needs might not be met by the existing offerings of exchange-traded derivative contracts.
- OTC derivatives introduce counterparty risk.
- Basis risk can increase tracking error.

Separately managed equity index-based portfolios hold all the constituent stocks in the index or a representative sample. They require regularly updated data on the index; sophisticated trading and accounting systems; well-established broker relationships to facilitate program trading and lower trading commissions; and compliance systems to ensure compliance with laws, regulations, and internal company policies.

LOS 16.d: Compare the full replication, stratified sampling, and optimization approaches for the construction of passively managed equity portfolios.

CFA® Program Curriculum, Volume 3, page 201

Passively managed index-based equity portfolios can be constructed by (1) full replication (hold all of the securities in the index), (2) holding a sample of the securities based on stratified sampling, or (3) using more complex optimization to maximize desirable characteristics while minimizing undesirable characteristics. In practice, a blend of these approaches may be used.

Full Replication

Full replication can be costly when there are large numbers of stock and liquidity is limited. The portfolio must be regularly reconstituted and rebalanced. The advantage of full replication is that it closely matches the index return (before transaction costs).

Stratified Sampling

To reduce the costs of full replication but still approximate the factor exposures of the underlying index, a manager may use **stratified sampling**. With stratified sampling, index stocks are divided into strata (subsets) based on key risk characteristics. Random samples of stocks within each strata are selected for inclusion in the portfolio. The weight of the stocks selected for each strata are such that the portfolio risk factor exposures match those of the index portfolio.

The strata of the constituent stocks must be mutually exclusive and exhaustive. The strata are often formed across multiple dimensions; for example, one strata may contain large capitalization stocks that have high-dividend yields and low momentum. Industry sector and country of domicile are also candidates for the characteristics of strata. The more criteria used in constructing strata, the smaller the tracking error—the degree to which the portfolio performance deviates from the index.

The manager must consider size of the sample used (i.e., how closely to approach full replication). Initially, tracking error declines as the size of the sample is increased. The manager will naturally first purchase the largest, most liquid, lowest cost stocks. But as more stocks are added and the portfolio approaches full replication, the added stocks will be less liquid, increasing the effect of transaction costs on tracking error.

Optimization

Optimization uses mean-variance analysis to minimize tracking error. The optimization typically maximizes a desirable result (e.g., returns) or minimizes an undesirable characteristic (e.g., variance), subject to one or more constraints. For an index portfolio, optimization seeks to minimize tracking error relative to the underlying index, and constraints may include a minimum number of stocks, a style tilt that matches that of the underlying index, or a minimum capitalization, among other possibilities. Optimization can be combined with stratified sampling, with optimization performed on each strata of a stratified sample.

A drawback of optimization is that it is based on historical relationships, which will change over time. Maintaining the optimal weights as these relationships change can be costly. Additionally, minimization of tracking error can result in portfolios that are not mean-variance efficient.

The advantages of optimization techniques are reduction of tracking error relative to stratified sampling and that they explicitly account for the covariances of constituent stock returns, rather than relying on a characteristic, such as industry sector, in constructing the portfolio.

Blended Approach

Full replication is preferred for indexes with small numbers of similar liquid stocks, while stratified sampling or optimization is preferable for indexes with many heterogeneous, thinly traded, small-capitalization stocks. For indexes with a large number of stocks—ranging from large and liquid to small and thinly traded, such as the Wilshire 5000—the manager may use a blended approach, with full replication for large liquid index stocks and stratified sampling or optimization for index stocks that are thinly traded.

MODULE QUIZ 16.2

To best evaluate your performance, enter your quiz answers online.

1. Discuss *two* advantages and *two* disadvantages of using equity index derivatives versus cash-based strategies for passive equity investing.

2. Discuss the advantages and disadvantages of using ETFs to implement a passive equity investing strategy.

3. As the number of constituent stocks in an index increases, the tracking error of a passively managed portfolio that uses the index as a benchmark will *most likely*:
   A. increase.
   B. decrease.
   C. first decrease and then eventually increase.

MODULE 16.3: TRACKING ERROR, RETURN, AND RISK

Video covering this content is available online.

LOS 16.e: Discuss potential causes of tracking error and methods to control tracking error for passively managed equity portfolios.

CFA® Program Curriculum, Volume 3, page 205

Causes of Tracking Error

Tracking error refers to the standard deviation of the differences between index portfolio returns and published index returns. Differences between portfolio returns and index returns are caused by:

- Management fees.
- Commissions on trades.
- Sampling—compared to full replication, sampling typically increases tracking error.
- Intraday trading, because index returns are based on closing prices.
- Cash drag—index funds may hold cash balances that reduce returns in rising markets and increase returns in falling markets, as cash returns differ from index returns.

Controlling Tracking Error

Reducing tracking error involves a tradeoff between the higher trading costs of full replication and the increased potential for tracking error that comes with sampling. Even a passive index fund must do some trading in response to cash inflows and outflows and to reinvest dividends. Derivative positions in index futures can be used to reduce cash drag.

LOS 16.f: Explain sources of return and risk to a passively managed equity portfolio.

CFA® Program Curriculum, Volume 3, page 208

Attribution Analysis

The manager of a passively managed equity portfolio needs to understand the sources of index returns in order to effectively manage a portfolio intended to replicate index returns. **Attribution analysis** can be used to help the manager identify the sources of tracking error and hopefully reduce them.

PROFESSOR'S NOTE

Attribution analysis is covered in more detail in a separate section of the curriculum.

Securities Lending

As discussed earlier, large passive portfolios can lend securities to generate additional income, which can offset management fees (and other costs as well if management fees are quite low), thereby reducing tracking error.

Proxy Voting

Even passive managers have a fiduciary duty to vote the proxies of portfolio stocks in the best interests of their investors. By voting in ways that improve operations, better manage risk, or provide better board oversight and corporate governance, returns to index stocks may be increased. Voting proxies effectively can be a costly undertaking for a passive manager who must research a myriad of corporate issues across a broad portfolio of companies. Because of that, many passive managers use proxy-voting services.

MODULE QUIZ 16.3

To best evaluate your performance, enter your quiz answers online.

1. **Explain** what cash drag is and how it results in tracking error.
2. **Explain** why tracking error is a better measure of a passive equity manager's skill than excess return.
3. **Explain** how securities lending can reduce tracking error in passively managed index portfolios.

KEY CONCEPTS

LOS 16.a

An equity index as a benchmark for equity investment strategies must be (1) rules-based, (2) transparent, and (3) investable.

Considerations in choosing a benchmark include (1) determine the desired market exposures, (2) be consistent with the client's objectives and constraints, and (3) identify the method used for constructing the index.

Constructing and maintaining an index involves the following:

- The weighting method to construct the index: (1) market-cap weighting, (2) price weighting, (3) equal weighting, or (4) fundamental weighting.
- Considering the level of stock concentration. The effective number of stocks can be determined as the reciprocal of the Herfindahl-Hirschman index (HHI).

$$HHI = \sum_{i=1}^{n} w_i^2$$

$$\text{effective number of stocks} = \frac{1}{HHI}$$

- The frequency of rebalancing (updating the weights of the stocks in the index) and reconstitution (removing and replacing stocks that no longer fit the index market exposure).

LOS 16.b

The return/risk characteristics of an index can be replicated by creating a portfolio with the same exposures to a set of risk factors as the index. This strategy is called a passive factor-based strategy.

Common factors are growth, value, size, yield, momentum, quality, and volatility.

There are three types of passive factor-based strategies: (1) return oriented, (2) risk oriented, and (3) diversification oriented.

LOS 16.c

Three common approaches to passive equity investing involve the use of (1) pooled investments, such as open-end mutual funds and ETFs, (2) derivatives-based strategies, and (3) separately managed index-based portfolios.

LOS 16.d

The three methods of constructing passively managed index-based equity portfolios are (1) hold and match the weights of all the securities in the index (full replication), (2) select a more liquid sample of securities to replicate the index (stratified sampling, often based on cell matching), (3) use a more technical and quantitative approach (optimization) to maximize desirable characteristics, and/or minimize undesirable characteristics. Blended approaches using a combination of these methods are also common.

LOS 16.e

Tracking error initially declines as sample size increases but then increases as costs (transaction, management, and illiquidity) outweigh the gains of increasing sample size. Intraday trading and cash drag also create tracking error.

Reducing tracking error requires a continuing evaluation of the tradeoff between the benefits of larger sample size and increasing costs. Derivatives can be used to reduce the effects of cash drag.

LOS 16.f

Attribution analysis is a key tool in helping the manager identify the sources of tracking error.

Securities lending can generate fee income to offset some of the costs of managing the portfolio and reduce tracking error.

Corporate governance and investor activism are important for both passive and active investors.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 16.1

1. **B** An equity index that is suitable as a benchmark should be rules-based, transparent, and investable. (LOS 16.a)

2. **B** Fundamentally weighted factor exposure strategies are considered to be return oriented because such strategies focus on the factors that have determined differences in return. (LOS 16.b)

Module Quiz 16.2

1. Advantages: Derivatives are (1) a quick, efficient, and cheap way to adjust exposure and (2) trade in liquid markets.

   Disadvantage: Derivatives (1) have finite expirations and so have to be rolled over, (2) some contracts have position limits, (3) specialty portfolio needs might not be met by the existing offering of exchange-traded derivative contracts, (4) OTC derivatives have counterparty risk, and (5) basis risk can increase tracking error. (LOS 16.c)

2. Advantages: ETFs handle shareholder redemptions more cheaply and efficiently than open-end mutual funds through in-kind delivery of stock. This reduces taxable gains and losses that would otherwise be passed on to shareholders.

   Disadvantages: Transaction costs from commissions and the bid-ask spread as well as illiquidity in some ETF secondary markets. (LOS 16.c)

3. **C** Adding to the sample size with liquid stocks first reduces tracking error; but as less liquid stocks are added, the costs and tracking error increase. (LOS 16.d)

Module Quiz 16.3

1. Even passive portfolios have some cash flows and some cash holdings, while indexes represent theoretical fully invested performance. Over time the cash is a low return asset, reducing the passive portfolio's return. The underperformance increases tracking error. (LOS 16.e)

2. The goal is to consistently match the index's performance and zero (or low) tracking error indicates a perfect (or close) match. (LOS 16.e)

3. Passive portfolios can lend their portfolio stocks to generate fee income (or return on collateral) and cover portfolio expenses. This can produce a better match of index performance, lowering tracking error. (LOS 16.f)

8The following is a review of the Equity Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #17.

READING 17: ACTIVE EQUITY INVESTING: STRATEGIES

Study Session 8

EXAM FOCUS

This reading focuses on active equity management strategies. It covers factor-based, activist, statistical arbitrage, fundamental, and quantitative strategies. It concludes with style classification based on holdings-based versus returns-based analysis. You will need to know the vocabulary and be able to understand the output, pros, and cons of the processes covered here.

MODULE 17.1: FUNDAMENTAL VS. QUANTITATIVE APPROACHES

Video covering this content is available online.

LOS 17.a: Compare fundamental and quantitative approaches to active management.

CFA® Program Curriculum, Volume 3, page 228

Active equity investing seeks to outperform a passive benchmark. At the broadest level these approaches can be divided into two categories: *fundamental* and *quantitative*.

Fundamental approaches are *subjective in nature*, relying on analyst discretion and judgment. An analyst will carry out and collate research on companies, markets, and economies; then using their skill and experience to estimate the intrinsic value of securities. The research will typically use the company's financial statements as well as insight into its business model, management team and industry positioning to establish a valuation of the company's shares.

These fundamental insights are used to generate forecasts. Higher conviction ideas will receive a larger weight in the portfolio, subject to risk parameters set out in fund mandates. Compared to the quantitative approach, there are likely to be fewer positions in the portfolio and the allocation to each will be larger. Risks to the strategy lie at the individual company level if the analyst has misestimated intrinsic value, or that the market fails to recognize the mispricing and the security remains mispriced. The fundamental manager continuously monitors stock positions and rebalances at any time according to their current opinion.

Quantitative approaches are *objective in nature*, relying on models that generate systematic rules to select investments. Expertise is required in statistical modeling, typically using large amounts of data. Historical data is analyzed to identify relationships between equity returns and variables (called *factors*) that have predictive power. These variables could relate to valuation (e.g., P/E ratio), size (e.g., market capitalization),

financial strength (e.g., debt-to-equity ratio), and industry sector or price related attributes (e.g., price momentum).

Quantitative managers focus on identifying relationships between returns and factors across a large group of securities, spreading their factor bets across smaller positions in a larger number of holdings. Portfolio optimization is used to set weights in the portfolio that maximize expected portfolio alpha or information ratio. Risks to the strategy lie at the portfolio level if the factors do not deliver the performance as predicted by the model. The quantitative manager automatically rebalances according to the systematic rules of the strategy at predetermined intervals such as monthly or quarterly.

PROFESSOR'S NOTE

Do not be overly rigid with these definitions. A fundamental manager could use quantitative techniques such as free cash flow modeling, screening, or regression to help establish their opinion. Likewise, quantitative models can be based on data relating to fundamental company information found in their financial statements. The key takeaway is that when it comes to the decision to invest, fundamental investing is based more on an opinion and quantitative investing is based more on rules derived from data driven modeling.

Types of Active Management Strategies: Bottom-Up vs. Top-Down

LOS 17.b: Analyze bottom-up active strategies, including their rationale and associated processes.

LOS 17.c: Analyze top-down active strategies, including their rationale and associated processes.

CFA® Program Curriculum, Volume 3, page 233

Both fundamental and quantitative managers can be further categorized as either bottom-up or top-down strategies.

Bottom-up strategies use information about individual companies such as profitability or price momentum to build portfolios by selecting the best individual investments. **Top-down strategies** use information about variables that affect many companies such as the macroeconomic environment and government policies to build portfolios by selecting the best markets or sectors.

Managers can use a blend of bottom-up and top-down approaches. For example, a top-down strategist sets target country or sector weights, and then bottom-up portfolio managers select the best investments consistent with these weights. Or the bottom-up managers could drive the portfolio construction process through selecting the best individual investments, with a top-down-based *derivatives overlay* added to remove unintended macro exposures.

Bottom-Up Strategies

Quantitative bottom-up managers look for quantifiable relationships between company-level information (e.g., P/E ratio) and expected return that will persist into the future.

Fundamental bottom-up managers incorporate both quantifiable and qualitative characteristics of individual companies into their analysis (e.g., business model and

branding, competitive advantage, and quality of company management and corporate governance).

PROFESSOR'S NOTE

The key takeaway is that fundamental bottom-up managers are looking for companies with strong business models, high brand quality and loyalty, strong competitive advantage and good management teams with solid corporate governance, because these companies may be best positioned to outperform their peers in the future.

Types of bottom-up strategies include both value-based and growth-based approaches, the sub-styles of which are summarized below:

Value-based approaches attempt to identify securities that are trading below their estimated intrinsic value. Sub-styles of value investing include the following:

- **Relative value**: Comparing price multiples such as P/E and P/B to peers. An undervalued company has an inexplicably low multiple relative to the industry average.
- **Contrarian investing**: Purchasing or selling securities against prevailing market sentiment. For instance, buying the securities of depressed cyclical stocks with low or negative earnings.
- **High-quality value**: Equal emphasis is placed on both intrinsic value and evidence of financial strength, high quality management, and demonstrated profitability (the "Warren Buffet" approach).
- **Income investing**: Focus is on high dividend yields and positive dividend growth rates.
- **Deep-value investing**: Focus is on extremely low valuations relative to assets (e.g., low P/B), often due to financial distress.
- **Restructuring and distressed debt investing**: Investing prior to or during an expected bankruptcy filing. The goal is to release value through restructuring the distressed company or through the company having sufficient assets in liquidation to generate appropriate returns.
- **Special situations**: Identifies mispricings due to corporate events such as divestures, spin-offs, or mergers.

Growth-based approaches attempt to identify companies with revenues, earnings, or cash flows that are expected to grow faster than their industry or the overall market. Analysts will be less concerned about high valuation multiples and more concerned about the source and persistence of the growth rates of the company. Focus could be on:

- Consistent long-term growth.
- Shorter-term earnings momentum.
- **GARP** (growth at a reasonable price); looking for growth at a reasonable valuation. Often this strategy will use the P/E-to-growth (PEG) ratio, which is calculated as the stock's P/E ratio divided by expected earnings growth in percentage terms.

EXAMPLE: **Bottom-up strategy securities selection**

Company	Share Price	Price to Book Value Ratio	Price to 12-Month Forward EPS	5-Year EPS Growth Forecast	Dividend Yield	Sector Average P/E
TW	3	0.75	1.5	–10%	–0.00%	8
NB	15	7.50	15.0	10%	1.0%	12
SO	30	10.00	20.0	2%	2.0%	30
TO	12	3.00	13.6	4%	9.0%	14

Based on the information in the table, determine which bottom-up investment strategy would most likely select each security. You must choose from the following list and each choice must be used only once.

- Deep value (of assets) investing
- GARP
- Income investing
- Relative value investing

Solution:

TW has the lowest P/B ratio 0.75. This low valuation of assets suggests a deep value approach would be appropriate, provided the analyst addresses reasons for the low valuation.

NB has the lowest PEG ratio of 15 / 10 = 1.5, which is substantially lower than the PEG ratio of the other stocks with positive earnings. This suggests GARP strategies might select this security.

SO has the lowest P/E of 20 versus its sector average of 30; a ratio of only 0.67. This suggests a relative value strategy might select this security, provided there are no obvious reasons why the valuation discount might exist. Note that TW has an even lower P/E versus its sector average P/E at 1.5 / 8 and would also appeal to a relative value strategy. But TW is the only security trading at a P/B below 1 and would be the only security likely to appeal to a deep discount strategy. TW must be selected for deep discount to meet the direction to use each strategy only once.

TO has the highest dividend yield of 1.08 / 12 = 9% which is substantially higher than the other securities. This suggests this company is a good candidate for income investing approaches.

Top-Down Strategies

Both fundamental and quantitative managers could use a top-down approach focusing on the overall macroeconomic environment and broad market variables rather than information relating to individual investments.

Top-down managers typically use broad market ETFs and derivatives to overweight the best markets and underweight the least attractive markets according to the following dimensions:

- Country/geography.
- Industry sector.
- Volatility: Volatility trading can be conducted through VIX futures, variance swaps, or option volatility strategies such as straddles.
- Thematic investment strategies: Focus on opportunities presented by new technologies, changes in regulations, and economic cycles. Themes could be long term and structural such as the shift to cloud computing, blockchain technology, or clean energy. Themes might also be shorter term in nature such as the impact on the value of a currency of a major political vote.

PROFESSOR'S NOTE

Recognize that the CFA curriculum will often list terms with no further explanation. Unless a term is discussed in detail, you are not responsible for researching that term. On the other hand, straddles are discussed in derivatives, which has already been discussed in the Level III curriculum, so of course you will want to be familiar with the basics of how a straddle works, by exam day.

The top-down allocation to country/geography and industry sector could be complemented by further insights from a fundamental bottom-up approach, which values a market through aggregation of the individual companies.

The proliferation over recent years of structured products and focused ETFs has provided managers with greater flexibility in implementing passive factor investing (sometimes referred to as 'smart beta' products), allowing the manager to target a specific style or sector at a time when they believe it will outperform.

PROFESSOR'S NOTE

Smart beta is just another example of a new term for an old idea. In original CAPM theory, beta is the systematic risk of the market, and investors should earn a return based on their level of systematic risk exposure. Then CAPM expanded to include other priced risk factors such as market cap and value/growth. Now, smart beta expands that idea by suggesting you identify factors (betas) that are related to systematic return and rotate your portfolio exposures into those betas (factors) that are expected to outperform. So, a smart beta approach is a form of top-down that identifies basic drivers of return as opposed to a bottom-up approach of identifying individual security misvaluations.

MODULE QUIZ 17.1

To best evaluate your performance, enter your quiz answers online.

1. Screening stock markets to identify companies with low price-to-book ratios for subsequent in-depth analysis is a process that could be used by:
   A. quantitative managers only.
   B. fundamental manager only.
   C. both fundamental and quantitative managers.
2. An active bottom-up manager aims to identify companies that have securities that are undervalued relative to the amount that would likely be received in a bankruptcy liquidation situation. This manager's strategy can be *best* described as:
   A. relative value.
   B. restructuring and distressed debt investing.
   C. deep value.
3. Which of the following active equity fund managers is *least likely* following a top-down investment approach?
   A. A manager that uses generalized autoregressive conditional heteroskedasticity (GARCH) models to forecast the volatility of U.S. market with the aim of buying options in times of low implied volatility and selling options in times of high implied volatility.
   B. A manager that aims to identify growth at a reasonable price (GARP) for individual components of the S&P 500.
   C. A manager that aims to identify subsectors of the energy and industrial goods sector that are likely to suffer due to changes to global climate change regulation.

MODULE 17.2: TYPES OF ACTIVE MANAGEMENT STRATEGIES

Video covering this content is available online.

Factor-Based Strategies

LOS 17.d: Analyze factor-based active strategies, including their rationale and associated processes.

CFA® Program Curriculum, Volume 3, page 243

A *factor* is a variable or characteristic with which asset returns are correlated. Typical examples are the size and value factors introduced by Fama and French (1993) in their multifactor model. They noticed that smaller companies tend to offer higher returns than larger companies (the *size* factor), and stocks with higher book values relative to market values also tended to outperform (the *value* factor). When such factors are identified, they can be used to rank stocks for investment with the aim of predicting future returns or risks.

Factors that are shown to have a positive association with a long-term positive risk premium are referred to as *rewarded* factors. Care must be taken when identifying factors to avoid factors that do not offer a persistent return (so-called *unrewarded* factors). It is very important that a factor makes intuitive sense. If not, aggressive backtesting of historical data will likely find spurious relationships that will not persist into the future.

PROFESSOR'S NOTE

These factors are the raw ingredients of quantitative (rule-driven) strategies but are also key ideas behind fundamental (judgment based) approaches we have already discussed. Once again, remember that the difference between the fundamental and quantitative approaches is not the rationale for outperformance, but how the decision to invest is made: fundamental is more subjectively driven by the managers and analysts, while quantitative is driven more by rules derived from historical data.

Identifying Factor Performance: The Hedged Portfolio Approach

Pioneered by Fama and French, the hedged portfolio approach follows the following process:

- Rank the investable stock universe by the factor (e.g., for the size factor, rank by market capitalization).
- Divide the universe into quantiles. A quantile is a defined percentage proportion of the universe. For example, the top 10% quantile for the size factor comprise the smallest 10% companies. Typical quantiles are deciles (10%) or quintiles (20%).
- Form a long/short portfolio by going long the best quantile and shorting the worst quantile. For the size factor based on deciles, this portfolio would buy the smallest 10% of the stock universe and short sell the largest 10% of the stock universe.
- The performance of this long/short portfolio is tracked over time and represents the performance of the factor.

Drawbacks to the hedged portfolio approach include:

1. The information in middle quantiles is lost in this approach. It could be that the best performing companies are not in the top quantile, but in a middle quantile. By going long and short the extreme quantiles this would be overlooked in construction of the factor.

2. It is assumed that the relationship between the factor and stock return is linear. In other words, as the factor increases, expected returns increase by a constant amount. Any nonlinear relationship between factors and performance will not be captured by the approach.
3. Portfolios can appear diversified when the manager uses multiple factors to select securities. But if the factors are highly correlated with each other, the diversification is likely to be less than expected.
4. The approach assumes the manager can short stocks to create the hedged portfolio.
5. The hedged portfolio is not a "pure" factor portfolio because it will typically have significant exposures to other risk factors.

A *factor mimicking portfolio* is a theoretical long/short portfolio that is dollar neutral with a unit (i.e., one-for-one) exposure to a chosen factor and an exposure of zero to other factors. These theoretical portfolios tend to be spread across a broad array of stocks. Managers may encounter liquidity and short selling constraints when attempting to construct them.

Investors who are restricted to long-only positions can tilt the portfolio toward factors that are expected to outperform the overall benchmark. If the tilts are modest the portfolio will still have low tracking error and could be considered an enhanced indexing strategy.

Types of Style Factor

Remember that factors can be constructed in any way that the manager chooses. The real value added is in identifying which factors will be predictive of the future.

Factor	Construction	Rationale for Risk Premium
Size	Long: small cap stocks Short: large cap stocks	Small companies at more risk of failure than large established companies
Value	Long: cheap; stocks with high book values to market values, high cash flows and/or low-price multiples Short: expensive companies with the opposite attributes	Could be explained by cheaper companies being more likely to be in financial distress—could also be explained by behavioral biases of market participants
Price momentum	Long: stocks that have recently outperformed Short: stocks that have recently underperformed	Behavioral biases such as belief in momentum that lead to an expectation that recent performance trends will continue
Growth	Long: companies with high historical or expected growth rates in earnings, revenues, and/or cash flows Short: companies with the opposite low growth prospects	Higher than average growth considered an indicator for strong future stock price performance
Quality	Long: companies with high quality earnings, evidenced by low non-cash accrual earnings and/or measures relating to changes in debt levels, profitability, stability or management efficiency measures; market sentiment measures based on analyst revisions could also be used; recent developments include natural language processing (NLP), which gauges sentiment through analysis of the type of language used in news stories Short: companies with low earnings quality with the opposite attributes to the long portfolio	Companies with higher quality earnings or improvement in sentiment are likely to outperform those with low quality earnings and deteriorating sentiment
Unstructured data	Uses big data, which includes both conventional market data and new forms of alternative unstructured data (e.g., satellite images, textual data, credit card data, or social media comments) An example is the customer-supplier-chain factor Long: companies with the largest customers that have the best trailing one-month stock price return. Short: companies with the largest customers that have the worst trailing one-month stock price return	Various rationales exist based on the nature of the big data used

Factor Timing

A common subcategory of factor investing is *equity style rotation*, where the manager believes that different factors work well at different times. These strategies allocate to portfolios that represent factor exposures when that particular style is expected to outperform.

Having constructed factors of interest, an analyst might want to investigate what market conditions lead to the factor outperforming. This could involve regressing factor performance against a variable, which is suspected to be a key driver of factor performance. This process is considered in the next example.

EXAMPLE: **Establishing drivers of style factor performance**

A quantitative manager is investigating whether central bank interest rate decision surprises are a key variable in driving equity style factor performance. They are particularly interested in the three factors of the Fama and French model: market risk, size, and value.

The manager collects monthly performance data for the three style factors and regresses these factor returns against a custom defined variable, $ISurprise_t$ that measures the extent of the surprise of an interest rate decision in a given month *t*. The variable is calculated by comparing the actual interest rate decision of the central bank with the expectations priced into Eurodollar futures contracts the day before the decision.

- A high value for $ISurprise_t$ indicates that the central bank decision was to target rates that were higher than that expected by market participants.
- A low value of $ISurprise_t$ indicates the central bank announced a target policy rate that was below market expectations.

The analyst explores possible contemporaneous and lagged relationships by performing two regressions using the current month's and the next month's factor returns respectively against the variable $ISurprise_t$:

$$f_{i,t} = \beta_{i,0} + \beta_{i,1} ISurprise_t + \varepsilon_{i,t}$$

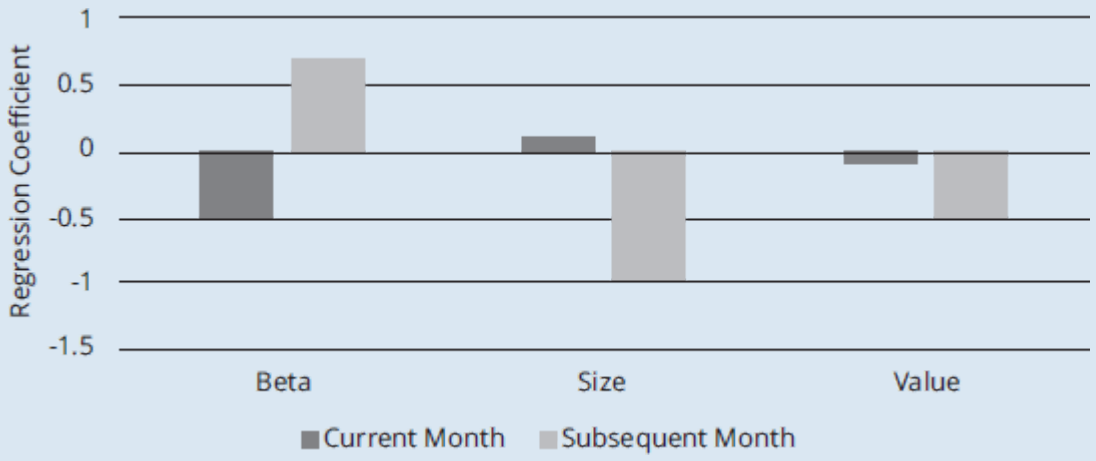
and:

$$f_{i,t+1} = \beta_{i,0} + \beta_{i,1} ISurprise_t + \varepsilon_{i,t}$$

where $f_{i,t}$ is the return of style factor *i* at time *t* and $f_{i,t+1}$ is the subsequent (next) month's return for style factor *i*.

The regression coefficients are presented in Figure 17.1.

Figure 17.1: Interest Rate Surprises and Style Factor Returns



Based on the data in Figure 17.1, answer the following questions:

1. **Discuss** the main factor rotation timing implications from the regression.
2. **Discuss** practical issues in using the model to time factor rotation.

Solutions:

1. For the current month:
   - The negative regression coefficient of 0.5 indicates that higher beta stocks underperform in the month of an upward surprise in interest rates, or outperform for a downward surprise.
   - Size and value provide no meaningful signal.

   For the subsequent month:
   - The strongest effect is the negative 1.0 regression coefficient indicating small companies underperform the month after higher than expected interest rates. Value companies also underperform for an upward surprise in rates while high beta stocks outperform with a roughly 0.7 positive regression coefficient.
2. Further analysis is needed in relation to the timing of the beta effect because the coefficient is negative for the current but positive for the subsequent month. For example, suppose there is a positive (upward surprise in rates) on the 20th of the month. How long will the negative effect on high beta stock performance last and when will it turn positive?

Activist Strategies

LOS 17.e: Analyze activist strategies, including their rationale and associated processes.

CFA® Program Curriculum, Volume 3, page 257

Activist investors specialize in taking stakes in listed companies and pushing for companies to make changes that are expected to enhance the value of the activist's stake. The changes could be nonfinancial in nature (e.g., related to environmental, social, or governance issues). One prominent activist is American hedge fund manager Carl Icahn, who has taken high-profile stakes in U.S. technology and pharmaceutical companies in recent years.

Typical Activist Investing Process

The investment process of an activist investor typically involves:

- Screening and analysis of activist opportunities.
- Buying an initial stake in the target company (typically less than 10% of voting rights).
- Submitting a public proposal for changes to the company, usually in the form of an open letter to the company.
- If no agreement, threatening a *proxy contest* (a proxy contest is a shareholder vote to force the proposed changes on the company).
- If no agreement, launching a proxy contest.
- Continuing to negotiate with management, but with no agreement eventually taking the matter to a proxy contest.

Popularity of Shareholder Activism

The foundations of activism go back to *corporate raiders* in the 1970s and 1980s who took large stakes in companies in order to influence operations and enhance value. Activist investing as a hedge fund style has seen assets under management more than

double between 2007 and 2015. The number of public announcements of activist campaigns has increased four-fold in this period.

Tactics Used by Activists

These include:

- Seeking board representation (once attained this can be used to change management).
- Writing open letters to management detailing the changes, meeting with management and engaging with other shareholders to court support in a proxy contest.
- Proposing changes at an annual general meeting (AGM).
- Proposing financial restructuring including increased dividends and share buybacks.
- Reducing extravagant management compensation.
- Launching legal proceedings against management for breach of fiduciary duties.
- Launching a media campaign against existing management.
- Breaking up a large inefficient conglomerate.

The typical defenses that are used by management resisting the activist's proposed changes include:

- Use of multi-class share structures, which grant multiple votes to founders.
- "Poison pill" clauses, which allow existing shareholders to purchase more shares in the target company at a discount, diluting the stake of the activist.
- Staggered board provisions, which mean the board is re-elected partially each year, and hence, cannot be replaced simultaneously.

Target Companies

Target companies tend to feature slower earnings and revenue growth than the market, negative share price momentum, and weak corporate governance. This poor track record is evidence that changes need to be made and makes it more likely the activist will garner support from other disgruntled shareholders in a proxy contest.

Impact

Studies show that activism does lead to improvements in growth, profitability, and corporate governance; however, it also leads to higher debt levels. The added performance of activist funds has been modest with hedge fund data showing Sharpe ratios slightly above the broad stock market.

Investors have generally reacted positively to activism announcements; data shows positive stock price outperformance for periods leading up to the announcement, with strongest outperformance on the day of the announcement, and modest outperformance over the follow month.

MODULE QUIZ 17.2

To best evaluate your performance, enter your quiz answers online.

1. An analyst is attempting to construct a hedged portfolio to represent the value factor in their domestic stock market. They use the following process:

   1. Rank securities in the domestic market in order of book value of equity in relation to market value of equity (book-to-market ratio).

   2. Purchase the quartile of securities with lowest book-to-market, short sell the quartile of securities with highest book-to-market ratio to create a dollar-neutral portfolio.

   3. Track the performance of the long/short portfolio over time.

   Which of the following statements *most accurately* describes an error in this process?

   A. Stage 1 is incorrect because price-to-book ratio should be used instead of book-to-market ratio.
   B. Stage 2 is incorrect because the top and bottom deciles of securities should be used to construct the dollar-neutral portfolio instead of the top and bottom quartile.
   C. Stage 2 is incorrect because the long/short portfolio should be constructed by purchasing the securities with the highest book-to-market and short selling the securities with the lowest book-to-market.

2. Which of the following strategies would *least likely* be used as part of the investment process of an activist investor?

   A. Buying a majority stake in the company to enforce value-enhancing changes on company management.
   B. Submit public proposal for changes to investee company, usually in the form of an open letter to the company.
   C. Launch a proxy contest against the current management team.

MODULE 17.3: OTHER STRATEGIES

Video covering this content is available online.

LOS 17.f: Describe active strategies based on statistical arbitrage and market microstructure.

CFA® Program Curriculum, Volume 3, page 264

Two other active equity strategies discussed are **statistical arbitrage** and **event-driven** strategies. Both are usually quantitative strategies, though they could incorporate judgment from a fundamental manager.

Statistical Arbitrage

Statistical arbitrage, or "stat arb" strategies, make extensive use of technical stock price and volume data to exploit pricing inefficiencies. Typically, they aim to profit from mean reversion in related share prices or by taking advantage of opportunities created by market microstructure issues.

Pairs trading is an example of a popular statistical arbitrage strategy. Pairs trading identifies two securities in the same industry that are historically highly correlated with each other and aims to profit from taking advantage of a temporary breakdown in this relationship. The strategy buys the underperforming security while shorting the outperforming securities. The strategy profits from mean reversion if the long (previous underperform) now outperforms, while the short (previous outperformer) now underperforms. The risk is that the breakdown of the observed previous relationship is long term in nature, there is no mean reversion, and in fact the long continues to underperform the short position in the pairs trade.

A simple pairs trading strategy might use the logarithm of the ratio of two related stock prices to generate trading signals, referred to as the *spread* (the logarithm is taken simply to make the signal more stable). This spread is deemed to be high when it is more than two standard deviations above its moving average, and low when it is more than two standard deviations below its moving average. The strategy would sell the spread when it is high, and buy the spread when it is low looking to profit from mean reversion.

PROFESSOR'S NOTE

Don't worry too much about the technical detail here. Converting the ratio to log value simply places more emphasis on the larger and presumably more profitable deviations in the ratio. The primary issue is that the spread generates a sell signal when it is high and a buy signal when it is low, and the strategy relies on the spread reverting to its mean.

Market microstructure-based arbitrage strategies take advantage of mispricing opportunities occurring due to imbalances in supply and demand that are expected to only last for a few milliseconds. Investors with the tools to analyze the limit order book of an exchange, and the capability for high-frequency trading are in a position to capture such opportunities.

Event-Driven Strategies

Even-driven strategies exploit market inefficiencies that may occur around corporate events such as mergers and acquisitions, earnings or restructuring announcements, share buybacks, special dividends, and spin-offs.

PROFESSOR'S NOTE

These events look a lot like the changes that activists may push for. The key difference here is that the event-driven manager simply tries to find pricing anomalies due to the event—the manager doesn't engage in activism to bring the event about.

The **risk arbitrage**, or "risk arb" strategy associated with merger and acquisition (M&A) activity is an example of an event-driven strategy.

In a cash merger, the risk arb manager will buy the shares of the target company after the deal has been announced. Due to the risk that the deal will be blocked for regulatory reasons or due to lack of shareholder approval, the stock price will be slightly below the deal price until the deal closes. The risk arb manager, therefore, will earn a profit when the deal closes. In a share-for-share transaction, the risk arb manager will simultaneously short sell the shares of the acquirer and purchase the shares of the target company in the same ratio as the proposed share exchange of the deal. Once again, the manager profits from the deal completing. The risk to the risk arb strategy is that the deal fails to close, which could cause large losses to the manager.

The key expertise of a risk arb manager is the ability to accurately estimate the risk of the deal failing and estimating deal duration and associated annualized premiums offered by stock prices.

EXAMPLE: **Identifying opportunities**

Jessica Nguyen, a portfolio analyst for Bridgeriver Associates, is reviewing several investment opportunities, as detailed in the following:

- Formby Corp is a large cap multinational technology company headquartered in the United States that designs consumer electronics and sells online computer services. After a decade of stellar

growth, the company has accumulated significant cash balances, but growth in core markets has slowed and recent product launches have missed expectations. The company currently doesn't pay a dividend.

- Parmeon SA is a large French retailer with a well-known brand. Competition from the internet has been strong in recent years and the company has experienced slow growth and declining margins. Parmeon has recently announced its intent to acquire another well-known retailer. Parmeon will issue one share of its stock for one share of the acquired company. The deal is likely to attract the attention of regulators because it will create the largest retailer in the sector.
- Baron PLC is a commodity trading and services company based in the United Kingdom. Recent moves in commodity prices and tightening up of credit conditions has led to the company issuing several profit warnings, with management being replaced and the new team announcing a focus on selling assets to raise liquidity. Analysts are questioning whether the company can continue to service its debt. The correlation coefficient of Baron and the largest company in the sector has historically been very strong but has recently broken down.

For *each* investment opportunity (Formby, Parmeon and Baron), **identify** the active equity strategy you would *most likely* take an interest in. Your identification must be made from the following list:

- Activist investing.
- Distressed debt investing.
- Event-driven investing.
- Pairs trading.

For *each* opportunity **discuss** how the active equity strategy might be applied in that opportunity.

Answer:

Formby Corp: Activist investing—invest in the shares and advocate for cash payouts to shareholders rather than investing in projects with sub-par profitability. The payout could be in the form of regular or special dividends, or a share buyback program.

Parmeon: Event-driven investing—the high uncertainty around the approval of the deal by regulators could lead to misvaluation. For example, if the deal has a higher probability of completion than is assumed by the market, the target company's stock price is likely to be relatively undervalued. Buy the target company and short sell Parmeon in the same proportion as the share-for-share proposed exchange.

Baron: Distressed debt investing—if the manager believes the market is too pessimistic, buy the bonds. The company might recover and the bonds would increase in value or in a restructuring swapping it for equity. **Note that a pairs trade is not appropriate for Baron.** The breakdown in the historical correlation of Baron to its competitor appears to be based on fundamental changes in the management and strategy of Baron. It is not appropriate to assume mean reversion to the past relationship and mean reversion is the underlying assumption in a pairs trade.

Creating a Fundamental Active Investment Strategy

LOS 17.g: Describe how fundamental active investment strategies are created.

CFA® Program Curriculum, Volume 3, page 267

The fundamental active investment process will likely include the following steps:

1. Define the investment universe in accordance with the fund mandate.
   - Define the market opportunity (investment thesis) and explain why it is there.
2. Prescreen the investment universe to obtain a manageable set of securities for detailed analysis.
   - For example, a value manager might screen to remove stocks with high P/E multiples.
3. Analyze the industry, competitive position and financial reports of the companies.

4. Forecast performance, most commonly based on cash flows or earnings.
5. Convert forecasts to valuations.
6. Construct a portfolio with the desired risk profile.
   - Incorporate any top-down views or constraints on sectors/markets.
7. Rebalance the portfolio as needed.

The process will most likely also include stock sell disciplines involving target prices to take profits and pre-defined stop loss levels to exit unsuccessful positions and mitigate behavioral biases that may bias the manager to hold on to losing positions.

Pitfalls in Fundamental Investing

Pitfalls in fundamental investing include the following.

Behavioral biases can affect the human judgment that fundamental strategies use for their insights into profitable investments. These biases include confirmation bias, the illusion of control, availability bias, loss aversion, overconfidence, and regret aversion bias.

PROFESSOR'S NOTE

Another discussion of behavioral biases that can lead generally rational people to, on occasion, make expensive mistakes.

A **value trap** where a stock that appears to be attractive because of a significant price fall, may in fact be overvalued and decline further. For example, a value manager who buys stocks based only on low P/E ratios risks buying securities of companies that are fundamentally deteriorating and may fail. Value managers need to also determine the stock is trading below intrinsic value given the company's future prospects and identify the trigger that will lead to upward revaluation of the stock.

A **growth trap** where the favorable future growth prospects are already reflected, or over-reflected, in the price. For example, the market price could reflect very aggressive growth of 15% and the price could decline if only above-average growth of 12% is realized. The trap is that growth stocks generally trade at a high P/E and even modest shortfalls in growth can lead to significant declines in P/E and stock price.

Creating a Quantitative Active Investment Strategy

LOS 17.h: Describe how quantitative active investment strategies are created.

CFA® Program Curriculum, Volume 3, page 274

The quantitative active investment strategy has a well-defined process:

1. Define the market opportunity.
2. Acquire and process data.
3. Back-test the strategy.
4. Evaluate the strategy.
5. Construct the portfolio.

Each one of these steps is discussed in more detail in the following paragraphs.

Define the Market Opportunity (Investment Thesis)

Quantitative managers use publicly available information to predict future returns of stocks, using factors to build their return-forecasting models. It is up to the manager to identify the opportunity.

Acquire and Process Data

This is the most time-consuming step. This involves building databases, mapping data from different sources, understanding data availability, cleaning up the data, and reshaping the data into a usable format. The categories of most commonly used data are:

- **Company mapping**: Tracking many companies over time and across data vendors. This will process company mergers, bankruptcies and map different unique stock identifiers across different data vendors.
- **Company fundamentals**: Collect company demographic, price, and other financial data from vendors such as Bloomberg.
- **Survey data**: Details on corporate earnings and forecasts, macroeconomic variables, sentiment indicators, and information on fund flows.
- **Unconventional data**: Unstructured data including satellite images, measures of news sentiment, customer-supplier chains, corporate events, and many other types of information. Recent developments in *machine learning* have supported the ability to examine more and less conventional data, leading to improvements in strategy performance.

Backtesting the Strategy

This involves applying the strategy to historical data to assess performance. The correlation between factor exposures and subsequent portfolio returns for a cross section of securities is used as a measure of factor performance in back-tests. The idea is that if there is a strong relationship between factor exposure and subsequent performance then the factor has high predictive power. This correlation coefficient is known as the factor's information coefficient (IC). *There will be two variations on the IC calculation.*

PROFESSOR'S NOTE

You should read this full section along with *Example: Pearson correlation coefficient IC and Spearman Rank IC.* The example elaborates on and further explains these issues.

Earnings yield (E/P) is a type of valuation factor. An analyst who believes the market undervalues earnings yield could go long securities with high earnings yield and short securities with low earnings yield to gain exposure to, and earn returns from, the factor. Backtesting is used to determine if historical data supports the analyst's belief. To perform the back test, the analyst could:

1. Obtain a sample of historical data on a cross section of stocks.
2. Calculate earnings yield and subsequent performance of each stock.
3. Rank the stocks by earnings yield (factor score). Factor score is measured as a standardized distance away from the average earnings yield. Suppose the average earnings yield is 3% and the standard deviation of earnings yield across stocks is

5% then a stock with an earnings yield of 7% would have a standardized factor exposure of (7% – 3%) / 5% = 0.8.

4. Calculate the IC. Assuming a linear relationship between the factor exposure and holding period return, IC is the correlation between the factor exposure and holding period return. This is called the **Pearson IC**. Like any correlation, the IC will range between +1 and –1 or +100% and –100% if expressed as a percentage. A monthly value of even 5% to 6% is considered very strong.
5. The Pearson IC of the raw data is sensitive to even a few outliers (extreme high or low historical return). The **Spearman Rank IC** addresses this issue and is often considered more robust (superior). The Spearman Rank IC is the correlation of the rank of the factor scores and rank of subsequent performance.

PROFESSOR'S NOTE

This calculation of a standardized factor exposure is simply an application of the idea of *z*-values from basic quant. We are not interested in absolute earnings yield, but how far our earnings yields are away from the average earnings yield in terms of standard deviations. If this is related to the future performance of securities, then the factor has predictive power.

EXAMPLE: **Pearson correlation coefficient IC and Spearman Rank IC**

An analyst collects a cross section sample of nine stocks and calculates the E/P factor score for each stock. The factor scores and subsequent month's return are shown in the table.

Stock	Factor Score	Subsequent Month's Return (%)	Rank of Factor Score	Rank of Return
A	–1.57	10.06%	9	1
B	–1.01	–0.60%	8	9
C	–0.73	–0.50%	7	8
D	–0.40	–0.48%	6	7
E	–0.01	1.20%	5	6
F	0.65	3.00%	4	5
G	0.75	3.02%	3	4
H	0.90	3.05%	2	3
I	1.43	5.20%	1	2
Mean	0.00	2.66%		
Standard Deviation	1.00	3.43%		
Pearson IC		–0.99%		
Spearman Rank IC				40%

Based on the table:

1. **Discuss** whether the earnings yield factor exhibits predictive power for this dataset. In your discussion, **comment** on both the Pearson and Spearman Rank IC.
2. **Calculate** the performance of a long/short factor portfolio with an equal weighting of the three most extreme factor scores.
3. Based on these results, **discuss** what should be done next.

Answer:

1. The Pearson IC of –0.99% is very small. It suggests an insignificant negative relationship between E/P and return.

   However, the Pearson IC was distorted by a nonlinear relationship between factor and subsequent return. Stock A had a negative score and by far the highest positive return. Spearman Rank IC shows a strong +40% IC and does support that high E/P is associated subsequent strong performance.

2.
   - The long position will equal weight G, H and I: (3.02% + 3.05% + 5.20%) / 3 = 3.76
   - Funded by an equal weighted short position in A, B and C: (10.06% – 0.6% – 0.5%) / 3 = 2.99%
   - Hence, the long/short factor portfolio would return 3.76% – 2.99% = 0.77%

3. A sample of nine stocks is not very large. The data supports the belief that high E/P is associated with favorable performance but also shows results can be significantly affected by outliers. Another larger sample, a different time period, and additional testing is appropriate.

Having considered individual factors, managers would then consider which factors to include in a **multi-factor model**. Managers can select and weight each factor using either a qualitative or systematic process. Factors could be treated like asset class weights and mean-variance optimization techniques used to decide optimal exposures. Investors should be aware that although factors appear effective individually, they may not add material value to a model if they are correlated with the other factors in the model.

Evaluating the Strategy

Out-of-sample testing, where the model is applied to data different to those that were used to build the model, is conducted to confirm model robustness. Managers would look at both returns generated and risk measures such as VaR and maximum drawdown.

Portfolio Construction

The following aspects are particularly relevant to quantitative investing when constructing portfolios:

- **Risk models:** Used to estimate the risk of the portfolio by considering individual variance of positions and correlation across positions. Managers generally rely on commercial risk model vendors for these data.
- **Trading costs:** Both explicit (e.g., commissions) and implicit (e.g., market impact cost) costs are considered. If two stocks have the same expected returns, the one with the lower trading costs will be selected.

Pitfalls in Quantitative Investing

Pitfalls in quantitative investing include the following:

- **Survivorship bias:** If back-tests are only applied to existing companies, then they will overlook companies that have failed in the past, and this will make the strategy look better than it actually is.
- **Look-ahead bias:** Results from using information in the model to give trading signals at a time when the information was not available. An example would be using December financial accounting data to generate trading signals for the following January. It is likely that the accounting data was not known by the market until the company issued its financial accounts well into the year, and therefore was not actually available to act as a trading signal in January.
- **Data-mining/overfitting**: Excessive search analysis of past financial data to find data that shows a strategy working. This should not be construed as proof that the

strategy works because data was mined until data was found that suggested the strategy worked. This is not rigorous statistical testing, but simply testing lots of data until the analyst finds what they are looking for.

- **Turnover**: Constraints on turnover may constrain the manager's ability to follow a strategy.
- **Lack of availability of stock to borrow:** For short selling, this may also constrain a manager's ability to follow a strategy.
- **Transaction costs:** This can quickly erode the returns of a strategy that looked good in backtesting.

Another risk of quantitative strategies is *quant overcrowding*, which can occur if many quantitative managers are following similar strategies. Once a strategy becomes crowded, there is the risk that a period of poor performance could cause many managers attempt to exit their positions at the same time. This rush for the exit could exaggerate losses and lead to margin calls from lenders forcing managers to further liquidate their positions at unfavorable prices. This is the most likely explanation for a meltdown in equity quant strategies in the relatively serene market of August 2007. Indicators such as short interest and price momentum can be combined to estimate the potential overcrowding of markets. A high correlation between short interest (that is, number of declared short positions) and price momentum could indicate a short trade that could suddenly unwind aggressively.

MODULE QUIZ 17.3

To best evaluate your performance, enter your quiz answers online.

1. High-frequency trading techniques are *most likely* used by:
   A. pairs-trading strategies.
   B. market microstructure strategies.
   C. event-driven strategies.
2. The *value trap* is *best* defined as:
   A. a stock that is trading at low multiples justified by deteriorating fundamental business conditions.
   B. a stock that is trading a low price multiples without justification.
   C. a stock that is trading at high price multiples justified by high expected earnings growth rates.
3. When backtesting a quantitative active investment strategy, a manager concerned about outliers in data is *most likely* to conclude that a factor has predictive power when:
   A. the information coefficient of factor scores versus contemporaneous returns is significantly different from zero.
   B. the Spearman Rank correlation coefficient of factor scores and subsequent returns is significantly different from zero and positive.
   C. the Pearson correlation coefficient of factor scores versus contemporaneous returns is significantly different from zero.

MODULE 17.4: EQUITY INVESTMENT STYLE CLASSIFICATION

Video covering this content is available online.

LOS 17.i: Discuss equity investment style classifications.

An investment style classification process is designed to split a stock universe into subgroups of stocks that represent the styles discussed in this reading (i.e., size, value, etc.). These groups should contain stocks that have a high correlation with each other (because they are part of the same style), but correlation between groups should be lower indicating that styles are distinct sources of risk and return. This process is useful for classifying the style of a portfolio and benchmarking managers.

Approaches to Style Classification

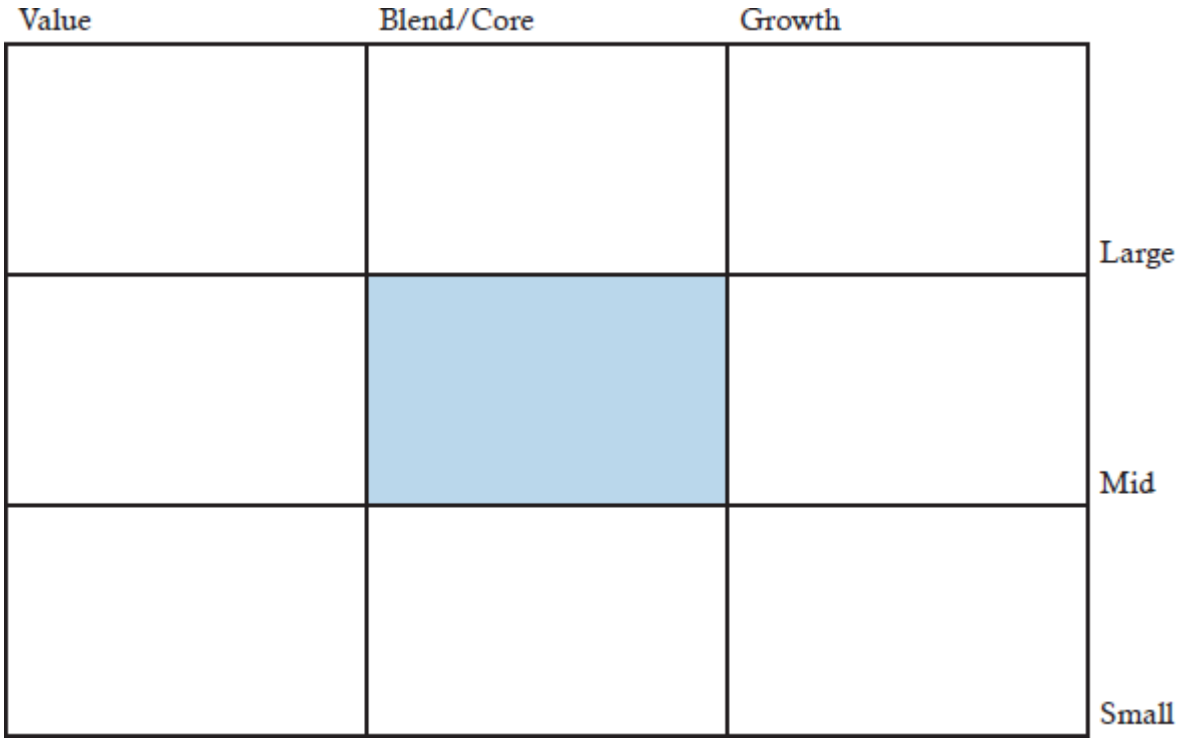
The two main approaches in style analysis are the **holdings-based** approach and the **returns-based** approach.

Holdings-Based Style Analysis

The holdings-based approach looks at the attributes of each individual stock in a portfolio and aggregates these attributes to conclude the overall style of the portfolio.

A common application of this idea is the *Morningstar Style Box*. In a style box, two factors —value and size—are each split into three groups, as shown in Figure 17.2.

Figure 17.2: Morningstar Fund Style Box



There is no consensus on the definition of large, mid, and small cap. One practice is to define large cap stocks as the top 70% of market capitalization of the universe, with mid-cap stocks represented by the next 20% of market capitalization, and small cap stocks the rest.

The style box approach aims to classify approximately the same number of stocks in each of the value, blend, and growth groups, essentially distributing the market value of each row evenly across the grid.

The classification of stocks into value/blend/growth involves assigning a *style score* to each individual stock. For example, to assign a value score, the dividend yield may be used. Stocks would be ranked according to their dividend yield and a score allocated to a

stock based on their percentile of the market value of their particular group. If the stock is at the lower end of the dividend yield range, it will receive a low score close to 0, if it is at the high end of the dividend yield range, it will receive a high score close to 100. A comprehensive scoring model would use many indicators of value and combine them together in a pre-determined weighting.

PROFESSOR'S NOTE

The actual process of allocating a style score is complicated and omitted from the curriculum, and therefore, beyond the scope of the exam. The key takeaway here is that stocks are allocated a style score between 0 and 100 in a way designed to distribute rows evenly across the columns of the grid.

The same process can be done for growth attributes such as earnings growth, revenue growth and cash-flow growth to establish a growth factor score for each security. Once again, this score will be a number between 0 and 100. The indicators used by Morningstar and the weightings given to them in the value and growth style scores are displayed in Figure 17.3.

Figure 17.3: Morningstar Value and Growth Scoring Scheme

Value Score Components and Weights		Growth Score Components and Weights	
Forward-looking measures	**50.0%**	*Forward-looking measures*	**50.0%**
*Price to projected earnings		*Long-term projected earnings growth	
Historical measures	**50.0%**	*Historical measures*	**50.0%**
*Price to book	12.5%	*Historical earnings growth	12.5%
*Price to sales	12.5%	*Sales growth	12.5%
*Price to cash flow	12.5%	*Cash flow growth	12.5%
*Dividend yield	12.5%	*Book value growth	12.5%

Once a security has both a value score and a growth score, the difference can be taken as a net style score. If the net style score is strongly negative, the stock is classified as value. If the net style score is strongly positive then the stock is classified as growth. If the net style score is close to zero then the stock will be classified as core.

PROFESSOR'S NOTE

Morningstar classifies **stocks** without a strong value/growth bias as core. **Funds** without a strong value/growth bias are classified as blend. These are just two different technical terms for the same idea—an investment without a strong value/growth bias.

Once constructed for a stock universe, the grid can be used as a visual aid to help categorize and track managed investment portfolios. At a glance, an investor can see where a manager is positioned on the grid, and, if historical data exists, how this style has changed over time.

Note that the Morningstar Style Box approach acknowledges that a single security can exhibit both value and growth characteristics at the same time. A simpler classification

system might assign a style score as a fraction of a stock's market cap to value and the complement to growth—for example, a system may assign a value score of 0.6 to a security indicating that 60% of the market cap of the company will be allocated to a value index and 40% allocated to a growth index.

Returns-Based Style Analysis

A returns-based style analysis aims to identify the style of a fund through regression of the funds returns against a set of passive style indices. By imposing a constraint on the regression that the sum of the slope coefficients should sum to a value of 1, the slope coefficients can be interpreted as the manager's allocation to that style during the period.

For example, a return-based style analysis might conduct a regression of fund returns versus four passive indices as follows:

$$R_p = a + b_1 SCG + b_2 LCG + b_3 SCV + b_4 LCV + \varepsilon$$

where:

R_p = returns on the manager's portfolio

a = a constant often interpreted as the value added by the fund manager

b_i = the fund exposure to style *i*

SCG = returns on a small-cap growth index

LCG = returns on a large-cap growth index

SCV = returns on a small-cap value index

LCV = returns on a large cap value index

ε = residual return not explained by styles used in the regression

giving an output of:

$b_1 = 0$, $b_2 = 0$, $b_3 = 0.15$, and $b_4 = 0.85$

From the values of the regression coefficients, we would conclude that the manager's portfolio has no exposure to growth stocks ($b_1 = 0$ and $b_2 = 0$), and that the manager is a value manager with primary exposure to large cap value ($b_4 = 0.85$) and a small exposure to small cap value ($b_3 = 0.15$).

Manager Self-Identification

The fund's investment strategy is usually self-described by the manager. Comparing that self-description with returns-based and holdings-based style analysis will either confirm a consistent identification or indicate a need for further investigation and analysis to explain the discrepancy. Some styles such as equity long/short, equity market neutral and short bias do not fit traditional style categories and the manager's description and fund prospectus becomes the key source of information on style of such funds.

Strengths and Limitations of Style Analysis

A summary of the advantages and disadvantages of returns-based versus holdings-based style analysis is displayed in the following:

Advantages of Returns-Based Analysis	Advantages of Holdings-Based Analysis
Does not require information on holdings.	Generally more accurate because it uses actual portfolio holdings.
Can be easily and universally applied.	Assesses each individual holding's contribution to style.
Disadvantages of Returns-Based Analysis	**Disadvantages of Holdings-Based Analysis**
Constraints on outputs can limit detection of extreme styles.	Requires the availability of all portfolio constituents and style attributes of each.
	Limited derivatives data may hinder analysis if derivatives are used.
	Different systems with different definitions of style will classify the same portfolio in different ways.

A holdings-based analysis pinpoints the current exposure of a fund. This is an advantage if the analyst wishes to know the most up-to-date positioning of a manager. However, if the analyst wishes to assess the average exposure a manager takes over time, then historical holdings-based analyses need to be available. A returns-based style analysis based on historical returns would capture this average exposure automatically through regressing historical returns.

MODULE QUIZ 17.4

To best evaluate your performance, enter your quiz answers online.

1. The use of derivatives overlay strategies with limited information is *likely* to hinder style analysis performed by which of the following approaches?
   A. Holdings-based analysis only.
   B. Returns-based analysis only.
   C. Both holdings-based and returns-based analyses.

KEY CONCEPTS

LOS 17.a

Active equity managers can be broadly divided into two groups: fundamental managers, which use discretionary judgment and quantitative managers, which use rules-based (systematic) data-driven models. The main differences between the approaches are the following:

	Fundamental	Quantitative
Style	Subjective	Objective
Decision-making	Discretionary	Systematic
Primary resources	Human skill, experience, judgment	Expertise in statistical modeling
Information used	Research	Data and statistics
Analyst focus	Conviction of insight into small number of investments	Application of rewarded factors over large number of securities
Purpose of analysis	Forecast future corporate performance	Find historical relationships between factors and performance likely to persist
Portfolio Construction	Judgment and conviction within portfolio risk parameters	Optimization
Monitoring and Rebalancing	Continuous monitoring: rebalancing according to views	Automatic systematic periodic rebalancing

LOS 17.b

Bottom-up strategies analyze information at the company level to generate investment ideas. Bottom-up strategies can be divided into value and growth styles. Value sub-styles include relative value, contrarian, high-quality value, income investing, deep-value, restructuring and distressed debt, and special situations.

LOS 17.c

Top-down strategies focus on the macroeconomic environment, demographic trends, and government policies to make investment decisions. Top-down strategies could focus on geography, industry, equity style rotation, volatility-based strategies, or thematic investment ideas.

LOS 17.d

Quantitative strategies often use factor-based models, which aim to identify factors that drive performance historically and are likely to continue to do so in the future. Factors can be based on fundamental characteristics such as value and growth, and price momentum, or on unconventional data.

LOS 17.e

Activist investors specialize in taking meaningful stakes in listed companies and then publicly pushing for changes to the management, strategy, or capital structure of the company that they believe will enhance value.

LOS 17.f

Statistical arbitrage funds look to profit from anomalies in technical market data (i.e., prices and volumes), for example, pairs trading. Event-driven strategies exploit market inefficiencies that may occur around mergers and acquisitions, earnings announcements, bankruptcies, share buybacks, special dividends, and spin-offs.

LOS 17.g

The fundamental active investment process consists of the following steps:

1. Define the investment universe in accordance with the fund mandate.

   - Define the market opportunity (investment thesis) and explain why it is there.
2. Prescreen the investment universe to obtain a manageable set of securities for detailed analysis.
   - For example, a value manager might screen to remove stocks with high P/E multiples.
3. Analyze the industry, competitive position, and financial reports of the companies.
4. Forecast performance, most commonly based on cash flows or earnings.
5. Convert forecasts to valuations.
6. Construct a portfolio of profitable investments with the desired risk profile.
   - Incorporate any top-down view on sectors/markets at this stage.
7. Rebalance the portfolio with buy and sell disciplines.

Pitfalls in fundamental investing include behavioral biases, the value trap, and the growth trap. Behavioral biases include confirmation bias, illusion of control, availability bias, loss aversion, overconfidence, and regret aversion.

LOS 17.h

The quantitative active investment process includes the following steps:

- Define the market opportunity.
- Acquire and process data.
- Back-test the strategy.
- Evaluate the strategy.
- Portfolio construction.

Pitfalls in quantitative investing include look-ahead and survivorship biases, overfitting, data mining, unrealistic turnover assumptions, transaction costs, and short availability.

LOS 17.i

The two main approaches used in style analysis are holdings-based and returns-based. Holdings-based approaches aggregate the style scores of individual holdings, while returns-based approaches analyze the investment style of portfolio managers by regressing historical portfolio returns against a set of style indexes.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 17.1

1. **C** Screening is a process that can be used by both fundamental and quantitative active managers. It is how the final investment decision is made that determines whether the manager is classified as quantitative or fundamental. If the decision is made based on systematic rules rigidly applied to company data, then the manager would be classified as quantitative. If the investment decision is made based on the manager's opinion using their skill and experience, then the manager is deemed to be fundamental. (LOS 17.a)

2. **B** Identifying securities that are undervalued versus the amount received in bankruptcy liquidation is a form of distressed debt investing. Answer A is incorrect

because a relative value manager would be searching for companies with low price multiples such as P/E without the need for a distressed situation that could lead to bankruptcy filing. Answer C is incorrect because a deep value manager looks for companies with low valuation relative to assets such as price-to-book, once again without the need for a distressed situation that could lead to bankruptcy filing. (LOS 17.b)

3. **B** A top-down investment approach focuses on broad macroeconomic variables to identify opportunities at the broad market level based on geography, industrial sector or thematic investing data. Manager B is least likely to be classified a top-down manager because they are using data relating to individual components of the S&P 500 rather than looking at data relating to the aggregate market. Managers A and C are looking at broad market or sector data in order to identify investment opportunities, making them top-down managers. (LOS 17.c)

Module Quiz 17.2

1. **C** Stages 1 and 3 are correct. It is up to the analyst's discretion as to what proportion of the stock universe is bought and sold to create the dollar neutral portfolio, hence using quartiles is not an error. The error is in Stage 2 where high book-value to market-value companies should be purchased because these are cheap companies, and low book-value to market-value companies should be sold because these represent expensive companies. (LOS 17.d)

2. **A** Activist investors do not take controlling majority stakes (greater than 50%) in companies they invest in. They usually take a significant but minority position of less than 10% and look to garner support from other shareholders in a proxy context to enforce the value-enhancing changes they want to occur. (LOS 17.e)

Module Quiz 17.3

1. **B** Market microstructure-based arbitrage strategies take advantage of mispricing opportunities occurring due to imbalances in supply and demand that are expected to only last for a few milliseconds. Investors with the tools to analyze the limit order book of an exchange and the capability for high-frequency trading are able to capture such opportunities. (LOS 17.f)

2. **A** A value trap is a company that is trading with low price multiples due to deteriorating fundamental business conditions. This security looks cheap due to its low price multiple; however, the valuation comes from the market correctly anticipating a further deterioration in business conditions and hence an improvement in share price is unlikely. (LOS 17.g)

3. **B** A manager would conclude that a factor has predictive power when a cross section of securities' factor scores is positively correlated with subsequent returns. When based on the Pearson correlation coefficient this is referred to as the information coefficient, hence, answers A and C are saying the same thing. They are incorrect choices because the manager would need to see non-zero correlation between factor scores and *subsequent* market returns, not contemporaneous market returns. Answer B is the best choice here—a manager would use the Spearman Rank correlation coefficient when concerned about outliers in the data causing the Pearson correlation coefficient to be biased. (LOS 17.h)

Module Quiz 17.4

1. **A** A manager performing holdings-based analysis may come to erroneous conclusions about manager style if they do not have details regarding derivatives overlay strategies used to change the exposure of the fund. This is less likely to be a problem for returns-based analysis because the regression of historical returns carried out under this method will likely pick up the impact of any derivatives overlay strategies being used by the manager. (LOS 17.i)

The following is a review of the Equity Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #18.

READING 18: ACTIVE EQUITY INVESTING: PORTFOLIO CONSTRUCTION

Study Session 8

EXAM FOCUS

This reading focuses on issues related to the active management of equity portfolios. It begins with the building blocks of active equity portfolio construction and how they relate to the sources of active return. It covers Active Share, active risk, and how they are related to various strategies. Risk budgeting and associated calculations are covered, as are issues related to the scalability of asset management approaches. The reading concludes with issues related to the use of short positions.

MODULE 18.1: BUILDING BLOCKS OF ACTIVE EQUITY PORTFOLIO CONSTRUCTION

Video covering this content is available online.

LOS 18.a: Describe elements of a manager's investment philosophy that influence the portfolio construction process.

CFA® Program Curriculum, Volume 3, page 306

Active equity portfolios aim to outperform a benchmark after all costs. In the simplest terms, the excess return above a benchmark (**active return**) will be positive if the manager overweights securities that outperform the benchmark, and underweights securities that underperform the benchmark, because active returns are driven by differences in weights between the active and benchmark portfolios:

$$R_A = \sum_{i=1}^{N} \Delta W_i R_i$$

where:

R_i = return from security *i*

ΔW_i = active weight, the difference between portfolio and benchmark weight for security *i*

Sources of Active Returns

Active returns come from three sources:

1. The level of strategic long-term exposures to **rewarded factors**.
   - Rewarded factors are risks that are widely accepted as offering long-term positive risk premiums [market risk (beta), size, value, liquidity, etc.]

2. Tactical exposures to **mispriced** securities, sectors, and rewarded risks that generate *alpha* (return that cannot be explained by long-term exposure to rewarded factors). Alpha is directly related to manager *skill*.
3. **Idiosyncratic risk** (from concentrated active positions) that generates returns related to *luck*. It is labeled *luck* in the sense that it is not due to market risk exposure or value-added alpha.

Different managers will generate different proportions of their active returns from each source.

The decomposition of realized (*ex post*) active return can be seen in the next equation:

$$R_A = \sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k + (\alpha + \varepsilon)$$

where:

β_{pk} = the sensitivity of the portfolio to each rewarded factor (k)

β_{bk} = the sensitivity of the benchmark to each rewarded factor

F_k = the return of each rewarded factor

$(\alpha + \varepsilon)$ = the return not explained by exposure to rewarded factors—alpha (α) is the active return attributable to manager skill, and ε is the idiosyncratic return—noise or luck (good or bad) (In practice it is very difficult to distinguish between α and ε)

Building Blocks Used in Portfolio Construction

The three main building blocks of portfolio construction are:

1. **Factor weightings.**
2. **Alpha skills.**
3. **Position sizing.**

These three building blocks are integrated into a successful portfolio construction process through a fourth component: **breadth of expertise**. Each component is considered in detail in the following.

First Building Block: Overweight/Underweight Rewarded Factors

This relates to the manager taking exposures to rewarded risks that differ from those of the benchmark. This can be thought of as active return due to differences in *beta*, where beta refers to sensitivity to a rewarded risk factor such as the market risk of CAPM, or the market, size, and value factors of the Fama and French model. With exposures to rewarded factors increasingly accessible via rules-based index products, simple static exposure to rewarded factors is no longer widely considered a source of alpha. Irrespective of the manager's approach, whether they explicitly target factor exposures or target individual securities, their performance can in part be attributed to sensitivity to these beta factors. This building block relates primarily to active return source number one: differences in exposures to long-term rewarded factors.

Second Building Block: Alpha Skills

Alpha skills are excess returns related to the unique skills and strategies of the manager. A manager can generate alpha through *factor timing*, which is skill in identifying when a

factor might outperform/underperform its average return. This could apply to a rewarded factor, (e.g., correctly determining when value stocks will outperform growth stocks), but it could also apply to *unrewarded* factors, such as correctly timing geographical or industry sector exposures, commodity prices, or even security selection (a discretionary manager might refer to these as *thematic exposures*). This building block relates primarily to active return source number two: identifying mispricings.

Third Building Block: Sizing Positions

Position sizing balances managers' confidence in their alpha and factor insights while mitigating idiosyncratic risks coming from concentrated positions. Position sizing will affect all three sources of active risk, but the most dramatic impact will be on idiosyncratic risk. The general rule is that smaller positions in a greater number of securities will diversify away idiosyncratic risk and lead to lower portfolio volatility.

A factor-oriented manager who spreads their portfolio across many assets is likely to minimize the impact of idiosyncratic risk. A stock-picker is likely to hold more concentrated positions based on their insights into individual securities, and hence, deliberately assume a higher degree of idiosyncratic risk.

Integrating the Building Blocks: Breadth of Expertise

Success at combining the three building blocks is a function of a manager's breadth of experience. A manager with broader expertise is more likely to generate consistent active returns. This can be seen in the **fundamental law of active management**:

$$E(R_A) = IC\sqrt{BR}\,\sigma_{R_A}\,TC$$

where:

$E(R_A)$ = expected active return of the portfolio

IC = expected information coefficient of the manager, calculated as the correlation between manager forecasts and realized active returns

BR = breadth—the number of truly independent decisions made by the manager each year

TC = transfer coefficient, a number between 0 and 1 that measures the level to which the manager is constrained—TC will take a value of 1 if the manager has no constraints, and 0 if the manager is fully constrained

σ_{R_A} = the manager's active risk (the volatility of active returns)

This equation clearly shows that there is a direct link between breadth and expected outperformance—a larger number of independent decisions (higher breadth) should lead to higher active return.

A manager who considers a single factor defined by a single metric is unlikely to be making truly independent decisions, because all investment decisions are being driven by the same dimension, and therefore, are likely to have low breadth. A manager who uses multiple factors and multiple metrics for each factor is likely to make more independent decisions when constructing their portfolio, and hence, have higher breadth.

Approaches to Portfolio Construction

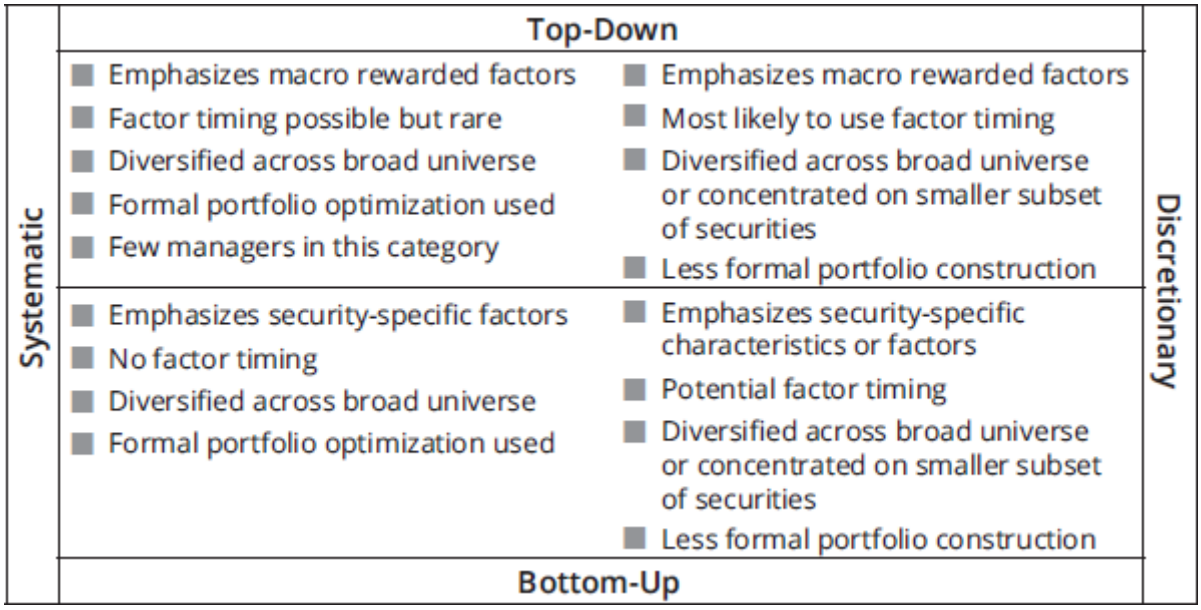
LOS 18.b: Discuss approaches for constructing actively managed equity portfolios.

The majority of investment approaches can be classified as:

- *Systematic or discretionary*: The degree to which the manager follows a set of systematic rules, rather than using discretionary judgment.
- *Bottom-up or top-down*: The degree to which the manager uses bottom-up stock-specific information, rather than macroeconomic information.

These approaches, and their use of the building blocks, are summarized in Figure 18.1.

Figure 18.1: Approaches and Their Use of Building Blocks



(*Based on Exhibit 6 in CFAI Reading 18*)

The Implementation Process: The Objectives and Constraints

Portfolio construction can be viewed as an optimization problem with a goal (the objective function) and a set of constraints. Objectives and constraints may be stated in absolute terms or relative to a benchmark; examples are given in Figure 18.2.

Figure 18.2: Objective Functions and Constraints of Portfolio Construction

	Absolute Framework	**Relative Framework**
Objective Function	Maximize Sharpe Ratio	Maximize Information Ratio
Constraints		
Sector/security weights	Maximum size in portfolio	Maximum deviation from benchmark
Risk	Maximum portfolio volatility specified as multiple (e.g., 0.9) of benchmark volatility	Maximum tracking error (active risk)
Market capitalization	Maximum/minimum set by mandate	Maximum/minimum set by mandate

Other approaches to optimization include:

- Specifying objectives in terms of *risk* (e.g., minimizing portfolio volatility, downside risk, or drawdowns).
- Maximizing exposure to rewarded factors (e.g., maximizing exposure to the size, value, and momentum factors).
- Maximizing exposure to securities having specific characteristics custom-defined by a discretionary manager [e.g., a custom-defined metric representing deep value (significant undervaluation)].
- Heuristic approaches that use less scientific methods, such as basing weighting on the ranking of securities with respect to a specified desired characteristic (e.g., low price to book).

MODULE QUIZ 18.1

To best evaluate your performance, enter your quiz answers online.

1. An active equity manager makes 10 independent decisions per month with an information coefficient of 0.1, active risk of 5% and a transfer coefficient of 0.5. The expected active annual return of this manager is *closest* to:
   A. 0.8%.
   B. 2.5%.
   C. 2.7%.
2. Which of the following managers is *most likely* to use an approach which uses factor timing techniques?
   A. Systematic bottom-up.
   B. Discretionary bottom-up.
   C. Discretionary top-down.

MODULE 18.2: ACTIVE SHARE AND ACTIVE RISK

Video covering this content is available online.

LOS 18.c: Distinguish between Active Share and active risk and discuss how each measure relates to a manager's investment strategy.

CFA® Program Curriculum, Volume 3, page 322

In addition to the dimensions discussed previously, investment approaches can also vary according to whether the manager is highly *benchmark-aware* or is *benchmark-agnostic* (i.e., pays little attention to the benchmark). Each manager will specify the acceptable levels of deviation from the benchmark, and quantify this deviation in terms of *Active Share* and *active risk*.

Active Share measures the degree to which the number and sizing of the positions in a manager's portfolio are different from those of a benchmark, and is given by the following equation:

$$\text{Active Share} = \frac{1}{2}\sum_{i=1}^{n}\left|W_{p,i} - W_{b,i}\right|$$

where:

n = total number of securities in the benchmark or the portfolio

$W_{p,i}$ = weight of security *i* in the portfolio

$W_{b,i}$ = weight of security *i* in the benchmark

The vertical line brackets indicate that we take the absolute value of the weighting difference, irrespective of whether it is positive or negative.

Active Share takes a value between 0 and 1. If a manager holds a portfolio of stocks that are not in the benchmark, their Active Share equals 1, whereas if they hold the benchmark weights in their portfolio their Active Share will be 0. If a portfolio has an Active Share of 0.5, we can conclude that 50% of the portfolio is identical to that of the benchmark and 50% is not.

PROFESSOR'S NOTE

Some simple numerical illustrations may help clarify the interpretation of Active Share:

Assume a universe of six stocks—A through F, with 25% of the benchmark invested in each of A, B, C, D.

The extreme cases:

Extreme Case 1: Portfolio matches benchmark (100% overlap), Active Share = 0

	Weighting			
Stock	Portfolio	Benchmark	Under	Over
A	0.25	0.25	0	0
B	0.25	0.25	0	0
C	0.25	0.25	0	0
D	0.25	0.25	0	0
E	0	0	0	0
F	0	0	0	0
	1	1	0	0
Active Share 0				

Extreme Case 2: No overlap between portfolio and benchmark, Active Share = 1

	Weighting			
Stock	Portfolio	Benchmark	Under	Over
A	0	0.25	0.25	0
B	0	0.25	0.25	0
C	0	0.25	0.25	0
D	0	0.25	0.25	0
E	0.4	0	0	0.4
F	0.6	0	0	0.6
	1	1	1	1
Active Share 1				

Per the equation, Active Share = $\frac{1}{2}\sum_{i=1}^{n}\left|W_{p,i} - W_{b,i}\right|$. In words, it is the average of the total degree of overweighting and the total degree of underweighting (ignoring the minus sign for

underweighting). Because, inevitably, total overweighting = total underweighting, Active Share = total overweighting or total underweighting (as seen previously).

(1 – Active Share) can be interpreted as the percent overlap between the portfolio and the benchmark. For example, in the upper example, the holdings in common are 0.1 in B, 0.25 in C, and 0.25 in D, a total of 0.6 (= 1 – 0.4). The lower example illustrates Active Share = 0.5 (50% overlap).

If two portfolios with the same benchmark invest only in benchmark securities, the portfolio with the *fewer* securities and therefore higher degree of concentration in positions will have a *higher* level of Active Share.

Active Share is used by many investors to assess the fees paid per unit of active management. For example, a fund with an Active Share of 0.2 would be considered expensive versus a fund with an Active Share of 0.5 if both funds were charging the same fees.

Active risk, also called *tracking error*, is the standard deviation of active returns (portfolio returns minus benchmark returns). As an equation:

$$\text{active risk}\left(\sigma_{R_A}\right) = \sqrt{\frac{\sum_{t=1}^{T}\left(R_{At}\right)^2}{T-1}}$$

where R_{At} is the active return at time t, and T is the number of return periods.

PROFESSOR'S NOTE

Simply put, active risk measures how consistent is/was the portfolio's performance relative to the benchmark.

There are two different measures of active risk: *realized* active risk, which depends on historical returns, and *predicted* active risk, which requires forward-looking estimates of correlations and variances.

Active risk is affected by the degree of cross-correlation between securities, whereas Active Share is not. For example, underweighting a pharmaceutical stock in order to overweight another pharmaceutical stock will certainly increase Active Share because the weights of the portfolio will be different to the weights in the benchmark. However, if the two pharmaceutical stocks are highly correlated, the portfolio will not behave markedly different from the benchmark, hence active risk is not likely to substantially increase. On the other hand, underweighting a pharmaceutical company and overweighting a security with a low correlation to the pharmaceutical company, such as a consumer discretionary company, will likely increase both Active Share and active risk.

A portfolio manager can completely control Active Share because they control the weights of the securities in the portfolio. However, a manager cannot completely control active risk because predicted active risk depends on estimations of correlations and variances of securities that may be different from those actually realized.

Decomposition of Active Risk

Given the earlier decomposition of active return into returns to factors, alpha, and idiosyncratic risk, it is possible to show that active risk is a function of the variance due to factor exposures and the variance due to idiosyncratic risk:

$$\sigma_{R_A} = \sqrt{\sigma^2\left(\sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k\right) + \sigma_e^2}$$

PROFESSOR'S NOTE

The variance of the skill of the manager (alpha) is deemed to be part of the idiosyncratic risk component here.

Research conclusions on the composition of active return include:

- High net exposure to a risk factor leads to high level of active risk.
- A portfolio with no net factor exposure will have active risk attributed entirely to Active Share.
- Active risk attributable to Active Share is inversely proportional to the number of securities in the portfolio.
- Active risk increases as factor and idiosyncratic risk levels increase.

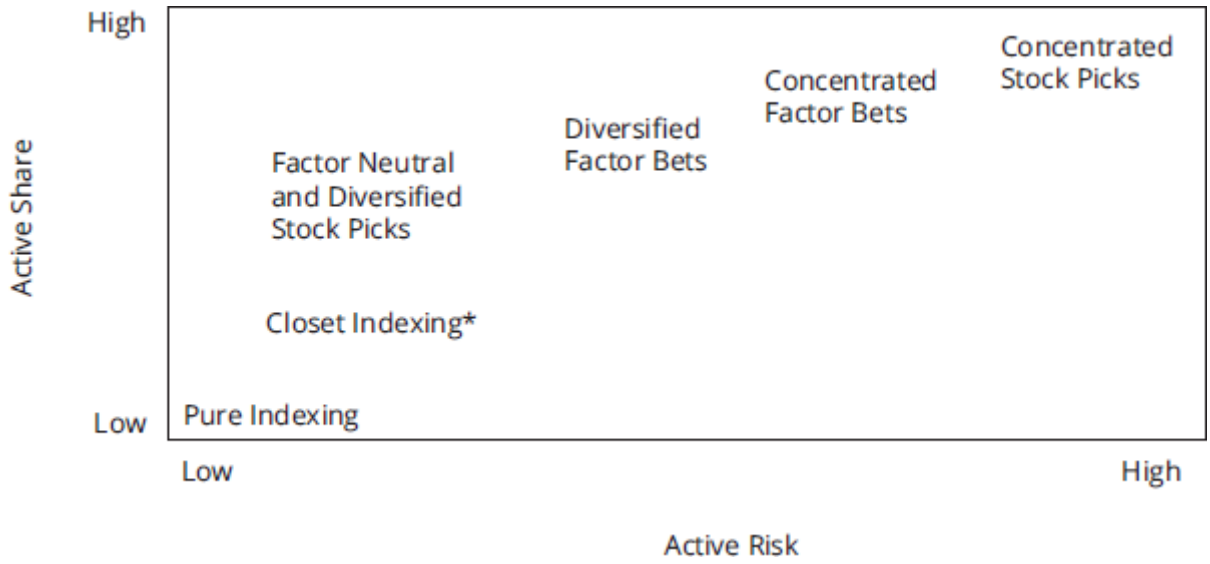
Distinguishing Between Different Portfolio Management Approaches

Active risk and Active Share can be used to discriminate between different portfolio management approaches, with respect to their factor exposures and level of diversification. The types of approaches, in order of increasing Active Share and active risk, can be broadly summarized as follows:

Investment Style	Description	Active Share and Active Risk
Pure indexing	No active positions: portfolio is equal to the benchmark	Zero Active Share and zero active risk
Factor neutral	No active factor bets—idiosyncratic risk low if diversified	Low active risk—Active Share low if diversified
Factor diversified	Balanced exposure to risk factors and minimized idiosyncratic risk through high number of securities in portfolio	Reasonably low active risk—high Active Share from large amount of securities used that are unlikely to be in the benchmark
Concentrated factor bets	Targeted factor bets—idiosyncratic risk likely to be high	High Active Share and high active risk
Concentrated stock picker	Targeted individual stock bets	Highest Active Share and highest active risk

This spectrum of manager styles and the approximate expected relationship with Active Share and active risk is displayed in Figure 18.3.

Figure 18.3: Approaches and Their Use of Building Blocks



*A *closet indexer* is defined as a fund that advertises itself as being actively managed but is substantially similar to an index fund in its exposures.

PROFESSOR'S NOTE

It may be helpful to remind ourselves here of the differences between the three terms: Active Share, factor bets, and active risk.

Active Share (a number between 0 and 1) measures how similar the portfolio is to the benchmark in terms of its stock holdings; the lower the value of Active Share, the closer the portfolio is to the benchmark.

A manager makes **factor bets** when their portfolio's exposure to one or more risk factors differs from that of the benchmark. Taking factor bets necessarily involves increased Active Share, whereas a higher value of Active Share does not necessarily imply that factor bets have been taken (for example, a manager might hold stock A instead of stock B, but the two stocks may have identical factor exposures).

Active risk measures the extent to which the active return (portfolio return minus benchmark return) varies from period to period. It can be seen as a consequence of Active Share and factor bets.

Manager styles can also be identified through observing their sector and security-specific constraints. For example, a **sector rotator** would need to have large permitted deviations in sector weights, while a stock picker would need to have large permitted deviations in individual security weights. A diversified multi-factor investor would not need such large deviations from index weights, but would still need some flexibility in order to generate a moderate level of active risk and return.

EXAMPLE: **Portfolio construction—approaches and return drivers**

Based on the following information regarding four managers benchmarked against the same index, **identify** and **justify** the manager most likely to be:

- A concentrated stock picker.
- A diversified multi-factor investor.
- A closet indexer.
- A sector rotator.

Use each category *only once* in your answer.

Manager Constraints:	A	B	C	D
Target active risk	8%	5%	1%	9%
Maximum sector deviations	20%	8%	2%	0%
Maximum risk contribution, single security	3%	1%	1%	6%

Answer:

The key to this type of question is to start with the most obvious identification. Of course not everyone will agree which is most obvious. The point is start where you find the issue to be most clear-cut based on the data available.

Manager A is a sector rotator because large deviations in sector weight are allowed.

Manager D is concentrated stock selection with large risk contributions (deviation in weighting) allowed by security but no deviation in sector weight allowed.

Manager C is the closet indexer with low targeted active risk and low deviations allowed.

Manager B is the diversified multi-factor investor with moderate (neither very high nor low) active risk and sector deviations. The low single security risk likely indicates a large number of positions (reflecting the use of multiple factors to select the holdings).

MODULE QUIZ 18.2

To best evaluate your performance, enter your quiz answers online.

1. A manager that substitutes a benchmark holding in their portfolio with a similar security not held in the benchmark will *most likely*:
   A. increase Active Share but not substantially increase active risk.
   B. increase active risk but not substantially increase Active Share.
   C. decrease Active Share and increase active risk.

MODULE 18.3: ALLOCATING THE RISK BUDGET

Video covering this content is available online.

LOS 18.d: Discuss the application of risk budgeting concepts in portfolio construction.

CFA® Program Curriculum, Volume 3, page 334

Risk budgeting is a process by which the total risk of a portfolio is allocated to constituents of the portfolio in the most efficient manner. It is an integral part of an effective risk management process. An effective risk management process has the following four steps:

1. Determine which *type* of risk measure is appropriate given the fund mandate.
   - **Absolute** risk measures are appropriate when the investment objective is expressed in terms of total returns (e.g., a long/short equity manager benchmarked against cash plus a margin).
   - **Relative** risk measures are appropriate when the investment objective is to outperform a market index.
2. Understand how each aspect of the strategy contributes to risk.

- Does risk come from exposure to rewarded factors or allocations to sectors/securities?

3. Determine what level of *risk budget* is appropriate.
   - This is the overall level of risk targeted.
4. Properly allocate risk among individual positions/factors.

Causes and Sources of Absolute Risk

Absolute risk measures focus on the size and composition of absolute portfolio variance (i.e., without reference to any benchmark variance).

The contribution of asset *i* to portfolio variance (CV_i) is given by the equation:

$$CV_i = \sum_{j=1}^{n} w_i w_j C_{ij} = w_i C_{ip}$$

where:

w_j = asset *j*'s weight in the portfolio

C_{ij} = the covariance of returns between asset *i* and asset *j*

C_{ip} = the covariance of returns between asset *i* and the portfolio $\left(= \sum_{j=1}^{n} w_j C_{ij} \right)$

The portfolio variance is the sum of each asset's contribution to portfolio variance.

EXAMPLE: **Absolute risk attribution**

A portfolio has the following characteristics:

	Portfolio Weight	Standard Deviation
Asset A	20%	22%
Asset B	30%	12%
Asset C	50%	10%
Portfolio	100%	8.6%

	Covariance		
	Asset A	Asset B	Asset C
Asset A	0.050000	0.006700	0.001300
Asset B	0.006700	0.014400	0.002000
Asset C	0.001300	0.002000	0.009800

1. **Calculate** the absolute contribution to portfolio variance of asset A.
2. Given that the absolute contribution to portfolio variance of assets B and C are 0.001998 and 0.002880 respectively, **calculate** the relative contribution to portfolio variance of asset A.

Answers:

1. Asset A's contribution to total portfolio variance:
   = weight of asset A × weight of asset A × covariance of asset A with asset A
   + weight of asset A × weight of asset B × covariance of asset A with asset B
   + weight of asset A × weight of asset C × covariance of asset A with asset C
   = (0.20 × 0.20 × 0.050000) + (0.20 × 0.30 × 0.006700) + (0.20 × 0.50 × 0.001300)

= 0.002 + 0.000402 + 0.00013

= 0.002532

2. Portfolio variance is the sum of the absolute contributions to variance:

   = 0.002532 + 0.001998 + 0.002880 = 0.00741

   Thus the relative contribution of asset A to portfolio variance = 0.002532 / 0.00741 = 0.34 or 34%.

Portfolio variance can be attributed to sectors, countries, or pools of assets representing factors (e.g., value vs. growth), in a similar manner. Analogous to the contribution to total variance of a single asset, the contribution to portfolio variance of a sector can be calculated as its weight in the portfolio multiplied by the covariance of the sector with the portfolio.

Portfolio variance can also be separated into variance attributed to factor exposures and unexplained variance. A manager that generates most of her returns from exposure to rewarded factors (such as a multi-factor diversified manager) would expect to see a large contribution to risk explained by rewarded factors and a low contribution to risk from unexplained idiosyncratic risks. The contribution to portfolio variance of a factor is analogous to the contribution to portfolio variance of an asset, with weights replaced by beta sensitivities and assets replaced by factors. The contribution of factor i to portfolio variance is given by the formula:

$$CV_i = \sum_{j=1}^{n} \beta_i \beta_j C_{ij} = \beta_i C_{ip}$$

where:

β = sensitivity of portfolio to factor i (regression coefficient)

C_{ij} = the covariance of factor i and factor j

C_{ip} = the covariance of factor i and the portfolio $\left(= \sum_{j=1}^{n} \beta_j C_{ij} \right)$

The portfolio variance is the sum of each factor's contribution to portfolio variance plus any unexplained variance.

EXAMPLE: **Factor-based risk budgeting**

The following table presents the risk-factor coefficients and variance/covariance matrix for a manager running a portfolio using a two-factor model (market and size).

		Variance/Covariance of Returns	
	Coefficients	Market	Size
Market	0.892	0.00178	0.00042
Size	–0.283	0.00042	0.00048

The standard deviation of the manager's return is 3.74%.

1. **Calculate** the proportion of the total portfolio variance explained by the market factor.
2. If the contribution to portfolio variance of the size factor is –0.00007, **calculate** the proportion of total portfolio variance that is unexplained.

Answers:

1. Variance attributed to the market factor (Factor 1):

   = coefficient of Factor 1 × coefficient of Factor 1 × covariance of Factor 1 with Factor 1

+ coefficient of Factor 1 × coefficient of Factor 2 × covariance of Factor 1 with Factor 2

= (0.892 × 0.892 × 0.00178) + (0.892 × –0.283 × 0.00042)

= 0.00131

Total portfolio variance is $0.0374^2 = 0.0013988$

So, proportion of total portfolio variance explained by the market factor = 0.00131 / 0.0013988 = 93.7%

2. Total variance explained by the factors:

= contribution to variance of Factor 1 + contribution to variance of Factor 2

= 0.00131 + (–0.00007) = 0.00124

Unexplained variance = total portfolio variance – variance explained by factors = 0.0013988 – 0.00124 = 0.00016

Hence proportion of total portfolio variance that is unexplained = 0.00016 / 0.0013988 = 11.4%

PROFESSOR'S NOTE

Note that the answers to parts 1 and 2 sum to more than 100%, because the size factor makes a negative contribution to total portfolio variance.

Causes and Sources of Relative/Active Risk

Relative risk is an appropriate measure when the manager is concerned with performance relative to a market index. Active variance, which is the variance of the differences between portfolio and benchmark returns, can be broken down in an analogous manner to absolute variance.

The contribution of asset *i* to portfolio *active* variance (CAV_i) is given by the equation:

$$CAV_i = (w_{pi} - w_{bi})RC_{ip}$$

where:

w_{pi} = weight of asset *i* in the portfolio

w_{bi} = weight of asset *i* in the benchmark

RC_{ip} = the covariance between the active returns of asset *i* and the active returns of the portfolio, which reflects the covariances between the active returns for asset *i* and the active returns for each of the *n* assets in the portfolio:

$$RC_{ip}\ RC_{ip} = \sum_{j=1}^{n}\left(w_{pj} - w_{bj}\right)RC_{ij}$$

Adding up the CAVs for all the assets in the portfolio will give the variance of the portfolio's active return (AV_p).

PROFESSOR'S NOTE

These formulas are analogous to those seen earlier for the contribution to absolute risk, but using active weight of the asset, and covariance of active returns. It is intuitively reasonable that an asset will contribute more to active variance if it has a higher active weight and if its active returns are related to overall portfolio active returns.

A simple example would be a benchmark composed of a 50/50 allocation to two equity indexes. The portfolio comprises allocations to these two indices and to a third asset, cash. Relevant information is displayed in Figure 18.4.

Figure 18.4: Relative Risk Attribution

	Benchmark Weight	Portfolio Weight	Standard Deviation	Active Risk	Correlation of Active Returns			Variance of Active Returns Attributed to Each Asset (%)
					Index A	Index B	Cash	
Index A	50%	35%	15%	6%	1.00	–1.00	–0.72	18%
Index B	50%	35%	9%	6%	–1.00	1.00	0.72	–18%
Cash	0%	30%	0.25%	12%	–0.72	0.72	1.00	100%
Total				3.60%	–0.72	0.72	1.00	100%

PROFESSOR'S NOTE

The formulas given have been used to compute $CAV_{Index\ A} = 0.000233$, $CAV_{Index\ B} = -0.000233$, and $CAV_{Cash} = 0.001296$, from which $AV_P = 0.001296$ and $\sigma_{AR} = \sqrt{0.001296} = 3.6\%$, as shown in the table. The rightmost column of the table gives each CAV as a percentage of AV_P. Note the calculation of CAV is not shown in the curriculum; thus, it will not be tested on the exam.

The important points to note are:

- Contribution to active variance is a function of active risk not absolute standard deviation. While cash has a very low standard deviation, it has an active risk twice that of the indexes comprising the benchmark due to the low correlation of cash versus the benchmark. This leads to cash contributing to 100% of the active variance.
- The correlation of the active returns of index A and index B is –1. This is because the benchmark is an equally weighted average of the two indices—when one is outperforming the benchmark (so has positive active returns) then the other must be underperforming the benchmark (giving negative active returns).

Similar to the absolute risk attribution of the previous section, relative risk attribution can be conducted on a country, sector or factor level.

Active portfolio variance can also be segmented into variance explained by active factor exposures, and unexplained active variance associated with idiosyncratic risks.

Determining the Appropriate Level of Risk

Practical considerations when considering the appropriate level of portfolio risk include:

1. *Implementation constraints*. Constraints on short positions or on leverage may limit the manager's ability to under/overweight. Liquidity issues may increase costs as a manager increases active risk, which leads to a degradation of the information ratio as the extra costs weigh on active returns.
2. *Limited diversification opportunities*. We know from basic portfolio theory that increasing risk leads to decreasing marginal increases in expected returns (this gives rise to the concave efficient frontier of Markowitz). Portfolios with higher risk/return targets eventually run out of high-return investment opportunities and lose the ability to diversify efficiently, thereby reducing the Sharpe ratio.
3. *Leverage and its implications for risk*. While leverage could be used to solve issue number two in a single period (allowing the portfolio to move up the linear capital allocation line, rather than following the curved efficient frontier), too much

leverage will eventually bring a reduction of expected compounded return in a multi-period setting. This comes from the fact that the geometric compounded returns (R_g) of a portfolio are approximately related to arithmetic non-compounded returns (R_a) and portfolio volatility σ as follows:

$$R_g = R_a - \frac{\sigma^2}{2}$$

Leverage increases both R_a and σ, but the squaring of σ in the expression means there will be a point where increasing leverage will lower expected geometric compounded returns over time.

PROFESSOR'S NOTE

Point three is related to the idea that geometric compounded returns over time fall as the volatility of a portfolio increases. For example, if a portfolio falls 2% and subsequently rises by 2% it will nearly return to its previous value (0.98 × 1.02 = 0.9996). However, if a portfolio falls by 20% and subsequently rises by 20% the portfolio value at the end of two periods will be lower (0.8 × 1.2 = 0.96). Both these portfolios have the same arithmetic uncompounded return of zero, yet the second has a lower compounded return over two periods because of its higher volatility.

Allocating the Risk Budget

An active manager should efficiently allocate their risk budget to sources that accurately represent their investment approach. Figure 18.5 compares sources of risk for a manager with balanced exposure to rewarded factors (Factor Diversified) versus a manager with concentrated sector and cash bets (Sector Rotator).

Figure 29.5: Comparative Sources of Risk, Drivers of Return

	Factor Diversified	Sector Rotator
Number of securities	High (in the hundreds)	Low (in the tens)
Position concentration	Low	High
Cash positions	Very low	High when allocated to cash
Market beta	Close to one (diversified)	Higher/lower than one depending on risk targets
Absolute risk	Lower	Higher, though tempered by large allocation to cash
Active risk	Lower	Higher due to large idiosyncratic risks coming from concentrated positions and sector bets
Active Share	Lower	Higher, consistent with higher security concentration
Average sector deviation	Lower	Higher, consistent with willingness to take sector bets
Source of risk: market	Higher	Lower, consistent with higher security concentration
Source of risk: sectors	Lower	Higher, consistent with sector bets
Source of risk: styles	Lower	Higher, consistent with concentrated positions
Source of risk: unexplained	Lower	Higher, consistent with sector rotation and concentrated positions

Additional Risk Measures

LOS 18.e: Discuss risk measures that are incorporated in equity portfolio construction and describe how limits set on these measures affect portfolio construction.

CFA® Program Curriculum, Volume 3, page 347

Risk constraints can be classified as *heuristic* or *formal*.

- **Heuristic risk constraints** are based on experience or general ideas of good practice. Examples include limits on exposure to individual positions, sectors or regions, limits on leverage, or measures designed to control the degree of illiquidity and turnover in the portfolio.
- **Formal risk constraints** are often statistical in nature. A key distinction between formal and heuristic risk measures is that formal risk measures require forecasts of return distributions, which introduces estimation error. Examples include limits on volatility, active risk, skewness, drawdowns, and VaR-based measures including:
  - Conditional VaR (CVaR)—the expected loss given VaR has been exceeded (also called expected tail loss or expected shortfall).

- Incremental VaR (IVaR)—the change in VaR from adding a new position to a portfolio.
- Marginal VaR (MVaR)—the impact of a very small change in position size on VaR.

Other points of note regarding risk constraints include:

- *Leverage* magnifies the negative impact of incorrect risk estimations. Infrequent but high impact negative "tail events" such as the market crashes seen in the early 2000s and 2008 can force a leveraged manager to liquidate all or part of his portfolio in an unfavorable environment, crystallizing significant losses.
- Unexpected increases in *volatility* can also derail investment strategies. Managers may tighten risk controls in more volatile periods to protect the portfolio from losses.
- Risk measures used depend on the style of management. A benchmark-agnostic manager with an absolute return philosophy is less likely to be concerned with statistical measures such as active risk and more concerned with more practical measures such as portfolio drawdown. A market-neutral equity manager is more likely to target keeping absolute volatility within a specific range in order to deliver the promised market-neutral low-volatility returns to investors.
- Portfolios with fewer positions will have higher estimation errors due to the random specific risks of concentrated positions, hence using formal risk measures is likely to be more difficult.

MODULE QUIZ 18.3

To best evaluate your performance, enter your quiz answers online.

1. The contribution to total variance of a geographical country allocation is *best* defined as:
   A. the weight of the country in the portfolio multiplied by the covariance of the country returns with the global market portfolio returns.
   B. the weight of the country in the portfolio multiplied by the correlation of the country returns with the portfolio returns.
   C. the weight of the country in the portfolio multiplied by the covariance of the country returns with the portfolio returns.
2. Forecasting of return distributions is *most likely* required by:
   A. heuristic risk constraints only.
   B. formal risk constraints only.
   C. both heuristic and formal risk constraints.

MODULE 18.4: IMPLICIT COST-RELATED CONSIDERATIONS IN PORTFOLIO CONSTRUCTION

Video covering this content is available online.

LOS 18.f: Discuss how assets under management, position size, market liquidity, and portfolio turnover affect equity portfolio construction decisions.

CFA® Program Curriculum, Volume 3, page 354

The *market impact* cost of an investment strategy is an implicit cost related to the price movement caused by managers executing trades in the market. A manager buying securities may force security prices up, similarly a manager selling securities may force security prices down, thereby eroding the manager's alpha.

Factors that affect market impact costs include:

- Assets under management (AUM) versus market capitalization of securities:
  - The lower absolute level of trading volume for *smaller* cap securities can be a liquidity barrier to managers with *higher* AUM.
  - For example, assume a small cap investment has a market capitalization of $5 billion and that 1% of its capitalization trades each day on average, implying daily turnover of 0.01 × $5 billion = $50 million. A manager of a $1 billion fund may have a liquidity constraint of not holding more than 10% of the average trading volume of a security, which would limit the holding in the company to 0.1 × $50 million = $5 million. This implies the maximum position in the fund the manager can take in the investment is $5 million / $1 billion = 0.5%. This may not be a large enough position to allow the manager to execute their strategy, particularly if the strategy involves concentrated positions.
- Higher **portfolio turnover** and shorter **investment horizons** generally lead to higher market impact costs.
- Managers whose trades include "information" (where the trades act as a signal to the market that investment conditions have changed and encourage other market participants to carry out similar trades) will likely have higher market impact costs.

The market impact cost of a single trade is often measured by "slippage." **Slippage** is defined as the difference between the execution price and the midpoint of the quoted market bid/ask spread at the time the trade was first entered. Estimates of slippage based on recent empirical data lead to four notable conclusions:

1. Slippage costs are usually higher than explicit costs.
2. Slippage costs are greater for smaller-cap securities than for large-cap securities.
3. Slippage costs are not necessarily greater in emerging markets.
4. Slippage costs are substantially higher in times of high market volatility.

For successful small-cap focused strategies, the ability of the manager to continue implementing the strategy as AUM grow may be impaired by increasing slippage costs. In this case, the manager should either close their funds to contributions from new investors or inform investors that their strategy may have to change. Investors should be wary of managers raising new funds on the back of a track record that cannot be scaled for higher AUM.

Due to the higher impact costs of smaller-cap securities, a fund with a focus on large-cap stocks can support a higher level of AUM than a similar-strategy fund focused on small-cap stocks. A firm focused on small-cap stocks must either limit its AUM, diversify, limit turnover, or adapt its trading strategy to cap impact costs as AUM grow.

> EXAMPLE: **Issues of scale**

A diversified multi-factor fund has a size of $200 million and 350 individual positions. The benchmark is a large/mid cap index with 1000 constituents and total market cap of approximately $20 trillion. The smaller securities in the index trade about 1.5% of shares outstanding daily. The strategy has the following constraints:

1. No investment can be made in any security that has an index weight of less than 0.02%.
2. The maximum fund position percentage holding is equal to the lesser of 10 × index weight or index weight plus 100 bps.
3. Absolute position sizes cannot exceed 5% of the security's average daily trading volume (ADV) over the trailing 12 months.

Based on the three constraints listed previously, **calculate** the level of AUM, which the fund's ability to execute this strategy is likely to be impaired.

Answer:

The limit on the absolute size of a stock that can be held in the fund for the smallest cap position is set by Constraints 1 and 3.

Constraint 1 indicates the manager cannot invest in stocks whose market cap is below approximately 0.0002 × $20 trillion = $4 billion.

The ADV of this smallest cap holding would be about 0.015 × $4bn = $60 million.

Constraint 3 implies the maximum absolute position size for this smallest cap holding is therefore 0.05 × $60 million = $3 million.

The strategy has a maximum position size set by Constraint 2.

Constraint 2 implies the maximum position for the smallest cap security is the lesser of 10 × 0.02% = 0.2% and 0.02% + 100 bps = 1.02%. This means the maximum position size in the fund is 0.2%.

If the manager cannot hold up to 0.2% of the fund in the smallest capitalization position, then the ability to carry out the strategy is potentially impaired.

Given that Constraints 1 and 3 imply the manager cannot hold more than $3 million in the smallest capitalization holding, this means the ability to carry out the strategy is impaired by illiquidity when AUM reach $3,000,000 / 0.002 = $1.5 billion.

If the fund size is higher than this, the manager is constrained by the liquidity of small cap positions and cannot hold the maximum weight allowed by the strategy.

MODULE QUIZ 18.4

To best evaluate your performance, enter your quiz answers online.

1. All else equal, higher market impact cost is *most likely* associated with:
   A. lower AUM.
   B. investing in large cap securities.
   C. higher portfolio turnover.

MODULE 18.5: THE WELL-CONSTRUCTED PORTFOLIO

Video covering this content is available online.

LOS 18.g: Evaluate the efficiency of a portfolio structure given its investment mandate.

CFA® Program Curriculum, Volume 3, page 360

A **well-constructed portfolio** should deliver the characteristics promised to investors in a cost-efficient and risk-efficient way. This involves:

- A clear investment philosophy and a consistent investment process.
- Risk and structural characteristics as promised to investors.
- Achieving desired risk exposures in the most efficient manner.

- Reasonably low operating costs, given the strategy.

Funds aiming to deliver different required characteristics will have different well-structured portfolios. The following general points can be made about portfolios that have the same desired characteristics:

- Portfolios that can achieve desired risk exposures *with fewer positions* are likely to have more focus on risk management in the portfolio construction process. While this will not guarantee excess return, it does indicate risk efficiency is likely higher.
- If two portfolios have similar risk factor exposures, the product with the *lower absolute volatility and lower active risk* will likely be preferred (assuming similar costs).
- If two portfolios have similar active and absolute risks, similar costs, similar manager alpha skills, then the portfolio *with the highest Active Share* is preferable because this will leverage the alpha skill of the manager and have higher expected return.
- When selecting equity managers to create the equity allocation of a multi-asset fund, managers should be combined to create an overall equity allocation in the portfolio that is well-constructed. A risk factor exposure that is desired but not present in one manager could be compensated for by adding a different manager that specializes in generating exposure to that risk factor.

Long/Short, Long Extension, and Market-Neutral Portfolio Construction

LOS 18.h: Discuss the long-only, long extension, long/short, and equitized market-neutral approaches to equity portfolio construction, including their risks, costs, and effects on potential alphas.

CFA® Program Curriculum, Volume 3, page 365

Short selling securities is the process of borrowing securities and selling them in the market, with the intention of buying the securities back later at a lower price and returning them to the lender. Short sellers therefore make profits from security prices falling.

Introducing the ability to short sell securities allows investment managers to take advantage of negative insights gained through their investment research. **Long/short** is a general term used to describe any portfolio that can short sell securities.

The Merits of Long-Only Investing

An investor's choice between following long-only or long/short strategies is influenced by several factors:

- **Long-term risk premiums**, such as the market risk premium, are earned by investors going net *long* securities. Investors that short sell securities over the long term will therefore suffer negative returns. Investors that have *shorter* time horizons concerned about negative returns may prefer strategies that have short exposures.
- The **capacity and scalability** of a long-only strategy is set by the liquidity of the underlying securities. Capacity of short selling strategies is set by the availability of

securities to *borrow* to facilitate short selling. This means the capacity of long/short strategies is likely to be lower than for long-only strategies, particularly those large-cap funds that face few long-only capacity issues.

- Due to **limited legal liability** laws, the maximum a long investor can lose is the amount they paid for the security (if the security falls to zero). The potential loss to a short seller is unlimited, however, as they lose as stock prices *rise*, and stocks prices have no price ceiling. This makes "naked" short selling with no hedging riskier than a long-only strategy.
- **Regulations** allow some countries to ban short selling in the interests of financial market stability.
- **Transactional complexity** is higher for a long/short fund. A long-only investor need only instruct a broker to buy shares and subsequently sell them. A short seller must source shares to borrow, provide collateral to the lender of the shares, and faces the risk the lender recalls the shares at an inopportune time. A short seller usually appoints a prime broker to deal with stock borrowing and collateral functions, which introduces an extra layer of counterparty risk, because if the prime broker goes bankrupt collateral may be lost.
- **Costs** are likely to be higher for long/short funds than long-only funds both in terms of management fees and operational expenses.
- The **personal ideology** of an investor might cause them to object to short selling. This may be because they find the concept of profiting from the failure of others morally wrong, or they believe the expertise to short sell is not consistently available from managers. Investors may find the leverage involved in some long/short strategies unacceptable.

Long/Short Portfolio Construction

There are many different styles of long/short strategies, defined by their *gross* and *net exposure*. Gross exposure is the sum of the value of the long positions plus the absolute value of the short position, expressed as a percent of investor's capital. Net exposure is the difference between the value of the long positions and the value of the short positions, again expressed as a percentage of investor's capital.

For example, a long/short fund raises $100 million of capital from investors. They invest $80 million in long positions and short sell $30 million of securities. Hence, the value of long positions is 80% and the value of short positions is 30%. Gross exposure is 110% (80% + 30%) and net exposure is 50% (80% – 30%). Note that this strategy will have a cash balance of $50 million comprising $20 million of uninvested capital on the long side ($100 million – $80 million), and $30 million of short sale proceeds.

Specific types of long/short funds include *long extension* and *market-neutral* funds.

Long extension portfolios are long/short strategies typically constrained to have a net exposure of 100%. For example, a long extension portfolio might have a long position of 130% and a short position of 30% (referred to as a 130/30 fund). This is a constrained form of long/short fund, in that the manager has no real discretion over gross/net exposure. This would be preferred by investors that want 100% net market exposure but also wish to allow the manager to engage in some level of short selling in order to benefit from negative views.

Market-neutral portfolios aim to remove market exposure through their long and short exposures. A simple example would be a fund that is long $200 million of assets with a market beta of 0.9 and short $150 million of assets with a market beta of 1.2, giving a net market beta of zero. If the long and short positions are of equal size (and thus have equal betas) then gross exposure will be twice the long position value and net exposure will be zero. These funds should have lower volatility than long-only strategies, and low correlation with other strategies. The objective will be to neutralize risks where the manager believes they have no comparative advantage in forecasting, allowing them to concentrate on their specific skills. Often market-neutral strategies are used for diversification purposes, rather than for the purpose of seeking high returns. Note that it is difficult in practice to maintain a zero beta, given that correlations between exposures change continually.

Market-neutral portfolios can be constructed through *pairs trading*, where the securities of similar companies are bought and sold to exploit perceived mispricings. Quantitative approaches to pairs trading are referred to as *statistical arbitrage* (stat arb).

PROFESSOR'S NOTE

Stat arb was previously discussed in detail.

The Benefits and Drawbacks of Long/Short Strategies

Long/short strategies offer the following *benefits*:

- Greater ability to express negative ideas than a long-only strategy. The most negative position a long-only manager can take is to not hold a security, meaning that maximum underweighting a long-only manager can take is set by the weight of the security in the benchmark. A long/short manager is not constrained in this way because they can short securities. This will increase the information ratio because lower constraints will increase the transfer coefficient of the manager (TC, measuring their ability to translate insights into investment decisions, as seen earlier in the fundamental law of active management).
- Ability to use the leverage generated by short positions to gear into high-conviction long ideas.
- Ability to remove market risk and act as a diversifying investment against other strategies.
- Greater ability to control exposure to risk factors. Because most rewarded factors (size, value, momentum, etc.) are obtained through a long/short portfolio, being able to short sell allows managers to better control their exposure to these factors.

PROFESSOR'S NOTE

Long/short portfolios that are constructed to represent rewarded factors were previously discussed.

Long/short strategies contain the following *drawbacks:*

- Unlike a long position, a short position will cause the manager to suffer losses if the price of the security increases. This means potential losses are unlimited, because security prices are not bounded above. It also means the manager is reducing long-term exposure to the market risk premium.

- Some long/short strategies require significant leverage, which magnifies losses as well as gains.
- The cost of borrowing securities can become too high, particularly for securities that are difficult to borrow.
- Losses on the short position will increase collateral demands from stock lenders, particularly if leverage has been used. This may force the manager to liquidate positions at unfavorable prices. The manager may also be vulnerable to a *short squeeze*, where a sudden rise in the price of a heavily-shorted security forces short sellers to cover positions, buy back shares and potentially force the share price higher. Lenders of securities could also recall shares at inopportune times causing disruption to the manager's strategy.

MODULE QUIZ 18.5

To best evaluate your performance, enter your quiz answers online.

1. If two portfolios have similar active and absolute risks, similar costs, and similar manager alpha skills, then:
   A. the portfolios must have equal Active Share.
   B. the portfolio with highest Active Share would be preferred.
   C. the portfolio with lowest Active Share would be preferred.
2. All of the following are potential drawbacks of long/short strategies except:
   A. the ability to use the leverage generated by short positions to gear into high conviction long ideas.
   B. the ability to gain exposure to long-term market risk premiums.
   C. the high leverage used by some market neutral strategies to generate investor returns.

KEY CONCEPTS

LOS 18.a

The three main building blocks of active return (excess return above a benchmark) for an active equity manager are:

- Active rewarded factor (beta) weightings (taking exposures that differ from the benchmark). Factor exposures include market, size, value, momentum, liquidity, et cetera.
- Alpha skills—timing rewarded and unrewarded factors, sectors, and securities. This primarily generates excess return through identifying mispricings.
- Position sizing—large positions affect all three sources of active returns, but will primarily generate high idiosyncratic risk (good/bad luck). It may be a required part of a concentrated manager's alpha-generating strategy.

Success at combining these building blocks comes from breadth of expertise, defined as the number of independent decisions the manager makes per year. Higher breadth implies higher ability to outperform benchmarks. We see this in the fundamental law of active management:

$$E(R_A) = IC\sqrt{BR}\,\sigma_{R_A}\,TC$$

LOS 18.b

Decision-making can be can be systematic (rule-driven) or discretionary (opinion-driven). Discretionary managers are more likely to engage in factor timing, hold concentrated portfolios, and are less likely to use formal portfolio optimization techniques. Information used can be top-down (relating to the macro environment) or bottom-up (relating to individual securities).

Objectives and constraints of managers can be absolute (e.g., maximize Sharpe ratio subject to maximum volatility) or relative (e.g., maximize information ratio subject to maximum active risk). Other constraints may focus on minimizing risk, maximizing exposures to desired factors, or heuristic approaches.

LOS 18.c

Active Share measures the degree to which the number and sizing of the positions in a manager's portfolio differ from those of a benchmark:

$$\text{Active Share} = \frac{1}{2}\sum_{i=1}^{n}\left|W_{p,i} - W_{b,i}\right|$$

Active Share falls between 0 and 1, and the lower the Active Share, the more similar are the portfolio's holdings to the benchmark. If a portfolio has an Active Share of 0.5, we can conclude that 50% of the portfolio is identical to that of the benchmark and 50% is not. A manager can completely control their Active Share because they completely control position sizes in the portfolio.

Active risk (tracking error), is the standard deviation of active returns (portfolio returns minus benchmark returns). A manager can not completely control active risk because it depends on estimates of covariances and variances of securities in the portfolio and the benchmark.

Active risk has two sources: active factor exposure (active beta) and idiosyncratic risk from concentrated positions (variance from both the skill and luck of the manager):

$$\text{Active risk}\left(\sigma_{R_A}\right) = \sqrt{\frac{\sum_{t=1}^{T}\left(R_{At}\right)^2}{T-1}} = \sqrt{\sigma^2\left(\sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k\right) + \sigma_e^2}$$

LOS 18.d

Risk budgeting is the process by which the contribution to total risk of the portfolio is allocated to constituents of the portfolio in the most efficient manner. Contribution to portfolio variance can be calculated on an absolute or relative basis.

- The contribution of asset *i* to absolute portfolio variance

$$= CV_i = \sum_{j=1}^{n} w_i w_j C_{ij} = w_i C_{ip}$$

- The contribution of factor *i* to absolute portfolio variance

$$= CV_i = \sum_{j=1}^{n} \beta_i \beta_j C_{ij} = \beta_i C_{ip}$$

- The contribution of asset *i* to relative portfolio variance

$$= CAV_i = \sum_{j=1}^{n}\left(w_{pi} - w_{bi}\right)\left(w_{pj} - w_{bj}\right)RC_{ij} = \left(w_{pi} - w_{bi}\right)RC_{ip}$$

Practical considerations when considering the appropriate level of portfolio risk include:

- Implementation constraints (e.g., limits on position sizes) causing information ratio degradation as active risk increases.
- Limited diversification opportunities in higher risk investments.
- Leverage increasing volatility and causing lower geometric average compounded returns over multiple periods.

LOS 18.e

Risk constraints can be classified as heuristic (based on experience like arbitrary position limits) or formal (based on statistical measures such as VaR). Formal constraints require the estimation of return distributions which introduces estimation error. This estimation error can be magnified by leverage and the idiosyncratic risk of concentrated positions.

LOS 18.f

The market impact cost of an investment strategy is an implicit cost related to the price movement caused by managers executing trades in the market. Managers with higher AUM, higher turnover and shorter time horizons, whose trades have a higher information content, dealing in smaller-cap less-liquid securities, will have higher market impact costs.

A firm focused on small-cap stocks must either limit its AUM, diversify, limit turnover, or adapt its trading strategy to cap impact costs as AUM grow.

LOS 18.g

A well-constructed portfolio should deliver the characteristics promised to investors in a cost-efficient and risk-efficient way. This involves:

- A clear investment philosophy and a consistent investment process.
- Risk and structural characteristics as promised to investors.
- Achieving desired risk exposures in the most efficient manner.
- Reasonably low operating costs given the strategy.

LOS 18.h

An investor's choice between following long-only or long/short strategies is influenced by several factors, including:

- Long-term risk premiums.
- Capacity and scalability.
- Limited legal liability.
- Regulation.
- Transactional complexity.
- Costs.
- Personal ideology.

Long extension portfolios guarantee investors 100% net exposure with a specified short exposure. A typical 130/30 fund will have 130% long and 30% short positions.

Market-neutral portfolios aim to remove market exposure through offsetting long and short positions. Pairs trading is a common technique in building market-neutral

portfolios, with quantitative pair trading referred to as statistical arbitrage.

Benefits of long/short strategies include the ability to better express negative views, the ability to gear into high-conviction long positions, the removal of market risk to diversify, and the ability to better control risk factor exposures.

Drawbacks of long/short strategies include potential large losses because share prices are not bounded above, negative exposures to risk premiums, potentially high leverage for market-neutral funds, the costs of borrowing securities, and collateral demands from prime brokers. Being subject to a short squeeze on short positions is also a risk.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 18.1

1. **C** The manager will take 10 × 12 = 120 independent decisions per year. According to the fundamental law of active management the expected annual active return of the manager will be $0.1 \times \sqrt{120} \times 5\% \times 0.5 = 2.74\%$. (LOS 18.a)

2. **C** Factor timing techniques are difficult to use in a systematic rules-driven way and signals used to generate trading ideas are more often top-down verse bottom-up. (LOS 18.b)

Module Quiz 18.2

1. **A** By substituting a benchmark holding with a non-benchmark holding the manager will increase Active Share because Active Share measures the overall differences in weights between the portfolio and the benchmark. However, if the new security introduced into the portfolio behaves similarly to the benchmark security that has been substituted there may not be a significant increase in active risk of the portfolio because the substitution is unlikely to cause a major increase in the relative volatility of portfolio returns versus benchmark returns. (LOS 18.c)

Module Quiz 18.3

1. **C** Analogous to the contribution to total variance of a single asset, the contribution to portfolio variance of a geography can be calculated as its weight in the portfolio multiplied by the covariance of the country with the portfolio. (LOS 18.d)

2. **B** Heuristic risk constraints are rules of thumb that are deemed to be good practice but lack empirical evidence, such as maximum position size. Formal risk constraints are statistical in nature and usually involves statistical forecasting of return distributions. (LOS 18.e)

Module Quiz 18.4

1. **C** Answer A is incorrect; higher AUM will cause higher market impact costs because fund trades will be larger. Answer B is incorrect; larger cap securities are likely to be more liquid, and hence, offer lower impact costs. Higher portfolio turnover means the manager needs to trade more frequently, which implies a bigger market impact cost because some market impact cost will occur every time the manager trades. (LOS 18.f)

Module Quiz 18.5

1. **B** If two portfolios have similar active and absolute risks, similar costs, similar manager alpha skills, then the portfolio *with the highest Active Share* is preferable because this will leverage the alpha skill of the manager and have higher expected return. (LOS 18.g)

2. **A** The ability to use the leverage generated by short positions to gear into high conviction long ideas is a benefit of long/short investing which should improve the manager's ability to earn alpha on the long portfolio. Answers B and C are drawbacks to long/short strategies. (LOS 18.h)

TOPIC QUIZ: EQUITY PORTFOLIO MANAGEMENT

You have now finished the Equity Portfolio Management topic section. On your Schweser online dashboard, you can find a Topic Quiz that will provide immediate feedback on how effective your study of this material has been. The test is best taken timed; allow three minutes per question. Topic Quizzes are more exam-like than typical QBank questions or module quiz questions. A score less than 70% suggests that additional review of the topic is needed.

FORMULAS

Expected Return is the sum of:

1. Coupon income: annual coupon amount / current bond price
2. Rolldown return: (projected ending bond price (BP) – beginning BP) / beginning BP; based on no change in the yield curve
3. Price change due to investor's benchmark yield change predictions: $(-MD \times \Delta Y) + (\frac{1}{2} \times C \times \Delta Y^2)$
4. Price change due to investor's spread change predictions: $(-MD \times \Delta S) + (\frac{1}{2} \times C \times \Delta S^2)$
5. Currency gain or loss: projected change in value of foreign currencies weighted for exposure to the currency

Rolling yield = coupon income + rolldown return

r_p = portfolio return (amount) / portfolio equity

Return for a leveraged portfolio: $r_I + [(V_B / V_E) \times (r_I - r_B)]$

where:
r_p = return on portfolio
r_I = return on invested assets
r_B = rate paid on borrowings
V_B = amount of leverage
V_E = amount of equity invested

leverage = (notional value of contract – margin amount) / margin amount

Rebate rate = collateral earnings rate – security lending rate

$$\text{convexity} = \frac{\text{Macaulay duration}^2 + \text{Macaulay duration} + \text{dispersion}}{(1 + \text{periodic IRR})^2}$$

BPV = MD × V × 0.0001 = price value of a basis point

$$\text{futures BPV} \approx \frac{\text{BPV}_{CTD}}{\text{CF}_{CTD}}$$

$$N_f = \frac{\text{BPV of liability} - \text{BPV of current portfolio}}{\text{BPV of futures}}$$

$$\text{effective D} = \frac{PV_- - PV_+}{2 \times \Delta\text{curve} \times PV_0}$$

In formulas that refer to MD, and if effective duration differs from MD, option positions are present and effective duration must be used instead of MD.

The notional swap principal (NP) required to close the duration gap for a 100% hedge is the duration gap in BPV divided by the swap BPV per 1 NP.

$$\text{effective duration} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{curve})(\text{PV}_0)}$$

$$\text{effective convexity} = \frac{(\text{PV}_-) + (\text{PV}_+) - 2(\text{PV}_0)}{(\Delta\text{curve})^2(\text{PV}_0)}$$

%Δ value = $-\text{MD}_{\text{key rate n}}\,\Delta y_n$

MD = Macaulay duration / $(1 + \text{YTM}_{\text{periodic}})$

%Δ value = $-\text{MD}\,\Delta y$

%Δ relative value = $-D_S\,\Delta s$

spread = $y_{\text{higher yield}} - y_{\text{government}}$

$$\text{KeyRateDur} = -\frac{\text{change in portfolio value}}{\text{portfolio value} \times \text{change in key rate}}$$

butterfly spread = – (short-term yield) + (2 × medium-term yield) – long-term yield
credit spread ≈ POD × LGD

$$\text{EffRateDur}_{\text{FRN}} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{MRR})(\text{PV}_0)}$$

$$\text{EffSpreadDur}_{\text{FRN}} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{DM})(\text{PV}_0)}$$

where:

ΔMRR = change in benchmark curve

ΔDM = change in DM

$$\text{effective spread duration} = \frac{(\text{PV}_-) - (\text{PV}_+)}{2(\Delta\text{spread})(\text{PV}_0)}$$

$$\text{effective spread convexity} = \frac{(\text{PV}_-) + (\text{PV}_+) - 2(\text{PV}_0)}{(\Delta\text{spread})^2(\text{PV}_0)}$$

%Δprice = $(-\text{EffSpreadDur} \times \Delta\text{spread}) + (\frac{1}{2} \times \text{EffSpreadCon} \times \Delta\text{spread}^2)$

DTS ≈ EffSpreadDur × spread

expected excess spread = spread – (EffSpreadDur × Δspread) – (POD × LGD)

effective spread for a buy order = trade size × (trade price – midquote)

effective spread for a sell order = trade size × (midquote – trade price)

where:

midquote = (bid + ask) / 2

CDS price ≈ 1 + [(fixed coupon – CDS spread) × EffSpreadDurCDS]

$R_{DC} = (1 + R_{FC})(1 + R_{FX}) - 1$

$$\text{forward rate} = \text{spot rate} \times \frac{\left(1 + r_{DC}\right)^{T}}{\left(1 + r_{FC}\right)^{T}}$$

$$\text{Herfindahl-Hirschman index (HHI): } HHI = \sum_{i=1}^{n} w_i^2$$

$$\text{effective number of stocks} = \frac{1}{HHI}$$

$$\text{fundamental law of active management: } E\left(R_A\right) = IC\sqrt{BR}\,\sigma_{R_A}\,TC$$

$$\text{Active Share} = \frac{1}{2}\sum_{i=1}^{n}\left|W_{p,i} - W_{b,i}\right|$$

$$\text{active risk}\left(\sigma_{R_A}\right) = \sqrt{\frac{\sum_{t=1}^{T}\left(R_{At}\right)^2}{T-1}} = \sqrt{\sigma^2\left(\sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k\right) + \sigma_e^2}$$

Contribution to portfolio variance calculated on an *absolute* or *relative* basis

- Contribution of asset *i* to *absolute* portfolio variance

$$= CV_i = \sum_{j=1}^{n} w_i w_j C_{ij} = w_i C_{ip}$$

- Contribution of factor *i* to *absolute* portfolio variance

$$= CV_i = \sum_{j=1}^{n} \beta_i \beta_j C_{ij} = \beta_i C_{ip}$$

- Contribution of asset *i* to *relative* portfolio variance

$$= CAV_i = \sum_{j=1}^{n}\left(w_{pi} - w_{bi}\right)\left(w_{pj} - w_{bj}\right)RC_{ij} = (w_{pi} - w_{bi})RC_{ip}$$

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