CFA Institute®
CFA Program

PORTFOLIO MANAGEMENT PATHWAY

CFA® Program Curriculum

2025 • LEVEL III PORTFOLIO MANAGEMENT PATHWAY • VOLUME 2

ISBN 978-1-961409-48-4 (paper)
ISBN 978-1-961409-60-6 (ebook)
May 2024

CONTENTS

How to Use the CFA Program Curriculum

The CFA® Program exams measure your mastery of the core knowledge, skills, and abilities required to succeed as an investment professional. These core competencies are the basis for the Candidate Body of Knowledge (CBOK™). The CBOK consists of four components:

- A broad outline that lists the major CFA Program topic areas (www.cfainstitute.org/programs/cfa/curriculum/cbok/cbok)
- Topic area weights that indicate the relative exam weightings of the top-level topic areas (www.cfainstitute.org/en/programs/cfa/curriculum)
- Learning outcome statements (LOS) that advise candidates about the specific knowledge, skills, and abilities they should acquire from curriculum content covering a topic area: LOS are provided at the beginning of each block of related content and the specific lesson that covers them. We encourage you to review the information about the LOS on our website (www.cfainstitute.org/programs/cfa/curriculum/study-sessions), including the descriptions of LOS "command words" on the candidate resources page at www.cfainstitute.org/-/media/documents/support/programs/cfa-and-cipm-los-command-words.ashx.
- The CFA Program curriculum that candidates receive access to upon exam registration

Therefore, the key to your success on the CFA exams is studying and understanding the CBOK. You can learn more about the CBOK on our website: www.cfainstitute.org/programs/cfa/curriculum/cbok.

The curriculum, including the practice questions, is the basis for all exam questions. The curriculum is selected or developed specifically to provide candidates with the knowledge, skills, and abilities reflected in the CBOK.

CFA INSTITUTE LEARNING ECOSYSTEM (LES)

Your exam registration fee includes access to the CFA Institute Learning Ecosystem (LES). This digital learning platform provides access, even offline, to all the curriculum content and practice questions. The LES is organized as a series of learning modules consisting of short online lessons and associated practice questions. This tool is your source for all study materials, including practice questions and mock exams. The LES is the primary method by which CFA Institute delivers your curriculum experience. Here, candidates will find additional practice questions to test their knowledge. Some questions in the LES provide a unique interactive experience.

DESIGNING YOUR PERSONAL STUDY PROGRAM

An orderly, systematic approach to exam preparation is critical. You should dedicate a consistent block of time every week to reading and studying. Review the LOS both before and after you study curriculum content to ensure you can demonstrate the knowledge, skills, and abilities described by the LOS and the assigned reading. Use the LOS as a self-check to track your progress and highlight areas of weakness for later review.

Successful candidates report an average of more than 300 hours preparing for each exam. Your preparation time will vary based on your prior education and experience, and you will likely spend more time on some topics than on others.

ERRATA

The curriculum development process is rigorous and involves multiple rounds of reviews by content experts. Despite our efforts to produce a curriculum that is free of errors, in some instances, we must make corrections. Curriculum errata are periodically updated and posted by exam level and test date on the Curriculum Errata webpage (www.cfainstitute.org/en/programs/submit-errata). If you believe you have found an error in the curriculum, you can submit your concerns through our curriculum errata reporting process found at the bottom of the Curriculum Errata webpage.

OTHER FEEDBACK

Please send any comments or suggestions to info@cfainstitute.org, and we will review your feedback thoughtfully.

Portfolio Management Pathway

LEARNING MODULE

5

Yield Curve Strategies

by Robert W. Kopprasch, PhD, CFA, and Steven V. Mann, PhD.

Robert W. Kopprasch, PhD, CFA, is at Bates Group, LLC (USA). Steven V. Mann, PhD, is at the University of South Carolina (USA).

LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	describe the factors affecting fixed-income portfolio returns due to a change in benchmark yields
☐	formulate a portfolio positioning strategy given forward interest rates and an interest rate view that coincides with the market view
☐	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
☐	formulate a portfolio positioning strategy based upon expected changes in interest rate volatility
☐	evaluate a portfolio's sensitivity using key rate durations of the portfolio and its benchmark
☐	discuss yield curve strategies across currencies
☐	evaluate the expected return and risks of a yield curve strategy

INTRODUCTION

1

The size and breadth of global fixed-income markets, as well as the term structure of interest rates within and across countries, lead investors to consider numerous factors when creating and managing a bond portfolio. While fixed-income index replication and bond portfolios that consider both an investor's assets and liabilities were addressed earlier in the curriculum, we now turn our attention to active bond portfolio management. In contrast to a passive index strategy, active fixed-income management involves taking positions in primary risk factors that deviate from those of an index in order to generate excess return. Financial analysts who can successfully apply fixed-income concepts and tools to evaluate yield curve changes and position a portfolio based upon an interest rate view find this to be a valuable skill throughout their careers.

Prioritizing fixed-income risk factors is a key first step. In what follows, we focus on the yield curve, which represents the term structure of interest rates for government or benchmark securities, with the assumption that all promised principal and interest payments take place. Fixed-income securities, which trade at a spread above the benchmark to compensate investors for credit and liquidity risk, will be addressed later in the curriculum. The starting point for active portfolio managers is the current term structure of benchmark interest rates and an interest rate view established using macroeconomic variables introduced earlier. In what follows, we demonstrate how managers may position a fixed-income portfolio to capitalize on expectations regarding the level, slope, or shape (curvature) of yield curves using both long and short cash positions, derivatives, and leverage.

2 KEY YIELD CURVE AND FIXED-INCOME CONCEPTS FOR ACTIVE MANAGERS

☐ describe the factors affecting fixed-income portfolio returns due to a change in benchmark yields

The factors comprising an investor's expected fixed-income portfolio returns introduced earlier in the curriculum are summarized in Equation 1:

$$\begin{aligned} E(R) \approx\ & \text{Coupon income} \\ & +/- \text{ Rolldown return} \\ & +/- E\ (\Delta \text{ Price due to investor's view of benchmark yields}) \\ & +/- E\ (\Delta \text{ Price due to investor's view of yield spreads}) \\ & +/- E\ (\Delta \text{ Price due to investor's view of currency value changes}) \end{aligned} \tag{1}$$

Sections 2 and 3 will focus on actively managing the first three components of Equation 1, and Section 4 will include changes in currency. Credit strategies driving yield spreads will be discussed in a later lesson. As active management hinges on an investor's ability to identify actionable trades with specific securities, our review of yield curve and fixed-income concepts focuses on these practical considerations.

Yield Curve Dynamics

When someone refers to "the yield curve," this implies that one yield curve for a given issuer applies to all investors. In fact, a yield curve is a stylized representation of the yields-to-maturity available to investors at various maturities for a specific issuer or group of issuers. Yield curve models make certain assumptions that may vary by investor or by the intended use of the curve, raising such issues as the following:

- Asynchronous observations of various maturities on the curve
- Maturity gaps that require interpolation and/or smoothing
- Observations that seem inconsistent with neighboring values
- Use of on-the-run bonds only versus all marketable bonds (i.e., including off-the-run bonds)
- Differences in accounting, regulatory, or tax treatment of certain bonds that may make them look like outliers

As an example, a yield curve of the most recently issued, or on-the-run, securities may differ significantly from one that includes off-the-run securities. Off-the-run bonds are typically less liquid than on-the-run bonds, and hence they have a lower price (higher yield-to-maturity). Inclusion of off-the-run bonds will tend to "pull" the yield curve higher.

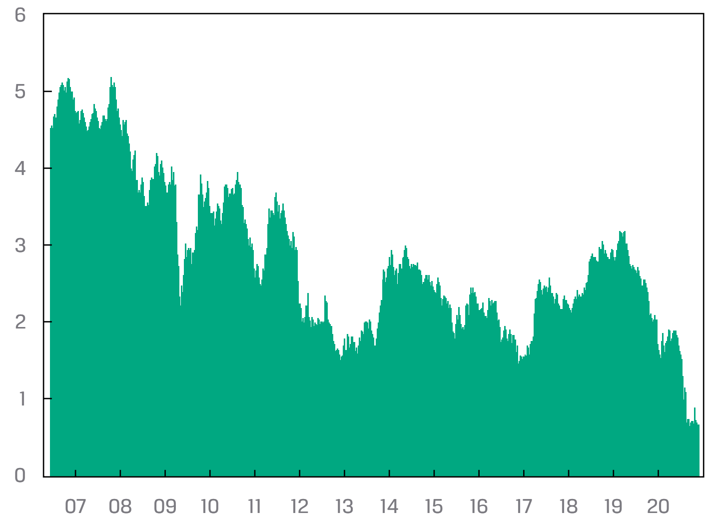
This illustrates two key points about yield curves. First, although we often take reported yield curves as a "given," they often do not consist of traded securities and must be derived from available bond yields-to-maturity using some type of model. This is particularly true for constant maturity yields, shown in some of the following exhibits. A constant maturity yield estimates, for example, what a hypothetical 5-year yield-to-maturity would be if a bond were available with exactly five years to maturity. While some derivatives reference the daily constant maturity yield, the current on-the-run 5-year Treasury issued before today has a maturity of less than five years. Estimating a constant maturity 5-year yield typically requires interpolating the yields-to-maturity on actively traded bonds with maturities *near* five years. Different models and assumptions can produce different yield curves. The difference between models becomes more pronounced as yields-to-maturity are converted to spot and forward rates (as spot and forward rate curves amplify yield curve steepness and curvature).

Second, a tradeoff exists between yield-to-maturity and liquidity. Active management strategies must assess this tradeoff when selecting bonds for the portfolio, especially if frequent trading is anticipated. While off-the-run bonds may earn a higher return if held to maturity, buying and selling them will likely involve increased trading costs (especially in a market crisis).

Primary yield curve risk factors are often categorized by three types: a change in (1) level (a parallel "shift" in the yield curve); (2) slope (a flattening or steepening "twist" of the yield curve); and (3) shape or curvature (or "butterfly movement"). Earlier in the curriculum, principal components analysis was used to decompose yield curve changes into these three separate factors. Level, slope, and curvature movements over time accounted for approximately 82%, 12%, and 4%, respectively, of US Treasury yield curve changes. Although based upon a specific historical period, the consistency of these results over time and across global markets underscores the importance of these factors in realizing excess portfolio returns under an active yield curve strategy.

The following exhibits provide historical context for the three yield curve factors using constant maturity US Treasury yields. Exhibit 1 shows US 10-year constant maturity yield levels.

Exhibit 1: 10-Year US Treasury Yield, 2007–2020 (%)



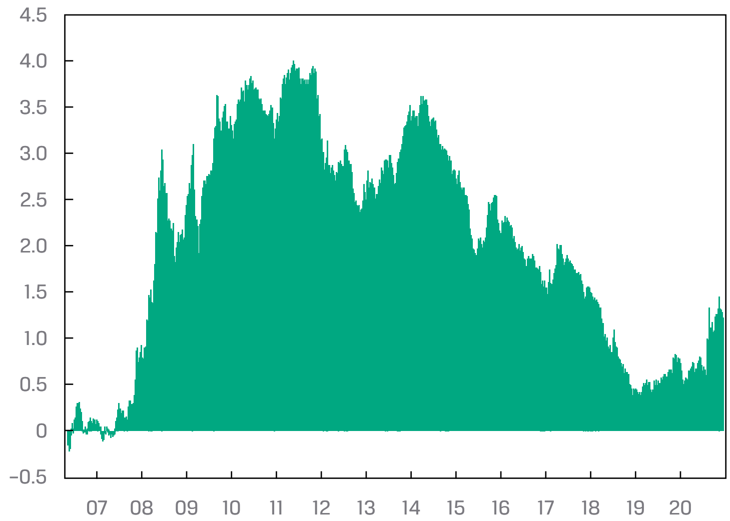
Source: US Federal Reserve.

During the period shown in Exhibit 1, 10-year US Treasury yields-to-maturity demonstrated significant volatility, falling to new lows in 2020 amid a flight to quality during the COVID-19 pandemic. Slower growth and accommodative monetary policy in the form of quantitative easing among global central banks since the 2008 global financial crisis years has driven government yields to zero and below. In 2020, negative yields were common on many Japanese, German, and Swiss government bonds, among others.

A change in yield *level* (or parallel shift) occurs when all yields-to-maturity represented on the curve change by the same number of basis points. Under this assumption, a portfolio manager might use a first-order duration statistic to approximate the impact of an expected yield curve change on portfolio value. This implies that yield curve changes occur only in parallel shifts, which is unreliable in cases where the yield curve's slope and curvature also change. Larger yield curve changes necessitate the inclusion of second- order effects in order to better measure changes in portfolio value.

Yield curve *slope* is often defined as the difference in basis points between the yield-to-maturity on a long-maturity bond and the yield-to-maturity on a shorter-maturity bond. For example, as of July 2020, the slope as measured by the 2s30s spread, or the difference between the 30-year Treasury bond (30s) and the 2-year Treasury note (2s) yields-to-maturity (1.43% and 0.16%, respectively), was 127 bps. Exhibit 2 shows the 2s30s spread for US Treasury constant maturity yields. As this spread increases, or widens, the yield curve is said to steepen, while a decrease, or narrowing, is referred to as a flattening of the yield curve. In most instances, the spread is positive and the yield curve is upward-sloping. If the spread turns negative, as was the case just prior to the 2008 global financial crisis, the yield curve is described as "inverted."

Exhibit 2: 2s30s US Yield Spread, 2007–2020 (%)



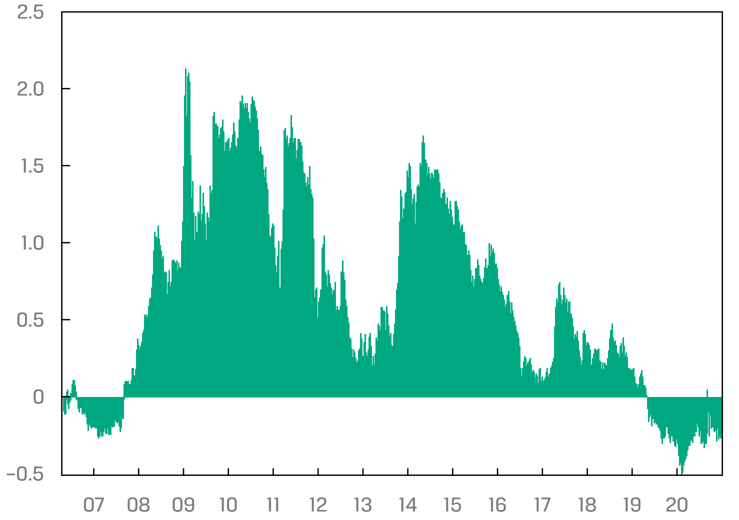
Source: US Federal Reserve.

Yield curve shape or *curvature* is the relationship between yields-to-maturity at the short end of the curve, at a midpoint along the curve (often referred to as the "belly" of the curve), and at the long end of the curve. A common measure of yield curve curvature is the **butterfly spread**:

$$\text{Butterfly spread} = -(\text{Short-term yield}) + (2 \times \text{Medium-term yield}) - \text{Long-term yield} \tag{2}$$

The butterfly spread takes on larger positive values when the yield curve has more curvature. Exhibit 3 displays this measure of curvature for the US Treasury constant maturity yield curve using 2-year, 10-year, and 30-year tenors. Curvature indicates a difference between medium-term yields and a linear interpolation between short-term and long-term yields-to-maturity. A positive butterfly spread indicates a "humped" or concave shape to the midpoint of the curve, while a "saucer" or convex shape indicates the spread is negative. The butterfly spread changes when intermediate-term yield-to-maturity changes are of a different magnitude than those on the wings (the short- and long-end of the curve). Note that as in the case of yield curve slope, the butterfly spread was generally positive until 2020, except for the period just prior to the 2008 global financial crisis.

Exhibit 3: US Butterfly Spread (2s/10s/30s), 2007–2020 (%)

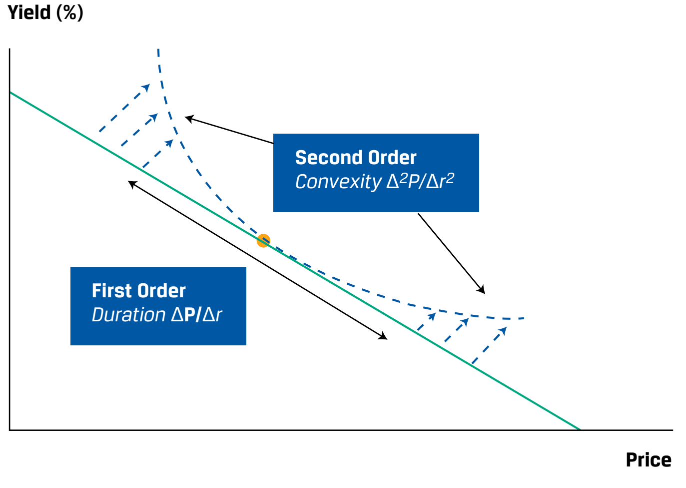


Source: US Federal Reserve.

Duration and Convexity

As active managers position their portfolios to capitalize on expected changes in the level, slope, and curvature of the benchmark yield curve, the anticipated change in portfolio value due to yield-to-maturity changes is captured by the third term in Equation 1—namely, the expected change in price due to investor's view of benchmark yields. The price/yield relationship for fixed-income bonds was established earlier in the curriculum as the combination of two factors: a negative, linear first-order factor (*duration*) and a usually positive, non-linear second-order factor (*convexity*), as shown in Exhibit 4.

Exhibit 4: Price–Yield Relationship for a Fixed-Income Bond



The third term in Equation 1 (Δ Price due to investor's view of benchmark yield), combines the duration and convexity effects in Equation 3 of the percentage change in the full price ($\%\Delta PV^{Full}$) for a single bond as introduced earlier:

$$\%\Delta PV^{Full} \approx -(\text{ModDur} \times \Delta\text{Yield}) + [\tfrac{1}{2} \times \text{Convexity} \times (\Delta\text{Yield})^2]. \tag{3}$$

Fixed-income portfolio managers often approximate changes in a bond portfolio's present value (PV) by substituting market value (MV)-weighted averages for modified duration and convexity into Equation 3.

$$\text{AvgModDur} = \sum_{j=1}^{J} \text{ModDur}_j \times \left(\frac{\text{MV}_j}{\text{MV}}\right). \tag{4}$$

$$\text{AvgConvexity} = \sum_{j=1}^{J} \text{Convexity}_j \times \left(\frac{\text{MV}_j}{\text{MV}}\right). \tag{5}$$

Active managers focus on the *incremental* effect on these summary statistics for a portfolio by adding or selling bonds in the portfolio or by buying and selling fixed-income derivatives. Duration is a first-order effect that attempts to capture a linear relationship between bond prices and yield-to-maturity. Convexity is a second-order effect that describes a bond's price behavior for larger movements in yield-to-maturity. This additional term is a positive amount on a traditional (option-free) fixed-rate bond for either a yield increase or decrease, causing the yield/price relationship to deviate from a linear relationship. Because duration is a first-order effect, it follows that duration management—accounting for changes in yield curve level—will usually be a more important consideration for portfolio performance than convexity management. This is consistent with our previous discussion of the relative importance of the yield curve level, slope, and curvature. As we shall see later in this lesson, convexity management is more closely associated with yield curve slope and shape changes.

All else equal, positive convexity is a valuable feature in bonds. If a bond has higher positive convexity than an otherwise identical bond, then the bond price increases more if interest rates decrease (and decreases less if interest rates increase) than the duration estimate would suggest. Said another way, the expected price of a bond with positive convexity for a given rate change will be higher than the price change of an identical-duration, lower-convexity bond. This price behavior is valuable to investors; therefore, a bond with higher convexity might be expected to have a lower yield-to-maturity than a similar-duration bond with less convexity. All else equal, bonds with longer durations have higher convexity than bonds with shorter durations. Also, as noted earlier in the curriculum, convexity is affected by the *dispersion* of cash flows—that is, the *variance* of the times to receipt of cash flow. Higher cash flow dispersion leads to an increase in convexity. This is in contrast to Macaulay duration, which measures the weighted *average* of the times to cash flow receipt. Note that throughout this lesson, we will use "raw" versus scaled (or "raw" divided by 100) convexity figures often seen on trading platforms. We can see the convexity effect by comparing two bond portfolios:

EXAMPLE 1

US Treasury Securities Portfolio

Tenor	Coupon	Price	ModDur	Convexity
2y	0.250%	$100	1.994	5.0
5y	0.875%	$100	4.880	26.5
10y	2.000%	$100	9.023	90.8

Consider two \$50 million portfolios: Portfolio A is fully invested in the 5-year Treasury bond, and Portfolio B is an investment split between the 2-year (58.94%) and the 10-year (41.06%) bonds. The Portfolio B weights were chosen to (approximately) match the 5-year bond duration of 4.88. How will the value of these portfolios change if all three Treasury yields-to-maturity immediately rise or fall by 50 bps?

Using Equation 3, we can derive the percentage value change for Portfolios A and B as well as the dollar value of each \$50 million investment:

Portfolio	+ 50 bps % Δ Price	+ 50 bps Δ Price	– 50 bps % Δ Price	– 50 bps Δ Price
A	−2.407%	(\$1,203,438)	2.473%	\$1,236,563
B	−2.390%	(\$1,194,883)	2.490%	\$1,245,170

For example, for the case of a 50 bp increase in rates:

$$-2.407\% = (-4.880 \times 0.005) + [0.5 \times 26.5 \times (0.005^2)]$$

$$-2.390\% = 0.5894 \times \{[-1.994 \times 0.005] + [0.5 \times 5 \times (0.005^2)]\} + 0.4106 \times \{[-9.023 \times 0.005] + [0.5 \times 90.8 \times (0.005^2)]\}$$

Note that Portfolio B gains *more* (\$8,607) than Portfolio A when rates fall 50 bps and loses *less* (\$8,555) than Portfolio A when rates rise by 50 bps.

The first portfolio concentrated in a single intermediate maturity is often referred to as a **bullet** portfolio. The second portfolio, with similar duration but combining short- and long-term maturities, is a **barbell** portfolio. Although the bullet and barbell have the same duration, the barbell's higher convexity (40.229 versus 26.5 for the bullet) results in a larger gain as yields-to-maturity fall and a smaller loss when yields-to-maturity rise. Convexity is therefore valuable when interest rate volatility is expected to rise. This dynamic tends to cause investors to bid up prices on more convex, longer-maturity bonds, which drives changes in yield curve shape. As a result, the long end of the curve may decline or even invert (or invert further), increasing the curvature of the yield curve.

EXAMPLE 2

Portfolio Convexity

1. Portfolio convexity is a second-order effect that causes the value of a portfolio to respond to a change in yields-to-maturity in a non-linear manner. Which of the following best describes the effect of positive portfolio convexity for a given change in yield-to-maturity?

   a. Convexity causes a greater increase in price for a decline in yields-to-maturity and a greater decrease in price when yields-to-maturity rise.

   b. Convexity causes a smaller increase in price for a decline in yields-to-maturity and a greater decrease in price when yields-to-maturity rise.

   c. Convexity causes a greater increase in price for a decline in yields-to-maturity and a smaller decrease in price when yields-to-maturity rise.

Solution:

The correct answer is c. Note that the convexity component of Equation 3 involves squaring the change in yield-to-maturity, or [½ × Convexity × $(\Delta\text{Yield})^2$], making the term positive as long as portfolio convexity is positive. This adds to the overall portfolio gain when yields-to-maturity decline and reduces the portfolio loss when yields-to-maturity rise.

YIELD CURVE STRATEGIES

3

- ☐ formulate a portfolio positioning strategy given forward interest rates and an interest rate view that coincides with the market view
- ☐ 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
- ☐ formulate a portfolio positioning strategy based upon expected changes in interest rate volatility
- ☐ evaluate a portfolio's sensitivity using key rate durations of the portfolio and its benchmark

Earlier in the curriculum, we established that yield curves are usually upward-sloping, with diminishing marginal yield-to-maturity increases at longer tenors—that is, flatter at longer maturities. As nominal yields-to-maturity incorporate an expected inflation premium, positively sloped yield curves are consistent with market expectations of rising or stable future inflation and relatively strong economic growth. Investor expectations of higher yields-to-maturity for assuming the increased interest rate risk of long-term bonds also contribute to this positive slope. Active managers often begin with growth and inflation forecasts, which they then translate into expected yield curve level, slope, and/or curvature changes. If their forecasts coincide with today's yield curve, managers will choose active strategies that are consistent with a static or stable yield curve. If their forecasts differ from what today's yield curve implies about these future yield curve characteristics, managers will position the portfolio to generate excess return based upon this divergent view, within the constraints of their investment mandate, using the cash and derivatives strategies we discuss next.

Static Yield Curve

A portfolio manager may believe that bonds are fairly priced and that the existing yield curve will remain unchanged over an investment horizon.

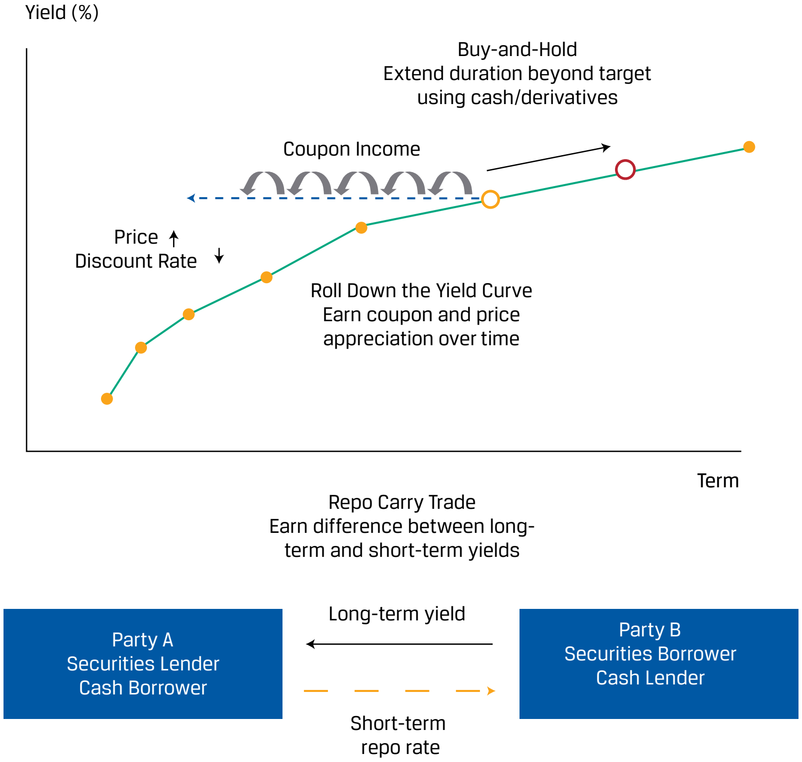
The two basic ways in which a manager may actively position a bond portfolio versus a benchmark index to generate excess return from a static or stable yield curve is to increase risk by adding either duration or leverage to the portfolio. If the yield curve is upward-sloping, longer duration exposure will result in a higher yield-to-maturity over time, while the "repo carry" trade (the difference between a higher-yielding instrument purchased and a lower-yielding (financing) instrument) will also generate excess returns.

Starting with cash-based instruments, "buy-and-hold" is an obvious strategy if the yield curve is upward-sloping. In an active context, this involves buying bonds with duration above the benchmark without active trading during a subsequent period. If the relationship between long- and short-term yields-to-maturity remains stable over this period, the manager is rewarded with higher return from the incremental duration. "Rolling down" the yield curve, a concept introduced previously, differs slightly from the "buy-and-hold" approach in terms of the investment time horizon and expected accumulation. The rolling yield component of Equation 1 (sometimes referred to as "carry-rolldown") incorporates not only coupon income (adjusted over time for any price difference from par) but also additional return from the passage of time and the investor's ability to sell the shorter-maturity bond in the future at a higher price (lower yield-to-maturity due to the upward-sloping yield curve) at the end of the investment horizon. If the yield curve is upward-sloping, buying bonds with a maturity *beyond* the investment horizon offers a total return (higher coupon plus price appreciation) greater than the purchase of a bond with maturity *matching* the investment horizon if the curve remains static. Finally, a common strategy known as a repurchase agreement or repo trade may be used in an expected stable rate environment to add leverage risk to the portfolio. The repo market involves buying a long-term security and financing it at a short-term rate below the long-term yield-to-maturity—that is, earning a positive "repo carry." At the end of the trade, the bond is sold and the repo is unwound. These cash-based strategies are summarized in Exhibit 5 and Exhibit 6.

Exhibit 5: Cash-Based Static Yield Curve Strategies

Strategy	Description	Income	Objective
Buy-and-hold	Constant without active trading	Coupon income	Add duration beyond target given static yield curve view
Rolling down the yield curve	Constant, with Δ Price as maturity shortens	Coupon income +/− Rolldown return	Add duration and increased return if future shorter-term yields are below current yield-to-maturity
Repo carry trade	Finance bond purchase in repo market	(Coupon income +/− Rolldown return)—Financing cost	Generate repo carry return if coupon plus rolldown exceeds financing cost

Exhibit 6: Carry, Rolldown, and Buy-and-Hold Strategies under a Static Yield Curve



Excess return under these strategies depends upon stable rate levels and yield curve shape. Note that a more nuanced "buy-and-hold" strategy under this scenario could also involve less liquid and higher-yielding government bonds (such as off-the-run bonds). The lack of portfolio turnover may make the strategy seem passive, but in fact it may be quite aggressive as it introduces liquidity risk, a topic addressed in detail later in the curriculum. The ability to benefit from price appreciation by selling a shorter-dated bond at a premium when rolling down (or riding) the yield curve hinges on a reasonably static and upward-sloping yield curve. Not only will the repo carry be maintained under this yield curve scenario, but it also will generate excess return due to the reduced cash outlay versus a term bond purchase.

Active managers whose investment mandate extends to the use of synthetic means to increase risk by adding duration or leverage to the portfolio might consider using the derivatives-based strategies in Exhibit 7 to increase duration exposure beyond a benchmark target. Although the long futures example is similar to rolling down the yield curve, it relies solely on price appreciation rather than bond coupon income. The receive-fixed swap, on the other hand, is similar to the cash-based repo carry trade, but the investor receives the fixed swap rate and pays a market reference rate (MRR), which is often referred to as "swap carry."

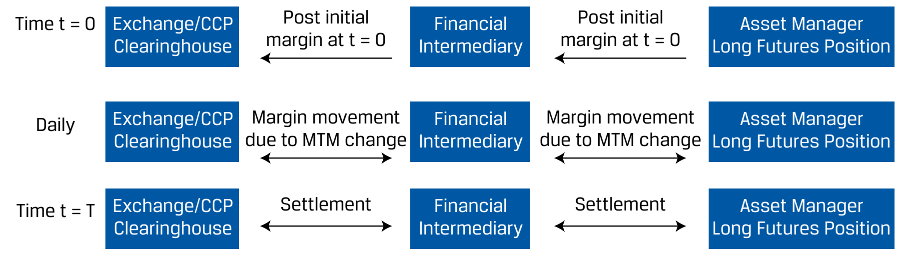
Exhibit 7: Derivatives-Based Static Yield Curve Strategies

Strategy	Description	Targeted Return	Goal
Long futures position	Purchase contract for future bond delivery	(Δ Price / Δ Bond yield) − Margin cost	Synthetically increase duration (up-front margin and daily mark-to-market valuation)
Receive-fixed swap	Fixed-rate receiver on an interest rate swap	(Swap rate − MRR) + (Δ Swap mark-to-market / Δ Swap yield)	Synthetically increase portfolio duration (up-front / mark-to-market collateral) + / − Swap carry

As mentioned previously in the curriculum, global exchanges offer a wide range of derivatives contracts across swap, bond, and short-term market reference rates for different settlement dates, and over the counter (OTC) contracts may be uniquely tailored to end user needs. Our treatment here is limited to futures and swaps and will extend to options in a later section.

Although margining was historically limited to exchange-traded derivatives, the advent of derivatives central counterparty (CCP) clearing mandated by regulatory authorities following the 2008 global financial crisis to mitigate counterparty risk has given rise to similar cash flow implications for OTC derivatives. Active managers using both exchange-traded and OTC derivatives must therefore maintain sufficient cash or eligible collateral to fulfill margin or collateral requirements. They must also factor any resulting foregone portfolio return into their overall performance. That said, since the initial cash outlay for a derivative is limited to initial margin or collateral as opposed to the full price for a cash bond purchase, derivatives have a high degree of implicit leverage. That is, a small move in price/yield can have a very large effect on a derivative's mark-to-market value (MTM) relative to the margin posted. Exhibit 8 shows these cash flow mechanics. This outsized price effect makes derivatives effective instruments for fixed-income portfolio management.

Exhibit 8: Derivatives Cash Flow Impact for a Fixed-Income Portfolio



For example, bond futures involve a contract to take delivery of a bond on a specific future date. Changes in the futures contract value mirror those of the underlying bond's price over time, allowing an investor to create an exposure profile similar to a long bond position by purchasing this contract with a fraction of the outlay of a cash bond purchase. While futures contracts are covered in detail elsewhere in the curriculum, for our purposes here it is important to establish the basis point value (BPV) of a futures contract. Most government bond futures are traded and settled using the least costly or cheapest-to-deliver (CTD) bond among those eligible for future delivery. For example, the CME Group's Ultra 10-Year US Treasury Note Futures contract specifies delivery of an original 10-year issue Treasury security with not less than 9 years, five months and not more than 10 years to maturity with an assumed 6% yield-to-maturity and contract size of \$100,000. The "duration" of the bond futures contract is assumed to match that of the CTD security. In order to determine the futures BPV, we use the following approximation introduced previously:

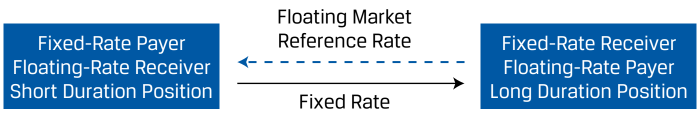
$$\text{Futures BPV} \approx \text{BPV}_{\text{CTD}} / \text{CF}_{\text{CTD}}, \quad (6)$$

where CF_{CTD} is the conversion factor for the CTD security. For government bond futures with a fixed basket of underlying bonds, such as Australian Treasury bond futures, the futures BPV simply equals the BPV of an underlying basket of bonds.

The manager in Example 1 can replicate the 10-year Treasury exposure using futures by matching the BPV of the cash bond. As explained elsewhere, the BPV of the \$20.53 million (or 41.06% × \$50 million) 10-year Treasury position equals the modified duration (9.023) multiplied by the full price (also known as the money duration) times one basis point, or \$18,524. If the CTD security under the Ultra 10-Year Futures contract is a Treasury bond also priced at par but with 9.5 years remaining to maturity, modified duration of 8.84, and a conversion factor of 0.684, then each \$100,000 futures contract has a BPV of \$129.24 (\$88.40/0.684). The manager must therefore buy approximately 143 futures contracts (\$18,524/\$129.24) to replicate the exposure. Note that as shown in Exhibit 8, this will involve an outlay of initial margin and margin movement due to MTM changes rather than investment of full principal.

An interest rate swap involves the net exchange of fixed-for-floating payments, where the fixed rate (swap rate) is derived from short-term market reference rates for a given tenor. As shown in Exhibit 9, the swap contract may be seen as a combination of bonds, namely a fixed-rate bond versus a floating-rate bond of the same maturity.

Exhibit 9: Swaps as a Duration Management Tool



Note the similarities between the "carry" trade in Exhibit 5 and the receive-fixed interest rate swap position on the right in Exhibit 9. The fixed-rate receiver is "long" a fixed-rate term bond and "short" a floating-rate bond, giving rise to an exposure profile that mimics a "long" cash bond position by increasing duration. A swap's BPV may be estimated using Equation 7.

$$\text{Swap BPV} = \text{ModDur}_{\text{Swap}} \times \text{Swap Notional}/10{,}000. \quad (7)$$

The difference between the receive-fixed swap and long fixed-rate bond positions is best understood via an example.

EXAMPLE 3

Calculating Bond versus Swap Returns

Say a UK-based manager seeks to extend duration beyond an index by adding 10-year exposure. The manager considers either buying and holding a 10-year, 2.25% semi-annual coupon UK government bond priced at £93.947, with a corresponding yield-to-maturity of 2.9535%, or entering a new 10-year, GBP receive-fixed interest rate swap at 2.8535% versus the six-month GBP MRR currently set at 0.5925%. The swap has a modified duration of 8.318. We compare the results of both strategies over a six-month time horizon for a £100 million par value during which both the bond yield-to-maturity and swap rates fall 50 bps. We ignore day count details in the calculation.

Position	Income	Price Appreciation/ MTM	Gain in 6 Months
10y UK bond	£1,125,000	£4,337,779	£5,462,778
10y GBP swap	£1,130,500	£4,234,260	£5,364,760

The relevant return components from Equation 1 are income, namely coupon income for the bond versus "carry" for the swap, and *E* (Δ Price due to investor's view of benchmark yield) in the form of price appreciation for the bond versus an MTM gain for the swap:

10-Year UK Government Bond:

Coupon income = £1,125,000, or (2.25%/2) × £100 million.

Price appreciation = £4,337,779. Using Excel, this is the difference between the 10-year, or [PV (0.029535/2, 20, 1.125, 100)], and the 9.5-year bond at the lower yield-to-maturity, or [PV (0.024535/2, 19, 1.125, 100)] × £1 million.

We can separate bond price appreciation into two components:

Rolldown return: The difference between the 10-year and 9.5-year PV with *no* change in yield-to-maturity of £262,363, or [PV (0.029535/2, 20, 1.125, 100)] – [PV (0.024535/2, 19, 1.125, 100)] × £1 million].

(Δ Price due to investor's view of benchmark yield): The difference in price for a 50 bp shift of the 9.5-year bond of £4,075,415, or [PV (0.029535/2, 19, 1.125, 100)] – [PV (0.024535/2, 19, 1.125, 100)] × £1 million.

10-Year GBP Swap:

Swap carry = £1,130,500, or [(2.8535% – 0.5925%)/2] × £100,000,000.

Swap MTM gain = £4,234,260. The swap MTM gain equals the difference between the fixed leg and floating leg, which is currently at par. The fixed leg equals the 9.5-year swap value given a 50 bp shift in the fixed swap rate, which is £104,234,260, or [PV(0.023535/2, 19, 2.8535/2, 100)] × £1 million, and the floating leg is priced at par and therefore equal to £100,000,000.

We can use Equation 7 to derive an approximate swap MTM change of £4,159,000 by multiplying swap BPV (8.318 × £100 million) by 50 bps. As in the case of a bond future, the cash outlay for the swap is limited to required collateral or margin for the transaction as opposed to the bond's full cash price. Note that for the purposes of this example, we have ignored any interest on the difference between the bond investment and the cash outlay for the swap.

While these strategies are designed to gain from a static or stable interest rate term structure, we now turn to portfolio positioning in a changing yield curve environment.

EXAMPLE 4

Static Yield Curve Strategies under Curve Inversion

1. An investment manager who pursues the cash-based yield curve strategies described in Exhibit 5 faces an inverted yield curve (with a decline in long-term yields-to-maturity and a sharp increase in short-term yields-to-maturity) instead of a static yield curve post implementation. Which of the following is the *least* likely portfolio outcome under this scenario?

   a. The manager realizes a loss on a "buy-and-hold" position that extends duration beyond that of the index.

   b. The manager faces negative carry when financing a bond purchase in the repo market.

   c. The manager is able to reinvest coupon income from a yield curve rolldown strategy at a higher short-term yield-to-maturity.

Solution:

The correct answer is a. The fall in long-term yields-to-maturity will lead to price *appreciation* under the "buy-and-hold" strategy. The difference between long-term and short-term yields-to-maturity in b will fall, leading to negative carry if short-term yields-to-maturity rise sharply. As for c, higher short-term yields-to-maturity will enable the manager to reinvest bond coupon payments at a higher rate.

Dynamic Yield Curve

Exhibits 1 through 3 show that yield curves are dynamic over time, with significant changes in the level, slope, and curvature of rates across maturities. Unless otherwise specified, the sole focus here is on instantaneous yield-to-maturity changes affecting E(Δ Price due to investor's view of benchmark yields), the third component of Equation 1.

Divergent Rate Level View

The principal components analysis cited earlier underscores that rate level changes are the key driver of changes in single bond or bond portfolio values. The first term in Equation 3 shows that bond value changes result from yield-to-maturity changes multiplied by a duration statistic. For active fixed-income managers with a divergent rate level view, positioning the portfolio to increase profit as yield levels fall or minimizing losses as yield levels rise is of primary importance. To be clear, a divergent rate level view implies an expectation of a *parallel* shift in the yield curve, as shown in Exhibit 10.

Exhibit 10: Yield Level Changes

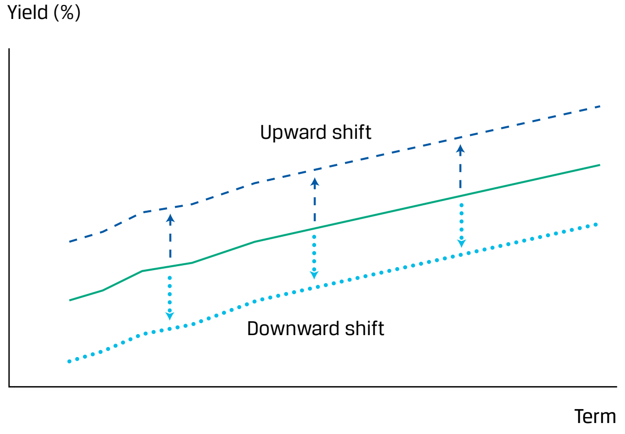


Exhibit 10 shows a general decline in bond yield levels, referred to as a bull market, since 2007. This trend began in late 1981 when the 10-year US Treasury yield-to-maturity peaked at nearly 16%, a consequence of contractionary US Federal Reserve monetary policy in which the short-term federal funds rate was raised to 20% to combat double-digit inflation. Extending duration beyond a target index over this period was a winning active strategy, despite occasional periods of yield increases. Exhibit 11 summarizes the major strategies an active manager might pursue if she expects lower yield levels and downside risks.

Exhibit 11: Major Yield Curve Strategies to Increase Portfolio Duration

Strategy	Description	Expected Excess Return	Downside Risks
Cash bond purchase ("bullet")	Extend duration with longer-dated bonds	Price appreciation as yield-to-maturity declines	Higher yield levels
Receive-fixed swap	Fixed-rate receiver on an interest rate swap	Swap MTM gain plus "carry" (fixed minus floating rate)	Higher swap yield levels and/or higher floating rates
Long futures position	Purchase contract for forward bond delivery	Futures MTM gain – Margin cost	Higher bond yields and/or higher margin cost

Assume the "index" portfolio equally weights the 2-, 5-, and 10-year Treasuries priced at par from Example 1, while a higher duration "active" portfolio is weighted 25% for 2- and 5-year Treasuries, respectively, and 50% in 10-year Treasuries. Average portfolio statistics are summarized here:

Portfolio	Coupon	Modified Duration	Convexity
Index	1.042%	5.299	40.8
Active (25/25/50)	1.281%	6.230	53.3

We can see from this table that the active portfolio has a blended coupon nearly 24 bps above that of the index.

We now turn to the impact of a parallel yield curve shift on the index versus active portfolios. Assuming an instantaneous 30 bp downward shift in yields-to-maturity, the index portfolio value would rise by approximately 1.608%, or $(-5.299 \times -0.003) + 0.5 \times (40.8) \times (-0.003^2)$, versus an estimated 1.893% increase for the actively managed portfolio, a positive difference of nearly \$285,000 for a \$100 million portfolio.

EXAMPLE 5

Portfolio Impact of Higher Yield-to-Maturity Levels

1. Consider a \$50 million Treasury portfolio equally weighted between 2-, 5-, and 10-year Treasuries using parameters from the prior example as the index, and an active portfolio with 20% each in 2- and 5-year Treasuries and the remaining 60% invested in 10-year Treasuries. Which of the following is closest to the active versus index portfolio value change due to a 40 bp rise in yields-to-maturity?

   a. Active portfolio declines by \$181,197 more than the index portfolio

   b. Active portfolio declines by \$289,915 more than the index portfolio

   c. Index portfolio declines by \$289,915 more than the active portfolio

Solution:

The correct answer is b. First, we must establish average portfolio statistics for the 20/20/60 portfolio using a weighted average of duration (6.79 versus 5.299 for the index) and convexity (60.8 versus 40.8 for the index). Second, using these portfolio statistics, we must calculate $\%\Delta PV^{Full}$, as shown in Equation 3, for both the index and active portfolios, which are −2.087% for the index and −2.667% for the active portfolio, respectively. Finally, we multiply the difference of −0.58% by the \$50 million notional to get −\$289,915.

Receive-fixed swaps or long futures positions may be used in place of a cash bond strategy to take an active view on rates. Note that most fixed-income managers will tend to favor option-free over callable bonds if taking a divergent rate level view due to the greater liquidity of option-free bonds. An exception to this arises when investors formulate portfolio positioning strategies based upon expected changes in interest rate volatility, as we will discuss in detail later in this lesson.

As 2020 began, some analysts expected government yields-to-maturity to eventually rise following over a decade of quantitative easing after the 2008 global financial crisis. However, yields instead reached new lows during 2020 when the COVID-19 pandemic caused a sharp economic slowdown, prompting additional monetary and fiscal policy stimulus. If analysts expected a strong economic rebound to increase yield levels, they might seek to lessen the adverse impact of higher rate levels by reducing duration. Exhibit 12 outlines major strategies to achieve this goal.

Exhibit 12: Major Yield Curve Strategies to Reduce Portfolio Duration

Strategy	Description	Expected Excess Return	Downside Risks
Cash bond sale ("bullet")	Reduce duration with short sale/switch to shorter-dated bonds	Smaller price decline as yield-to-maturity increases	Lower yield levels
Pay-fixed (interest rate swap)	Fixed-rate payer on an interest rate swap	Swap MTM gain plus "swap carry" (MRR − Fixed swap rate)	Swap MTM loss amid lower swap yield levels and/or lower floating rates
Short futures position	Sell contract for forward bond delivery	Futures MTM gain − Margin cost	Futures MTM loss amid lower bond yields and/or higher margin cost

Returning to our "index" portfolio of equally weighted 2-, 5-, and 10-year Treasuries, we now consider an active portfolio positioned to reduce downside exposure to higher yields-to-maturity versus the index. In order to limit changes to the bond portfolio, the manager chooses a swap strategy instead.

EXAMPLE 6

Five-Year Pay-Fixed Swap Overlay

In this example, the manager enters into a pay-fixed swap overlay with a notional principal equal to one-half of the size of the total bond portfolio. We will focus solely on first-order effects of yield changes on price (ignoring coupon income and swap carry) to determine the active and index portfolio impact. As the pay-fixed swap is a "short" duration position, it is a negative contribution to portfolio duration and therefore subtracted from rather than added to the portfolio. Recall the \$100 million "index" portfolio has a modified duration of 5.299, or (1.994 + 4.88 + 9.023)/3. If the manager enters a \$50 million notional 5-year pay-fixed swap with an assumed modified duration of 4.32, the portfolio's modified duration falls to 3.139, or [(5.299 × 100) − (4.32 × 50)]/100. Stated differently, the bond portfolio BPV falls from \$52,990 to \$31,390 with the swap. For a 25 bp yield increase, this \$21,600 reduction in active portfolio BPV reduces the adverse impact of higher rates by approximately \$540,000 versus the "index" portfolio.

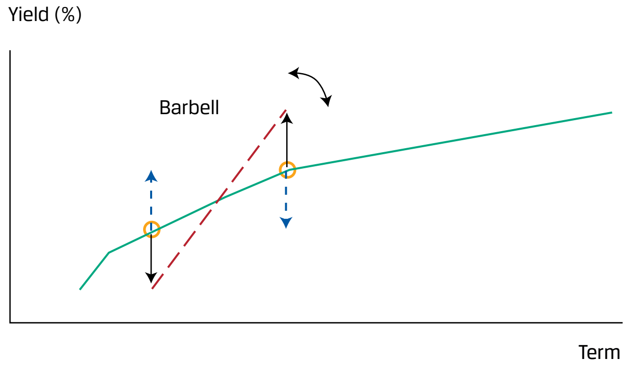
One point worth noting related to short duration positions is that with the exception of distressed debt situations addressed later in the curriculum, the uncertain cost and availability of individual bonds to borrow and sell short leads many active managers to favor the use of derivatives over short sales to establish a short bond position. Derivatives also facilitate duration changes without interfering with other active bond strategies with a portfolio.

Portfolio managers frequently use average duration and yield level changes to estimate bond portfolio performance in broad terms. However, these approximations are only reasonable if we assume a parallel yield curve shift. As Exhibits 2 and 3 show, non-parallel changes, or shifts in the slope and/or shape of the yield curve, occur frequently and require closer examination of individual positions and rate changes across maturities.

Divergent Yield Curve Slope View

Exhibit 2 established that while a positively sloped yield curve prevails under most economic scenarios, this difference between long-term and short-term yields-to-maturity can vary significantly over time. Changes in monetary policy, as well as expectations for growth and inflation, affect yields differently across the term structure, resulting in an increase (steepening) or decrease (flattening) in this spread. Although the **barbell** strategy combining extreme maturities is often referred to in a long-only context as in Example 1, here we take a more generalized approach in which the short-term and long-term security positions within the barbell trade may move in opposite directions—that is, combining a "short" and a "long" position. This type of barbell is an effective tool employed by managers to position a bond portfolio for yield curve steepening or flattening changes, as shown in Exhibit 13.

Exhibit 13: Barbell Strategy for a Yield Curve Slope Change



A manager could certainly use a bullet to increase or decrease exposure to a specific maturity in anticipation of a price change that changes yield curve slope, but a *combination* of positions in both short and long maturities with greater cash flow dispersion is particularly well-suited to position for yield curve slope changes or twists. Managers combine long or short positions in either maturity segment to take advantage of expected yield curve slope changes—which may be duration neutral, net long, or short duration depending upon *how* the curve is expected to steepen or flatten in the future. Also, in some instances, the investment policy statement may allow managers to use bonds, swaps, and/or futures to achieve this objective. Finally, while not all strategies shown are cash neutral, here we focus solely on portfolio value changes due to yield changes, ignoring any associated funding or other costs that might arise as a result.

Yield curve steepener strategies seek to gain from an increase in yield curve slope, or a greater difference between long-term and short-term yields-to-maturity. This may be achieved by combining a "long" shorter-dated bond position with a "short" longer-dated bond position. For example, assume an active manager seeks to benefit from yield curve steepening with a net zero duration by purchasing the 2-year Treasury and selling the 10-year Treasury securities from our earlier example, both of which are priced at par.

Tenor	Coupon	Position ($ MM)	Modified Duration	Convexity
Long 2y	0.25%	163.8	1.994	5.0
Short 10y	2.00%	−36.2	9.023	90.8

Note that here and throughout the lesson, negative portfolio positions reflect a "short" position. We can approximate the impact of *parallel* yield curve changes using portfolio duration and convexity. Portfolio duration is approximately zero, or [1.994 × 163.8/(163.8 – 36.2)] + [9.023 × –36.2/(163.8 – 36.2)], and portfolio convexity equals –19.34, or [5.0 × 163.8/(163.8 – 36.2)] + [90.8 × –36.2/(163.8 – 36.2). A 25 bp increase in *both* 2-year and 10-year Treasury yields-to-maturity therefore has no duration effect on the portfolio, although negative convexity leads to a 0.006%, or $7,712 decline in portfolio value, or $127,600,000 × 0.5 × –19.34 × 0.0025^2.

However, changes in the *difference* between short- and long-term yields-to-maturity are not captured by portfolio duration or convexity but rather require assessment of individual positions. For example, if yield curve *slope* increases from 175 bps to 225 bps due to a 25 bp *decline* in 2-year yields-to-maturity and a 25 bp *rise* in 10-year yields-to-maturity, the portfolio increases in value by $1,625,412 as follows:

2y: $\$819,102 = \$163,800,000 \times (-1.994 \times -0.0025 + 0.5 \times 5.0 \times -0.0025^2)$

10y: $\$806,310 = -\$36,200,000 \times (-9.023 \times 0.0025 + 0.5 \times 90.8 \times 0.0025^2)$

EXAMPLE 7

Barbell Performance under a Flattening Yield Curve

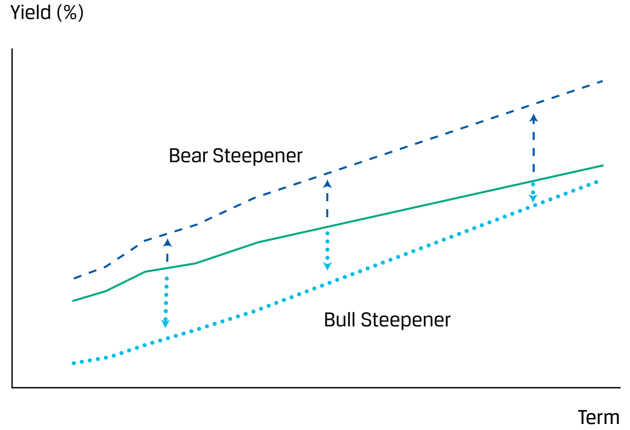
Consider a Treasury portfolio consisting of a $124.6 million long 2-year zero-coupon Treasury with an annualized 2% yield-to-maturity and a short $25.41 million 10-year zero-coupon bond with a 4% yield-to-maturity. Calculate the net portfolio duration and solve for the first-order change in portfolio value based upon modified duration assuming a 25 bp rise in 2-year yield-to-maturity and a 30 bp decline in 10-year yield-to-maturity.

First, recall from earlier in the curriculum that Macaulay duration (MacDur) is equal to maturity for zero-coupon bonds and modified duration (ModDur) is equal to MacDur/1+*r*, where *r* is the yield per period. We can therefore solve for the modified duration of the 2-year zero as 1.96 (= 2/1.02) and the 10-year zero as 9.62 (= 10/1.04), so net portfolio duration equals zero, or (124.6 - 25.41 × 1.96) + (-25.4/124.6 - 25.41 × 9.62).

We may show that the 2-year Treasury BPV is close to $24,430 (= 1.96 × 124,600,000/10,000) and the 10-year Treasury position BPV is also approximately $24,430 (= 9.61 × 25,410,000/10,000), but it is a short position. Therefore a 25 bp *increase* in 2-year yield-to-maturity *decreases* portfolio value by $610,750 (25 bps × $24,430), while a 30 bp *decrease* in the 10-year yield-to-maturity also *decreases* portfolio value (due to the short position) by an additional $732,900 (= 30 bps × $24,430), for a total approximate portfolio *loss* of $1,343,650.

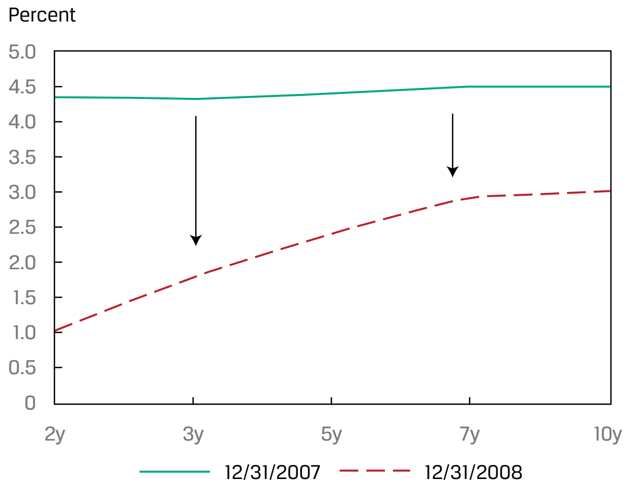
The portfolio manager is indifferent as to whether the portfolio gain from a greater slope arises due to a greater change in value from short-term or long-term yield movements as the duration is matched between the two positions. Two variations of a steeper yield curve adapted from Smith (2014) are shown in Exhibit 14.

Exhibit 14: Yield Curve Slope Changes—Steepening



In an earlier lesson on establishing a rate view, we highlighted a **bull steepening** scenario under which short-term yields-to-maturity fall by more than long-term yields-to-maturity if the monetary authority cuts benchmark rates to stimulate economic activity during a recession. Exhibit 15 shows the bull steepening that occurred in the UK gilt yield curve amid the 2008 global financial crisis. After reaching a cycle peak of 5.75% in July 2007, the Bank of England cut its monetary policy base rate six times, down to 2.00% in early December 2008, due to weakening economic conditions and financial market stress.

Exhibit 15: UK Government Yields, 2007 versus 2008 (Year End)



Source: Bloomberg.

On the other hand, a **bear steepening** occurs when long-term yields-to-maturity rise more than short-term yields-to-maturity. This could result from a jump in long-term rates amid higher growth and inflation expectations while short-term rates remain unchanged. In this case, an analyst might expect the next central bank policy change to be a monetary tightening to curb inflation.

Bull or bear steepening expectations will change the strategy an active fixed-income manager might pursue, as seen in Exhibit 16.

Exhibit 16: Yield Curve Steepener Strategies

Strategy	Description	Expected Excess Return	Downside Risks
Duration neutral	Net zero duration	Portfolio gain from yield curve slope increase	Yield curve flattening
Bear steepener	Net negative ("short") duration	Portfolio gain from slope increase and/or rising yields	Yield curve flattening and/or lower yields
Bull steepener	Net positive ("long") duration	Portfolio gain from slope increase and/or lower yields	Yield curve flattening and/or higher yields

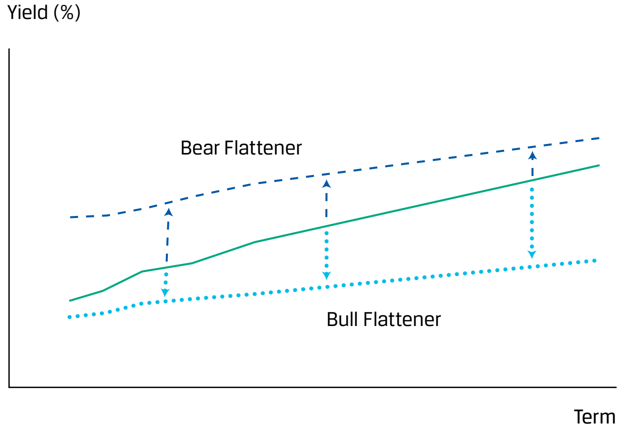
For example, assume an active manager expects the next yield curve change to be a bull steepening and establishes the following portfolio using the same 2-year and 10-year Treasury securities as in our prior examples.

Tenor	Coupon	Position ($ MM)	Modified Duration	Convexity
Long 2y	0.25%	213.8	1.994	5.0
Short 10y	2.00%	–36.2	9.023	90.8

In contrast to the earlier duration-matched steepener, the bull steepener increases the 2-year long Treasury position by $50 million, introducing a net long duration position to capitalize on an anticipated greater decline in short-term yields-to-maturity. We can see this by solving for portfolio duration of 0.5613, or [1.994 × 213.8/(213.8 – 36.2)] + [9.023 × –36.2/(213.8 – 36.2)], which is equivalent to a portfolio BPV of approximately $9,969, or 0.5613 × [($213,800,000 – $36,200,000)/10,000]. We may use this portfolio BPV to estimate the approximate portfolio gain if the 2-year yield-to-maturity and the 10-year yield-to-maturity fall by 25 bps, which is equal to $249,225 (= 25 bps × $9,969).

Yield curve flattening involves an anticipated narrowing of the difference between long-term and short-term yields-to-maturity, two basic variations of which are shown in Exhibit 17 and are adapted from Smith (2014).

Exhibit 17: Yield Curve Slope Changes—Flattening



A flatter yield curve may follow monetary policy actions due to changing growth and inflation expectations. For example, a **bear flattening** scenario might follow the bear steepening move seen in Exhibit 15 if policymakers respond to rising inflation expectations and higher long-term rates by raising short-term policy rates. It was established earlier in the curriculum that investors sell higher risk assets and buy default risk-free government bonds in a flight to quality during highly uncertain markets, a situation which often contributes to **bull flattening** as long-term rates fall more than short-term rates. Flattener strategies may use a barbell strategy, which reverses the exposure profile of a steepener—namely, a "short" short-term bond position and a "long" long-term bond position. The bull and bear variations of this strategy are summarized in Exhibit 18.

Exhibit 18: Yield Curve Flattener Strategies

Strategy	Description	Expected Excess Return	Downside Risks
Duration neutral	Net zero duration position	Portfolio gain from yield curve slope decrease	Yield curve steepening
Bear flattener	Net negative duration position	Portfolio gain from slope decrease and/or rising yields	Yield curve steepening and/or lower yields
Bull flattener	Net positive duration position	Portfolio gain from slope decrease and/or lower yields	Yield curve steepening and/or higher yields

Say, for example, a French investor expects the government yield curve to flatten over the next six months following years of quantitative easing by the European Central Bank through 2019. Her lack of a view as to whether this will occur amid lower or higher rates causes her to choose a duration neutral flattener using available French government (OAT) zero-coupon securities. She decides to enter the following trade at the beginning of 2020:

Tenor	Yield	Price	Notional (€ MM)	Modified Duration	Position BPV	Convexity
Short 2y	–0.65%	€101.313	–83.24	2.013	(€16,975)	6.1
Long 10y	0.04%	€99.601	17.05	9.996	€16,977	110

Note that as the Excel PRICE function returns a #NUM! error value for bonds with negative yields-to-maturity, we calculate the 2-year OAT zero-coupon bond price of 101.313 using $100/(1 - 0.0065)^2$. The initial portfolio BPV close to zero tells us that parallel yield curve shifts will have little effect on portfolio value, while the short 2-year and long 10-year trades position the manager to profit from a decline in the current 69 bp spread between 2- and 10-year OAT yields-to-maturity. After six months, the portfolio looks as follows:

Tenor	Yield	Price	Notional (€ MM)	Modified Duration	Convexity
Short 1.5y	–0.63%	€100.95	–83.24	1.51	3.8
Long 9.5y	–0.20%	€101.92	17.05	9.52	100.2

At the end of six months (June 2020), the sharp decline in economic growth and inflation expectations due to the COVID-19 pandemic caused the OAT yield curve to flatten as the 10-year yield-to-maturity fell. The six-month barbell return of €695,332 is comprised of rolldown return and yield changes, calculated as follows:

Rolldown Return

Zero-coupon bonds usually accrete in value as time passes if rates remain constant and the yield-to-maturity is positive. However, under negative yields-to-maturity, amortization of the bond's premium will typically result in a *negative* rolldown return. In our example, the investor is short the original 2-year zero and therefore realizes a *positive* rolldown return on the short position. Rolldown return on the barbell may be shown to be approximately €277,924, as follows:

"Short" 2-year: $-€83.24\text{ MM} \times ([1/(1 + -0.65\%)^{1.5}] - [1/(1 + -0.65\%)^{2})]$

"Long" 10-year: $€17.05\text{ MM} \times ([1/(1 + 0.04\%)^{9.5}] - [1/(1 + 0.04\%)^{10})]$

Δ Price Due to Benchmark Yield Changes

The yield difference falls from 69 bps to 43 bps, mostly due to a 24 bp decline in the 10-year yield-to-maturity. Note that the Excel DURATION and MDURATION functions also return a #NUM! error for negative yields-to-maturity. We may use either price changes, as shown next, or the modified duration and convexity statistics as of the end of the investment horizon, just shown, to calculate a return of €417,408 using Equation 3.

"Short" 2-year: $-€83.24\text{ MM} \times ([1/(1 + -0.63\%)^{1.5}] - [1/(1 + -0.65\%)^{1.5}])$

"Long" 10-year: $€17.05\text{ MM} \times ([1/(1 - 0.20\%)^{9.5}] - 1/(1 + 0.04\%)^{9.5}])$

As we have considered duration-neutral, long, and short duration strategies to position the portfolio for expected yield curve slope changes, average duration is clearly no longer a sufficient summary statistic. A barbell strategy has greater cash flow dispersion and is therefore more convex than a bullet strategy, implying that its value will decrease by less than a bullet if yields-to-maturity rise and increase by more than a bullet if yields-to-maturity fall. We therefore must consider portfolio convexity in addition to duration when weighing yield curve slope strategies under different scenarios.

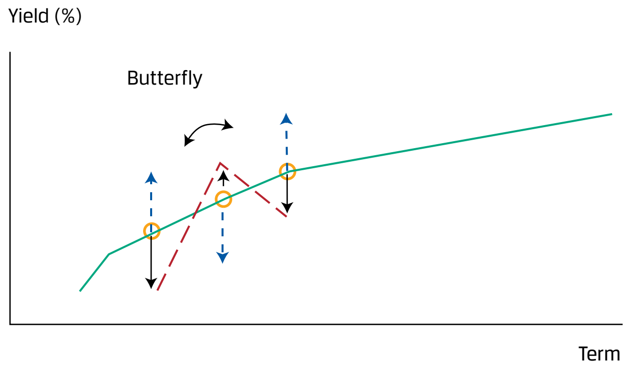
Divergent Yield Curve Shape View

As described in Section 2.1, yield curve shape or curvature describes the relationship between short-, medium-, and long-term yields-to-maturity across the term structure. Recall from Equation 2 that we quantify the butterfly spread by subtracting both short- and long-term rates from twice the intermediate yield-to-maturity. Since the difference between short- and medium-term rates is typically greater than that between medium- and long-term rates, the butterfly spread is usually positive, as seen earlier in Exhibit 3.

What factors drive yield curve curvature changes as distinct from rate level or curve slope changes? The segmented markets hypothesis introduced previously offers one explanation: Different market participants face either regulatory or economic asset/liability management constraints that drive the supply and demand for fixed-income instruments within different segments of the term structure. For example, a potential factor driving the apparent butterfly spread volatility in Exhibit 3 is the active central bank purchases of Treasury securities at specific maturities under its quantitative easing policy.

The most common yield curve curvature strategy combines a long bullet with a short barbell portfolio (or vice versa) in what is referred to as a **butterfly strategy** to capitalize on expected yield curve shape changes. The short-term and long-term bond positions of the barbell form the "wings," while the intermediate-term bullet bond position forms the "body" of the butterfly, as illustrated in Exhibit 19. Note that unlike the steepener and flattener cases, the investor is either “long” or “short” *both* a short-term and long-term bond and enters into an intermediate-term bullet trade in the opposite direction.

Exhibit 19: Butterfly Strategy



For example, consider a situation in which an active manager expects the butterfly spread to rise due to lower 2- and 10-year yields-to-maturity and a higher 5-year Treasury yield-to-maturity. Using the same portfolio statistics as in prior examples with bonds priced at par, consider the following combined *short* (5-year) bullet and *long* (2-year and 10-year) barbell strategy.

Tenor	Yield to Maturity	Position ($ MM)	Modified Duration	Position BPV	Convexity
Long 2y	0.25%	110	1.994	$21,934	5.0
Short 5y	0.875%	–248.3	4.88	($121,170)	26.5
Long 10y	2.00%	110	9.023	$99,253	90.8

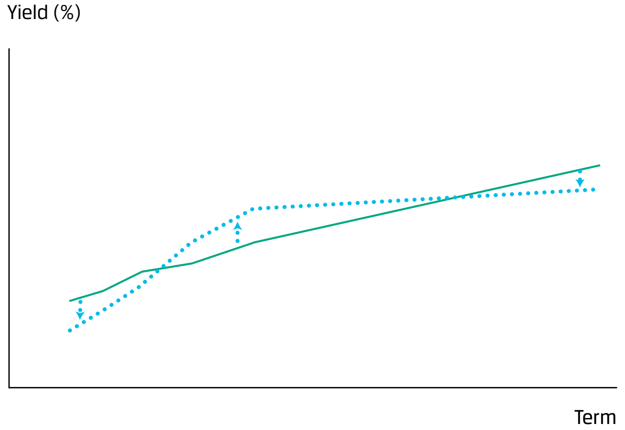
While the sum of portfolio positions (–$28.3 MM) shows that the investor has a net “short” bond position, we can verify the strategy is duration neutral by either adding up the position BPVs or calculating the portfolio duration, or [1.994 × (110/–28.3)] + [4.88 × (–248.3/–28.3)] + [9.023 × (110/–28.3)] to confirm that both are approximately zero. The portfolio convexity may be shown as –139.9, or [5.0 × (110/–28.3)] + [26.5 × (–248.3/–28.3)] + [90.8 × (110/–28.3)].

How does this portfolio perform if 2- and 10-year Treasury yields-to-maturity fall by 25 bps each and the 5-year yield-to-maturity rises by 50 bps? A duration-based estimate multiplying each position BPV by the respective yield change gives us an approximation of $9,088,175, or (+25 bps × $21,934) + –(50 bps × -$121,170) + (+25 bps × $99,253). A more precise answer of $9,038,877 incorporating convexity for each position may be derived using Equation 3. You might ask why the precise portfolio value change is below our approximation. The answer lies in the relative *magnitude* of yield changes across the curve. Since the 5-year yield-to-maturity is assumed to increase by 50 bps rather than 25 bps, the convexity impact of the short bullet position outweighs that of the long barbell. Although the portfolio is nearly immune to parallel yield curve changes with a BPV close to zero, the portfolio gain in our example coincides with an increase in the butterfly spread from –50 bps to +100 bps.

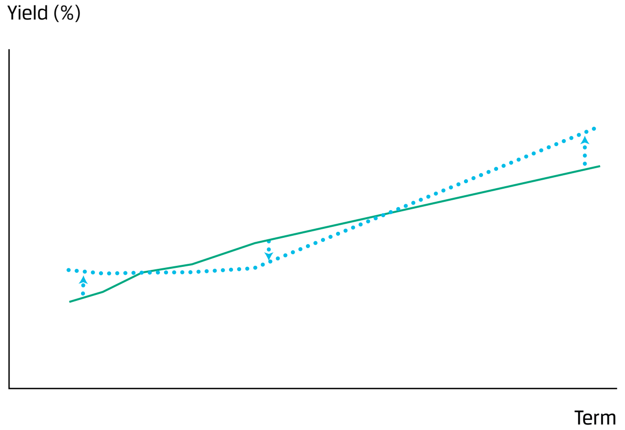
This example shows that an active manager’s specific view on *how* yield curve shape will change will dictate the details of the combined bullet and barbell strategy. Exhibit 20, adapted from Smith (2014), shows both the **negative butterfly** view just shown as well as a **positive butterfly**, which indicates a *decrease* in the butterfly spread due to an expected rise in short- and long-term yields-to-maturity combined with a lower medium-term yield-to-maturity. Note that a positive butterfly view indicates a decrease in butterfly spread due to a bond's inverse price–yield relationship.

Exhibit 20: Yield Curve Curvature Changes

A. Negative Butterfly



B. Positive Butterfly



Note that as in the case of yield curve slope strategies, the *combination* of a short bullet and long barbell increases portfolio convexity due to higher cash flow dispersion, making this a more meaningful portfolio risk measure for this strategy than average duration (which remains neutral in the Exhibit 20 example). Exhibit 21 summarizes the two butterfly strategies.

Exhibit 21: Yield Curve Curvature Strategies

Expected Scenario	Investor's Expectation	Active Position
Negative butterfly	Lower short- and long-term yields, Higher medium-term yields	Short bullet, Long barbell (long positions in short- and long-term bonds)
Positive butterfly	Higher short- and long-term yields, Lower medium-term yields	Long bullet, Short barbell (short positions in short- and long-term bonds)

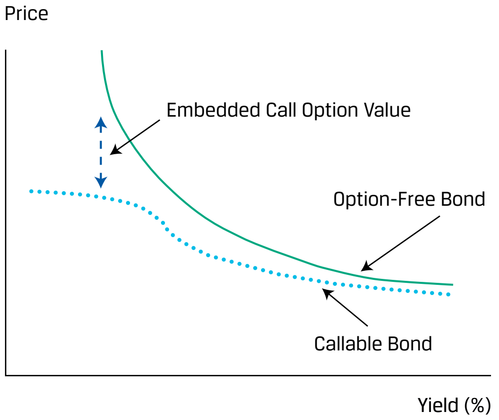
Yield Curve Volatility Strategies

While the prior sections focused on strategies using option-free bonds and swaps and futures as opposed to bonds with embedded options and stand-alone option strategies, we now explicitly address the role of volatility in active fixed-income management.

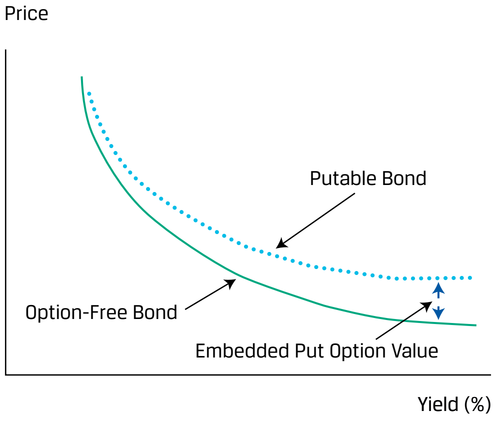
Option-only strategies play a more modest role in overall yield curve management. In markets such as in the United States where a significant portion of outstanding fixed-income bonds, such as asset-backed securities, have embedded options, investors use cash bond positions with embedded options more frequently than stand-alone options to manage volatility. For example, as of 2019 approximately 30% of the Bloomberg Barclays US Aggregate Bond Index was comprised of securitized debt, which mostly includes bonds with embedded options. As outlined earlier, the purchase of a bond call (put) option offers an investor the right, but not the obligation, to buy (sell) an underlying bond at a pre-determined strike price. An active manager's choice between purchasing or selling bonds with embedded call or put options versus an option-free bond with otherwise similar characteristics hinges upon expected changes in the option value and whether the investor is "short" volatility (i.e., has sold the right to call a bond at a fixed price to the issuer), as in the case of callable bonds, or "long" volatility (i.e., owns the right to sell the bond at a fixed price to the issuer), as for putable bonds. Exhibit 22 shows how callable and putable bond prices change versus option-free bonds as yields-to-maturity change.

Exhibit 22: Callable and Putable versus Option-Free Bonds

A. Callable Bond



B. Putable Bond



EXAMPLE 8

Option-Free Bonds versus Callable/Putable Bonds

1. An investment manager is considering an incremental position in a callable, putable, or option-free bond with otherwise comparable characteristics. If she expects a downward parallel shift in the yield curve, it would be most profitable to be:

   a. long a callable bond.

   b. short a putable bond.

   c. long an option-free bond.

Solution:

"C" is correct. The value of a bond with an embedded option is equal to the sum of the value of an option-free bond plus the value to the embedded option. The bond investor can be either long or short the embedded option, depending on the type of bond. With a callable bond, the embedded call option is owned by the issuer of the bond, who can exercise this option if yields-to-maturity decrease (the bond investor is short the call option). With a putable bond, the embedded put option is owned by the bond investor, who can exercise the option if yields-to-maturity increase. For a decrease in yields-to-maturity—as given in the question—the value of the embedded call option increases and the value of the embedded put option decreases. This means that a long position in a callable bond ("A") would underperform compared to a long position in an option-free bond. A short position in a putable bond ("B") would underperform a long position in an option-free bond primarily because yields-to-maturity were declining, although the declining value of the embedded put option would mitigate some of the loss (the seller of the putable bond has "sold" the embedded put).

As mentioned earlier in the curriculum, effective duration and convexity are the relevant summary statistics when future bond cash flows are contingent upon interest rate changes.

$$\text{Effective Duration (EffDur)} = \frac{(PV_-) - (PV_+)}{2 \times (\Delta\text{Curve})(PV_0)}. \tag{8}$$

$$\text{Effective Convexity (EffCon)} = \frac{(PV_-) + (PV_+) - 2(PV_0)}{(\Delta\text{Curve})^2 \times (PV_0)}. \tag{9}$$

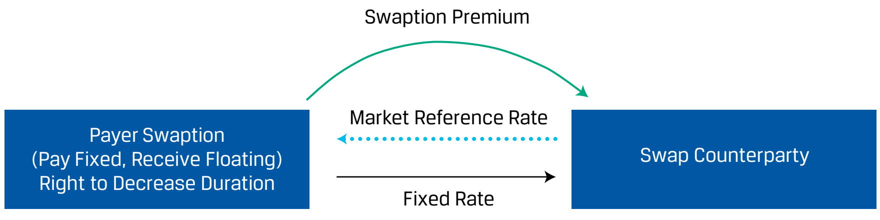
In Equation 8 and Equation 9, PV_- and PV_+ are the portfolio values from a decrease and increase in yield-to-maturity, respectively, PV_0 is the original portfolio value, and ΔCurve is the change in the benchmark yield-to-maturity.

Although cash-based yield curve volatility strategies are limited to the availability of liquid callable or putable bonds, several stand-alone derivatives strategies involve the right, but not the obligation, to change portfolio duration and convexity based upon an interest rate-sensitive payoff profile.

Interest rate put and call options are generally based upon a bond's price, not yield-to-maturity. Therefore, the purchase of a bond call option provides an investor the right, but not the obligation, to acquire an underlying bond at a pre-determined strike price. This purchased call option adds convexity to the portfolio and will be exercised if the bond price appreciates beyond the strike price (i.e., generally at a lower yield-to-maturity). On the other hand, a purchased bond put option benefits the owner if prices fall (i.e., yields-to-maturity rise) beyond the strike prior to expiration. Sale of a bond put (call) option limits an investor's return to the up-front premium received in exchange for assuming the potential cost of exercise if bond prices fall below (rise above) the pre-determined strike. Note that the option seller must post margin based on exchange or counterparty requirements until expiration.

An interest rate **swaption** involves the right to enter into an interest rate swap at a specific strike price in the future. This instrument grants the contingent right to increase or decrease portfolio duration. For example, Exhibit 23 shows a purchased payer swaption, which a manager might purchase to benefit from higher rates using an option-based strategy.

Exhibit 23: Purchased Payer Swaption



Options on bond futures contracts are liquid exchange-traded instruments frequently used by fixed-income market participants to buy or sell the right to enter into a futures position. Long option, swaption, and bond futures option strategies are summarized in Exhibit 24.

Exhibit 24: Long Option, Swaption, and Bond Futures Option Strategies

Strategy	Description	Targeted Return	Portfolio Duration Impact
Long bond call option	Purchase right to take forward bond delivery	Max (Bond price at lower yield – Strike price, 0) – Call premium	Increase portfolio duration
Long bond put option	Purchase right to deliver bond in the future	Max (Strike price – Bond price at higher yield, 0) – Put premium	Decrease portfolio duration
Long payer swaption	Own the right to pay-fixed on an interest rate swap at a strike rate	Max (Strike rate – Swap rate, 0) – Swaption premium	Decrease in portfolio duration
Long receiver swaption	Own the right to receive-fixed on an interest rate swap at a strike rate	Max (Swap rate – Strike rate, 0) – Swaption premium	Increase in portfolio duration
Long call option on bond future	Own the right to take forward bond delivery at a strike price	Max (Bond futures price at lower yield – Strike price, 0) – Call premium	Increase in portfolio duration
Long put option on bond future	Own the right to deliver bond in the future at a strike price	Max (Strike price – Bond futures price at higher yield, 0) – Put premium	Decrease in portfolio duration

EXAMPLE 9

Choice of Option Strategy

1. A parallel upward shift in the yield curve is expected. Which of the following would be the best option strategy?

   a. Long a receiver swaption

   b. Short a payer swaption

   c. Long a put option on a bond futures contract

Solution:

C is correct. With an expected upward shift in the yield curve, the portfolio manager would want to reduce portfolio duration in anticipation of lower bond prices. A put option increases in value as the yield curve shifts upward, while the price of the underlying bond declines below the strike. A is incorrect because a receiver swaption is an option to receive-fixed in an interest rate swap. With fixed-rate bond prices expected to fall as rates rise, the portfolio manager would not want to exercise an option to receive a fixed strike rate, which is similar to owning a fixed-rate bond. B is incorrect because a payer swaption is an option to pay-fixed/receive-floating in an interest rate swap. A *long*, not a short, position in a payer swaption would benefit from higher rates.

In an expected stable or static yield curve environment, an active manager may aim to "sell" volatility in the form of either owning callable bonds (which is an implicit "sale" of an option) or selling stand-alone options in order to earn premium income, if this is within the investment mandate. The active portfolio decision here depends upon the manager's view as to whether future realized volatility will be greater or less than the implied volatility, as reflected by the price of a stand-alone option or a bond with embedded options. The manager will benefit if rates remain relatively constant and the bond is not called and/or the options sold expire worthless. Alternatively, if yield curve volatility is expected to increase, a manager may prefer to be long volatility in order to capitalize on large changes in level, yield curve slope, and/or shape using option-based contracts.

EXAMPLE 10

Option-Free versus Callable and Putable Bonds Amid Higher Yield Levels

1. Given a parallel shift upwards in the yield curve, what is the most likely ordering in terms of expected decline in value—from least to most—for otherwise comparable bonds? Assume that the embedded options are deep out-of-the-money.

   a. Callable bond, option-free bond, putable bond
   b. Putable bond, callable bond, option-free bond
   c. Putable bond, option-free bond, callable bond

Solution:

Answer: B is correct. The value of a bond with an embedded option may be considered as the value of an option-free bond plus the value of the embedded option. While the upward shift in the yield curve will cause the option-free component of each bond to depreciate in value, this change in yields-to-maturity will also affect the value of embedded options.

For a putable bond, the bond investor has the option to "put" the bond back to the issuer if yields-to-maturity rise. The more rates rise, the more valuable this embedded option becomes. This increasing option value will partially offset the decline in value of the putable bond relative to the option-free bond. This can be seen in the lower panel of Exhibit 22: The dotted line for the putable bond has a flatter slope than the solid line for the option-free bond; its price will decrease more slowly as yields-to-maturity increase. For a callable bond, the bond issuer has an option to "call" the bond if yields-to-maturity decline; the more rates rise, the lower the call option value. Since the bond investor is short the embedded option and the value of the embedded option has fallen, this will partially offset the decline in the value of the callable bond relative to the option-free bond. The top panel of Exhibit 22 shows that the dotted line for the callable bond has a flatter slope than the solid line for the option-free bond.

As rates continue to increase, the embedded option for the putable bond rises in value more quickly at the margin as it shifts toward becoming an in-the-money option. In contrast, the deep out-of-the-money embedded call option moves further out-of-the-money as rates increase and the marginal impact of further rate increases declines.

Key Rate Duration for a Portfolio

So far, we have evaluated changes in yield curve level, slope, and curvature using one, two, and three specific maturity points across the term structure of interest rates, respectively. The concept of **key rate duration** (or partial duration) introduced previously measures portfolio sensitivity over a set of maturities along the yield curve, with the sum of key rate durations being identical to the effective duration:

$$\text{KeyRateDur}_k = \frac{1}{\text{PV}} \times \frac{\Delta \text{PV}}{\Delta r_k} \tag{10}$$

$$\sum\nolimits_{k=1}^{n} \text{KeyRateDur}_k = \text{EffDur}, \tag{11}$$

where r_k represents the kth key rate and PV is the portfolio value. In contrast to effective duration, key rate durations help identify "shaping risk" for a bond portfolio—that is, a portfolio's sensitivity to changes in the shape of the benchmark yield curve. By breaking down a portfolio into its individual duration components by maturity, an active manager can pinpoint and quantify key exposures along the curve, as illustrated in the following simplified zero-coupon bond example.

Compare a passive zero-coupon US Treasury bond portfolio versus an actively managed portfolio:

"Index" Zero-Coupon Portfolio

Tenor	Coupon	Annualized Yield	Price (per $100)	Position ($ MM)	ModDur	KeyRateDur
2y	0.00%	1%	98.03	98.03	1.980	0.738
5y	0.00%	2%	90.57	90.57	4.902	1.688
10y	0.00%	3%	74.40	74.40	9.709	2.747

Assume the "index" portfolio is simply weighted by the price of the respective 2-, 5-, and 10-year bonds for a total portfolio value of $263 million, or $1 million × (98.03 + 90.57 + 74.4). We can calculate the portfolio modified duration as 5.173, or [1.98 × (98.03/263)] + [4.902 × (90.57/263)] + [9.709 × (74.40/263)]. Or, we could calculate each key rate duration by maturity, as in the far right column. For example, the 2-year key rate duration (KeyRateDur_2) equals 0.738, or 1.98 × (98.03/263). Note that these three key rate duration values also sum to the portfolio value of 5.173.

"Active" Zero-Coupon Portfolio

Tenor	Coupon	Annualized Yield	Price (per $100)	Position ($ MM)	ModDur	KeyRateDur
2y	0.00%	1%	98.03	51.40	1.980	0.387
5y	0.00%	2%	90.57	−46.00	4.902	−0.857
10y	0.00%	3%	74.40	257.60	9.709	9.509

As in the case of the "index" portfolio, the "active" zero-coupon portfolio has a value of $263 million, or [$1 million × (51.4 − 46 + 257.6)], but the portfolio duration is greater at 9.039, or [1.98 × (51.4/263)] + [4.902 × (−46/263)] + [9.709 × (257.6/263)]. Note that the short 5-year active position has a negative key rate duration of −0.857, or 4.902 × (−46/263).

By now, you may have noticed that our active manager is positioned for the combination of a negative butterfly and a bull flattening at the long end of the yield curve. However, a comparison of the active versus index portfolio duration summary statistic does not tell the entire story. Instead, we can compare the key rate or partial durations for specific maturities across the index and active portfolios to better understand exposure differences:

Tenor	Active	Index	Difference
2y	0.39	0.74	−0.35
5y	−0.86	1.69	−2.55
10y	9.51	2.75	6.76
Portfolio	9.04	5.17	3.87

The key rate duration differences in this chart provide more detailed information regarding the exposure differences across maturities. For example, the negative differences for 2-year and 5-year maturities (−0.35 and −2.55, respectively) indicate that the active portfolio has lower exposure to short-term rates than the index portfolio. The large positive difference in the 10-year tenor shows that the active portfolio has far greater exposure to 10-year yield-to-maturity changes. This simple zero-coupon bond example may be extended to portfolios consisting of fixed-coupon bonds, swaps, and other rate-sensitive instruments that may be included in a fixed-income portfolio, as seen in the following example.

EXAMPLE 11

Key Rate Duration

1. A fixed-income manager is presented with the following key rate duration summary of his actively managed bond portfolio versus an equally weighted index portfolio across 5-, 10-, and 30-year maturities:

Tenor	Active	Index	Difference
5y	−1.188	1.633	−2.821
10y	2.909	3.200	−0.291

Tenor	Active	Index	Difference
30y	11	8.067	2.933
Portfolio	12.72	12.9	–0.179

Assume the active manager has invested in the index bond portfolio and used only derivatives to create the active portfolio. Which of the following most likely represents the manager's synthetic positions?

a. Receive-fixed 5-year swap, short 10-year futures, and pay-fixed 30-year swap

b. Pay-fixed 5-year swap, short 10-year futures, and receive-fixed 30-year swap

c. Short 5-year futures, long 10-year futures, and receive-fixed 30-year swap

Solution:

Answer: B is correct. The key rate duration summary shows the investor to be net short 5- and 10-year key rate duration and long 30-year key rate duration versus the index. A combines synthetic long, short, and short positions in the 5-, 10-, and 30-year maturities, respectively. C combines short, long, and long positions across the curve. The combination of a pay-fixed (short duration) 5-year swap, a short 10-year futures position, and a receive-fixed (long duration) 30-year swap is, therefore, the best answer.

4 ACTIVE FIXED-INCOME MANAGEMENT ACROSS CURRENCIES

☐ discuss yield curve strategies across currencies

The benefits of investing across borders to maximize return and diversify exposure is a consistent theme among portfolio managers. While both the tools as well as the strategic considerations of active versus passive currency risk management within an investment portfolio are addressed elsewhere, here we will primarily focus on extending our analysis of yield curve strategies from a single yield curve to multiple yield curves across currencies.

An earlier currency lesson noted that investors measure return in functional currency terms—that is, considering domestic currency returns on foreign currency assets, as shown in Equation 12 and Equation 13.

$$\text{Single asset: } R_{DC} = (1 + R_{FC})\,(1 + R_{FX}) - 1 \tag{12}$$

$$\text{Portfolio: } R_{DC} = \sum_{i=1}^{n} \omega_i \left(1 + R_{FC,i}\right) \left(1 + R_{FX,i}\right) - 1 \tag{13}$$

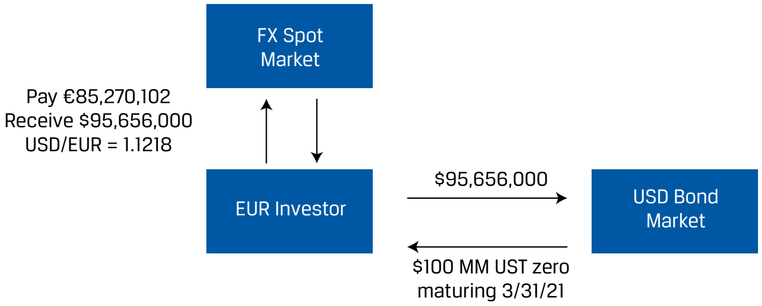
R_{DC} and R_{FC} are the domestic and foreign currency returns expressed as a percentage, R_{FX} is the percentage change of the domestic versus foreign currency, while ω_i is the respective portfolio weight of each foreign currency asset (in domestic currency terms) with the sum of ω_i equal to 1. In the context of Equation 1, R_{DC} simply combines the third factor, +/–*E* (Δ Price due to investor's view of benchmark yield), and the fifth factor, +/–*E* (Δ Price due to investor's view of currency value changes), factors in the expected fixed-income return model.

In a previous term structure lesson, we highlighted several macroeconomic factors that influence the bond term premium and required returns, such as inflation, economic growth, and monetary policy. Differences in these factors across countries are frequently reflected in the relative term structure of interest rates as well as in exchange rates.

For example, after a decade of economic expansion following the 2008 global financial crisis, the US Federal Reserve's earlier reversal of quantitative easing versus the European Central Bank through 2019 led to significantly higher short-term government yields-to-maturity in the United States versus Europe.

Against this historical backdrop, assume a German fixed-income manager decides to buy short-term US Treasuries to take advantage of higher USD yields-to-maturity. At the end of March 2019, a USD Treasury zero-coupon bond maturing on 31 March 2021 had a price at 95.656, with an approximate yield-to-maturity of 2.25%. Based upon the then-current USD/EUR spot rate of 1.1218 (that is, $1.1218 = €1), the manager pays €85,270,102 (= $95,656,000/1.1218) for a $100 million face value Treasury security, as seen in Exhibit 25.

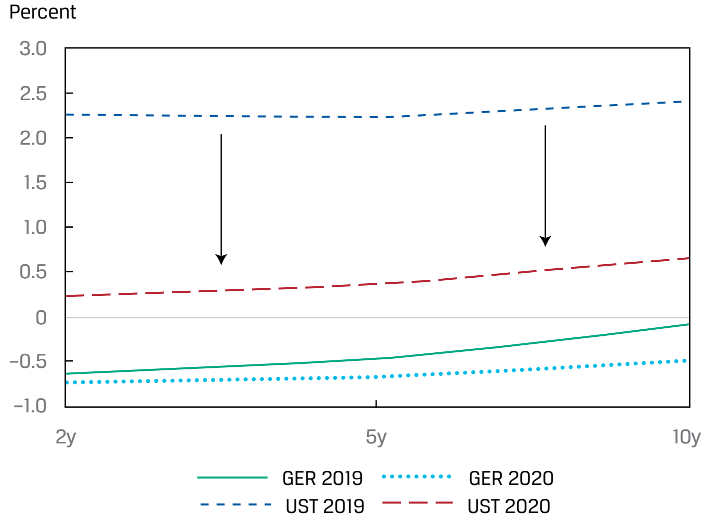
Exhibit 25: USD/EUR Spot Trade and US Treasury Zero Purchase



As in the single currency yield curve case, the investor will benefit from bond price appreciation if the US Treasury yield-to-maturity falls during the holding period. In addition, since her domestic returns are measured in EUR, she will also benefit if the USD she receives upon sale of the bond or at maturity buy more EUR per USD in the future—that is, if USD/EUR decreases (i.e., USD *appreciates* versus EUR).

In fact, the flight to quality induced by the COVID-19 pandemic in early 2020 led to a sharp decline in US Treasury yields-to-maturity. Exhibit 26 shows how the relationship between US and German government rates changed between March 2019 and March 2020.

Exhibit 26: US vs. German Government Yield Curves, 2019 and 2020



Source: Bloomberg.

As a result, one year after purchase (31 March 2020), the US Treasury zero-coupon bond maturing 31 March 2021 traded at a price of 100.028 and the USD/EUR spot was 1.1031.

Now we calculate the German investor's 1-year domestic currency return from holding the $100 million par value US Treasury zero-coupon bond.

Equation 12 separates this return into two key components:

$\boldsymbol{R_{FC}}$: 4.57%, = ($100,028,000/$95,656,000) − 1, as the investor receives $100,028,000 upon sale of the US Treasury bond purchased a year earlier at $95,656,000.

$\boldsymbol{R_{FX}}$: 1.70%, = (1.1218/1.1031 − 1), as the investor converted €85,270,102 into USD to purchase the bond at 1.1218 and then converted USD proceeds back to EUR at 1.1031. The EUR depreciated (i.e., lower USD/EUR spot rate) over the 1-year period.

$\boldsymbol{R_{DC}}$ may be shown to be 6.34%, solved either using Equation 12 or directly for the 1-year return on investment in EUR terms, = (€90,678,996/€ 85,270,102) –1.

In contrast to the *unhedged* 1-year example, let us now assume that the German manager fully hedges the foreign currency risk associated with the US Treasury bond purchase and holds it instead for two years, at which time she receives the bond's face value of $100,000,000. Specifically, the manager enters a 2-year FX forward agreement at the time of bond purchase to sell the future $100,000,000 payment upon bond maturity and buy EUR at the then current 2-year USD/EUR forward rate of 1.1870, locking in a certain €84,245,998, = $100,000,000/1.1870, in two years' time.

If fully hedged, the expected annualized return, R_{DC}, in EUR terms on the 2-year US Treasury zero-coupon bond hedged EUR investment over two years is equal to –0.60%, = $(€84{,}245{,}998/€85{,}270{,}102)^{0.5}$ – 1, which matches the 2-year annualized German government zero-coupon bond yield-to-maturity upon inception. This may also be calculated using Equation 12, with R_{FC} = 2.25% and R_{FX} = –2.785%, or $(1.1218/1.1870)^{0.5}$ – 1.

The fully hedged investment example is a reminder from earlier lessons that **covered interest rate parity** establishes a fundamental no-arbitrage relationship between spot and forward rates for individual cash flows in T periods, as shown in Equation 14.

$$F\left(\frac{\text{DC}}{\text{FC}}, T\right) = S_0(\text{DC/FC})\frac{\left(1 + r_{\text{DC}}\right)^T}{\left(1 + r_{\text{FC}}\right)^T} \tag{14}$$

F denotes the forward rate; S is the spot rate; and r_{DC} and r_{FC} reflect the respective domestic and foreign currency risk-free rates. If an investor uses a forward contract to fully hedge foreign currency cash flows, she should expect to earn the domestic risk-free rate, as seen in our example. Recall also that this implies in general that a higher-yielding currency will trade at a forward discount, while a lower-yielding currency will trade at a premium. This is consistent with USD/EUR spot versus forward exchange rates (1.1218 spot versus the 1.187 2-year forward rate) as well as the relationship between USD rates and EUR rates in 2019, as shown in Exhibit 26.

In contrast, **uncovered interest rate parity** suggests that over time, the returns on unhedged foreign currency exposure will be the same as on a domestic currency investment. Although forward FX rates should in theory be an unbiased predictor of future spot FX rates if uncovered interest rate parity holds, in practice investors sometimes seek to exploit a persistent divergence from interest rate parity conditions (known as the **forward rate bias**) by investing in higher-yielding currencies, which is in some cases enhanced by borrowing in lower-yielding currencies.

This demonstrates that active fixed-income strategies across currencies must factor in views on currency appreciation versus depreciation as well as yield curve changes across countries. Our investor's USD versus EUR interest rate view in the previous example combined with an implicit view that USD/EUR would remain relatively stable led to the highest return in the unhedged case with a 1-year investment horizon. This stands in contrast to the relationship between USD/EUR spot and 2-year forward rates at the inception of the trade on 31 March 2019, when implied (annualized) EUR appreciation was 2.87%, = $(1.187/1.1218)^{0.5} - 1$.

The European fixed-income manager in our example might use leverage instead of cash by borrowing in euros when buying the 2-year US Treasury zero. This is an extension of the single currency repo carry trade shown in Exhibit 5, in which an investor borrows short-term in one currency and invests in another higher-yielding currency. This **carry trade across currencies** is a potential source of additional income subject to short-term availability if the positive interest rate differential persists for the life of the transaction. Given the preponderance of fixed-rate coupon versus zero-coupon bonds, our analysis turns next to these securities. As in the case of the fully hedged German investor in US Treasuries, we first establish the necessary building blocks to replicate a risk-free domestic currency return when investing in a foreign currency fixed-income coupon bond. We then consider how an active investor might deviate from this exposure profile to generate excess return.

Consider the example of a Japan-based investor who buys a fixed-rate USD coupon bond. In order to fully hedge JPY domestic currency cash flows for the foreign currency bond, as in the case of the earlier German investor, the investor must first sell Japanese yen (JPY) and purchase USD at the current spot rate to purchase the bond. At the end of each semi-annual interest period, the investor receives a USD coupon, which must be converted at the future JPY/USD spot rate (that is, the number of JPY required to buy one USD). At maturity, the investor receives the final semi-annual coupon and principal, which must be converted to JPY using the future JPY/USD spot rate to receive the final payment in domestic currency.

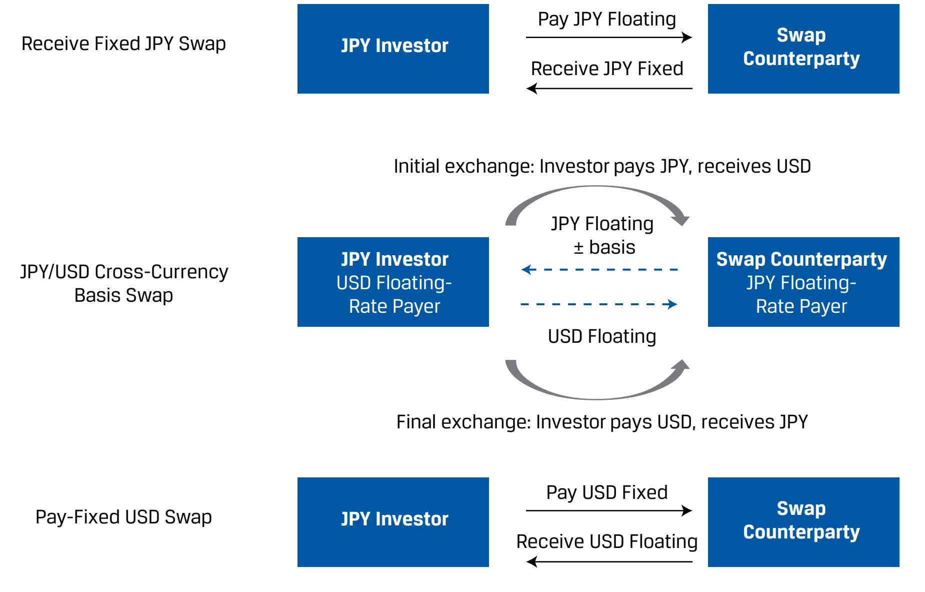
The fixed-rate foreign currency bond exposes the Japanese investor to a series of FX forward exposures that may be hedged upon purchase with a cross-currency swap, as seen in Exhibit 27 with the example of a par 10-year US Treasury bond with a 0.625% coupon issued in May 2020.

Exhibit 27: Fixed-Fixed Cross-Currency Swap Diagram and Details

Trade Details	JPY/USD Fixed-Fixed Cross-Currency Swap
Start date	15 May 2020
Maturity date	15 May 2030
Fixed USD payer	JPY Investor
Fixed JPY payer	Swap counterparty
Initial exchange	JPY investor pays JPY10.706 billion and receives USD100 million as of 15 May 2020
Fixed USD rate	0.625% Semiannual, Act/Act
Fixed JPY rate	−0.726% Semiannual, Act/365
Final exchange	JPY investor pays USD100 million and receives JPY10.706 billion as of 15 May 2030

Note that the fixed-fixed cross-currency swap components, shown in Exhibit 28, are a combination of three distinct hedging transactions: a receive-fixed JPY interest rate swap, a USD-JPY **cross-currency basis swap** involving the exchange of floating JPY for floating USD payments, and a pay-fixed USD interest rate swap.

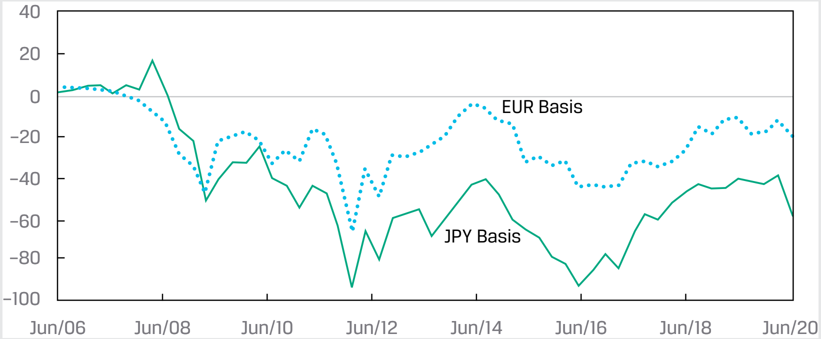
Exhibit 28: Fixed-Fixed Cross-Currency Swap Components



CROSS-CURRENCY BASIS AND COVERED INTEREST RATE PARITY

The "basis" or spread, as shown in the cross-currency basis swap, is the difference between the USD interest rate and the synthetic USD interest rate derived from swapping JPY into US dollars. A positive (negative) currency basis means that the direct USD interest rate is higher (lower) than the synthetic USD interest rate. While covered interest rate parity suggests that cross-currency basis should be close to zero, Exhibit 29 shows that the JPY and EUR cross-currency basis was persistently negative following the 2008 global financial crisis.

Exhibit 29: Five-Year JPY and EUR Cross-Currency Basis, 2006–2020



Cross-currency basis is widely seen as a barometer for global financial conditions. For example, greater credit and liquidity risk within the EU financial sector and the European Central Bank's aggressive quantitative easing have been cited as causes of the wider USD/EUR cross-currency basis.

Du, Tepper, and Verdelhan (2018) investigate the persistent no-arbitrage violation of covered interest rate parity implied by wider cross-currency basis observed across G-10 countries and offer several explanations. First, higher financial intermediation costs since the 2008 global financial crisis, such as higher bank regulatory capital requirements, prevent market participants from taking advantage of basis arbitrage opportunities. Second, covered interest rate parity violations suggest international imbalances in the form of high demand for investments in high interest rate currencies and a large supply of savings in low interest rate currencies. These deviations are magnified by divergent monetary policies across jurisdictions.

The building blocks of the fixed-fixed cross-currency swap shown in Exhibit 28 offer an active fixed-income investor a simplified framework within which one can take interest rate or currency positions to deviate from a risk-free domestic currency return. For example, by foregoing the pay USD fixed swap, the JPY investor takes a USD rate view by earning the USD fixed coupon and paying USD floating while fully hedging the currency exposure via the cross-currency basis swap. Similar principles apply as in the single currency case—namely, to go long (or overweight) assets expected to appreciate and go short (or underweight) assets expected to decline in value or appreciate less. The overweight and underweight bond positions may now be denominated in different currencies, with the active strategy often using an underweight position in one currency to fund an overweight position in another. The resulting yield curve strategy faces three potential risks: (1) yield curve movements—level, slope, or curvature—in the overweight currency; (2) yield curve changes in the underweight currency; and (3) exchange rate changes.

Consider the following unhedged example of a higher- versus lower-yielding currency.

EXAMPLE 12

MXN Carry Trade

Consider the case of a portfolio manager examining a cross-currency carry trade between US dollar (USD) and Mexican peso (MXN) money market rates. The manager is contemplating borrowing in USD for one year and investing in 90-day Mexican treasury bills, rolling them over at maturity for the next 12 months. Assume that today's 1-year USD interest rate is 1.85%, the 90-day MXN interest rate is currently 7.70% (annualized), and the MXN/USD spot exchange rate is 19.15 (that is, it takes 19.15 MXN to buy one USD).

If the manager expected that Mexican money market rates and the MXN/USD exchange rate would remain stable, the expected profit from this carry trade is:

$$(1 + 0.0770/4)^4 - (1 + 0.0185) \approx 6.08\%.$$

However, money market and exchange rates are rarely stable; this trade is exposed to changes in both the 90-day MXN interest rate and the MXN/USD spot exchange rate. (The 1-year fixed-rate USD loan eliminates exposure to USD rate changes). Assume that 90-day MXN interest rates and exchange rates change as follows over the 12-month period.

Rate / Time	Today	90 Days	180 Days	270 Days	360 Days
90-day MXN rate	7.70%	7.85%	8.15%	8.20%	N/A
MXN/USD spot rate	19.15	18.05	19.05	18.80	19.65

Note that 90-day MXN yields-to-maturity rose and that MXN depreciated slightly versus USD over the 360-day period. If the manager had rolled over this trade for the full 12 months, the realized return would have been:

$$\left(1 + \frac{0.0770}{4}\right)\left(1 + \frac{0.0785}{4}\right)\left(1 + \frac{0.0815}{4}\right)\left(1 + \frac{0.082}{4}\right) \times \frac{19.15}{19.65}$$
$$-(1 + 0.0185) \approx 3.61\%$$

While the cross-currency carry trade was ultimately profitable, it was exposed to risks over the horizon; moreover, despite the rise in 90-day MXN yields-to-maturity, a late-period MXN depreciation undercut the profitability of the trade. This underscores the fact that carry trades are unhedged and are most successful in stable (low volatility) markets: Unforeseen market volatility can quickly erase even the most attractive cross-currency carry opportunities. For example, in the first quarter of 2020 at the start of the COVID-19 pandemic, MXN depreciated against the USD by approximately 25% in just over a month.

While an endless number of unhedged strategies seeking to capitalize on a level, slope, or curvature view across currencies exist, Exhibit 30 summarizes several of these major strategies.

Exhibit 30: Active Cross-Currency Strategies

Strategy	Purchase	Sell / Borrow	Expected Unhedged Return
Receive-fixed/ pay-fixed	High-yielding fixed-income asset	Lower-yield fixed-rate loan	Carry (higher yield minus lower yield) assuming uncovered interest parity does not hold
Receive-fixed/ pay-floating	High-yielding fixed-rate asset	Short-term, lower yield floating-rate loan rolled over until maturity	Carry (higher yield minus lower yield) plus long- versus short-term rate differential for lower-yielding currency
Receive-floating/ pay-fixed	High-yield floating-rate asset	Lower-yield fixed-rate loan	Carry (higher floating yield minus lower fixed yield)
Receive-floating/ pay-floating	High-yield floating-rate asset	Short-term, lower yield floating-rate loan rolled over until maturity	Carry (higher floating yield minus lower floating yield)

EXAMPLE 13

Bear Flattening Impact

1. A fixed-income manager is considering a foreign currency fixed-income investment in a relatively high-yielding market, where she expects bear flattening to occur in the near future and her lower-yielding domestic yield curve to remain stable and upward-sloping. Under this scenario, which of the following strategies will generate the largest carry benefit if her interest rate view is realized?

   a. Receive-fixed in foreign currency, pay-fixed in domestic currency
   b. Receive-fixed in foreign currency, pay-floating in domestic currency
   c. Receive-floating in foreign currency, pay-floating in domestic currency

Solution:

The correct answer is C. If the higher-yielding foreign currency experiences a bear flattening in the yield curve as the manager expects, then foreign currency short-term yields-to-maturity will increase by more than long-term yields-to-maturity; thus she will want receive-floating in foreign currency. Given the upward-sloping domestic yield curve, we would expect the carry difference between receiving foreign currency floating rates and paying domestic currency floating rates to be the highest.

A FRAMEWORK FOR EVALUATING YIELD CURVE STRATEGIES 5

☐ evaluate the expected return and risks of a yield curve strategy

The factors affecting the expected return of a fixed-income portfolio were summarized in Equation 1. The key underlying assumption in this calculation is that the inputs rely on the fixed-income manager's expectations under an active strategy. As we have seen earlier, unexpected changes to the level, slope, and shape of the yield curve as well as currency changes can impact a portfolio's value in a number of ways—as quantified by the use of portfolio duration and convexity statistics in Equation 3 for a single currency and in Equation 13 for a multicurrency portfolio.

Practitioners frequently evaluate fixed-income portfolio risk using **scenario analysis**, which involves changing multiple assumptions at once to assess the overall impact of unexpected market changes on a portfolio's value. Managers may use historical rate and currency changes or conduct specific stress tests using this analysis. For example, a leveraged investor might evaluate how much rates or currencies must move before she faces a collateral or margin call or is forced to unwind a position. Fixed-income portfolio models offer practitioners a variety of historical or user-defined scenarios. The following scenario analysis example shows how this may be done for the US Treasury portfolio seen earlier.

EXAMPLE 14

Scenario Analysis—US Treasury Securities Portfolio

Tenor	Coupon	Price	Modified Duration	Convexity
2y	0.25%	100	1.994	5.0
5y	0.875%	100	4.88	26.5
10y	2.00%	100	9.023	90.8

In Example 1, we compared two $50 million portfolios. Portfolio A is fully invested in the 5-year Treasury bond, while Portfolio B is split between 2-year (58.94%) and 10-year (41.06%) bonds to match a 5-year bond duration of 4.88. Rather than the earlier parallel yield curve shift, we now analyze two yield curve slope scenarios—namely, an immediate bear steepening and bull flattening of the US Treasury yield curve. The bear steepening scenario involves a 50 bp and 100 bp *rise* in 5- and 10-year yields-to-maturity, respectively, while the bull flattening is assumed to result from a 50 bp fall in 5-year rates and a 100 bp fall in 10-year rates. Using Equation 3, our scenario analysis looks as follows:

Scenario	Portfolio A % Δ Price	Portfolio A Δ Price	Portfolio B % Δ Price	Portfolio B Δ Price
Bear steepening	−2.407%	($1,203,437)	−3.518%	($1,759,216)
Bull flattening	2.473%	$1,236,563	3.891%	$1,945,628

We may conclude from our analysis that although Portfolios A and B have similar duration and therefore perform similarly if the yield curve experiences a parallel shift (except for the convexity difference) seen in Example 1, they perform very differently under various yield curve slope scenarios.

The fixed-income portfolio risk and return impact of rolldown return versus carry, changes in the level, slope, and shape of a single currency yield curve, and an extension to multiple currencies (where spot and forward FX rates are related to relative interest rates) are best illustrated with a pair of examples.

EXAMPLE 15

AUD Bullet versus Barbell

A US-based portfolio manager plans to invest in Australian zero-coupon bonds denominated in Australian dollars (AUD). He projects that over the next 12 months, the Australian zero-coupon yield curve will experience a downward parallel shift of 60 bps and that AUD will appreciate 0.25% against USD. The manager is weighing bullet and barbell strategies using the following data:

Statistic	Bullet	Barbell
Investment horizon (years)	1.0	1.0
Average bond price in portfolio (today)	98.00	98.00
Average portfolio bond price (in 1 year/stable yield curve)	99.75	100.00
Expected portfolio effective duration (in 1 year)	3.95	3.95
Expected portfolio convexity (in 1 year)	19.50	34.00

Statistic	Bullet	Barbell
Expected change in AUD zero-coupon yields	−0.60%	−0.60%
Expected change in AUD versus USD	+0.25%	+0.25%

Solve for the expected return over the 1-year investment horizon for each portfolio using the step-by-step estimation approach in Equation 1.

Rolling Yield

The sum of coupon income (in %) and the price effect on bonds from "rolling down the yield curve." Since both portfolios contain only zero-coupon bonds, there is no coupon income and we calculate the rolldown return using (PV_1 – PV_0) / PV_0, where PV_0 is today's bond price and PV_1 is the bond price in one year, assuming no shift in the yield curve.

1. **Bullet:** 1.7857% = (99.75 – 98.00) / 98.00
2. **Barbell:** 2.0408% = (100.000 – 98.00) / 98.00

E (Δ Price Due to Investor's View of Benchmark Yield)

The effect of the interest rate view on expected portfolio return may be estimated using Equation 3, using effective duration and convexity in one year's time to evaluate the expected 60 bp downward parallel yield curve shift:

1. **Bullet:** 2.4051% = $(-3.95 \times -0.0060) + [1/2 \times 19.5 \times (-0.0060)^2]$
2. **Barbell:** 2.4312% = $(-3.95 \times -0.0060) + [1/2 \times 34.0 \times (-0.0060)^2]$

$E(R) \approx$ % Rolldown return + E (% Δ Price due to investor's view of benchmark yield) + E (% Δ Price due to investor's view of currency value changes)

In addition to rolldown return and expected price changes due to changes in yield-to-maturity, the expected 0.25% appreciation of AUD versus USD must be incorporated in order to arrive at the USD investor's domestic currency return. Using Equation 12, R_{FC} equals the sum of rolldown return and changes in price due to yield-to-maturity changes, while R_{FX} is 0.25%. Expected returns are as follows:

$$E(R_1) = 4.4513\%, \text{ or } [(1 + 0.017857 + 0.024051) \times (1.0025)] - 1$$

$$E(R_2) = 4.7332\%, \text{ or } [(1 + 0.020408 + 0.024312) \times (1.0025)] - 1$$

Overall, the barbell outperforms the bullet by approximately 28 bps. Rolldown return contributes most of this outperformance. Rolldown return contributed approximately 25.5 bps of outperformance (i.e., 2.0408% – 1.7857%) for the barbell, and the greater convexity of the barbell portfolio contributed just over 2.6 bps of outperformance (i.e., 2.4312% – 2.4051%). Currency exposure had the same impact on both strategies. The strong rolldown contribution is likely driven by the stronger price appreciation (under the stable yield curve assumption) of longer-maturity zeros in the barbell portfolio relative to the price appreciation of the intermediate zeros in the bullet portfolio as the bonds ride the curve over the 1-year horizon to a shorter maturity.

EXAMPLE 16

US Treasury Bullet versus Barbell

Assume a 1-year investment horizon for a portfolio manager considering US Treasury market strategies. The manager is considering two strategies to capitalize on an expected rise in US Treasury security zero-coupon yield levels of 50 bps in the next 12 months:

1. A bullet portfolio fully invested in 5-year zero-coupon notes currently priced at 94.5392.
2. A barbell portfolio: 62.97% is invested in 2-year zero-coupon notes priced at 98.7816, and 37.03% is invested in 10-year zero-coupon bonds priced at 83.7906.

Further assumptions for evaluating these portfolios are shown here:

Statistic	Bullet	Barbell
Investment horizon (years)	1.0	1.0
Average bond price in portfolio (today)	94.5392	92.6437
Average portfolio bond price (in 1 year/stable yield curve)	96.0503	94.3525
Expected portfolio effective duration (in 1 year)	3.98	3.98
Expected portfolio convexity (in 1 year)	17.82	32.57
Expected change in US Treasury zero-coupon yields	0.50%	0.50%

Solve for the expected return over the 1-year investment horizon for each portfolio using the step-by-step estimation approach in Equation 1.

Rolling Yield

The sum of coupon income (in %) and the price effect on bonds from "rolling down the yield curve." Since both portfolios contain only zero-coupon bonds, there is no coupon income and we calculate the rolldown return using $(PV_1 - PV_0) / PV_0$, where PV_0 is today's bond price and PV_1 is the bond price in one year, assuming no shift in the yield curve.

Bullet: (96.0503 – 94.5392) ÷ 94.5392 = 1.5984%

Barbell: (94.3525 – 92.6437) ÷ 92.6437 = 1.8445%

E (Δ Price Due to Investor's View of Benchmark Yield)

The effect of the interest rate view on expected portfolio return may be estimated with Equation 3, using effective duration and convexity in one year's time to evaluate the expected 50 bp upward parallel yield curve shift:

Bullet: $-1.9677\% = (-3.98 \times 0.0050) + [1/2 \times 17.82 \times (0.0050)^2]$

Barbell: $-1.9493\% = (-3.98 \times 0.0050) + [1/2 \times 32.57 \times (0.0050)^2]$

Expected total return in percentage terms for each portfolio is equal to:

$E(R)$ = % Rolldown return + E (% Δ Price due to investor's view of benchmark yield)

The total expected return over the 1-year investment horizon for the bullet portfolio is therefore –0.3693%, or 1.5984% – 1.9677%, and the expected return for the barbell portfolio is –0.1048%, or 1.8445% – 1.9493%.

If the manager's expected market scenario materializes, the barbell portfolio outperforms the bullet portfolio by 26 bps. The higher barbell convexity contributed just under 2 bps of outperformance, whereas the rolldown return contributed nearly 25 bps. Stronger price appreciation (under the stable yield curve assumption) resulted from a greater rolldown effect from the 10-year zeros in the barbell versus the 5-year zeros over one year.

SUMMARY

This reading addresses active fixed-income yield curve management using cash- and derivative-based strategies to generate returns which exceed those of a benchmark index due to yield curve changes. The following are the main points in the reading:

- A par yield curve is a stylized representation of yields-to-maturity available to investors at various maturities, which often does not consist of traded securities but must be extracted from available bond yields using a model.
- Primary yield curve risk factors may be categorized by changes in level (or a parallel "shift"), slope (a flatter or steeper yield curve), and shape or curvature.
- Yield curve slope measures the difference between the yield-to-maturity on a long-maturity bond and the yield-to-maturity on a shorter-maturity bond. Curvature is the relationship between short-, intermediate-, and long-term yields-to-maturity.
- Fixed-income portfolio managers can approximate actual and anticipated bond portfolio value changes using portfolio duration and convexity measures. Duration measures the linear relationship between bond prices and yield-to-maturity. Convexity is a second-order effect describing a bond's price behavior for larger rate movements and is affected by cash flow dispersion.
- A barbell portfolio combining short- and long-term bond positions will have greater convexity than a bullet portfolio concentrated in a single maturity for a given duration.
- Active managers seeking excess return in an expected static yield curve environment that is upward-sloping can use a buy-and-hold strategy to increase duration, roll down the yield curve, or use leverage via a carry trade in cash markets. Receive-fixed swaps and long futures positions replicate this exposure in the derivatives market.
- Derivatives offer the opportunity to synthetically change exposure with a far smaller initial cash outlay than cash strategies but require managers to maintain sufficient cash or eligible securities to fulfill margin or collateral requirements.
- Active fixed-income managers with a divergent rate level view increase duration exposure above a target if yields-to-maturity are expected to decline and reduce duration if expecting higher yields-to-maturity to minimize losses.
- Yield curve steepeners seek to gain from a greater spread between short- and long-term yields-to-maturity by combining a "long" short-dated bond position with a "short" long-dated bond position, while a flattener involves sale of short-term bonds and purchase of long-term bonds.

- Steepener and flattener strategies may be net duration neutral or net long or short duration depending upon a manager's view of how the yield curve slope will change—that is, the relative contribution of short- and long-term yield-to-maturity changes to the expected yield curve slope change.
- The butterfly strategy combining a long bullet with a short barbell portfolio (or vice versa) is commonly used to capitalize on expected yield curve shape changes.
- Active managers capitalize on a view as to whether future realized interest rate volatility will be greater or less than implied volatility by purchasing or selling bonds with embedded options or by using stand-alone interest rate options.
- Stand-alone interest rate put and call options are generally based upon a bond's price, not yield-to-maturity.
- Interest rate swaptions and options on bond futures are among the common tools used by active managers to alter portfolio duration and convexity subject to yield-to-maturity changes. An interest rate swaption involves the right to enter into an interest rate swap at a specific strike price in the future, while an option on a bond future involves the right, not the obligation, to buy or sell a futures contract.
- Key rate durations can be used in active fixed-income management to identify a bond portfolio's sensitivity to changes in the shape of the benchmark yield curve, allowing an active manager to quantify exposures along the curve.
- Fixed-income managers engaged in active yield curve strategies across currencies measure excess return from active management in functional currency terms—that is, considering domestic currency returns on foreign currency assets within a portfolio.
- Interest rate parity establishes the fundamental relationship between spot and forward exchange rates, with a higher-yielding currency trading at a forward discount and a lower-yielding currency trading at a premium.
- Covered interest rate parity involves the use of a forward contract to lock in domestic currency proceeds, while uncovered interest rate parity suggests that over time, the returns on unhedged foreign currency exposure will be the same as on a domestic currency investment.
- Active investors use the carry trade across currencies to take advantage of divergence from interest rate parity by borrowing in a lower-yield currency and investing in a higher-yield currency.
- A cross-currency swap enables investors to fully hedge the domestic currency value of cash flows associated with foreign currency bonds.
- Active managers deviate from fully hedged foreign currency bond cash flows by entering overweight and underweight bond positions denominated in different currencies, often using an underweight position in one currency to fund an overweight position in another.
- Investors evaluate the expected return on an active fixed-income portfolio strategy by combining coupon income and rolldown return with expected portfolio changes based on benchmark yield-to-maturity, credit, and currency value changes over the investment horizon.
- Unexpected market changes or risks to portfolio value are frequently evaluated using scenario analysis.

PRACTICE PROBLEMS

The following information relates to questions 1-8

A Sydney-based fixed-income portfolio manager is considering the following Commonwealth of Australia government bonds traded on the ASX (Australian Stock Exchange):

Tenor	Coupon	Yield	Price	Modified Duration	Convexity
2y	5.75%	0.28%	110.90	1.922	4.9
4.5y	3.25%	0.55%	111.98	4.241	22.1
9y	2.50%	1.10%	111.97	8.175	85.2

The manager is considering portfolio strategies based upon various interest rate scenarios over the next 12 months. She is considering three long-only government bond portfolio alternatives, as follows:

Bullet: Invest solely in 4.5-year government bonds

Barbell: Invest equally in 2-year and 9-year government bonds

Equal weights: Invest equally in 2-year, 4.5-year, and 9-year bonds

1. The portfolio alternative with the *highest* modified duration is the:
   - **A.** bullet portfolio.
   - **B.** barbell portfolio.
   - **C.** equally weighted portfolio.

2. The manager estimates that accelerated economic growth in Australia will increase the *level* of government yields-to-maturity by 50 bps. Under this scenario, which of the three portfolios experiences the *smallest* decline in market value?
   - **A.** Bullet portfolio
   - **B.** Barbell portfolio
   - **C.** Equally weighted portfolio

3. Assume the manager is able to extend her mandate by adding derivatives strategies to the three portfolio alternatives. The best way to position her portfolio to benefit from a *bear flattening* scenario is to combine a:
   - **A.** 2-year receive-fixed Australian dollar (AUD) swap with the *same* modified duration as the bullet portfolio.
   - **B.** 2-year pay-fixed AUD swap with *twice* the modified duration as the 2-year government bond in the barbell portfolio.

C. 9-year receive-fixed AUD swap with *twice* the modified duration as the 9-year government bond position in the equally weighted portfolio.

4. In her market research, the manager learns that ASX 3-year and 10-year Treasury bond futures are the most liquid products for investors trading and hedging medium- to long-term Australian dollar (AUD) interest rates. Although neither contract matches the exact characteristics of the cash bonds of her choice, which of the following additions to a barbell portfolio *best* positions her to gain under a *bull flattening* scenario?

   A. Purchase a 3-year Treasury bond future matching the money duration of the short-term (2-year) position.

   B. Sell a 3-year Treasury bond future matching the money duration of the short-term bond position.

   C. Purchase a 10-year Treasury bond future matching the money duration of the long-term bond position.

5. An economic slowdown is expected to result in a 25 bp decline in Australian yield *levels*. Which portfolio alternative will experience the largest gain under this scenario?

   A. Bullet portfolio

   B. Barbell portfolio

   C. Equally weighted portfolio

6. The portfolio alternative with the *least* exposure to convexity is the:

   A. bullet portfolio.

   B. barbell portfolio.

   C. equally weighted portfolio.

7. The current butterfly spread for the Australian government yield curve based upon the manager's portfolio choices is:

   A. 83 bps.

   B. 28 bps.

   C. –28 bps.

8. If the manager has a positive butterfly view on Australian government yields-to-maturity, the *best* portfolio position strategy to pursue is to:

   A. purchase the bullet portfolio and sell the barbell portfolio.

   B. sell the bullet portfolio and buy the barbell portfolio.

   C. purchase the equally weighted portfolio and sell the barbell portfolio.

---

9. An analyst manages an active fixed-income fund that is benchmarked to the Bloomberg Barclays US Treasury Index. This index of US government bonds currently has a modified portfolio duration of 7.25 and an average maturity of 8.5 years. The yield curve is upward-sloping and expected to remain unchanged.

Which of the following is the *least* attractive portfolio positioning strategy in a static curve environment?

A. Purchasing a 10-year zero-coupon bond with a yield of 2% and a price of 82.035

B. Entering a pay-fixed, 30-year USD interest rate swap

C. Purchasing a 20-year Treasury and financing it in the repo market

10. An investment manager is considering decreasing portfolio duration versus a benchmark index given her expectations of an upward parallel shift in the yield curve. If she has a choice between a callable bond which is unlikely to be called, a putable bond which is likely to be put, or an option-free bond with otherwise comparable characteristics, the most profitable position would be to:

A. own the callable bond.

B. own the putable bond.

C. own the option-free bond.

11. An active fixed-income manager holds a portfolio of commercial and residential mortgage-backed securities that tracks the Bloomberg Barclays US Mortgage-Backed Securities Index. Which of the following choices is the most relevant portfolio statistic for evaluating the first-order change in his portfolio's value for a given change in benchmark yield?

A. Effective duration

B. Macaulay duration

C. Modified duration

12. An active fund trader seeks to capitalize on an expected steepening of the current upward-sloping yield curve using option-based fixed-income instruments. Which of the following portfolio positioning strategies *best* positions her to gain if her interest rate view is realized?

A. Sell a 30-year receiver swaption and a 2-year bond put option.

B. Purchase a 30-year receiver swaption and a 2-year bond put option.

C. Purchase a 30-year payer swaption and a 2-year bond call option.

The following information relates to questions 13-16

A financial analyst at an in-house asset manager fund has created the following spreadsheet of key rate durations to compare her active position to that of a benchmark index so she can compare the rate sensitivities across maturities.

Tenor	$KeyRateDur^{Active}$	$KeyRateDur^{Index}$	Difference
2y	−0.532	0.738	−1.270
5y	0.324	1.688	−1.364

Tenor	KeyRateDur^{Active}	KeyRateDur^{Index}	Difference
10y	5.181	2.747	2.434
30y	1.142	2.162	−1.020
Portfolio	6.115	7.335	−1.220

13. Which of the following statements is true if yield *levels* increase by 50 bps?

A. The active portfolio will outperform the index portfolio by approximately 61 bps.

B. The index portfolio will outperform the active portfolio by approximately 61 bps.

C. The index portfolio will outperform the active portfolio by approximately 21 bps.

14. Which of the following statements best characterizes how the active portfolio is positioned for yield curve changes *relative* to the index portfolio?

A. The active portfolio is positioned to benefit from a bear steepening of the yield curve versus the benchmark portfolio.

B. The active portfolio is positioned to benefit from a positive butterfly movement in the shape of the yield curve versus the index.

C. The active portfolio is positioned to benefit from yield curve flattening versus the index.

15. Which of the following derivatives strategies would *best* offset the yield curve exposure difference between the active and index portfolios?

A. Add a pay-fixed 10-year swap and long 2-year, 5-year, and 30-year bond futures positions to the active portfolio.

B. Add a receive-fixed 30-year swap, a pay-fixed 10-year swap, and short positions in 2-year and 5-year bond futures to the active portfolio.

C. Add a pay-fixed 10-year swap, a short 30-year bond futures, and long 2-year and 5-year bond futures positions to the active portfolio.

16. Which of the following statements best describes the forward rate bias?

A. Investors tend to favor fixed-income investments in currencies that trade at a premium on a forward basis.

B. Investors tend to hedge fixed-income investments in higher-yielding currencies given the potential for lower returns due to currency depreciation.

C. Investors tend to favor unhedged fixed-income investments in higher-yielding currencies that are sometimes enhanced by borrowing in lower-yielding currencies.

The following information relates to questions 17-19

A US-based fixed-income portfolio manager is examining unhedged investments in Thai baht (THB) zero-coupon government bonds issued in Thailand and is considering two investment strategies:

1. **Buy-and-hold:** Purchase a 1-year, THB zero-coupon bond with a current yield-to-maturity of 1.00%.
2. **Roll down the THB yield curve:** Purchase a 2-year zero-coupon note with a current yield-to-maturity of 2.00% and sell it in a year.

THB proceeds under each strategy will be converted into USD at the end of the 1-year investment horizon. The manager expects a stable THB yield curve and that THB will appreciate by 1.5% relative to USD. The following information is used to analyze these two investment strategies:

Statistic	Buy and Hold	Yield Curve Rolldown
Investment horizon (years)	1.0	1.0
Bond maturity at purchase (years)	1.0	2.0
Yield-to-maturity (today)	1.00%	2.00%
Average portfolio bond price (today)	99.0090	96.1169
Expected average portfolio bond price (in 1 year)	100.00	99.0090
Expected currency gains (in 1 year)	1.5%	1.5%

17. The *rolldown returns* over the 1-year investment horizon for the Buy-and-Hold and Yield Curve Rolldown portfolios are closest to:

    A. 1.00% for the Buy-and-Hold portfolio and 3.01% for the Yield Curve Rolldown portfolio, respectively.

    B. 0.991% for the Buy-and-Hold portfolio and 3.01% for the Yield Curve Rolldown portfolio, respectively.

    C. 0.991% for the Buy-and-Hold portfolio and 2.09% for the Yield Curve Rolldown portfolio, respectively.

18. The *total expected return* over the 1-year investment horizon for the Buy-and-Hold and Yield Curve Rolldown portfolios are closest to:

    A. 2.515% for the Buy-and-Hold portfolio and 4.555% for the Yield Curve rolldown portfolio, respectively.

    B. 2.42% for the Buy-and-Hold portfolio and 4.51% for the Yield Curve Rolldown portfolio, respectively.

    C. 2.491% for the Buy-and-Hold portfolio and 3.59% for the Yield Curve Rolldown portfolio, respectively.

19. Which of the following statements best describes how the expected total return results would *change* if THB yields were to rise significantly over the investment

horizon?

A. Both the Buy-and-Hold and Yield Curve Rolldown expected portfolio returns would *increase* due to higher THB yields.

B. Both the Buy-and-Hold and Yield Curve Rolldown expected portfolio returns would *decrease* due to higher THB yields.

C. The Buy-and-Hold expected portfolio returns would be *unchanged* and the Yield Curve Rolldown expected portfolio returns would *decrease* due to the rise in yields.

---

20. A Dutch investor considering a 5-year EUR government bond purchase expects yields-to-maturity to decline by 25 bps in the next six months. Which of the following statements about the rolldown return is *correct*?

A. The rolldown return equals the difference between the price of the 5-year bond and that of a 4.5-year bond at the lower yield-to-maturity.

B. The rolldown return consists of the 5-year bond's basis point value multiplied by the expected 25 bp yield-to-maturity change over the next six months.

C. The rolldown return will be negative if the 5-year bond has a zero coupon and is trading at a premium.

21. An active investor enters a duration-neutral yield curve flattening trade that combines 2-year and 10-year Treasury positions. Under which of the following yield curve scenarios would you expect the investor to realize the *greatest* portfolio loss?

A. Bear steepening

B. Bull flattening

C. Yields unchanged

SOLUTIONS

1. B is correct. The modified duration of a fixed-income portfolio is approximately equal to the market value-weighted average of the bonds in the portfolio, so the barbell has a modified duration of 5.049, or (1.922 + 8.175)/2), which is larger than that of either the bullet (4.241) or the equally weighted portfolio (4.779, or (1.922 + 4.241 + 8.175)/3.

2. A is correct. The change in portfolio value due to a rise in Australian government rate levels may be calculated using Equation 3:

   $\%\Delta PV^{Full} \approx -(ModDur \times \Delta Yield) + [½ \times Convexity \times (\Delta Yield)^2]$,

   where ModDur and Convexity reflect portfolio duration and convexity, respectively. Therefore, the bullet portfolio declines by 2.093%, or −2.093% = (−4.241 × 0.005) + [0.5 × 22.1 × (0.005^2)], followed by a drop of 2.343% for the equally weighted portfolio, or −2.343% = (−4.779 × 0.005) + [0.5 × 37.4 × (0.005^2)], and a drop of 2.468% for the barbell portfolio, or −2.468% = (−5.049 × 0.005) + [0.5 × 45.05 × (0.005^2)].

3. B is correct. A bear flattening scenario is a decrease in the yield spread between long- and short-term maturities driven by higher short-term rates. The manager must therefore position her portfolio to benefit from rising short-term yields. Under A, the receive-fixed 2-year swap is a synthetic long position, increasing portfolio duration that will result in an MTM loss under bear flattening. The receive-fixed swap in answer C will increase duration in long-term maturities. In the case of B, the pay-fixed swap with twice the modified duration of the barbell will more than offset the existing long position, resulting in net short 2-year and long 9-year bond positions in the overall portfolio and a gain under bear flattening.

4. C is correct. A bull flattening is a decrease in the yield spread between long- and short-term maturities driven by lower long-term yields-to-maturity. Both A and B involve changes in portfolio exposure to short-term rates, while C increases the portfolio exposure to long-term rates to benefit from a fall in long-term yields-to-maturity.

5. B is correct. The portfolio value change due to lower Australian government rate levels may be calculated using Equation 3:

   $\%\Delta PV^{Full} \approx -(ModDur \times \Delta Yield) + [½ \times Convexity \times (\Delta Yield)^2]$,

   where ModDur and Convexity reflect portfolio duration and convexity, respectively. Therefore, the barbell portfolio rises by 1.276%, or (−5.049 × −0.0025) + [0.5 × 45.05 × (-0.0025^2)], followed by the equally weighted portfolio at 1.207%, or (−4.779 × −0.0025) + [0.5 × 37.4 × (-0.0025^2)], and the bullet portfolio at 1.067%, or (−4.241 × −0.0025) + [0.5 × 22.1 × (-0.0025^2)].

6. A is correct. The bullet portfolio has the same convexity as the 4.5-year bond, or 22.1. The barbell portfolio in B has portfolio convexity of 45.05, = (4.9 + 85.2)/2, while the equally weighted portfolio has portfolio convexity of 37.4, = (4.9 + 22.1 + 85.2)/3.

7. C is correct. The butterfly spread is equal to twice the medium-term yield minus the short-term and long-term yields, as in Equation 2, or −28 bps, or −0.28% + (2 × 0.55%) − 1.10%).

8. A is correct. A positive butterfly view indicates an expected decrease in the butterfly spread due to an expected rise in short- and long-term yields-to-maturity combined with a lower medium-term yield-to-maturity. The investor therefore benefits from a long medium-term (bullet) position and a short short-term and long-term (barbell) portfolio. The portfolio in answer B represents the opposite exposure and benefits from a negative butterfly view, while in C, combining short barbell and long equally weighted portfolios leaves the investor with bullet portfolio exposure.

9. B is correct. The 30-year pay-fixed swap is a "short" duration position and also results in negative carry (that is, the fixed rate paid would exceed MRR received) in an upward-sloping yield curve environment; therefore, it is the least attractive static curve strategy. In the case of a.), the manager enters a "buy-and-hold" strategy by purchasing the 10-year zero-coupon bond and extends duration, which is equal to 9.80 = 10/1.02 since the Macaulay duration of a zero equals its maturity, and ModDur = MacDur/(1+r) versus 7.25 for the index. Under c.), the manager introduces leverage by purchasing a long-term bond and financing it at a lower short-term repo rate.

10. B is correct. The value of a bond with an embedded option is equal to the sum of the value of an option-free bond plus the value to the embedded option. With a putable bond, the embedded put option is owned by the bond investor, who can exercise the option if yields-to-maturity increase, as in this scenario. Under A, the embedded call option is owned by the bond issuer, who is more likely to exercise if yields-to-maturity decrease (that is, the bond investor is short the call option). As for C, the option-free bond underperforms the putable bond given the rise in value of the embedded put option.

11. A is correct. Effective duration is a yield duration statistic that measures interest rate risk using a parallel shift in the benchmark yield curve (ΔCurve), as in Equation 8. Effective duration measures interest rate risk for complex bonds whose future cash flows are uncertain because they are contingent on future interest rates. Both Macaulay duration (B) and modified duration (C) are relevant statistics only for option-free bonds.

12. C is correct. A steepening of the yield curve involves an increase in the slope, or the difference between long-term and short-term yields-to-maturity. An optimal portfolio positioning strategy is one which combines a short duration exposure to long-term bonds and a long duration exposure to short-term bonds. Portfolio C involves the right (but not the obligation) to purchase a 2-year bond, which will increase in value as short-term yields fall with the right to pay-fixed on a 30-year swap, which increases in value if long-term yields rise. Portfolio A involves the sale of two options. Although they will expire unexercised in a steeper curve environment, the investor's return is limited to the two option premia. Portfolio B is the opposite of Portfolio C, positioning the investor for a flattening of the yield curve.

13. A is correct. Recall from Equation 11 that the sum of the key rate durations equals the effective portfolio duration. The approximate (first-order) change in portfolio value may be estimated from the first (modified) term of Equation 3, namely (–EffDur × ΔYield). Solving for this using the –1.22 effective duration difference multiplied by 0.005 equals 0.0061, or 61 bps.

14. B is correct. A positive butterfly indicates a decrease in the butterfly spread due to an expected rise in short- and long-term yields-to-maturity combined with a lower medium-term yield-to-maturity. Since the active portfolio is short duration versus the index in the 2-year, 5-year, and 30-year maturities and long duration in

the 10-year, it will generate excess return if the butterfly spread falls.

15. A is correct. A net positive key rate duration difference indicates a long duration position relative to the index, while a net negative duration difference indicates a short position. Relative to the index, the active portfolio is "short" in the 2-year, 5-year, and 30-year maturities and "long" the 10-year maturity versus the index. The pay-fixed 10-year swap and long 2-year, 5-year, and 30-year bond futures positions best offset these differences.

16. C is correct. Forward rate bias is defined as an observed divergence from interest rate parity conditions under which active investors seek to benefit by borrowing in a lower-yield currency and investing in a higher-yield currency. A is incorrect since lower-yielding currencies trade at a forward premium. B is incorrect due to covered interest rate parity; fully hedged foreign currency fixed-income investments will tend to yield the domestic risk-free rate.

17. A is correct. Since both strategies use zero-coupon bonds, the rolldown return is calculated from expected bond price changes from "rolling down" the THB yield curve, which is assumed to be static.

    Buy and Hold: 1.00% = (100.00 – 99.009)/99.009

    Yield Curve Rolldown: 3.01% = (99.009 – 96.1169)/96.1169

18. A is correct. Under a static yield curve assumption, expected returns are equal to rolldown return plus changes in currency over the investment horizon. Using Equation 12, we solved for R_{FC} for both portfolios in Question 18, and R_{FX} is 1.5%. Expected returns are:

    Buy and Hold: $E(R)$ = 2.515%, or (1.01 × 1.015) – 1

    Yield Curve Rolldown: $E(R)$ = 4.555%, or (1.0301 × 1.015) – 1

19. C is correct. In a higher THB yield scenario in one year, the Yield Curve Rolldown expected return would fall since a higher THB yield-to-maturity in one year would reduce the price at which the investor could sell the 1-year zero in one year. The Buy-and-Hold portfolio return will be unaffected since the 1-year bond matures at the end of the investment horizon.

20. C is correct. Rolldown return is the difference between the price of the 5-year bond and that of a 4.5-year bond at the *same* yield-to-maturity. A 5-year zero-coupon bond trading at a premium has a negative yield. As the price "pulls to par" over time, the premium amortization will be a loss to the investor. A reflects the full price appreciation since it is calculated using the lower yield-to-maturity, while B equals E (Δ Price due to investor's view of benchmark yield).

21. C is correct. A duration-neutral flattening trade involves a short 2-year bond position and a long 10-year bond position, which have a "matched" duration or portfolio duration of zero. This portfolio will realize a loss if the slope of the yield curve—that is, the difference between short-term and long-term yields—increases. Yield curve inversion is an extreme version of flattening in which the spread between long-term and short-term yields-to-maturity falls below zero. The bear steepening in A involves a rise in the 10-year yield-to-maturity more than in the 5-year yield-to-maturity, causing a portfolio loss. The bull flattening in B combines a constant 2-year yield-to-maturity with lower 10-year rates, resulting in a gain on the 10-year bond position and an unchanged 2-year bond position.

LEARNING MODULE

6

Fixed-Income Active Management: Credit Strategies

by Campe Goodman, CFA, and Oleg Melentyev, CFA.

Campe Goodman, CFA, is at Wellington Management (USA). Oleg Melentyev, CFA, is at Bank of America Merrill Lynch (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	describe risk considerations for spread-based fixed-income portfolios
☐	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
☐	discuss bottom-up approaches to credit strategies
☐	discuss top-down approaches to credit strategies
☐	discuss liquidity risk in credit markets and how liquidity risk can be managed in a credit portfolio
☐	describe how to assess and manage tail risk in credit portfolios
☐	discuss the use of credit default swap strategies in active fixed-income portfolio management
☐	discuss various portfolio positioning strategies that managers can use to implement a specific credit spread view
☐	discuss considerations in constructing and managing portfolios across international credit markets
☐	describe the use of structured financial instruments as an alternative to corporate bonds in credit portfolios
☐	describe key inputs, outputs, and considerations in using analytical tools to manage fixed-income portfolios

1 INTRODUCTION

Most fixed-income instruments trade at a nominal yield to maturity (YTM) that lies above that for an equivalent government or benchmark bond of similar maturity. This **yield spread** or difference compensates investors for the risk that they might not receive interest and principal cash flows as expected, whether as a result of a financially distressed corporate borrower, a sovereign issuer unable (or unwilling) to meet scheduled payments, or a deterioration in credit quality in an underlying pool of assets of a structured instrument such as an asset-backed security. A portion of the yield spread reflects the bid–offer cost of buying or selling a particular bond versus a government security, a liquidity premium that varies based on market conditions. Active managers of spread-based fixed-income portfolios take positions in credit and other risk factors that vary from those of an index to generate excess return versus passive index replication. Financial analysts who build on their foundational knowledge by mastering these more advanced fixed-income concepts and tools will broaden their career opportunities in the investment industry.

We begin by reviewing expected fixed-income portfolio return components with a particular focus on credit spreads. These spreads are not directly observable but rather derived from market information. Similar to benchmark yield curves, credit-spread curves are often defined by spread level and slope, and usually grouped by credit rating to gauge relative risk as well as to anticipate and act on expected changes in these relationships over the business cycle. We outline credit spread measures for fixed- and floating-rate bonds and quantify the effect of spread changes on portfolio value. Building blocks for active credit management beyond individual bonds include exchange-traded funds (ETFs), structured financial instruments, and derivative products such as credit default swaps (CDS). These tools are used to describe bottom-up and top-down active credit management approaches as well as how managers position spread-based fixed-income portfolios to capitalize on a market view.

2 KEY CREDIT AND SPREAD CONCEPTS FOR ACTIVE MANAGEMENT

- ☐ describe risk considerations for spread-based fixed-income portfolios
- ☐ 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

Managers seeking to maximize fixed-income portfolio returns will usually buy securities with a higher YTM (and lower equivalent price) than a comparable default risk-free government bond. The excess return targeted by active managers of spread-based fixed-income portfolios is captured in the fourth term of the now familiar fixed-income return equation:

$$
\begin{aligned}
E(R) \approx\ & \text{Coupon income} \\
& +/- \text{ Rolldown return} \\
& +/- E\ (\Delta \text{ Price due to investor's view of benchmark yields}) \\
& +/- E\ (\Delta \text{ Price due to investor's view of yield spreads}) \\
& +/- E\ (\Delta \text{ Price due to investor's view of currency value changes})
\end{aligned}
\tag{1}
$$

Similar to the benchmark yield curve addressed earlier in the curriculum, yield spreads for a specific bond issuance over a comparable government bond cannot be directly observed but are rather derived or estimated from market information. This yield spread is a risk premium that primarily compensates investors for assuming credit and liquidity risks.

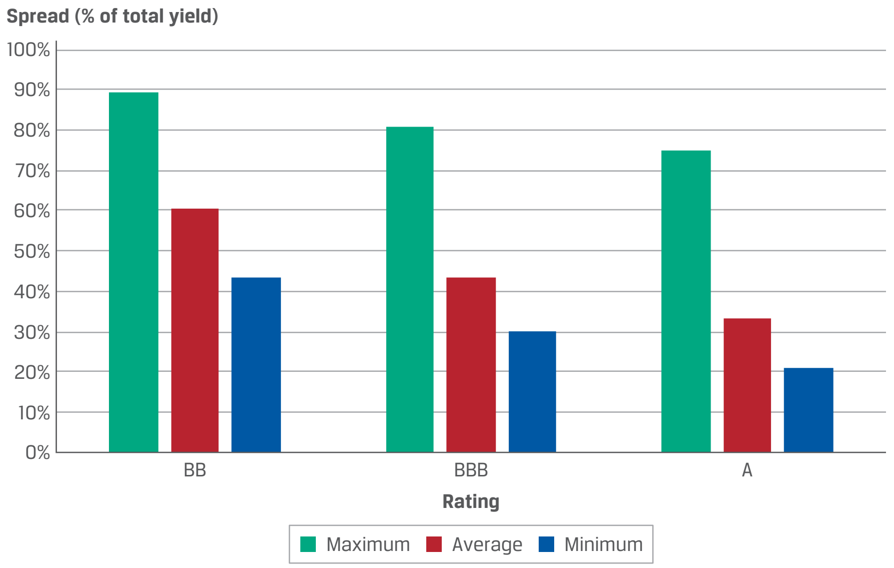
While credit risk for a specific borrower depends on both the likelihood of default and the loss severity in a default scenario, credit risk for a specific bond *issuance* also depends on the period over which payments are promised, the relative seniority of the debt claim, and the sources of repayment, such as the value of underlying collateral, among other factors.

Liquidity risk refers to an investor's ability to readily buy or sell a specific security. The YTM difference (or bid–ask spread) between the purchase and sale price of a bond depends on market conditions and on the specific supply-and-demand dynamics of each fixed-income security. As active fixed-income portfolio managers identify and pursue specific credit strategies, they must also consider trading costs when calculating expected excess returns.

Credit Risk Considerations

Yield spreads over default risk-free government bonds mostly compensate investors for the potential of not receiving promised cash flows (issuer default) and for the loss severity if a default occurs. Spreads range widely across ratings categories and time periods. For example, Exhibit 1 shows yield spreads as a percentage of total YTM for A-, BBB-, and BB rated US corporate issuers from mid-2009 to mid-2020.

Exhibit 1: Yield Spreads as a Percentage of YTM, 2009–2020



Source: Bloomberg

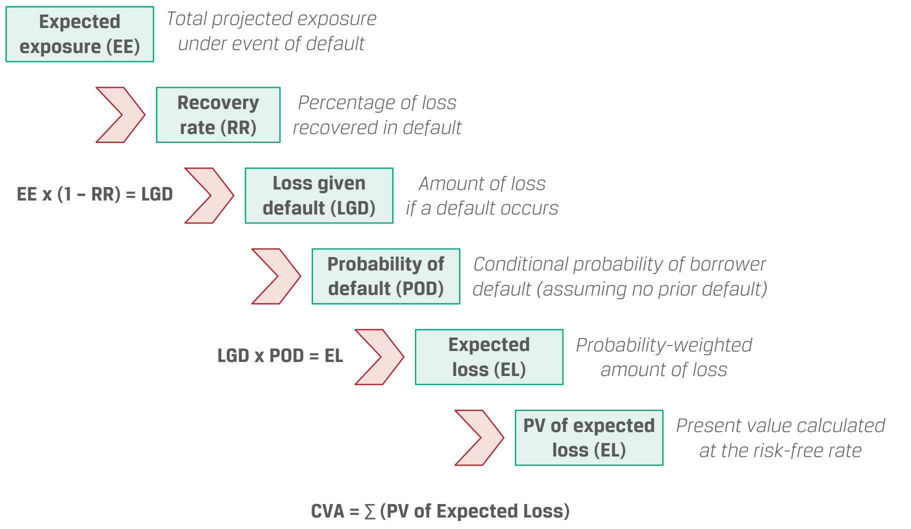
On average, 60% of total YTM was attributable to yield spread for BB rated issuers versus 33% for A rated issuers over the period. This percentage was at a minimum for all rating categories in 2010 as the US economy recovered from the 2008–09 financial crisis and reached its peak in early 2020 during the economic slowdown due to the

COVID-19 pandemic. The higher average proportion of all-in yield attributable to credit risk warrants a greater focus on this factor among high-yield investors over the credit cycle.

Default Probabilities and Recovery Rates

The **credit valuation adjustment (CVA)** framework shown earlier in the curriculum and in Exhibit 2 comprises the present value of credit risk for a loan, bond, or derivative obligation.

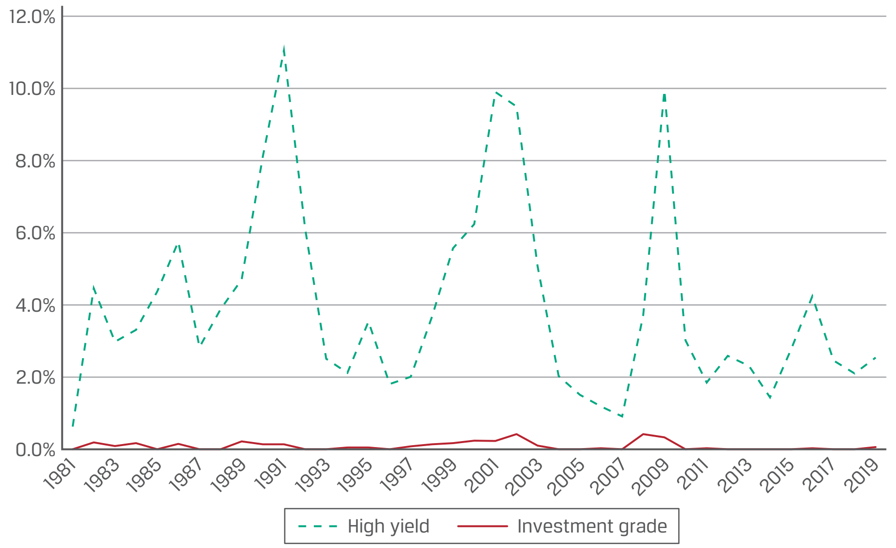
Exhibit 2: Credit Valuation Adjustment



The CVA framework provides a useful means to evaluate the two key components of credit risk. These include (1) **default risk** (also called **probability of default** [POD]), or the likelihood that a borrower defaults or fails to meet its obligation to make full and timely payments of principal and interest according to the terms of the debt security; and (2) **loss severity** (also called loss given default [LGD]), which is the amount of loss if a default occurs. POD is usually expressed as a percentage in annual terms. LGD is most often expressed as a percentage of par value. Recall that the one-period credit spread estimate from an earlier lesson on CDS where we ignored the time value of money was simply the product of LGD and POD (Spread ≈ LGD × POD). This implies that a simple one-period POD can be approximated by dividing credit spread by LGD (POD ≈ Spread/LGD). While this estimate works well for bonds trading close to par, distressed bonds tend to trade on a price rather than a spread basis, which approaches the recovery rate (1 – LGD) as default becomes likely.

The historical POD and the LGD rate is much lower for investment-grade bonds than for high-yield bonds. A **credit loss rate** represents the *realized* percentage of par value lost to default for a group of bonds, or the bonds' default rate multiplied by the loss severity. According to Moody's Investors Service, the highest annual credit loss rate for US investment-grade corporate bonds from 1983 to 2019 was 0.41%, with an average of just 0.05%. For high-yield bonds, the average credit loss rate over the same period was 2.53%, and in several years, usually around economic recessions, losses exceeded 5%. Exhibit 3 shows global annual corporate default rates from S&P Global Ratings for a similar period.

Exhibit 3: Annual Global Corporate Bond Default Rates (%)



Source: S&P Global Ratings

Exhibit 3 makes clear that the likelihood of default rises significantly as the economy slows, reaching peaks during the 1990–91, 2001, and 2008 recessions. The percentage of par value lost in a default scenario depends on a bond's (or loan's) relative position in the capital structure and whether it is secured or unsecured, as shown in Exhibit 4.

Exhibit 4: Average Volume Weighted US Corporate Debt Recovery Rates, 1983–2019

First lien bank loan	64%
Second lien bank loan	29%
Senior unsecured bank loan	44%
First lien bond	55%
Second lien bond	45%
Senior unsecured bond	35%
Senior subordinated bond	27%
Subordinated bond	28%
Junior subordinated bond	14%

Source: Moody's Investors Service

EXAMPLE 1

Estimating Credit Spreads Using POD and LGD

A bank analyst observes a first lien bank loan maturing in two years with a spread of 100 bps from an issuer considering a new second lien bank loan. Using average historical volume weighted corporate debt recovery rates (RR) as a guide, what is the estimated credit spread for the new second lien bank loan?

Solution:

1. Using the POD approximation (POD ≈ Spread/LGD and LGD = (1 − RR)), the analyst uses the current first lien bank loan credit spread and expected first lien bank loan recovery rate to estimate the issuer's POD to be 2.778% (=1.00%/(1 − 0.64)).
2. Using the issuer POD from Answer 1 and the expected second lien bank loan recovery rate of 29%, the bank analyst solves for the expected second lien spread using (POD × LGD) to get 197 bps (=2.778% × (1 − 0.29)).

Default versus Credit Migration

Although actual defaults are relatively rare among higher-rated bond issuers, changes in the *relative* assessment of creditworthiness occurs more frequently. **Credit migration**, or the likelihood of a change in a bond's public credit rating, usually has a negative effect on bond prices. This effect occurs because the chance of downgrade exceeds that of an upgrade, and the yield spread increase at lower credit ratings is far greater than the spread decrease in the event of a credit upgrade.

The POD versus credit migration varies significantly across the credit spectrum. For example, Exhibit 5 shows the two-year average rate of global corporate default and one-notch downgrade.

Exhibit 5: Two-Year Average Global Corporate Default/ Downgrade,1981–2019

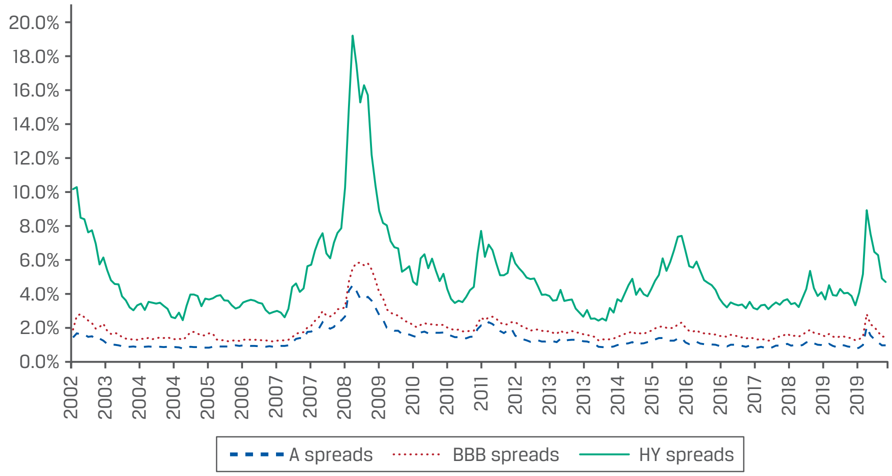
Statistic/Rating	AAA	AA	A	BBB	BB	B	CCC
Default Probability (%)	0.03	0.06	0.14	0.45	1.96	7.83	36.49
One Notch Downgrade (%)	16.22	13.79	8.81	5.66	9.82	5.22	

Source: S&P Global Ratings

Investors typically categorize credit risk using public debt ratings, distinguishing between investment-grade and high-yield market segments. Investment-grade bonds generally have higher credit ratings, lower default risk, and higher recovery in the event of default and offer lower all-in yields to maturity. High-yield bonds usually have higher yields to maturity as a result of lower (sub-investment or speculative grade) credit ratings, higher default risk, and lower recovery in the event of default. In an earlier yield curve strategies lesson, changes in the level, slope, and shape of the government bond term structure across maturities were established as primary risk factors. The level and slope of credit spread curves are often categorized by public credit rating to distinguish relative market changes across the credit spectrum.

For example, the relative historical yield spread *level* across public rating categories for US corporate borrowers is shown in Exhibit 6.

Exhibit 6: A, BBB, and High-Yield US 10-year Corporate Spread Levels (%)



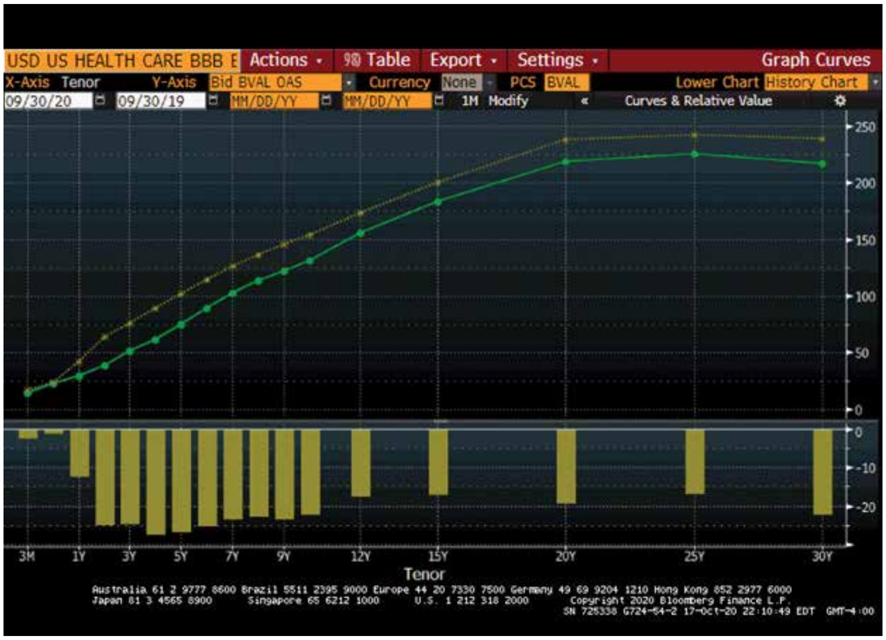
Source: Bloomberg

Lower-rated bonds face a greater impact from adverse market events, as evidenced by the widening gap between BBB rated and high-yield bonds during the 2008 financial crisis and the COVID-19 pandemic in 2020.

Credit Spread Curves

Active managers often position spread-based portfolios to capitalize on expected credit spread curve changes in a way similar to the benchmark yield curve strategies seen in an earlier lesson. While frequent issuers with many bonds outstanding across maturities have their own issuer-specific credit curve, credit spread curves are usually categorized by rating, issuer type, and/or corporate sector. These curves are derived from the difference between all-in yields to maturity for bonds within each respective category and a government benchmark bond or swap yield curve, with adjustments for specific credit spread measures covered in detail later. For example, Exhibit 7 shows the decline in option-adjusted spreads for US BBB rated health care companies over a one-year period from the end of Q3 2019 to 2020, with the bar graph at the bottom showing the decrease for each maturity.

Exhibit 7: BBB Rated US Corporate Health Care Spreads, 2019–2020



Source: Bloomberg

Primary credit risk factors for a specific issuer include the level and slope of the issuer's credit spread curve. For instance, ignoring liquidity differences across maturities, an upward-sloping credit spread curve suggests a relatively low near-term default probability that rises over time as the likelihood of downgrade and/or default increases. A flatter credit spread curve in contrast indicates that downgrade/default probabilities are equally likely in the near- and long-term.

Credit spread curve changes are broadly driven by the **credit cycle**, the expansion and contraction of credit over the business cycle, which translates into asset price changes based on default and recovery expectations across maturities and rating categories. Exhibit 8 outlines key credit cycle characteristics and the general effect on credit spread curve levels and slope for high- and low-rated issuers.

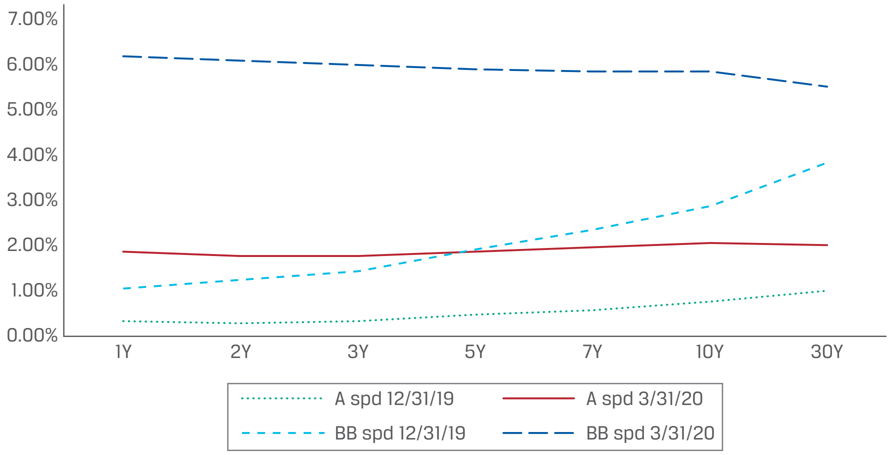
Exhibit 8: General Credit Cycle Characteristics

	Early Expansion (Recovery)	Late Expansion	Peak	Contraction (Recession)
Economic Activity	Stable	Accelerating	Decelerating	Declining
Corporate Profitability	Rising	Peak	Stable	Falling
Corporate Leverage	Falling	Stable	Rising	Peak
Corporate Defaults	Peak	Falling	Stable	Rising
Credit Spread Level	Stable	Falling	Rising	Peak
Credit Spread Slope	Stable for high grade, inverted for low ratings	Steeper for both higher and lower ratings	Steeper for both higher and lower ratings	Flatter for high grade, inverted for low ratings

Exhibit 3 and Exhibit 6 demonstrate the significant variability in annual credit loss rates and credit spread changes, respectively, across the ratings spectrum. Lower-rated issuers tend to experience greater slope and level changes over the credit cycle, including more frequent inversion of the credit curve, given their larger rise in annual credit losses during economic downturns. Higher-rated issuers, in contrast, face smaller credit spread changes and usually exhibit upward-sloping credit curves and fewer credit losses during periods of economic contraction. Credit spread differences *between* major ratings categories tend to narrow during periods of strong economic growth and widen when growth is expected to slow.

For example, consider the widening of BB versus single-A US corporate spreads during Q1 2020 shown in Exhibit 9. The difference between two-year BB spreads and A spreads for the same tenor more than tripled over this three-month period.

Exhibit 9: BB versus A Credit Spread Curve, 2019 versus 2020



Source: Bloomberg

EXAMPLE 2

Credit Cycle and Credit Spread Curve Changes

1. Which of the following *best* describes the expected shape of the credit spread curve in an economic downturn?

   A. Investment-grade and high-yield issuers usually experience similar credit spread curve steepening because of declining corporate profitability.

   B. High-yield issuers usually experience more spread curve steepening than investment-grade issuers because higher leverage leads to a greater decline in profitability.

   C. High-yield issuers often experience more pronounced flattening or credit spread curve inversion in an economic downturn because the probability of downgrade or default is higher in the near term than the long term.

Solution:

The correct answer is C. While investment-grade and high-yield issuers both experience declining profitability in an economic downturn, as in answers A and B, this usually leads to a flatter credit spread curve for investment-grade issuers and often to credit spread curve inversion for high-yield issuers, given a rise in near-term downgrades and defaults.

Actual price movements of lower-rated bonds can be quite different from what analytical models based on benchmark rates and credit spreads would predict under issuer-specific and market stress scenarios. For example, issuer financial distress will cause a bond's price to diverge from what a model using benchmark rates would suggest. As an issuer nears default, the price of its bond approaches the estimated recovery rate, regardless of the current benchmark YTM, because investors no longer expect to receive risky future coupon payments. Under a "flight to quality" market stress scenario, investors sell high-risk, low-rated bonds, which fall in price, and purchase government bonds, which experience price appreciation. This observed negative correlation between high-yield credit spreads and government benchmark yields to maturity often leads fixed-income practitioners to use statistical models and historical bond market data to estimate **empirical duration** rather than rely on analytical duration estimates based on duration and convexity. This market stress scenario is addressed in the following example.

EXAMPLE 3

Empirical versus Analytical Duration

1. A high-yield bond fund manager is considering adding a US$50 million face value, five-year, 6.75% semiannual coupon bond with a YTM of 5.40% to an active portfolio. The manager uses regression analysis to estimate the bond's empirical duration to be 2.95. Calculate the bond's analytical duration, and estimate the difference in the expected versus actual market value change for this position, given a 50 bp decline in benchmark yields to maturity using these two measures.

Solution:

1. Solve for the bond's analytical duration by using the Excel MDURATION function (MDURATION(settlement, maturity, coupon, yield, frequency, basis)) using a settlement date of 1 January 2022, maturity of 1 January 2027, a 6.75% coupon, 5.40% YTM, semiannual frequency and basis of 0 (30/360 day count) to get 4.234. Note the analytical duration is greater than the observed empirical duration of 2.95.
2. The bond position value can be calculated using the Excel PRICE function (PRICE(settlement, maturity, coupon, yield, frequency, basis)) to solve for a price of 105.847 per 100 face value, or a price of US$52,923,500 for a US$50 million face value.
3. The difference in percentage market value change can be estimated using the 0.50% yield change multiplied by modified duration (–ModDur × ΔYield) for the two estimates. If the benchmark YTM declines by 50 bps, then

   Analytical duration estimate: 2.117% = (−4.234 × −0.5%)

   Empirical duration estimate: 1.475% = (−2.95 × −0.5%)

The analytical duration calculation overestimates the price gain versus the empirical duration estimate.

4. The difference is 0.642% (2.117% − 1.475%), or an expected US$339,769 (=0.642% × $52,923,500) value difference between the two measures.

While the concept of empirical duration emphasizes the *direction* of high-yield credit spread changes versus benchmark rates, as suggested earlier, the *magnitude* of credit spread changes is greater for lower- versus higher-rate bonds. As we will see later in the lesson, this empirical observation leads to the use of credit spread measure changes based on *percentage* as opposed to absolute credit spread changes for lower-rated issuers.

Credit Spread Measures

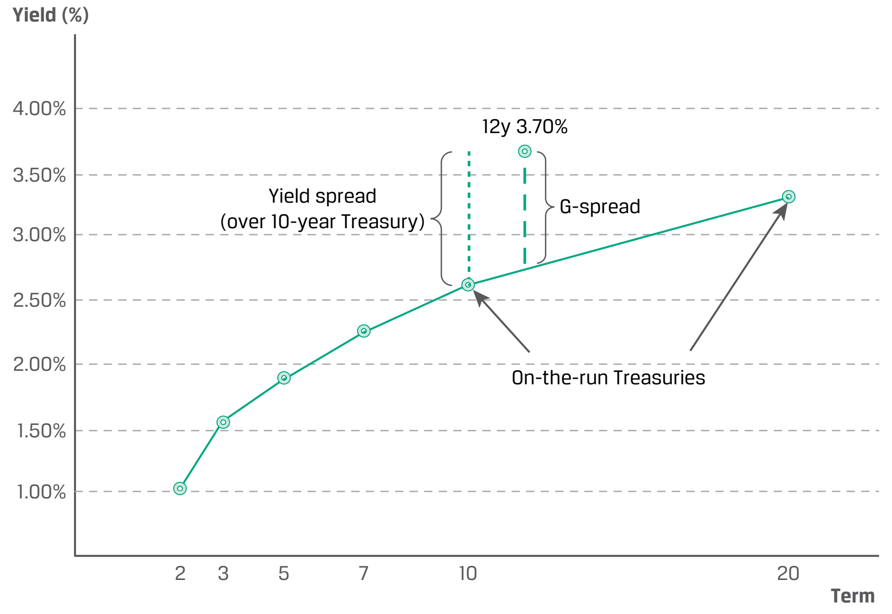
Fixed-Rate Bond Credit Spread Measures

The estimation of yield spreads from market information gives rise to several measures of the difference between a fixed-rate bond's YTM and a benchmark rate. Recall that the YTM is an internal rate of return calculation of all bond cash flows that assumes any earlier payments are reinvested at the same rate and the bond is held to maturity. Spread comparisons are accurate when comparing bonds with identical maturities but different coupons. Because bond maturities vary in practice, a mismatch arises that creates measurement bias if the yield curve is sloped. As a bond rolls down the curve, the benchmark security can also change over time. Finally, yield-based measures do not accurately gauge the return of carry-based strategies often used by active managers (for example, long a risky bond, short a default risk-free position in the repo market).

The yield spread (or benchmark spread) defined earlier as the simple difference between a bond's YTM and the YTM of an on-the-run government bond of similar maturity is easy to calculate and interpret for option-free bonds, and it is particularly useful for infrequently traded bonds. The yield spread also facilitates the approximation of bond price changes for a given benchmark YTM change, assuming a constant yield spread. That said, this simple government bond–based measure has both curve slope and maturity mismatch biases and lacks consistency over time because government benchmarks change as a bond nears maturity.

The **G-spread** uses constant maturity Treasury yields to maturity as the benchmark. Exhibit 10 shows the difference between yield spread and G-spread measures using the example of a bond with 12 years remaining to maturity. While the yield spread for this bond would likely be quoted over a 10-year government benchmark rate, the G-spread involves an interpolation between 10-year and 20-year government yields to maturity.

Exhibit 10: Yield Spread versus G-Spread



EXAMPLE 4

Yield Spread versus G-Spread

A portfolio manager considers the following annual coupon bonds:

Issuer	Term	Coupon	Yield	ModDur
Bank	8y	2.75%	2.68%	7.10
Government	7y	1.5%	1.39%	6.61
Government	10y	1.625%	1.66%	9.16

1. Calculate the yield spread and G-spread for the bank bond.

Solution:

Yield spread for the bank bond is 1.290%, or the simple difference between the 2.68% bank bond YTM and the 1.39% YTM of the nearest on-the-run government bond.

The G-spread is the difference between the bank bond YTM and a linear interpolation of the YTMs of the 7-year government bond (r_{7yr}) and the 10-year government bond (r_{10yr}). Calculate the approximate 8-year government rate as follows:

1. Solve for the weights of the 7-year and the 10-year bond in the interpolation calculation.

7-year bond weight = w_7 = 66.7% (= (10 − 8)/(10 − 7))

10-year bond weight = w_{10} = 33.3% (or (1 − w_7))

Note that (w_7 × 7) + (w_{10} × 10 = 8).

2. The 8-year government rate is a weighted average of the 7-year bond rate and the 10-year bond rate using the weights in Step 1.

$r_{8yr} = w_7 \times r_{7yr} + w_{10} \times r_{10yr}$

$= (66.7\% \times 1.39\%) + (33.3\% \times 1.66\%) = 1.48\%$

3. The G-spread, or the difference between the bank bond YTM and the 8-year government rate, equals 1.20% (= 2.68% – 1.48%).

2. An increase in expected inflation causes the government yield curve to steepen, with a 20-point rise in the 10-year government bond YTM and no change in the 7-year government YTM. If the respective bank bond yield spread measures remain unchanged, calculate the expected bank bond percentage price change in each case, and explain which is a more accurate representation of the market change in this case.

Solution:

For the yield spread measure, neither the 1.29% spread nor the 7-year government rate of 1.39% has changed, so an analyst considering only these two factors would expect the bank bond price to remain unchanged.

However, for the G-spread measure, the 20 bp increase in the 10-year government YTM causes the 8-year interpolated government YTM to change.

1. The 7-year and the 10-year bond weights for the interpolation are the same as for Question 1, w_7 = 66.7% and w_{10} = 33.3%.
2. The new 8-year government rate is a weighted average of the 7-year bond rate and the 10-year bond rate using the weights in Step 1.

$r_{8yr} = w_7 \times r_{7yr} + w_{10} \times r_{10yr}$

$= (66.7\% \times 1.39\%) + (33.3\% \times 1.86\%) = 1.55\%$

3. The bank bond YTM has risen by 0.07% to 2.75% (=1.55% + 1.20%).
4. The bank bond price change can be estimated by multiplying the yield change by modified duration (–ModDur × ΔYield) as in earlier lessons. This change can be calculated as -0.497% (=–7.1 × 0.07%).

   Note that we can confirm this using the Excel PV function (=–PV (rate, nper, pmt, FV, type)) where "rate" is the interest rate per period (0.0268), "nper" is the number of periods (8), "pmt" is the periodic coupon (2.75), "FV" is future value (100), and "type" corresponds to payments made at the end of each period (0).

Initial bank bond price: 100.50 (=–PV (0.0268, 8, 2.75, 100, 0)

New bank bond price: 100 (=–PV (0.0275, 8, 2.75, 100, 0)

Price change: –0.497% (= (99.39 – 100.50)/100.50)

The G-spread calculation provides a more accurate representation of the estimated bank bond price change in this case because it incorporates the term structure of interest rates.

The **I-spread (interpolated spread)** uses interest rate swaps as the benchmark. Recall that swap rates are derived using short-term lending or market reference rates (MRRs) rather than default-risk-free rates, and unlike government bonds, they are quoted across all maturities. Short-term MRR were historically survey-based Libor rates and are transitioning to transaction-based, secured overnight funding rates.

The spread over an MRR-based benchmark can be interpreted as a *relative* rather than absolute credit risk measure for a given bond issuer. An issuer might use the MRR spread to determine the relative cost of fixed-rate versus floating-rate borrowing alternatives, while an investor can use the I-spread to compare pricing more readily across issuers and maturities. Swap benchmarks have the added benefit of directly measuring all-in bond YTMs with an instrument that can be used both as a duration hedge and to measure carry return more accurately for a leveraged position. While the I-spread addresses the maturity mismatch of bonds and benchmarks as raised earlier, it incorporates yield levels using a point on the curve to estimate a risky bond's yield spread rather than the term structure of interest rates and is limited to option-free bonds as a credit risk measure.

Asset swaps convert a bond's periodic fixed coupon to MRR plus (or minus) a spread. If the bond is priced close to par, this spread approximately equals the bond's credit risk over the MRR. Exhibit 11 shows the mechanics of an asset swap.

Exhibit 11: Asset Swap Mechanics

The **asset swap spread (ASW)** is the difference between the bond's fixed coupon rate and the fixed rate on an interest rate swap versus MRR, which matches the coupon dates for the remaining life of the bond. If we assume an investor purchases a bond at par, the asset swap transforms the fixed-rate coupon to an equivalent spread over MRR for the life of the bond. Note that under a bond default scenario, the asset manager would still face the mark-to-market settlement of the swap.

EXAMPLE 5

ASW versus I-Spread

1. Consider the information from the bank and government annual coupon bonds from the prior example:

Issuer	Term	Coupon	Yield	ModDur
Bank	8y	2.75%	2.68%	7.10
Government	7y	1.5%	1.39%	6.61
Government	10y	1.625%	1.66%	9.16

Assuming that 7- and 10-year swap spreads over the respective government benchmark yields to maturity are 15 bps and 20 bps, calculate the ASW and the I-spread for the bank bond, and interpret the difference between the two.

Solution:

1. Solve for the weights of the 7-year and the 10-year bond in the interpolation calculation.

7-year bond weight = w_7 = 66.7% (= (10 − 8)/(10 − 7)).

10-year bond weight = w_{10} = 33.3% (or $(1 - w_7)$.

Note that $(w_7 \times 7) + (w_{10} \times 10) = 8$.

2. The interpolated 8-year swap rate is a weighted average of the 7-year swap rate (1.54% = 1.39% + 0.15%) and the 10-year swap rate (1.86% = 1.66% + 0.20%).

$r_{Swap8yr} = w_7 \times r_{Swap7yr} + w_{10} \times r_{Swap10yr}$

(66.7% × 1.54%) + (33.3% × 1.86%) = 1.647%

3. The ASW equals the difference between the bank bond *coupon* of 2.75% and the 8-year swap rate of 1.647%, or 110.3 bps.
4. The I-spread is the difference between the bank bond's current YTM of 2.68% and the 8-year swap rate of 1.647%, or 103.3 bps.

The ASW is an estimate of the spread over MRR versus the bond's original coupon rate to maturity, while the I-spread is an estimate of the spread over MRR for a new par bond from the bank issuer, with the difference largely reflecting the premium or discount of the outstanding bond price.

While both the G-spread and I-spread use the same discount rate for each cash flow, a more precise approach incorporating the term structure of interest rates is to derive a constant spread over a government (or interest rate swap) spot curve instead. This spread is known as the **zero-volatility spread (Z-spread)** of a bond over the benchmark rate. The Z-spread formula shown in Equation 2 was introduced in an earlier reading.

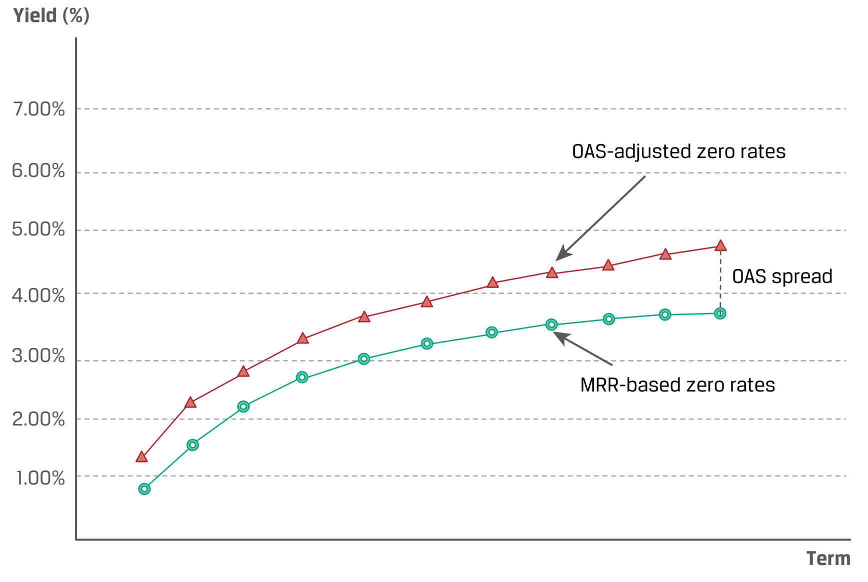
$$PV = \frac{PMT}{(1 + z_1 + Z)^1} + \frac{PMT}{(1 + z_2 + Z)^2} + \ldots + \frac{PMT + FV}{(1 + z_N + Z)^N} \quad (2)$$

Here the bond price (PV) is a function of coupon (PMT) and principal (FV) payments in the numerator with respective benchmark spot rates $z_1 \ldots z_N$ derived from the swap or government yield curve and a constant Z-spread per period (Z) in the denominator discounted as of a coupon date. While more accurate than either the G-spread or I-spread, this is a more complex calculation that is conducted by practitioners using either a spreadsheet or other analytical model.

Credit default swap (CDS) basis refers to the difference between the Z-spread on a specific bond and the CDS spread of the same (or interpolated) maturity for the same issuer. Recall from earlier in the curriculum that a CDS is a derivative contract in which a protection buyer makes a series of premium (or CDS spread) payments to a protection seller in exchange for compensation for credit losses (or the difference between par and the recovery rate) under a credit event. Negative basis arises if the yield spread is above the CDS spread, and positive basis indicates a yield spread tighter than the CDS spread. Although spreads for a single issuer across bond and CDS markets should be closely aligned in principle, in practice, CDS basis arises because of such factors as bond price differences from par, accrued interest, and varying contract terms, among other items. As in the case of asset swaps, CDS basis is a pricing measure, but unlike ASW, a CDS contract is terminated and settled following a credit event with no residual interest rate swap mark-to-market exposure. Similar to the I-spread using swaps or the asset swap just mentioned, CDS basis is a useful credit measure for investors actively trading or hedging credit risk using CDS, as addressed in detail later.

The **option-adjusted spread (OAS)** is a generalization of the Z-spread calculation that incorporates bond option pricing based on assumed interest rate volatility. Earlier readings established the use of the term structure of zero rates combined with a volatility assumption to derive forward interest rates used to value bonds with embedded options. The OAS is the constant yield spread over the zero curve which makes the arbitrage-free value of such a bond equal to its market price as shown in Exhibit 12. Note that the Z-spread for an option-free bond is simply its OAS, assuming zero volatility.

Exhibit 12: OAS



The OAS approach is the most appropriate yield spread measure for active fixed-income portfolio managers because it provides a consistent basis for comparing credit risk yield spreads for option-free, callable, putable, and structured fixed-income instruments. OAS calculations typically rely on fixed-income analytical models that incorporate the current term structure of interest rates, interest rate volatility, and term structure model factors introduced earlier in addition to the specific option-based features of a particular bond. Although OAS provides the best means to facilitate yield spread comparisons across different fixed-income securities, the main drawback of the OAS is that it is highly dependent on volatility and other model assumptions. For example, returns on structured financial instruments are highly dependent on prepayment versus extension risk, as outlined in an earlier lesson. While some analytical models calculate OAS using a standard or constant prepayment speed assumption, values based on historical or empirical analysis might provide very different and more accurate results. Also, the theoretical nature of the OAS calculation implies that bonds with embedded options are unlikely to realize the spread implied by the bond's OAS. Despite these shortcomings, OAS is the most widely accepted credit spread measure for comparing bonds with and without optionality across a fixed-income bond portfolio.

EXAMPLE 6

Portfolio OAS

1. A European portfolio manager is presented with the following information on a portfolio of two bonds. Calculate the OAS of the portfolio.

Issuer	Face Value	Price*	Accrued Interest*	OAS (bps p.a.)
Company A	€ 100,000,000	95	1.5	125
Company B	€ 200,000,000	97	2.0	150

**Per 100 of par value*

Solution:

1. Solve for bond and portfolio values:
   - A. Company A bond: €96,500,000 = €100,000,000 × (0.95 +0.015)
   - B. Company B bond: €198,000,000 = €200,000,000 × (0.97 +0.02)
   - C. Portfolio: €294,500,000 = €96,500,000 + €198,000,000
2. Solve for portfolio weights w_A and w_B:
   - A. Company A (w_A): 32.8% = €96,500,000/€294,500,000
   - B. Company B (w_B): 67.2% = €198,000,000/€294,500,000
3. Solve for portfolio OAS using ($OAS_A \times w_A$) + ($OAS_B \times w_B$).

OAS = 142 bps p.a. = (0.328 × 125 bps) + (0.672 × 150 bps)

Exhibit 13 summarizes these fixed-rate bond credit spread measures adapted from O'Kane and Sen (2005).

Exhibit 13: Key Fixed-Rate Bond Credit Spread Measures

Spread	Description	Advantages	Disadvantages
Yield spread	Difference between bond YTM and government benchmark of similar tenor	Simple to calculate and observe	Maturity mismatch, curve slope bias, and inconsistent over time
G-spread (Government spread)	Spread over interpolated government bond	Transparent and maturity matching default risk-free bond	Subject to changes in government bond demand
I-spread (Interpolated spread)	Yield spread over swap rate of same tenor	Spread versus market based (MRR) measure often used as hedge or for carry trade	Point estimate of term structure and limited to option-free bonds
ASW (Asset swap)	Spread over MRR of fixed bond coupon	Traded spread to convert current bond coupon to MRR plus a spread	Tradable spread rather than spread measure corresponding to cashflows and limited to option-free bonds

Spread	Description	Advantages	Disadvantages
Z-spread (Zero volatility spread)	Yield spread over a government (or swap) spot curve	Accurately captures term structure of government or swap zero rates	More complex calculation limited to option-free bonds
CDS Basis	Yield spread versus CDS spread of same tenor	Interpolated CDS spread versus Z-spread	Traded spread rather than spread measure corresponding to cashflows and limited to option-free bonds
OAS	Yield spread using Z-spread including bond option volatility	Provides generalized comparison for valuing risky option-free bonds with bonds with embedded options	Complex calculation based on volatility and prepayment assumptions; bonds with embedded options are unlikely to earn OAS over time

EXAMPLE 7

Comparison of Fixed-Rate Bond Credit Spread Measures

1. An active manager observes a yield spread for an outstanding corporate bond that is above the G-spread for that same bond. Which of the following is the most likely explanation for the difference?

   A. The government benchmark bond used to calculate the yield spread has a *shorter* maturity than the corporate bond, and the benchmark yield curve is *upward* sloping.

   B. The government benchmark bond used to calculate the yield spread has a *shorter* maturity than the corporate bond, and the benchmark curve is *downward* sloping.

   C. The government benchmark bond used to calculate the yield spread has a *longer* maturity than the corporate bond, and the benchmark yield curve is *upward* sloping.

Solution:

The correct answer is A. For a given all-in YTM, the lower the (on-the-run or interpolated) benchmark rate, the higher the relevant spread measure over the benchmark. Therefore, the higher yield spread versus G-spread most likely arises from the government benchmark having a shorter maturity than the bond and an upward sloping government yield curve. As for B and C, the yield spread would be lower than the G-spread for a downward sloping yield curve.

2. An active manager is weighing the purchase of two callable bonds with similar credit risks and the same final maturity. Which of the two bonds is more likely to be called on the next call date?

   A. The bond with the lower ASW

   B. The bond with the lower Z-spread

   C. The bond with the lower OAS

Solution:

The correct answer is C. The OAS measure is best suited to compare the impact of embedded options on similar bonds because it incorporates a volatility assumption to account for the value of bond options. Answer A indicates the spread over MRR for an outstanding bond swapped versus the original coupon rate, while the Z-spread in B assumes zero volatility and therefore does not capture the value of bond options.

Floating-Rate Note Credit Spread Measures

In contrast to fixed-rate bonds, floating-rate notes (FRNs) pay a periodic interest coupon comprising a variable MRR plus a (usually) constant yield spread. While fixed- and floating-rate bonds both decline in price if credit risk rises, interest rate risk on these bond types differs, and the associated FRN credit spread measures warrant our attention.

An earlier reading provided a simplified framework for valuing a floating-rate bond on a payment date, shown in Equation 3:

$$\text{PV} = \frac{\left(\frac{(\text{MRR}+\text{QM})\times\text{FV}}{m}\right)}{\left(1+\frac{(\text{MRR}+\text{DM})}{m}\right)^{1}} + \frac{\left(\frac{(\text{MRR}+\text{QM})\times\text{FV}}{m}\right)}{\left(1+\frac{(\text{MRR}+\text{DM})}{m}\right)^{2}} + \ldots + \frac{\left(\frac{(\text{MRR}+\text{QM})\times\text{FV}}{m}\right)+\text{FV}}{\left(1+\frac{(\text{MRR}+\text{DM})}{m}\right)^{N}} \tag{3}$$

Each interest payment is MRR plus the **quoted margin** (QM) times par (FV) and divided by m, the number of periods per year. Rather than a fixed YTM as for fixed-rate bonds, the periodic discount rate per period is MRR plus the **discount margin** (DM) divided by the periodicity (m), or (MRR + DM)/m. Note that for the purposes of Equation 3, MRR is based on current MRR and therefore implies a flat forward curve. The QM is the yield spread over the MRR established upon issuance to compensate investors for assuming the credit risk of the issuer. While some FRN bond indentures include an increase or decrease in the QM if public ratings or other criteria change, given that this spread is usually fixed through maturity, the QM does not reflect credit risk changes over time.

The discount (or required) margin is the yield spread versus the MRR such that the FRN is priced at par on a rate reset date. For example, assume an FRN issued at par value pays three-month MRR plus 1.50%. The QM is 150 bps. If the issuer's credit risk remains unchanged, the DM also equals 150 bps. On each quarterly reset date, the floater will be priced at par value. Between coupon dates, the flat price will be at a premium or discount to par value if MRR falls or rises. If on a reset date, the DM falls to 125 bps because of an issuer upgrade, the FRN will be priced at a premium above par value. The amount of the premium is the present value of the premium future cash flows. The annuity difference of 25 bps per period is calculated for the remaining life of the bond. Exhibit 14 summarizes the relationship between the QM versus DM and an FRN's price on any reset date.

Exhibit 14: FRN Discount, Premium, and Par Pricing

FRN price	Description	QM versus DM
Par	FRN trades at a price (PV) equal to its future value (FV)	QM = DM
Discount	FRN trades at PV < FV	QM < DM
Premium	FRN trades at PV > FV	QM > DM

EXAMPLE 8

Discount Margin

1. A London-based investor owns a five-year £100 million FRN that pays three-month MRR + 1.75% on a quarterly basis. The current MRR of 0.50% is assumed to remain constant over time. If the issuer's credit risk deteriorates and the DM rises to 2.25%, explain whether the FRN is trading at a discount or premium, and calculate the price difference from par.

Solution:

The FRN is trading at a discount because the QM is below the DM. We can solve for the price difference using the following steps.

1. Solve for the quarterly interest payment (=(MRR + QM) × FV/m) in the numerator and the discount rate (=(MRR + DM)/m) in the denominator of Equation 3 with QM = 1.75%, DM = 2.25%, MRR = 0.50%, and m = 4.
   - **A.** Quarterly interest payment: £562,500 (= (0.50% + 1.75%) × £100,000,000/4)
   - **B.** Discount rate: 0.6875% (= (0.50% + 2.25%)/4)
2. Solve for the new price using results from 1A and 1B with N = 20.

$$\text{£}97,671,718 = \frac{\text{£}562,500}{(1+0.6875\%)} + \frac{\text{£}562,500}{(1+0.6875\%)^2} + \frac{\text{£}562,500}{(1+0.6875\%)^3} + \ldots + \frac{\text{£}100,562,500}{(1+0.6875\%)^{20}}$$

3. The price difference is £2,328,282 (= £100,000,000 – £ 97,671,718).

The **zero-discount margin (Z-DM)** incorporates forward MRR into the yield spread calculation for FRNs. As in the case of the zero-volatility spread for fixed-rate bonds shown earlier, the Z-DM is the fixed periodic adjustment applied to the FRN pricing model to solve for the observed market price. As Equation 4 shows, this calculation incorporates the respective benchmark spot rates z_i derived from the swap or government yield curve for the Z-spread into the FRN pricing model shown earlier.

$$PV = \frac{\left(\frac{(MRR + QM) \times FV}{m}\right)}{\left(1 + \frac{(MRR + Z\text{-}DM)}{m}\right)^1} + \frac{\left(\frac{(z_2 + QM)\times;FV}{m}\right)}{\left(1 + \frac{(z_2 + Z\text{-}DM)}{m}\right)^2} + \ldots + \frac{\left(\frac{(z_N + QM) \times FV}{m}\right) + FV}{\left(1 + \frac{(z_N + Z\text{-}DM)}{m}\right)^N} \quad (4)$$

As in the case of the Z-spread for fixed-rate bonds, the Z-DM will change based on changes in the MRR forward curve. For example, in an upward-sloping yield curve, the Z-DM will be below the DM. Also, the Z-DM assumes an unchanged QM and that the FRN will remain outstanding until maturity. Exhibit 15 summarizes FRN credit spreads as adapted from O'Kane and Sen (2005).

Exhibit 15: Key FRN Credit Spread Measures

Spread	Description	Advantages	Disadvantages
QM	Yield spread over MRR of original FRN	Represents periodic spread related FRN cash flow	Does not capture changes in credit risk over time
DM	Yield spread over MRR to price FRN at par	Establishes spread difference from QM with constant MRR	Assumes a flat MRR zero curve
Z-DM	Yield spread over MRR curve	Incorporates forward MRR rates in yield spread measure	More complex calculation and yield spread does not match FRN cash flows

EXAMPLE 9

Floating-Rate Credit Spread Measure

1. An Australian investor holds a three-year FRN with a coupon of three-month MRR + 1.25%. Given an expected strong economic recovery, she anticipates a rise in Australian MRR over the next three years and an improvement in the FRN issuer's creditworthiness. Which of the following credit spread measures does she expect to be the *lowest* as a result?

   A. QM

   B. DM

   C. Z-DM

Solution:

The correct answer is C. The QM will be above the DM if issuer creditworthiness improves. As MRRs rise over the next three years, the upward-sloping curve will cause the Z-DM to remain below the DM.

Portfolio Return Impact of Yield Spreads

We now turn from credit spread measures to their impact on expected portfolio return. The first and third variables in Equation 1, namely roll-down return and E (Δ Price due to investor's view of yield spreads), are directly relevant for active managers targeting excess return above a benchmark portfolio using credit strategies.

In the first instance, recall from earlier lessons that investors "rolling down" the yield curve accumulate coupon income and additional return from fixed-rate bond price appreciation over an investment horizon if benchmark rates are positive and the yield curve slopes upward. For fixed-rate bonds priced at a spread over the benchmark, return from coupon income is higher by the bond's original credit spread. The roll-down return due to price appreciation will also be higher than for an otherwise identical government security because the higher-yielding instrument will generate greater carry over time. Note that this higher return comes with greater risk and assumes all promised payments take place and the bond remains outstanding—that is, no default or prepayment occurs, and the bond is not called.

EXAMPLE 10

Corporate versus Government Bond Roll Down

A London-based investor wants to estimate rolling yield attributable to a fixed-rate, option-free corporate bond versus UK gilts over the next six months assuming a static, upward-sloping government yield curve and a constant credit spread. The corporate bond has exactly 10 years remaining to maturity, a semiannual coupon of 3.25%, and a YTM of 2.75%, while the closest maturity UK gilt is a 1.75% coupon currently yielding 1.80%, with 9.5 years remaining to maturity.

1. Calculate the annualized rolling yield to the UK corporate bond versus the government bond over the next six months.

Solution:

Solve for the annualized difference in rolling yield by calculating the change in price plus the coupon income for both the corporate bond and the government bond.

1. Calculate the corporate bond rolling yield per £100 face value. For price changes, use the Excel PV function (= –PV(rate, nper, pmt, FV, type)) where "rate" is the interest rate per period (0.0275/2), "nper" is the number of periods (20), "pmt" is the periodic coupon (3.25/2), "FV" is future value (100), and "type" corresponds to payments made at the end of each period (0).
   - **A.** Initial price is 104.346 (= –PV (0.0275/2, 20, 3.25/2, 100, 0)).
   - **B.** Price in six months is 104.155 (= –PV (0.0275/2, 19, 3.25/2, 100, 0)). Price *depreciation* is 0.18% (= (104.155 – 104.346)/104.346).
   - **C.** Six-month coupon income is 1.625 (= 3.25/2), or equal to 1.557% (=1.625/104.346), which combined (without rounding) with –0.18% from B results in a 1.375% six-month return (2.75% annualized).
2. Calculate the UK gilt price change and coupon income.
   - **A.** Initial price is 99.565 (= –PV (0.018/2, 19, 1.75/2, 100, 0)).
   - **B.** Price in six months is 99.586 (= –PV (0.018/2, 18, 1.75/2, 100, 0)). Price *appreciation* is 0.021% (= (99.586 – 99.565)/99.565).
   - **C.** Six-month coupon income is 0.875 (=1.75/2), or equal to 0.879% (0.875/99.565), which combined with +0.021% equals 0.9% for six months (1.80% annualized).

The annualized rolling yield difference is the 2.75% corporate bond realized return less the 1.80% UK gilt realized return, or 0.95%.

2. Describe how the relative rolling yield would change if the investor were to use an interpolated government benchmark rather than the actual 9.5-year gilt.

Solution:

The interpolated benchmark involves the use of the most liquid, on-the-run government bonds to derive a hypothetical 10-year UK gilt YTM. Because the UK gilt yield curve is upward sloping in this example, we can conclude that the relative rolling yield using an interpolated benchmark would be lower than the 0.95% difference in Question 1.

Active credit managers often view the E (Δ Price due to investor's view of yield spreads) term in Equation 1 on a stand-alone basis because they manage benchmark rate risks separately from credit. Equation 5 is similar to equations from earlier lessons quantifying the change in bond price for a given YTM change, but it is limited here to yield spread changes, or $\%\Delta PV^{Spread}$ (= ΔPV/ΔSpread).

$$\%\Delta PV^{Spread} \approx -(\text{EffSpreadDur} \times \Delta\text{Spread}) + (½ \times \text{EffSpreadCon} \times (\Delta\text{Spread})^2) \quad (5)$$

where effective spread duration (EffSpreadDur) and effective spread convexity (EffSpreadCon) reflect spread rather than curve changes, and ΔSpread is typically defined as the change in OAS.

$$\text{EffSpreadDur} = \frac{(PV_-) - (PV_+)}{2 \times (\Delta\text{Spread})(PV_0)} \quad (6)$$

$$\text{EffSpreadCon} = \frac{(PV_-) + (PV_+) - 2(PV_0)}{(\Delta\text{Spread})^2 \times (PV_0)} \quad (7)$$

The first term of Equation 5 is sometimes simply referred to as **spread duration**, or, alternatively, as **OAS duration** when OAS is the underlying spread. Active managers approximate bond portfolio value changes due to spread changes by substituting market value–weighted averages for the duration and convexity measures in Equation 5. As noted earlier, spread changes for lower-rated bonds tend to be consistent on a proportional percentage rather than absolute basis; therefore, adjusting spread duration to capture this **Duration Times Spread (DTS)** effect is important, as in Equation 8.

$$\text{DTS} \approx (\text{EffSpreadDur} \times \text{Spread}) \quad (8)$$

A portfolio's DTS is the market value–weighted average of DTS of its individual bonds, and spread changes of a portfolio are measured on a percentage (ΔSpread/Spread) basis rather than in absolute basis point terms, as in the following example.

EXAMPLE 11

DTS Example

1. A financial analyst compares a portfolio evenly split between two technology company bonds trading at par to an index with an average OAS of 125 bps.

Issuer	OAS	EffSpreadDur
A Rated Bond	100 bps	3.0
BB Rated Bond	300 bps	4.0

Calculate the portfolio DTS, and estimate how the technology bond portfolio will perform if index OAS widens by 10 bps.

Solution:

Portfolio DTS is the market value–weighted average of DTS based on Equation 8, or $\sum_{i=1}^{n} w_i(\text{EffSpreadDur}_i \times \text{Spread}_i)$.

1. Portfolio DTS in this two-asset example is $w_A(\text{EffSpreadDur}_A \times \text{Spread}_A) + w_{BB}(\text{EffSpreadDur}_{BB} \times \text{Spread}_{BB})$ with equal weights ($w_A = w_{BB} = 0.50$). Solve for portfolio DTS of 750 (= (0.5 × 100 bps × 3.0) + (0.5 × 300 bps × 4.0)).
2. Index spread widening of 10 bps is equivalent to 8% (10 bps/125 bps spread) on a ΔSpread/Spread basis. We can therefore calculate the estimated basis point change in the technology bond portfolio by multiplying the portfolio DTS of 750 by the 8% expected percentage spread change to get an expected 60 bps p.a. widening for the technology bond portfolio.

As active credit managers consider *incremental* effects of credit-based portfolio decisions, they often use spread duration–based statistics to gauge the first-order impact of spread movements. For example, Equation 9 approximates the annualized **excess spread** return for a spread-based bond:

$$\text{ExcessSpread} \approx \text{Spread}_0 - (\text{EffSpreadDur} \times \Delta\text{Spread}) \quad (9)$$

Spread_0 is the initial yield spread, which changes to (Spread_0/Periods Per Year) for holding periods of less than a year. Note that this calculation assumes no defaults for the period in question. While relatively rare, as an event of default grows more likely, expected future bond cash flows are impaired, and a bond's value instead approaches the present value of expected recovery. The annualized expected excess return shown in Equation 10 incorporates both default probability and loss severity:

$$E\,[\text{ExcessSpreadReturn}] \approx$$

$$\text{Spread}_0 - (\text{EffSpreadDur} \times \Delta\text{Spread}) - (\text{POD} \times \text{LGD}) \quad (10)$$

Equation 10 captures a key goal of active credit management, which is to maximize expected spread return in excess of the portfolio credit loss or realized percentage of par value lost to defaults over time.

EXAMPLE 12

Excess Spread and Expected Excess Spread

A corporate bond has an effective spread duration of five years and a credit spread of 2.75% (275 bps).

1. What is the approximate excess return if the bond is held for six months and the credit spread narrows 50 bps to 2.25%? Assume the spread duration remains at five years and that the bond does not experience default losses.

Solution:

Using Equation 9 (Spread_0 – (EffSpreadDur × ΔSpread)), the excess return on the bond is 3.875% = (2.75% × 0.5) – [(2.25% – 2.75%) × 5].

2. What is the instantaneous (holding period of zero) excess return if the spread rises to 3.25%?

Solution:

Using Equation 9, the instantaneous excess return on the bond is approximately −2.5% = (2.75% × 0) − [(3.25% − 2.75%) × 5].

3. Assume the bond has a 1% annualized expected POD and expected loss severity of 60% in the event of default. What is the expected excess return if the bond is held for six months and the credit spread is expected to fall to 2.25%?

Solution:

Using Equation 10 (Spread_0 − (EffSpreadDur × ΔSpread) − (POD × LGD)), the expected excess return on the bond is approximately 3.575% = (2.75% × 0.5) − [(2.25% − 2.75%) × 5] − (0.5 × 1% × 60%).

Finally, we must address the difference in duration as an interest rate sensitivity measure for FRNs versus fixed-rate bonds. The periodic reset of MRRs in both the FRN numerator and denominator leads to a *rate* duration of near zero for floaters trading at par on a reset date (prior to MRR reset). As we saw in an earlier DM example, changes in *spread* (DM or Z-DM) are the key driver of price changes for a given FRN yield change. The respective FRN rate and spread duration measures are shown in Equation 11 and Equation 12 and demonstrated in the following example.

$$\text{EffRateDur}_{\text{FRN}} = \frac{(PV_-) - (PV_+)}{2 \times (\Delta \text{MRR}) \, (PV_0)} \tag{11}$$

$$\text{EffSpreadDur}_{\text{FRN}} = \frac{(PV_-) - (PV_+)}{2 \times (\Delta \text{DM}) \, (PV_0)} \tag{12}$$

We return to the example of a five-year £100 million FRN at three-month MRR + 1.75%, with a DM of 2.25% and a 0.50% MRR priced at £97,671,718. We can derive the FRN's effective rate duration by first calculating PV_- and PV_+ using a spreadsheet by shifting MRR down and up by 0.05% as follows:

$$\text{PV0} = £97,671,718 = \frac{£562,500}{(1 + 0.6875\%)} + \frac{£562,500}{(1 + 0.6875\%)^2} + \ldots + \frac{£100,562,500}{(1 + 0.6875\%)^{20}}$$

$$PV_- = £97,668,746 = \frac{£550,000}{(1 + 0.6750\%)} + \frac{£550,000}{(1 + 0.6750\%)^2} + \ldots + \frac{£100,550,000}{(1 + 0.6750\%)^{20}}$$

$$PV_+ = £97,674,685 = \frac{£575,000}{(1 + 0.7000\%)} + \frac{£575,000}{(1 + 0.7000\%)^2} + \ldots + \frac{£100,575,000}{(1 + 0.7000\%)^{20}}$$

Solving for $\text{EffRateDur}_{\text{FRN}}$, we arrive at a rate duration of −0.061, which is slightly negative because the floater trades at a discount. The spread duration statistic $\text{EffSpreadDur}_{\text{FRN}}$ is calculated in a similar manner by shifting DM down and up by 0.05%, with PV_- and PV_+ equal to £97,972,684 and £97,515,401 and $\text{EffSpreadDur}_{\text{FRN}}$ equal to 4.682.

3 CREDIT STRATEGIES

- ☐ discuss bottom-up approaches to credit strategies
- ☐ discuss top-down approaches to credit strategies

Bottom-Up Credit Strategies

As active fixed-income managers consider the selection process for spread-based bond portfolio investments, they must assess different ways in which to maximize excess spread across the fixed-income issuer types, industries, and instruments within their prescribed investment mandate. A fundamental choice these investors face is whether to engage in an individual security selection process or bottom-up approach; a macro- or market-based, top-down approach in pursuing this objective; or a combination of both.

Fundamental credit analysis covered earlier in the curriculum considers the basis on which a specific issuer can satisfy its interest and principal payments through bond maturity. Analysts often assess unsecured corporate bonds using factors such as profitability and leverage to identify the sources and variability of cash flows available to an issuer to service debt. These measures are usually chosen and compared relative to an industry and/or the jurisdiction in which the issuer operates. In the case of a sovereign borrower, the relevant metric is the economic activity within a government's jurisdiction and the government's ability and willingness to levy taxes and generate sufficient revenue to meet its obligations. Alternatively, for a special purpose entity issuer with bonds backed by mortgage-based or other securitized cash flows, a credit measure of both the residential borrowers and underlying collateral value as well as internal credit enhancements are among the primary factors considered in the assessment.

While individual bonds across all these issuer types are usually rated by at least two of the major credit rating agencies, active managers typically conduct their own credit assessment of individual borrowers rather than relying on ratings, which are frequently used to define a mandate (e.g., investment grade versus high yield), categorize, or benchmark investments of similar credit quality.

Defining the Credit Universe

A bottom-up approach typically begins with a manager defining the universe of eligible bonds within a mandate and then grouping the universe into categories that allow consistent relative value analysis across comparable borrowers. For example, a corporate bond portfolio manager is likely to divide eligible bonds into industry sectors, such as media and telecommunications and industrials, as well as into subsectors and/or firms located in different jurisdictions. Media and telecommunications subsectors include firms in the cable and satellite industries, internet media, and telecommunications carriers. Within each sector or subsector based on either industry classification methodologies or a customized approach, she can use relative value analysis to determine the bonds that are attractively valued.

EXAMPLE 13

Dividing the Credit Universe

1. An investor is conducting a relative value analysis on global bond issuers in the health care sector. He is trying to decide whether the global health care sector is a sufficiently narrow sector for his analysis. Through his research, he has determined the following:

   - Biotech and pharmaceutical companies are active globally across Europe, Asia, and the Americas.
   - Health care facilities are typically local in nature and tend to sell into only one of these three regions.
   - Medical equipment and devices is a more cyclical business, and many of these firms are part of multi-industry companies in which health care accounts for a smaller fraction of overall company sales.

   Describe considerations that the investor can use in determining how to best divide the health care sector into comparable companies.

Solution:

An investor typically seeks to isolate a sector that contains a set of companies for which he expects company-level risks, rather than industry or macro risks, to be the dominant factors. Based on the investor's analysis, biotech and pharmaceutical companies differ meaningfully from health care facilities and medical equipment manufacturers. Health care facilities have a narrow regional focus in contrast to the global focus in biotech and pharma.

The investor might therefore want to divide the global health care sector into global biotech and global pharmaceuticals. Hospitals and other health care facilities warrant separate treatment given their narrow geographic focus and different industry drivers. He might want to consider a different approach to medical device companies given their multi-industry profiles.

Bottom-Up Credit Analysis

Once the credit universe has been divided into sectors and prospective bonds identified, the investor evaluates each issuer's implied credit risk comparing company-specific financial information to spread-related compensation for assuming default, credit migration, and liquidity risks for comparative purposes.

Beyond the prospects within a company's industry, its competitive position within that industry, and operating history, financial ratios are a valuable tool to compare creditworthiness across firms. Earlier lessons stressed the value of key ratios, including profitability and cash flow, leverage, and debt coverage, which are summarized in Exhibit 16.

Exhibit 16: Key Financial Ratios for Bottom-Up Credit Analysis

Ratio	Description	Advantages	Disadvantages
EBITDA/ Total Assets	**Profitability** Cash flow as a percentage of assets	Combines operating income with non-cash expense	Ignores capital expenditures and working capital changes
Debt/ Capital	**Leverage** Fraction of company's capital financed with debt	Direct measure of relative reliance on debt financing	More relevant for investment-grade than high-yield issuers
EBITDA/ Interest Expense	**Coverage** Cash flow available to service debt	Measures relative issuer ability to meet debt payments	Volatile measure for firms with high cash flow variability

While offering a relatively consistent basis for comparison across firms and over time, reliance on financial ratios based on publicly available accounting data alone is of limited value because of comparability issues across firms and industries as well as the historical nature of financial statements. Alternative measures combine several relevant financial ratios with market-based measures to establish a forward-looking approach to creditworthiness.

A previous lesson established that statistical credit analysis models to measure individual issuer creditworthiness can be categorized as either **reduced form credit models** or **structural credit models**. Reduced form models solve for **default intensity**, or the POD over a specific time period, using observable company-specific variables such as financial ratios and recovery assumptions as well as macroeconomic variables, including economic growth and market volatility measures. Structural credit models use market-based variables to estimate the market value of an issuer's assets and the volatility of asset value. The likelihood of default is defined as the probability of the asset value falling below that of liabilities.

An early example of the reduced form approach is the **Z-score** established by Altman (1968), which combined liquidity (working capital/total assets), profitability (retained earnings/total assets), asset efficiency (EBIT/ total assets), market versus book value of equity, and asset turnover (sales/total assets) factors weighted by coefficients to form a composite score. Each composite, or Z-score, was used to classify manufacturing firms into those expected to remain solvent and those anticipated to go bankrupt. Similar to credit scoring models, this multiple discriminant analysis reduces the dimensionality of the input variables to a single cutoff Z-score that represents the default threshold, as shown in the following example.

EXAMPLE 14

Z-Score Comparison of Two Firms

A United Kingdom–based financial analyst considers a Z-score model in evaluating two publicly traded non-manufacturing companies as follows:

Z-Score Model = 1.2 × A + 1.4 × B + 3.3 × C + 0.6 × D + 0.999 × E,

where

A is Working Capital/Total Assets

B is Retained Earnings/Total Assets

C is EBIT/Total Assets

D is Market Value of Equity/Total Liabilities

E is Sales/Total Assets

Firms with a Z-score greater than 3.0 are considered financially sound, those scoring between 3.0 and 1.8 are at greater risk of financial distress, and those with a Z-score below 1.8 are likely to face insolvency.

1. Calculate the Z-score for Firm 1 and Firm 2. Which has a higher likelihood of financial distress based on this measure?

Financial Data (GBP thousands)/Firm	Firm 1	Firm 2
Total Sales	23,110	15,270
EBIT	6,910	2,350
Current Assets	7,560	4,990
Total Assets	36,360	23,998
Current Liabilities	5,400	3,564
Total Liabilities	9,970	10,050
Retained Earnings	20,890	13,787
Market Value of Equity	29,000	18,270

Solution:

First, calculate the respective ratios for both firms as follows, noting that working capital is equal to current assets minus current liabilities:

Z-Score Factors	Firm 1	Firm 2
Working Capital/Assets	0.059	0.059
Retained Earnings/Assets	0.575	0.575
EBIT/Total Assets	0.190	0.098
Market Value of Equity/Total Liabilities	2.909	1.818
Sales/Total Assets	0.636	0.636

Solving for the respective Z-scores, we find that Firm 1 has a Z-score of 3.883, while Firm 2 has a Z-score of 2.925. Firm 2 therefore has a greater likelihood of financial distress.

2. Evaluate the most likely reasons for the difference in creditworthiness between the two firms based on the Z-score model factors.

Solution:

Comparing the respective Z-score ratios of Firm 1 and Firm 2, we find that Firm 2 has a far lower asset efficiency (EBIT/Total Assets of 9.8% versus 19% for Firm 1) and a lower relative equity market value (Market Value of Equity/Total Liabilities of 1.818 versus 2.909 for Firm 1) than Firm 1, while all other ratios are comparable.

Structural credit models used in practice include Moody's Analytics Expected Default Frequency (EDF) and Bloomberg's Default Risk (DRSK) models, both of which provide daily POD estimates for a broad range of issuers over a selected period. The EDF model estimates a forward-looking POD defined as the point at which the market value of assets falls below a firm's obligations. The model uses asset volatility to determine the likelihood of reaching the default point and is calibrated for different industries, regions, and observed credit market dynamics.

Bloomberg's DRSK model estimate for AbbVie Inc., as shown in Exhibit 17, includes a market-based asset value measure derived from equity market capitalization and equity volatility as well as a default threshold measured using the book value of liabilities. These and other DRSK model inputs in the left column of the screen can be defined by users and compared within and across industry sectors. In addition to the one-year POD estimate of 0.0413%, DRSK calculates a "model" CDS spread (upper left corner) which can be compared to the actual market CDS spread.

Exhibit 17: Bloomberg DRSK Model Estimate for AbbVie Inc.

Source: Bloomberg

Both the EDF and DRSK approaches are sometimes referred to as "distance to default" models because a probability distribution is used to determine how far an issuer's current market value of assets is from the default threshold for a given period.

EXAMPLE 15

"Distance to Default" Models

1. An active manager is weighing an investment in the bonds of two issuers in the same industry with identical PODs using a structural credit model. Which of the following changes to the model inputs for one of the issuers would lead the analyst to expect an increase in the POD for that issuer?

   A. An increase in the issuer's coverage ratio

   B. An increase in the volatility of the issuer's stock price

   C. A decrease in the issuer's leverage ratio

Solution:

The correct answer is B. Higher equity volatility increases the likelihood that the market value of the issuer's assets will fall below the default threshold. A higher coverage ratio in A implies higher cash flow as a percentage of assets, increasing the issuer's ability to service its debt obligations. The decrease in the issuer's leverage ratio in C represents a decline in the amount of debt versus equity, reducing the issuer's likelihood of financial distress.

Bottom-Up Relative Value Analysis

Given two issuers with similar credit risk, the investor will typically choose bonds of the issuer with the higher yield spread, given the greater potential for excess returns. For issuers with different credit-related risk, the investor must decide whether the additional spread is sufficient compensation for the incremental exposure. The excess expected return calculation in Equation 10 captures the relationship between yield spreads and the components of credit risk, as seen in the following example.

EXAMPLE 16

Comparing Investments Using Expected Excess Return

A portfolio manager considers two industrial bonds for a one-year investment:

Issuer	Rating	EffSpreadDur	YTM	Z-Spread
A Rated Industrial	A2	5.0	4.0%	100 bps
B Rated Industrial	B2	7.0	6.5%	350 bps

The manager observes a historical annual default probability of 0.27% for A2 rated issuers and 3.19% for B2 rated issuers and assumes a 40% recovery rate for both bonds.

1. Compute the estimated excess return for each bond assuming no change in spreads, and interpret whether the B rated bond spread provides sufficient compensation for the incremental risk.

Solution:

As per Equation 10,

$$E\,[\text{ExcessSpread}] \approx \text{Spread}_0 - (\text{EffSpreadDur} \times \Delta\text{Spread}) - (\text{POD} \times \text{LGD}).$$

A rated expected excess return is 0.84% = 1% – (5 × 0) – (0.27% × 60%). B rated expected excess return is 1.59% = 3.5% – (7 × 0) – (3.19% × 60%). The B rated bond appears to provide sufficient compensation for the added risk.

2. Which bond is more attractive if spreads are expected to widen by 10%?

Solution:

Recalculate Equation 10 with ΔSpread of 10 bps for the A rated bond and 35 bps for the B rated bond.

A rated excess return is 0.34% = 1% − (5 × 0.1%) − (0.27% × 60%).

B rated excess return is −0.86% = 3.5% − (7 × 0.35%) − (3.19% × 60%).

The A rated bond is more attractive under this scenario.

In practice, bonds from different issuers usually also have various maturity, embedded call or put provisions, liquidity, and other characteristics, so these additional features should be taken into account during the security selection process. For example, structural differences such as callability or priority within the capital structure must be factored in because they affect valuation. Also, bonds recently issued in larger tranches by frequent issuers will tend to have narrower bid–offer spreads and greater daily transaction volume, allowing investors to buy or sell the bond at a lower cost. This feature is likely to be of greater importance to investors who expect short-term spread narrowing and/or have a relatively short investment time horizon. Note that relative liquidity tends to decline over time, particularly if the same issuer returns to the bond market and offers a price concession for new debt. If, on the other hand, an investor has a longer investment horizon with the flexibility to hold a bond to maturity, he might be able to increase excess return via a greater liquidity premium. Finally, other factors driving potential yield spread differences to be considered include split ratings or negative ratings outlooks, potential merger and acquisition activity, and other positive or negative company events not adequately reflected in the analysis.

When deciding among frequent issuers with several bond issues outstanding, investors might consider using credit spread curves for these issuers across maturities to gauge relative value.

EXAMPLE 17

Using Spread Curves in Relative Value Analysis

A United States–based issuer has the following option-free bonds outstanding:

Outstanding Debt	Term	Coupon	Price	YTM
2-year issue	2	4.25%	106.7	0.864%
5-year issue	5	3.25%	106	1.984%
15-year issue	15	2.75%	91	3.528%

Current on-the-run US Treasury YTMs are as follows:

Tenor	Coupon	Price
2y	0.250%	100
5y	0.875%	100
10y	2.000%	100
20y	2.250%	100

An investor conxsiders the purchase of a new 10-year issue from the company and expects the new bond to include a 10 bp new issue premium. What is the fair value spread for the new issue based on outstanding debt?

1. First, solve for the credit spreads for outstanding bonds as the difference in the YTM from an actual or interpolated government bond:

5-year spread: 110.9 bps (= 1.984% − 0.875%)

15-year spread: Solve for 10- and 20-year bond interpolation weights.

10-year weight: w_{10} = 0.50% (= (20 − 10)/(15 − 10))

20-year weight: w_{20} = 0.50% (= (1 − w_{10}))

15-year interpolated bond: 2.125% = (2.00% × 0.5) + (2.25% × 0.5)

15-year spread: 140.3 bps (= 3.528% − 2.125%)

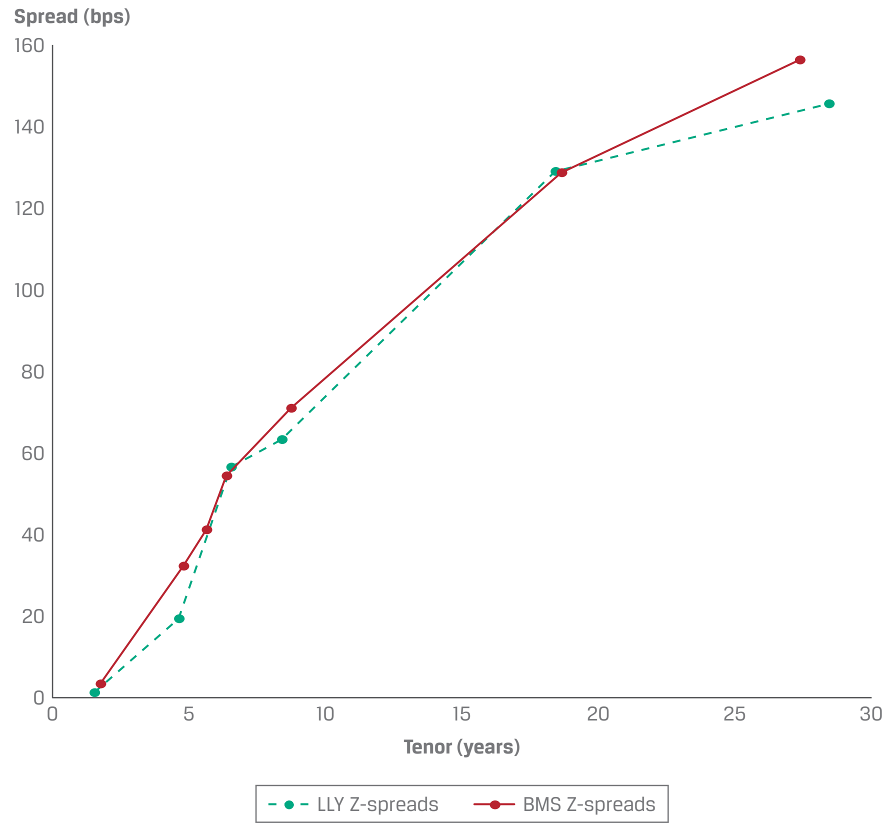
2. Derive the implied 10-year new issue spread by interpolating the 5- and 15-year credit spreads using the same interpolation weights as for Treasuries and adding the 10 bp new issue premium.

10-year spread: 135.6 bps = 0.1% + (1.109% × 0.5 + 1.403% × 0.5)

Many issuers have several bond issues, each of which typically has a different maturity and duration. To reflect the various maturities, a spread curve can be developed for each issuer and can be useful in conducting relative value analysis. A spread curve is the fitted curve of credit spreads for similar bonds of an issuer plotted against the maturity of those bonds.

Exhibit 18 plots the Z-spread versus maturities for select outstanding bonds of two A2/A+ rated health care companies, Eli Lilly (LLY) and Bristol-Myers Squibb (BMS), which have similar probabilities of default.

Exhibit 18: Spread Curves for Eli Lilly and Bristol-Myers Squibb



Source: Bloomberg

These spread curves are closely aligned except in roughly five-year and nearly 30-year maturities, where the BMS spreads are approximately 10 bps wider than those of LLY. If the bonds have similar features and liquidity, then a manager might conclude that the market perceives BMS credit risk to be slightly higher than that of LLY. However, if the manager believes that BMS is the stronger credit, several actions are possible depending on portfolio objectives and constraints. For example, if the investment mandate is to outperform a benchmark using long-only positions, the manager might overweight BMS bonds and underweight LLY bonds relative to the benchmark. If the objective is to generate positive absolute returns, underweighting or avoiding LLY bonds is less appropriate because such actions are meaningful only in the context of a benchmark. If permitted, the manager could also consider a long–short CDS strategy outlined later.

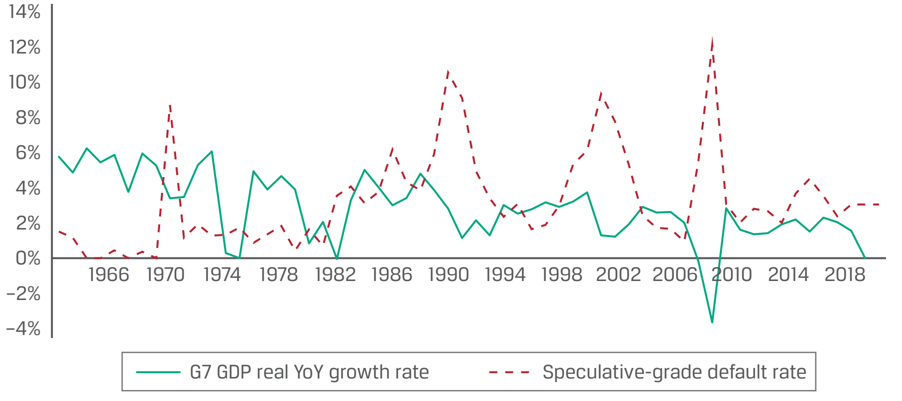
Once a manager has identified specific issuers and bond maturities to actively over- or underweight versus a benchmark, the next important step is to quantify and track these active investments in the context of the primary indexing risk factors identified in an earlier lesson in the active portfolio construction process. For example, if an investor chooses to overweight specific health care industry issuers versus the respective sector and spread duration contributions of the benchmark index, the difference in portfolio weights between the active and index positions establishes a basis upon which excess return can be measured going forward.

Top-Down Credit Strategies

A top-down approach to credit strategy focuses on a broader set of factors affecting the bond universe in contrast to the more detailed and issuer-specific bottom-up approach. Macro factors critical to credit investors include economic growth, real rates and inflation, changes in expected market volatility and risk appetite, recent credit spread changes, industry trends, geopolitical risk, and currency movements. Assessment of these factors guides investors in selecting credit market sectors with attractive relative value characteristics, with an increased bond allocation to more attractive sectors and an underweight (or possibly short bond positions in) less favorable sectors. Top-down investors frequently use broader sector distinctions than under a bottom-up approach. For example, a top-down investor expecting credit spreads to narrow might favor the relative value opportunity of high-yield bonds over investment-grade bonds.

GDP growth is critical to the credit cycle, as seen in Exhibit 19, which shows global speculative-grade default rates versus the real GDP growth rate among G7 countries from 1962 to 2019. Sharp declines in GDP growth are often associated with rising default rates.

Exhibit 19: Global Speculative-Grade Default Rate and Real GDP Growth Rate for G7 countries, 1962–2019



Sources: Moody's Investors Service, OECD (IHS Markit)

A portfolio manager or analyst might decide to factor this relationship into the investment decision-making process; for example, an above-consensus real GDP growth forecast might lead to an increased high-yield allocation if future defaults are expected to remain below market expectations.

Assessing Credit Quality in a Top-Down Approach

Active top-down and bottom-up credit managers frequently use public ratings to categorize and rank the credit quality of bonds within a portfolio. As investors compare investments across credit ratings, the fact that default risk rises more rapidly as ratings decline is important to consider. The use of weighted factors, such as those established by Moody's based on the likelihood of credit loss over a specific period versus ordinal factors across the credit spectrum, enables managers to capture this effect more accurately, as demonstrated in Exhibit 20.

Exhibit 20: Weighted Versus Ordinal Credit Rating Categories

Moody's	S&P	Fitch	Ordinal	Weighted
Aaa	AAA	AAA	1	1
Aa1	AA+	AA+	2	10
Aa2	AA	AA	3	20
Aa3	AA-	AA-	4	40
A1	A+	A+	5	70
A2	A	A	6	120
A3	A-	A-	7	180
Baa1	BBB+	BBB+	8	260
Baa2	BBB	BBB	9	360
Baa3	BBB-	BBB-	10	610
Ba1	BB+	BB+	11	940
Ba2	BB	BB	12	1,350
Ba3	BB-	BB-	13	1,766
B1	B+	B+	14	2,220
B2	B	B	15	2,720
B3	B-	B-	16	3,490
Caa1	CCC+	CCC+	17	4,770
Caa2	CCC	CCC	18	6,500
Caa3	CCC-	CCC-	19	10,000
Ca	CC	CC	20	

Source: Moody's Investors Service

The impact of weighted ratings is best demonstrated using an example. For instance, assume a manager is assessing credit quality for a portfolio in which half of the bonds are rated A1/A+ and the other half are rated Ba3/BB-. Using an ordinal scale, the average portfolio credit quality score is 9 (= 50% × 5 + 50% × 13), which corresponds to an average rating of Baa2/BBB in Exhibit 20. However, using the weighted scale at the far right, the portfolio's average credit quality score is 918 (= 50% × 70 + 50% × 1,766), or closer to Ba1/BB+, two levels (notches) below the average rating derived using an ordinal scale.

Earlier readings underscored the risks of relying on public credit ratings, in particular that ratings tend to lag the market's pricing of credit risk critical to an active investor. In addition, one should note that S&P's and Moody's ratings capture different types of risks, with S&P ratings focused on the POD, while Moody's focuses on expected losses, which could influence historical comparisons. The credit rating time horizon is also critical because ratings agencies issue both short-term and long-term ratings for specific issuers, which might warrant additional attention. For these reasons, active managers often prefer to use credit spread measures such as OAS to measure average portfolio credit quality. To calculate a portfolio's average OAS, each bond's individual OAS is weighted by its market value. A manager might also group bonds by OAS categories, which are sometimes mapped to public ratings for comparative purposes.

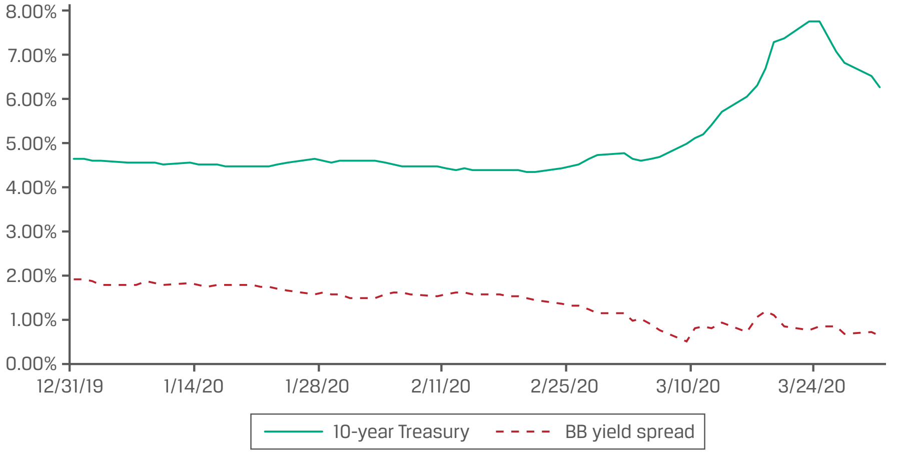
The use of spread-based rather than rating-based measures also facilitates the measurement of changes in portfolio value due to spread changes. As shown earlier, Equation 5 provides a framework to quantify portfolio value changes due to yield spread movements:

$$\%\Delta PV^{Spread} \approx -(\text{EffSpreadDur} \times \Delta\text{Spread}) + (½ \times \text{EffSpreadCon} \times (\Delta\text{Spread})^2)$$

Smaller yield spread changes are often estimated using the first term in Equation 5. This analytical duration approach provides a reasonable approximation of the price–yield spread relationship for investment-grade bonds with low credit spreads. However, for bonds with greater default risk further down the credit spectrum, changes to both the EffSpreadDur and the ΔSpread terms might be required to accurately reflect empirical observations of how credit risk changes affect overall portfolio value.

In isolating portfolio value changes due to yield spread changes using EffSpreadDur, Equation 5 implicitly assumes that government bond YTMs and credit spreads are uncorrelated, independent variables. However, empirical duration estimates using statistical models often diverge from analytical duration calculations over time and in different interest rate environments. For instance, under a "flight to quality" scenario, the macroeconomic factors driving government bond YTMs *lower* will cause high-yield bond credit spreads to *rise* as the result of an expectation of a greater likelihood and higher severity of financial distress, as shown in Exhibit 21 during the COVID-19 pandemic in early 2020.

Exhibit 21: US Treasury Yields versus US Corporate BB Spreads, 2020



Source: Bloomberg

As for ΔSpread, recall the empirical observation that bonds trading at wider spreads usually experience larger spread changes, which are proportional to the DTS measure in Equation 8.

These greater changes in bond spread have an impact similar to that of the weighted Moody's credit rating categories in Exhibit 18.

EXAMPLE 18

Top-Down Excess Returns

1. An investor has formed expectations across four bond rating categories and intends to overweight the category with the highest expected excess return over the next 12 months. Evaluate which rating group is the most attractive based on the information in the following table and assuming no change in spread duration:

Rating Category	Current OAS	Expected ΔOAS	Expected Loss (POD × LGD)	EffSpreadDur
A	1.05%	–0.25%	0.06%	5.5
Baa	1.35%	–0.35%	0.30%	6.0
Ba	2.45%	–0.50%	0.60%	4.5
B	3.50%	–0.75%	3.00%	4.0

Solution:

The following table summarizes expected excess returns E [ExcessSpread] ≈ Spread_0 – (EffSpreadDur × ΔSpread) – (POD × LGD) for each of the four rating categories. For example, expected excess return for rating category A is 2.37% (=1.05% – (5.5 × –0.25%) – 0.06%).

Rating Category	Current OAS	Expected ΔOAS	Expected Loss (POD × LGD)	EffSpreadDur	E(Excess Return)
A	1.05%	–0.25%	0.06%	5.5	2.37%
Baa	1.35%	–0.35%	0.30%	6.0	3.15%
Ba	2.45%	–0.50%	0.60%	4.5	4.10%
B	3.50%	–0.75%	3.00%	4.0	3.50%

Given that the Ba category has the highest expected excess return, it is the most attractive rating category to overweight in the portfolio.

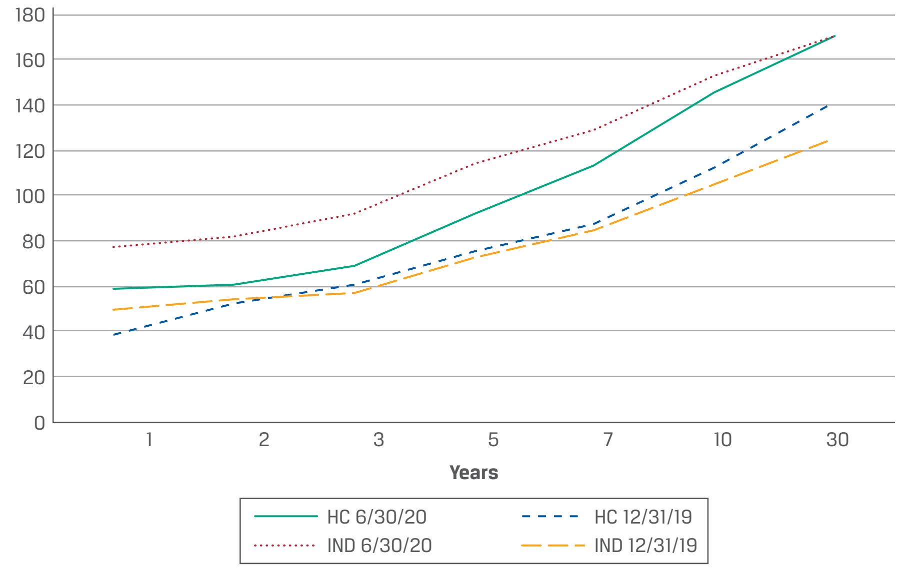
Sector Allocation in a Top-Down Approach

Industry sector allocations (or weightings) are an important part of a top-down approach to credit strategy. To determine which sector(s) to over- or underweight, an active portfolio manager usually begins with an interest rate and overall market view established using macroeconomic variables introduced earlier. This view is a key step in determining whether specific sectors of the economy are likely to over- or underperform over the manager's investment time horizon.

Quantitative methods such as regression analysis are often used in making industry allocation decisions. For example, the average spread of bonds within an individual industry sector and rating category might be compared with the average spread of the bonds with the same rating but excluding the chosen industry sector. Alternatively, a portfolio manager might also use financial ratios in comparing sector spreads and sector leverage. Generally speaking, higher leverage should imply higher credit risk and thus wider spreads. A portfolio manager could therefore compare sectors on a spread-versus-leverage basis to identify relative value opportunities.

Sector- and rating-specific spread curves are a useful tool in guiding decision making for top-down sector allocations. A comparison of curves combined with an investor's view could lead to credit portfolio positioning based on a view that a specific credit spread curve will flatten or steepen, or that two spread curves will converge or diverge. For example, Exhibit 22 shows the divergence in industrial versus health care spreads for BBB rated US issuers over the first half of 2020 during the COVID-19 pandemic. The flatter industrial credit spread curve reflects that sector's relatively weak credit outlook versus health care over the period.

Exhibit 22: US BBB Industrial versus Health Care Spreads (bps p.a.)



Source: Bloomberg

Factor-Based Credit Strategies

While the top-down approach to fixed-income portfolio construction outlined in the previous section grouped investment choices by sector and public ratings, active credit investors are increasingly turning to strategies based on style factors.

Key Factors Affecting Credit Spreads

Factor investing has long been applied in equity markets as noted in earlier lessons, but the application of systematic risk factors such as size, value, and momentum in fixed-income markets is relatively new. For example, Israel, Palhares, and Richardson (2018) established a framework for evaluating excess corporate bond returns based on a number of characteristics, evaluating their significance in explaining fixed-income returns. The authors found strong evidence of positive risk-adjusted returns to measures of carry, defensive, momentum, and value. Exhibit 23 lists these four factors, their rationale, and the measures used in their analysis.

Exhibit 23: Selected Fixed-Income Factors

Factor	Rationale	Measures Used
Carry	Expected return measure if POD or aggregate risk premium is unchanged	OAS
Defensive	Empirical research suggests safer low-risk assets deliver higher risk-adjusted returns	Market-based leverage, gross profitability, and low duration
Momentum	Bonds with higher recent returns outperform those with lower recent returns	Trailing six-month excess bond and equity returns
Value	Low market value versus fundamental value indicates greater than expected return	Bond spread less default probability measure, which includes rating, duration, and excess return volatility

The returns represented diversification with respect to common market risk sources such as equity or credit risk premia and are similar in characteristic to those factors shown to be significant in equity markets, with some adjustments. Investigation of the source of returns suggested neither traditional risk exposures nor mispricing provided a comprehensive explanation for the excess returns.

Environmental, Social, and Governance Factors

The growing relevance of environmental, social, and governance (ESG) factors in active portfolio management is evidenced by growing adoption of the Principles for Responsible Investment. This independent body established in partnership with the United Nations to promote ESG factors in investing has more than 3,000 signatories worldwide with more than $100 trillion in assets under management.

Active credit investors usually incorporate ESG factors into portfolio strategies in one of three basic ways:

- The use of screens to either exclude specific industries with less favorable ESG characteristics, such as firearms, tobacco, or coal, or to rule out specific companies or sovereign issuers with ESG-specific ratings below a threshold
- Use of ESG ratings to target issuers within a given sector or rating category with relatively favorable ESG characteristics while matching a specific index risk and return
- Targeting fixed-income investments that directly fund ESG-specific initiatives

ESG-specific ratings for private and public issuers are a key element in the portfolio selection process. The wide range of quantitative and qualitative criteria used to measure ESG attributes and differences in methodology and weighting leads to greater dispersion in ESG versus credit ratings. That said, ESG and credit ratings tend to be positively correlated for two reasons. First, issuers with more financial resources are better able to meet more stringent ESG standards, while those with a greater likelihood of financial distress often face governance or other adverse risks. Second, major rating agencies now explicitly incorporate ESG risks into the traditional credit rating process. In 2019, Moody's cited ESG risks as a material factor in one-third of its credit rating actions among private sector issuers.

Green bonds are fixed-income instruments that directly fund ESG-related initiatives such as those related to environmental or climate benefits. This rapidly growing segment of the fixed-income market includes corporate, financial institution, and public issuers where bond proceeds are directed to projects that reduce air pollution, recycle post-consumer waste products, underwrite environmental remediation projects, and invest in alternative construction materials for environmentally sustainable buildings. Issuers frequently agree to voluntary guidelines such as the International Capital Market Association's Green Bond Principles (2018) to ensure that these securities meet investor ESG requirements. Although green bonds usually rank pari passu (or at the same level) with the issuer's outstanding senior unsecured bonds and therefore reflect similar pricing, the favorable ESG characteristics often result in greater investor demand than for standard debt issues. For example, in October 2020, the European Union issued €17 billion in new 10-year and 20-year debt in its first-ever offering of social bonds to finance its COVID-19 pandemic-related job support program. At nearly 14 times the issuance size, the €233 billion in investor orders for the new bonds represented the largest demand ever for a primary bond issuance.

4 LIQUIDITY AND TAIL RISK

- ☐ discuss liquidity risk in credit markets and how liquidity risk can be managed in a credit portfolio
- ☐ describe how to assess and manage tail risk in credit portfolios

Liquidity Risk

The feasibility and cost of buying and selling fixed-income instruments are important considerations for active investors. Trading volumes and bid–offer costs vary widely across fixed-income markets and regions. For instance, sovereign bonds in large developed markets are highly liquid, usually offering institutional bid–offer spreads in secondary markets for on-the-run securities of less than one basis point during trading hours. Smaller, off-the-run corporate bonds or structured notes, on the other hand, might command bid–offer spreads of 10 bps or more and take days to execute, given that many outstanding bonds do not trade at all on a given trading day.

Consider, for example, the US corporate bond market, wherein a single major issuer might have dozens of outstanding debt tranches of varying tenor, currency, or other feature, each separately traded and identifiable via a specific CUSIP or ISIN (International Securities Identification Number). As mentioned earlier in the curriculum, individual bond issuance and trading has historically taken place in over-the-counter (OTC) markets as opposed to on an exchange. OTC market liquidity rests with individual dealers, their specific portfolio and depth of inventory, and appetite to supply liquidity at a cost. Corporate bonds are traditionally traded on a request-for-quote basis, in which investors reach out to multiple dealers to request a fixed price quote for a specific trade size. The use of electronic trading platforms for bond trading has grown because higher regulatory capital requirements reduced bond inventories among dealers after the 2008–09 global financial crisis. While electronic trading platforms comprised less than one-third of individual corporate bond trading volume as of 2020, trading in bond portfolios and bond ETFs, addressed later in this lesson, has grown in importance.

Transaction cost estimates in bond markets vary significantly from those in equity markets because of market structure differences. Price discovery for infrequently traded individual bonds often begins with **matrix pricing (or evaluated pricing)** techniques introduced earlier in the curriculum using bonds from similar issuers and actively traded government benchmarks to establish a bond's fair value. For bonds quoted actively on a request-for-quote system by individual dealers, the effective spread transaction cost statistic introduced in an earlier lesson and shown in Equation 13 provides an estimate of trading cost.

$$\text{Trade size} \times \begin{cases} \text{Trade price} - (\text{Bid} + \text{Ask})/2 \text{ for buy orders} \\ (\text{Bid} + \text{Ask})/2 - \text{Trade price for sell orders} \end{cases} \quad (13)$$

However, the effective spread is an inadequate gauge of trading costs for positions that are traded in smaller orders over time and/or whose execution affects market spreads. A separate, ex-post liquidity gauge specific to the US corporate bond market is the TRACE (Trade Reporting and Compliance Engine) reporting system introduced in 2002 to track real-time price and volume reporting for bond transactions. Portfolio managers will often review recent TRACE trading activity to gauge the estimated cost of trading a bond position.

Active portfolio managers take several steps in managing the liquidity risk of bond portfolios, given the significant market risk involved in trading less liquid positions. First, active managers will usually favor on-the-run government bonds or most recently issued corporate or other bonds for short-term tactical portfolio positioning, while reserving relatively illiquid positions for buy-and-hold strategies or strategic positioning to minimize expected return erosion due to trading costs. Second, active managers might consider liquid alternatives to individual bond trades to close portfolio gaps where active management adds little value, or to react quickly to rapidly changing markets. These alternatives include CDS outlined later and bond ETFs.

Fixed-income ETFs are liquid, exchange-traded bond portfolios that create and redeem shares using an OTC primary market that exists between a set of institutional investors (or **authorized participants**) and the ETF sponsor. These ETF shares trade in the secondary market on an exchange, overcoming the liquidity constraints of individual OTC-traded bonds. Bond ETFs have enjoyed significant growth and are available across the credit spectrum as well as for different maturities and in different markets. Although the underlying cash flow exposures are similar, ETFs usually neither mature nor experience duration drift (with the exception of target maturity ETFs) as do individual bonds. As ETF sponsors target a specific index or profile, ETFs offer relatively constant portfolio duration and pay variable monthly interest based on the overall portfolio. Active credit managers use ETFs to quickly and efficiently overweight or underweight exposures in rapidly changing markets and to take on strategic exposure in segments of the market where individual or bottom-up bond selection is less of a focus.

When relatively illiquid bond positions are purchased or sold over longer periods, portfolio managers might consider hedging strategies such as asset swaps to mitigate the benchmark risk of a portfolio position as outlined in the following example.

EXAMPLE 19

Using Asset Swaps to Manage Liquidity Risk

1. Recall the earlier example of a United States–based issuer with the following option-free bonds outstanding:

Outstanding Debt	Term	Coupon	Price	YTM
2-year issue	2	4.25%	106.7	0.864%
5-year issue	5	3.25%	106.0	1.984%
15-year issue	15	2.75%	91.0	3.528%

Assume the investor instead holds a US$50 million face value position in the outstanding 15-year bond. Historical TRACE data suggest an average $5 million daily trading volume in the 15-year bond. Which of the following statements *best* describes how the issuer might use an asset swap to manage the benchmark interest rate risk associated with liquidating this bond position?

A. The investor should enter into an asset swap where he receives fixed and pays floating, unwinding the swap position once the bond position is sold.

B. The investor should enter into an asset swap where he pays fixed and receives floating, unwinding the swap position once the bond position is sold.

C. The investor should enter into an asset swap where he pays fixed and receives floating, unwinding the swap position over time in proportion to the amount of the bond sold.

Solution:

The correct answer is C. Because the investor's bond position represents a long position (i.e., long both spread duration and benchmark duration), the best hedge would be a short-duration (or pay-fixed swap) position rather than A. As for B, the hedge unwind occurs once the bond position is sold rather than over time, which exposes the investor to benchmark interest rate risk for the portion of the bond sold. The proportional swap unwind in C ensures that the offsetting swap position matches the benchmark interest rate risk of the bond.

Tail Risk

Extreme adverse outcomes that exceed those to be expected from a normally distributed portfolio are often referred to as tail events. In the context of active fixed-income management, the measurement and management of tail risk involves stress testing a portfolio's value based on the key fixed-income returns factors in Equation 1. In an earlier lesson on measuring and managing market risk, **value at risk (VaR)** was introduced as a measure of the minimum portfolio loss expected to occur over a given time period at a specific confidence level. For example, a 5% daily VaR of €8.7 million implies that a portfolio manager should expect a daily portfolio loss of *at least* €8.7 million on 5% of all trading days. Assuming normally distributed portfolio returns, the 5% confidence level translates to an outcome at least 1.65 standard deviations below the mean, while a 1% confidence interval lies at least 2.33 standard deviations below the mean. Risk managers often use expected returns, volatilities, and correlations to estimate parametric VaR in addition to either historical simulation or Monte Carlo methods. The following example shows a simple parametric VaR calculation for a bond position.

EXAMPLE 20

Fixed-Rate Bond VaR

1. Consider the earlier case of an investor holding $50 million face value of a 15-year bond with a semiannual coupon of 2.75%, a current YTM of 3.528%, and a price of 91 per 100 of face value. What is the VaR for the full bond price at a 99% confidence interval for one month if annualized daily yield volatility is 1.75% (1.75 bps) and we assume that interest rates are normally distributed?

Solution:

First, we must adjust the annualized yield volatility to reflect a one-month period instead. The time interval under consideration is $1/12^{\text{th}}$ of a year, and therefore the volatility measure is 0.00505 (1.75% × $\sqrt{1/12}$), which for a 99% confidence interval equals 117.7 bps = (0.00505 × 2.33 standard deviations). We may quantify the bond's market value change using either a duration approximation or the actual price change as follows. We may use the Excel MDURATION to solve for the bond's duration as 12.025. We can therefore approximate the change in bond value using the familiar (-ModDur x ΔYield) expression as $6,439,808 = ($50 million x 0.91 x (-12.025 x .0177)). We can also use the Excel PRICE function to directly calculate the new price of 88.75 and multiply the price change of -2.25 by the face value to get $1,125,000.

The simplicity and transparency of VaR can be misleading if it is used as a tool for quantifying tail risk for several reasons. First, VaR tends to underestimate the frequency and severity of extreme adverse events. It also fails to capture the downside correlation and liquidity risks associated with market stress scenarios. Finally, although VaR addresses *minimum* loss for a specific confidence level, it fails to quantify the *average* or expected loss under an extreme adverse market scenario. **Conditional value at risk** (CVaR), or expected loss, measures the average loss over a specific time period conditional on that loss exceeding the VaR threshold. While computationally more complex and beyond the scope of this lesson, CVaR is often measured using historical simulation or Monte Carlo techniques. Two related measures of portfolio VaR include incremental and relative measures. For example, an analyst seeking to measure the impact of adding or removing a portfolio position might use an **incremental VaR (or partial VaR)** calculation for this purpose. As mentioned in an earlier lesson, an investor could use **relative VaR** to measure the expected tracking error versus a benchmark portfolio by calculating VaR (or CVaR) based on a portfolio containing the active positions *minus* the benchmark holdings under a market stress scenario.

EXAMPLE 21

VaR Measures

1. An active fixed-income manager is considering increasing an overweight portfolio allocation to BBB rated health care issuers versus a targeted index. Which of the following VaR measures is the most appropriate to evaluate the impact of this decision on overall portfolio VaR?

   A. Incremental VaR

   B. Relative VaR

   C. CVaR

Solution:

The correct answer is A. Incremental VaR measures the impact of a specific portfolio position change on VaR, while relative VaR in answer B evaluates all active portfolio positions versus the benchmark index and could be important for an active fixed-income mandate that aims to beat an index once the portfolio change has been made. CVaR in C measures a portfolio's average loss over a specific time period conditional on that loss exceeding the VaR threshold.

Tail risk assessment is typically conducted using one of the three methods summarized in Exhibit 24.

Exhibit 24: Methods to Assess Portfolio Tail Risk

Method	Description	Advantages	Disadvantages
Parametric Method	Uses expected value and standard deviation of risk factors assuming normal distribution	Simple and transparent calculation	Not well suited for non-normally distributed returns or option-based portfolios
Historical Simulation	Prices existing portfolio using historical parameters and ranking results	Actual results, accommodates options, with no probability distribution assumed	Highly dependent on historical period and repetition of historical market trends
Monte Carlo Analysis	Involves generating random outcomes using portfolio measures and sensitivities	Randomly generated results from a probability distribution, accommodates options	Highly dependent on model assumptions and less transparent

Hypothetical scenario analyses are often used to supplement these three methods of analysis to test portfolio vulnerabilities to specific portfolio parameter changes over time.

In addition to portfolio measures of duration and convexity as a basis for portfolio value changes, analytical models often rely on implied volatility parameters for benchmark interest rates and currencies, such as swaption volatility or currency option volatility, respectively, while reduced form or structural credit models incorporating CDS or equity volatility can be used to model expected spread volatility. Finally, term structure models introduced in an earlier lesson that incorporate interest rate volatility and drift in an equilibrium or arbitrage-free framework are frequently incorporated to simulate term structure changes over time.

Once tail risk under an extreme market scenario has been quantified, it is important to weigh this exposure against other binding portfolio constraints and to take steps to manage the downside risk. For example, a leveraged portfolio might face forced liquidation of certain bond positions beyond a certain tail risk threshold. Alternatively, a defined-benefit pension fund manager might be required to increase plan contributions if extreme market moves cause plan funding status to fall below a statutory minimum. Finally, a bank treasury officer could face increased regulatory capital requirements if adverse market changes under a stress test show significant portfolio losses.

A fixed-income portfolio manager can reduce tail risk by establishing position limits, risk budgeting, or using similar techniques designed to reduce portfolio concentration or to cap portfolio risk exposure to certain issuers, credit ratings, or regions. Alternatively, a portfolio manager might consider the use of derivatives to protect against downside portfolio risk. For example, the manager could consider purchasing a swaption (or the right to enter an interest rate swap at a pre-agreed rate in the future) or a credit default swaption (the right to purchase credit protection on an issuer or index at a strike rate in the future) to protect against the risk of benchmark YTM changes or credit spread changes, respectively. However, each of these strategies requires an upfront premium that will reduce excess portfolio spread over time. In addition, establishing these hedges in a distressed market will greatly increase hedging cost because of higher option volatility, so the manager must weigh these hedging costs against a risk mitigation strategy to determine the best course of action.

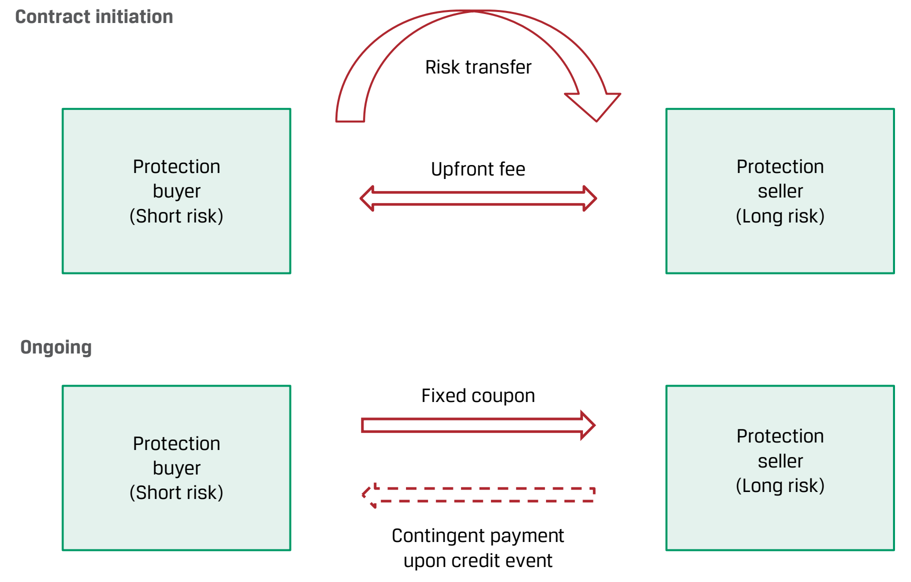
5 SYNTHETIC CREDIT STRATEGIES

☐ discuss the use of credit default swap strategies in active fixed-income portfolio management

As outlined in an earlier lesson, a CDS is the basic building block for strategies to manage credit risk separately from interest rate risk. CDS are often more liquid than an issuer's underlying bonds, enabling investors to take long or short positions, access maturities, and establish other exposures unavailable in cash markets with a smaller cash outlay than direct bond purchases.

Exhibit 25 shows CDS contract mechanics under which a protection "buyer" purchases credit protection from a protection "seller." Each contract references a specific issuer (or issuers) as well as credit event terms that, when triggered, lead to a settlement payment equal to the LGD multiplied by the contract notional amount from the seller to the buyer.

Exhibit 25: CDS Mechanics



CDS contracts are usually quoted on an issuer's CDS spread, which corresponds to a price equal to the present value difference between the CDS spread and a fixed coupon rate on the notional amount over the contract life. Fixed CDS coupon rates of 1% for investment-grade issuers and 5% for high-yield issuers were established when the International Swaps and Derivatives Association standardized CDS market conventions following the 2008 financial crisis. CDS pricing models discount future payments by the swap zero curve multiplied by the **hazard rate**, or the likelihood that an issuer credit event will occur given that it has not already occurred in a prior period.

The CDS price at contract inception or on a coupon payment date as a percentage of notional can be approximated using Equation 14:

$$\text{CDS Price} \approx 1 + ((\text{Fixed Coupon} - \text{CDS Spread}) \times \text{EffSpreadDur}_{\text{CDS}}) \qquad (14)$$

where CDS Spread is the issuer's current CDS market spread and $\text{EffSpreadDur}_{\text{CDS}}$ is the CDS contract's effective spread duration (sometimes referred to as CDS DV01). At contract inception, the protection buyer must either make a payment to or receive a payment from the protection seller equal to the CDS contract price difference from par, as shown in Exhibit 26.

Exhibit 26: Upfront Payment at CDS Contract Inception

Description	Upfront Premium
CDS Spread = Fixed Coupon	None
CDS Spread < Fixed Coupon	Protection buyer *receives* ((Fixed Coupon - CDS Spread) × $\text{EffSpreadDur}_{\text{CDS}}$)
CDS Spread > Fixed Coupon	Protection buyer *pays* ((CDS Spread - Fixed Coupon) × $\text{EffSpreadDur}_{\text{CDS}}$)

CDS contracts have similarities to both bonds and interest rate swaps. As with a cash bond priced at a discount when its coupon is below current market rates, the protection seller is entitled to an upfront payment in exchange for accepting a fixed coupon below the CDS market spread. As with a standard interest rate swap, a CDS contract priced at par has a zero net present value, and the notional is not exchanged but rather serves as a basis for spread and settlement calculations.

EXAMPLE 22

CDS Price and Price Changes

An investor seeks to purchase credit protection under a five-year CDS contract at a CDS market spread of 0.50% p.a. for an investment-grade issuer with an estimated effective spread duration ($\text{EffSpreadDur}_{\text{CDS}}$) of 4.75.

1. Determine whether the investor must pay or receive an upfront amount upon CDS contract inception and calculate the difference from par.

Solution:

Because investment-grade CDS contracts have a fixed coupon of 1.00% p.a. versus the 0.50% p.a. CDS market spread, the investor buying protection should receive the difference from par upfront in exchange for paying an "above market" coupon under the contract. Calculate the estimated difference using Equation 14 ((Fixed Coupon – CDS Spread) × $\text{EffSpreadDur}_{\text{CDS}}$)) with CDS Spread of 0.50%, Fixed Coupon of 1.00%, and $\text{EffSpreadDur}_{\text{CDS}}$ equal to 4.75.

Upfront premium: 2.375% of CDS notional (= (1.00% − 0.50%) × 4.75).

2. Calculate the change in contract price if the CDS spread rises to 0.60% p.a. and interpret the impact of the change on the protection buyer.

Solution:

Calculate the upfront premium using Equation 14 and a 0.60% spread.

Upfront premium: 1.90% of CDS notional (= (1.00% − 0.60%) × 4.75).

The protection buyer realizes a mark-to-market gain equal to 0.475% (2.375% – 1.90%) of the CDS contract notional because of the wider CDS spread.

CDS price changes for a given CDS spread change can be quantified using the contract's effective spread duration:

$$\Delta(\text{CDS Price}) \approx -(\Delta(\text{CDS Spread}) \times \text{EffSpreadDur}_{\text{CDS}}) \tag{15}$$

Active fixed-income portfolio managers buy or sell CDS protection across issuers, maturities, and/or sectors to alter portfolio exposure, as illustrated in the following example.

EXAMPLE 23

Credit Underweight Using CDS

1. A European-based fixed-income manager intends to underweight exposure to a BBB rated French media and telecommunications issuer. She observes that the issuer's current on-the-run five-year CDS contract is trading at a spread of 110 bps p.a. with an $\text{EffSpreadDur}_{\text{CDS}}$ of 4.595. Which position

should she take in the CDS market? Calculate the result if spreads widen to 125 bps for a €10 million notional position.

Solution:

The manager can underweight the issuer's credit by *purchasing* protection in the CDS market. This short risk position will realize a gain if the issuer's spreads widen. For example, if the issuer's credit spreads widen from 110 bps p.a. to 125 bps p.a., we can estimate the change in CDS contract value by multiplying ($-\Delta$(CDS Spread) × $\text{EffSpreadDur}_{CDS}$) from Equation 15 by the CDS notional to get €68,925 (=–€10,000,000 × (–0.15% × 4.595)).

While CDS contracts are available across maturities, the five-year tenor is generally the most frequently traded contract. Exhibit 27 summarizes the most common CDS strategies used in practice.

Exhibit 27: Credit Derivative–Based Alternatives to Corporate Bonds

Instrument	Description	Targeted Return	Portfolio Impact
Single-Name CDS	Protection buyer pays premium to seller in exchange for payment if credit event occurs	Buyer gains and seller loses if single-name credit spread widens or credit event occurs	Short (buyer) or long (seller) single-name credit spread exposure
Index-Based CDS	Protection buyer pays premium in exchange for partial payment if credit event occurs for index member	Buyer gains and seller loses if index member spreads widen or if credit event occurs	Short (buyer) or long (seller) index-based credit spread exposure
Payer Option on CDS Index	Option buyer pays premium for right to buy protection ("pay" coupons) on CDS index contract at a future date	Max (Credit spread at expiration – CDS Credit Spread Strike, 0) – Option Premium	Short CDS index-based credit spread exposure
Receiver Option on CDS Index	Option buyer pays premium for right to sell protection ("receive" coupons) on CDS index contract at a future date	Max (CDS Credit Spread Strike – CDS Credit Spread at expiration, 0) – Option Premium	Long CDS index-based credit spread exposure

Single-name reference entities include both private corporations and sovereign borrowers. Several CDS indexes are available across regions and often also offer subindexes covering a particular sector or borrower type. For example, the Markit CDX North American Investment Grade index consists of 125 equally weighted CDS contracts on entities, including six subindexes (High Volatility, Consumer Cyclical, Energy, Financials, Industrial, and Telecom, Media, and Technology).

CDS strategies are commonly used by active fixed-income portfolio managers to over- or underweight credit spread exposure to individual issuers, specific sectors, or borrower types. As with benchmark yield curves, CDS portfolio positioning strategies are usually based on expected changes in the credit curve level, slope, or shape. The credit curve referred to here is the **CDS curve**, or the plot of CDS spreads across maturities for a single reference entity or index, rather than the fitted credit spread curves addressed earlier. This might involve an investor taking a long or short CDS position in one issuer or issuer type, or a long or short position overweighting one reference entity or group of entities and underweighting another. Investors using CDS strategies to hedge bond portfolios must always consider the potential impact of basis changes on the strategy over the investment horizon.

Fixed-income ETFs offer derivatives such as futures and options that are different from CDS contracts. As with bond futures, ETF futures are a contract to take future delivery of an ETF and trade on a price rather than a spread basis. Because underlying ETF prices are derived from all-in bond yields held by the fund, ETF derivative prices change with changes in both benchmark rates and credit spreads.

CDS long–short strategies based on spread level are appropriate for both bottom-up and top-down approaches. Assume, for example, that an investor believes that issuer A's credit spreads will likely narrow versus those of issuer B. To capitalize on this view in the cash market, the investor would first source A's individual bonds for purchase and then seek a duration-matched amount of issuer B's bonds to borrow and sell short. The existence of a liquid single-name CDS market for both issuers allows the investor to simply sell protection on A and purchase protection on B for the same notional and tenor.

EXAMPLE 24

CDS Long–Short Strategies

1. Consider the investor from the prior example who sought to underweight a French media and telecommunications issuer. Assume instead that the investor seeks to maintain a constant media and telecommunications credit allocation by overweighting a BBB rated German media and telecommunications competitor. CDS contract details are as follows:

Issuer	Tenor	CDS Spread	$\text{EffSpreadDur}_{CDS}$
French Media & Telecoms Issuer	5 years	110 bps	4.697
German Media & Telecoms Issuer	5 years	130 bps	4.669

Describe an appropriate long–short CDS strategy to meet this goal, and calculate the investor's return if the French issuer's spreads widen by 10 bps and those of the German issuer narrow by 25 bps based on €10 million notional contracts.

Solution:

The manager purchases protection on the French issuer and simultaneously sells protection on the German issuer. Use ($-\Delta$(CDS Spread) × $\text{EffSpreadDur}_{CDS}$) from Equation 15 multiplied by the CDS notional to solve for changes in the short and long risk positions:

Short risk (French issuer): €46,970 (= –€10,000,000 × (–0.10% × 4.697))

Long risk (German issuer): €116,725 (= €10,000,000 × (–(–0.25%) × 4.669))

The total gain on the long–short strategy is €163,695 (= €46,970 + €116,725).

A similar long–short strategy can be applied under a top-down approach. For example, an investor might overweight (underweight) a specific sector given an expectation of narrower (wider) spread levels versus the total portfolio by selling (buying) protection on a CDS subindex contract. Alternatively, assume an active manager expects a weaker economy and a widening of high-yield versus investment-grade credit spread levels. The manager can capitalize on this view by buying five-year protection on a high-yield CDS index and selling protection on an investment-grade CDS index for the same tenor. Standardized CDS contracts eliminate the impact of duration difference, liquidity, and other factors that arise under a similar strategy in the cash bond market.

CDS long–short strategies based on expected credit curve slope changes involve CDS curve trades. For example, an upward-sloping credit curve implies relatively low near-term expected default probability that rises over time. An investor might expect an issuer's CDS curve to steepen if its near-term default probability declines as a result of higher than expected profits and stable leverage. This investor can capitalize on this view by selling short-term protection using a single-name CDS contract and buying long-term protection on that same reference entity. As shown in the following example, capitalizing on spread changes for different maturities requires duration matching of the positions, as in the case of benchmark yield curve strategies.

EXAMPLE 25

Duration-Weighted Single-Name CDS Curve Steepener

1. Returning to our earlier example of the German media and telecommunications issuer, the investor decides instead to position her portfolio for a steepening of the issuer's credit curve using the CDS market. Details of on-the-run 5- and 10-year CDS contracts outstanding are as follows.

Issuer	Tenor	CDS Spread	$\text{EffSpreadDur}_{\text{CDS}}$
German Media & Telecoms Issuer	5 years	130 bps	4.669
German Media & Telecoms Issuer	10 years	175 bps	8.680

Describe an appropriate long–short CDS strategy to meet this goal assuming a €10,000,000 10-year CDS contract notional. Calculate the investor's return if the 5-year spreads rise 10 bps and the 10-year spreads rise 20 bps.

Solution:

A steeper credit curve implies that ((CDS Spread)$_{10\text{yr}}$ – (CDS Spread)$_{5\text{yr}}$) will increase. The appropriate long–short strategy to position for this change is to purchase protection based on the 10-year, €10,000,000 notional and to sell protection on an equivalent duration 5-year CDS contract.

1. Calculate the 5-year CDS contract notional that matches the basis point value (BPV) of a 10-year, €10,000,000 CDS ($\text{BPV}_{10\text{yr}}$ = $\text{EffSpreadDur}_{10\text{yrCDS}}$ × notional) using the effective spread duration ratio of 1.859 ($\text{EffSpreadDur}_{10\text{yrCDS}}/\text{EffSpreadDur}_{5\text{yrCDS}}$ = 8.68/4.669) multiplied by €10,000,000 to get €18,590,000.

   Confirm this equivalence by comparing $\text{BPV}_{5\text{yr}}$ and $\text{BPV}_{10\text{yr}}$:

$\text{BPV}_{5\text{yr}}$: €8,680 = €18,590,000 × 4.669/10,000

BPV_{10yr}: €8,680 = €10,000,000 × 8.68/10,000

2. Calculate portfolio return for a 10 bp increase in 5-year CDS spreads and a 20 bp increase in 10-year CDS spreads using Equation 15 ($-\Delta$(CDS Spread) × $EffSpreadDur_{CDS}$) multiplied by the CDS notional.

5 year (long risk): –€86,800 (= €18,590,000 × (–0.1% × 4.669))

10 year (short risk): €173,600 (=–€10,000,000 × (–0.2% × 8.68))

Net portfolio gain: €86,800 = €173,600 – €86,800

The same curve strategy just described applies to expected credit curve slope changes for a CDS index or subindex. For instance, an investor who believes the economy is nearing the end of a growth cycle might expect the CDS curve for industrial issuers to flatten amid rising near-term credit spreads. Under this expected scenario, an investor purchases short-term CDS subindex protection on industrials and sells long-term protection on the same subindex to capitalize on a flattening view. Alternatively, an investor taking a top-down approach who shares a similar bearish economic view might consider a flattening trade for an entire CDS index.

Additional CDS strategies seek to either capitalize on the basis difference between CDS and cash bonds or take advantage of specific events that affect CDS spreads and curves. As noted earlier, basis differences arise from a number of factors but are also due to differences in liquidity across derivative and cash markets, a detailed treatment of which is beyond the scope of this lesson. Corporate events that influence CDS spreads by affecting bondholders differently from shareholders include mergers and acquisitions and leveraged buyouts, both of which are addressed elsewhere in the curriculum.

CREDIT SPREAD CURVE STRATEGIES

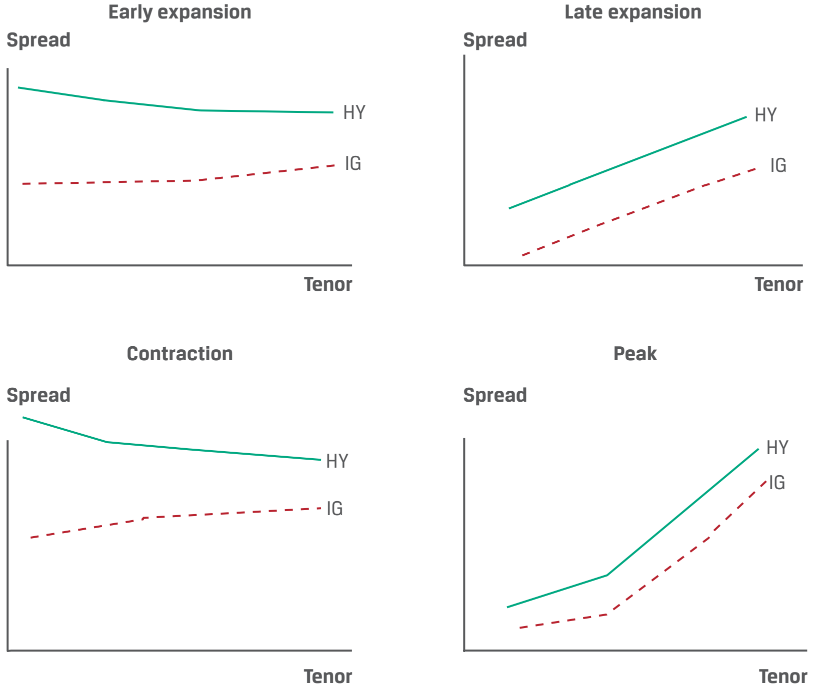
6

☐ discuss various portfolio positioning strategies that managers can use to implement a specific credit spread view

Earlier in the lesson, we established that the credit cycle is a key driver of credit spread changes across maturities and ratings. The probability of issuer default and severity of loss over the cycle must be considered within the context of an overall market view. For example, positively sloped credit spread curves suggest relatively low near-term default probability, a view consistent with stable or rising future inflation and relatively strong expected economic growth. Investor demand for higher credit spreads for assuming the risk of downgrade or default for longer periods also contributes to a positive slope.

The level and slope of credit curves change over the economic cycle. Early in an expansion, as profits rise and defaults remain high, high-yield spreads remain elevated and well above investment-grade spreads, which often exhibit a flat to inverted spread curve. As an expansion progresses, lower defaults and increased profits cause short-term high-yield and investment-grade spreads to decline and credit spread curves to steepen. Credit curve steepening continues as economic growth peaks amid higher leverage and inflation expectations. As economic growth slows or the economy enters a recession, credit spreads rise, and spread curves flatten, with the high-yield curve inverting in some instances amid falling profitability and rising defaults. Although no two credit cycles are alike, Exhibit 28 presents a stylized view of these credit spread curve level and shape changes for investment-grade (IG) and high-yield (HY) issuers over the economic cycle.

Exhibit 28: Credit Spread Curves over the Economic Cycle



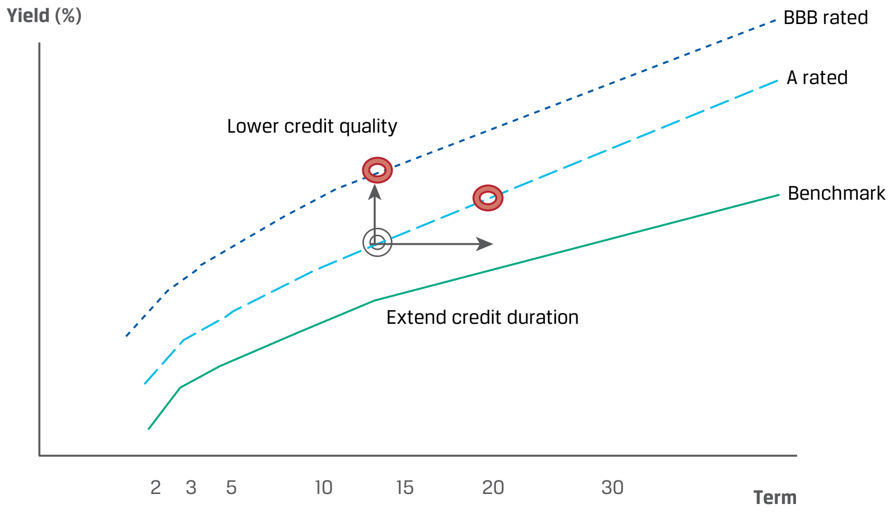
Active credit managers often incorporate the credit cycle into economic growth and inflation forecasts, which are then translated into sector- and issuer-specific views driving specific credit curve level and slope expectations using the bottom-up or top-down approaches outlined earlier. If these forecasts coincide with current credit spread curves, managers will choose active credit strategies consistent with static or stable credit market conditions. However, if an investor's views differ from what today's credit curve implies about future defaults and the severity of credit loss, they will position the portfolio to generate excess return based on this divergent view within investment mandate constraints using the cash and derivative strategies outlined in the following section.

Static Credit Spread Curve Strategies

An active credit manager might believe that current credit spreads are reasonably priced and that credit curves will remain stable or unchanged over an investment horizon while credit defaults and annual loss rates remain low. Exhibit 29 shows that a manager could position a portfolio to generate excess return in this scenario by either lowering the portfolio's average credit rating or adding credit spread duration by investing in longer-dated bonds with a similar rating to the current portfolio.

In the first case, a portfolio tilt toward lower-rated bonds will increase expected spread return, as seen in Equation 10 (E [ExcessSpread] ≈ Spread_0 – (EffSpreadDur × ΔSpread) – (POD × LGD)) if Spread, POD, and LGD remain stable. The shift from an average A rated to BBB rated portfolio in Exhibit 29 is an extension of an earlier case (Example 10) that quantified corporate versus government bond rolling yields as the YTM difference assuming constant spreads and default rates.

Exhibit 29: Buy-and-Hold Strategies under a Static Credit Curve



The increase in credit spread duration in the second case involves a "buy and hold" or "carry and roll down" approach familiar from the earlier yield curve strategies lesson. The first involves buying risky bonds with durations above the benchmark without active trading during a subsequent period. If the relationship between long- and short-term credit spreads remains stable over the investment horizon, the manager is rewarded with greater return from the higher spread duration. "Rolling down" the credit curve not only generates incremental coupon income (adjusted over time for any price difference from par) due to wider spreads but also adds return from the passage of time and the investor's ability to sell the shorter-maturity position in the future at a lower credit spread at the end of the investment horizon. The following example illustrates this second case, shown in Exhibit 29.

EXAMPLE 26

Adding Credit Duration under a Static Credit Curve

1. A Sydney-based investor notes the following available option-free bonds for an A rated Australian issuer:

Debt Term	Coupon	YTM	Price
5 years	1.00%	1.00%	100
10 years	1.35%	1.25%	100.937
15 years	2.00%	1.95%	100.648

The 5-year, 10-year, and 15-year Australian government bonds have YTMs and coupons of 0.50%, 0.75%, and 1.10%, respectively, and both corporate and government bonds have a semiannual coupon. As an active manager who expects stable benchmark yields and credit spreads over the next six months, the investor decides to overweight (by AUD50,000,000 in face value) the issuer's 15-year versus 10-year bond for that period. Calculate the return to the investor of the roll-down strategy in AUD and estimate the returns attributable to benchmark yield versus credit spread changes.

Solution:

To estimate credit curve rolling yield returns, we must solve for the first two return components from Equation 1 (Coupon income +/– Roll-down return) and separate the impact of benchmark yield versus credit spread changes.

1. Solve for the respective 5-year, 10-year, and 15-year bond credit spreads. Yield spread and G-spread are reasonable approximations because the bonds are option-free, with maturities closely aligned to par government securities.

5-year spread: 0.50% (= 1.00% − 0.50%)

10-year spread: 0.50% (= 1.25% − 0.75%)

15-year spread: 0.85% (= 1.95% − 1.10%)

2. Solve for 6-month expected returns of the 10-year versus 15-year bond:

   a. Incremental coupon income = $162,500 (= (2.00% – 1.35%)/2 × $50 million)

Debt Tenor	Coupon	Yield Spread	Total Coupon Income	Coupon (Benchmark Yield)	Coupon (Credit Spread)
10 years	1.35%	0.50%	$337,500	$187,500	$150,000
15 years	2.00%	0.85%	$500,000	$275,000	$225,000

Divide incremental coupon into benchmark and credit spread components:

Income due to benchmark yields: $87,500 = $275,000 − $187,500

Income due to credit spreads: $75,000 = $225,000 − $150,000

   b. Price appreciation is determined by the bond's price today and in six months' time based on unchanged benchmark rates. In six months, the 10-year and 15-year positions will be 9.5-year and 14.5-year bonds, respectively, at a yield and yield spread point along the curve. Estimate all-in YTMs and yield spreads using interpolation to arrive at the following results:

Debt Tenor	Date	Coupon	All-In Yield	Benchmark Yield	Yield Spread
5 years	Today	1.00%	1.00%	0.50%	0.50%
10 years	Today	1.35%	1.25%	0.75%	0.50%
15 years	Today	2.00%	1.95%	1.10%	0.85%

Debt Tenor	Date	Coupon	All-In Yield	Benchmark Yield	Yield Spread
9.5 years	In six months	1.35%	1.225%	0.725%	0.50%
14.5 years	In six months	2.00%	1.88%	1.065%	0.815%

Calculate price appreciation using the difference between current bond prices and those in six months using the Excel PV function (= –PV(rate, nper, pmt, FV, type)) where "rate" is the interest rate per period (0.01225/2), "nper" is the number of periods (19), "pmt" is the periodic coupon (1.35/2), "FV" is future value (100), and "type" (0) involves payments made at the end of each period.

10-year: Initial price: 100.937

Price in six months: 101.118 (= −PV (0.01225/2, 19, 1.35/2, 100, 0))

Price appreciation: $90,500 (= (101.118 − 100.937)/100.000 × $50 million)

Because the yield spread curve is flat at 0.50%, the full $90,500 price change in the 10-year is benchmark yield curve roll down.

15-year: Initial price: 100.648

Price in six months: 101.517 (= −PV (0.0188/2, 29, 1, 100, 0))

Price appreciation: $434,500 (= (101.517 − 100.648)/100.000 × $50 million)

Because the 0.07% decline in YTM is estimated to be equally attributable to benchmark yield and yield spread changes, each is assumed equal to $217,250.

3. Incremental income due to price appreciation is therefore $344,000 (=$434,500 – $90,500), of which $217,250 is attributable to credit spread changes.

In total, the incremental roll-down strategy generates $506,500 (=$344,000 + 163,500) of which $292,250 (=217,250 + $75,000) is estimated to be due to credit spread curve roll down.

Derivative-based credit strategies to add credit spread duration or increase credit exposure include selling CDS single-name or index protection for longer maturities or lower credit quality or using a long–short approach to achieve a similar objective.

EXAMPLE 27

Using CDS for a Static Fixed-Income Credit Strategy

1. Returning to our earlier example of the investment-grade German media and telecommunications issuer, the investor decides instead to overweight exposure to this name by taking a long risk position in the single-name

10-year CDS market for one year. Details of today's 5-year and 10-year CDS contracts are as follows.

Issuer	Tenor	CDS Spread	$EffSpreadDur_{CDS}$
German Media & Telecoms Issuer	5 years	130 bps	4.669
German Media & Telecoms Issuer	10 years	175 bps	8.680

Describe the roll-down strategy using CDS and calculate the one-year return in euros on a €10,000,000 position assuming an annual coupon payment and a 9-year $EffSpreadDur_{CDS}$ of 7.91.

Solution:

The investor sells 10-year CDS protection on the German issuer to overweight exposure and terminates the position in one year. As with the bond example, the sold protection strategy generates coupon income if the issuer does not default and price appreciation if credit spreads decline over time.

1. The fixed coupon received at the end of one year equals the notional multiplied by the standard 1% investment-grade coupon for the period, or €100,000, or €10,000,000 × 1.00% for one year.
2. Estimate the CDS price change over one year by interpolating the 9-year issuer spread under a static credit curve assumption.

Solve for the 5-year and 10-year CDS spread weights in the 9-year spread interpolation calculation.

5-year CDS weight = w_5 = 20% (= (10 − 9)/(10 − 5))

10-year CDS weight = w_{10} = 80% (or (1 − w_5)

Note that (w_5 × 5) + (w_{10} × 10) = 9

The 9-year spread is a weighted average of 5- and 10-year CDS spreads.

$\text{CDS Spread}_{9yr} = w_5 \times \text{CDS Spread}_{5yr} + w_{10} \times \text{CDS Spread}_{10yr}$

1.66% (=1.30% × 0.2 + 1.75% × 0.8)

Estimate the CDS contract price change by multiplying the change in CDS price from Equation 14 (CDS Price ≈ 1 + ((Fixed Coupon – CDS Spread) × $EffSpreadDur_{CDS}$)) by the CDS notional.

10-year CDS per €1 par: 0.934 = (1 + (−0.75% × 8.68))

9-year CDS per €1 par: 0.947794 = (1 + (−0.66% × 7.91))

Calculate the price appreciation by multiplying the price change by the contract notional to get €128,940 (= (0.947794 – 0.9349) × €10,000,000).
Total return equals the sum of the coupon income and price appreciation, or €228,940 (= €100,000 + €128,940).

Dynamic Credit Spread Curve Strategies

Active credit managers seek to capitalize on divergent market views using cash-based or derivative strategies related to specific issuers, sectors, or the overall credit market over the credit cycle given anticipated credit curve changes across both maturities and rating categories. The following examples demonstrate how an active manager might position a credit portfolio in anticipation of these changes to generate excess return.

EXAMPLE 28

Tactical Credit Strategies – Economic Slowdown Scenario

An active credit portfolio manager considers the following corporate bond portfolio choices familiar from an earlier example:

Rating Category	Current OAS	Expected Loss (POD × LGD)	EffSpreadDur
A	1.05%	0.06%	5.5
Baa	1.35%	0.30%	6.0
Ba	2.45%	0.60%	4.5
B	3.50%	3.00%	4.0

The investor anticipates an economic slowdown in the next year that will have a greater adverse impact on lower-rated issuers. Assume that an index portfolio is equally allocated across all four rating categories, while the investor chooses a tactical portfolio combining equal long positions in the investment-grade (A and Baa) bonds and short positions in the high-yield (Ba and B) bonds.

1. Calculate excess spread on the index and tactical portfolios assuming no change in spreads over the next year (ignoring spread duration changes).

Solution:

The following table summarizes expected excess returns E [ExcessSpread-Return] ≈ Spread_0 – (EffSpreadDur × ΔSpread) – (POD × LGD) for each of the four rating categories with no change in spreads. For example, expected excess return for rating category A is 0.99% (=1.05% – (5.5 × 0) – 0.06%).

Rating Category	Excess Spread Return
A	0.99%
Baa	1.05%
Ba	1.85%
B	0.50%

Solve for the equally weighted versus tactical portfolios as follows:

Equally weighted index: 1.10% (= (0.99% + 1.05% + 1.85% + 0.50%)/4)

Tactical portfolio: −0.16% (= (0.99% + 1.05%)/2 − (1.85% + 0.50%)/2)

2. Calculate excess spread under an economic downturn scenario for the index and tactical portfolios where both OAS and expected loss rise 50% for investment-grade bonds and double for high-yield bonds.

Solution:

The following table summarizes expected excess returns E [ExcessSpreadReturn] ≈ $Spread_0$ – (EffSpreadDur × ΔSpread) – (POD × LGD) for each of the four rating categories with the expected 50% increase in both OAS and expected loss under the slowdown scenario. For example, expected excess return for rating category A is –1.928% (=1.05% – (5.5 × 0.525%) – 0.09%).

Rating Category	E(OAS)	E(Expected Loss)	E(Excess Spread Return)
A	1.575%	0.09%	–1.928%
Baa	2.025%	0.45%	–3.150%
Ba	4.900%	1.20%	–9.775%
B	7.000%	6.00%	–16.500%

Solve for the equally weighted versus tactical portfolios as follows.

Equally weighted index: −7.84% = (−1.928% − 3.150% −9.775% − 16.500%)/4)

Tactical portfolio: +10.6% = (−1.928% − 3.150%)/2 − (−9.775% − 16.500%)/2)

This example assumes that an active manager is able to source and borrow the necessary Ba- and B rated bonds to sell short at no cost. However, in practice, the availability and cost of shorting bonds vary over the economic cycle, and shorting bonds is often far more difficult and costly during an economic slowdown. The synthetic, CDS-based strategy in the following example targets a similar objective.

EXAMPLE 29

Synthetic Credit Strategies: Economic Slowdown Scenario

As in the prior example, an active fixed-income manager anticipates an economic slowdown in the next year with a greater adverse impact on lower\u0002rated issuers. The manager chooses a tactical CDX (credit default swap index) strategy combining positions in investment-grade and high-yield CDX contracts to capitalize on this view. The current market information for investment-grade and high-yield CDX contracts is as follows:

CDX Contract	Tenor	CDS Spread	$EffSpreadDur_{CDS}$
CDX IG Index	5 years	120 bps	4.67
CDX HY Index	5 years	300 bps	4.65

Assume that both CDX contracts have a $10,000,000 notional with premiums paid annually, and that the $EffSpreadDur_{CDS}$ for the CDX IG and CDX HY contracts in one year are 3.78 and 3.76, respectively. We ignore the time value of money for purposes of this example.

1. Describe the appropriate tactical CDX strategy and calculate the one-year return assuming no change in credit spread levels.

Solution:

The investor should initially sell protection on the CDX IG Index and buy protection on the CDX HY Index. Current CDS prices are estimated by multiplying $EffSpreadDur_{CDS}$ by the spread difference from the standard rates of 1% and 5%, respectively:

CDX HY: 109.3 per \$100 face value, or 1.093 (= 1 + (5.00% − 3.00%) × 4.65)

CDX IG: 99.066 per \$100 face value, or 0.99066 (
= 1 + (1.00% − 1.20%)× 4.67)

Since the investor is both buying HY protection at a premium to par (that is, agreeing to pay the 5% standard coupon while the underlying CDS spread is 3.00%) and selling IG protection at a discount from par (or agreeing to receive the standard 1.00% while the underlying index spread is 1.20%), the investor will receive an upfront payment for entering both positions as follows:

1,023,400 = [\$10,000,000 × (1.093 – 1)] + [\$10,000,000 × (1 –0.99066)]

In one year, the return is measured by combining the net CDX coupon income or expense with the price appreciation assuming no spread change. As the investor is long protection CDX HY protection (i.e., pays the 5.00% standard HY coupon) and short protection CDX IG protection (or receives the standard 1.00% IG coupon), the net annual premium paid by the investor at year end is \$400,000 (=\$10,000,000 × (–5.00% + 1.00%). The respective CDS prices in one year are as follows:

CDX HY: 107.52 per \$100 face value, or 1.0752 (=1 + (2.00% × 3.76))

CDX IG: 99.244 per \$100 face value, or 0.99244 (=1 + (−0.20% × 3.78))

To offset the existing CDX positions in one year, the investor would sell HY protection and buy IG protection. The investor is able to sell HY protection at a premium of 7.52, resulting in a \$178,000 gain from the long CDX HY position over one year (1.093 – 1.0752) × \$10,000,000). Since the investor must buy IG protection in one year at a lower discount to par of (1 – 0.99244), it has a \$17,800 loss from the CDX IG position (= (0.99244 – 0.99066) × \$10,000,000). Subtracting the \$400,000 net coupon payment made by the investor results in a one-year loss from the strategy of \$239,800 (= \$178,000 – \$17,800 – \$400,000) with constant spreads.

2. Calculate the one-year return on the tactical CDX strategy under an economic downturn scenario in which investment-grade credit spreads rise by 50% and high-yield credit spreads double.

Recall from Equation 14 that the price of a CDS contract may be approximated as follows:

$$\text{CDS Price} \approx 1 + ((\text{Fixed Coupon} - \text{CDS Spread}) \times EffSpreadDur_{CDS})$$

Solution:

Initial CDS prices are derived exactly as in Question 1:

CDX HY: 109.3 per \$100 face value, or 1.093 (= 1 + (2.00% × 4.65))

CDX IG: 99.066 per \$100 face value, or 0.9966 (= 1 + (−0.2% × 34.67))

In one year, the return is measured by combining the coupon income with the price appreciation given the rise in the CDX IG spread to 1.80% and the CDX HY spread to 6.00%. The net annual premium paid is \$400,000. Respective CDS prices in one year are as follows:

CDX HY: 96.24 per \$100 face value, or 0.9624 (=1 + (−1.00% × 3.76))

CDX IG: 96.976 per \$100 face value, or 0.96976 (=1 + (−0.80% × 3.78)

When offsetting the transaction in one year, the investor suffers a \$209,000 loss from the short CDX IG position ((0.99066 – 0.96976) × –\$10,000,000) and benefits from a \$1,306,000 gain from offsetting the CDX HY position (1.093 – 0.9624) × \$10,000,000). Subtracting the \$400,000 net premium paid results in a one-year gain from the strategy of \$697,000 (= \$1,306,000 – \$209,000 - \$400,000) under the second scenario.

The early expansion phase of the credit cycle is usually characterized by rising profits and falling leverage, as shown earlier in Exhibit 8, increasing cash flow coverage available to service outstanding debt. This reduction in the likelihood of near-term financial distress leads to both lower credit spread levels and a steeper credit curve, an effect that is more pronounced for lower-rated issuers in cyclical industries. The following examples illustrate how an active manager might capitalize on this credit cycle view in cash and synthetic markets.

EXAMPLE 30

Tactical Credit Strategies: Economic Recovery Scenario

1. A long-only active credit manager faces similar corporate bond portfolio choices to those in an earlier example:

Rating Category	OAS	EffSpreadDur	Expected Loss
A	1.40%	5.5	0.10%
Baa	2.00%	6.0	0.30%
Ba	3.75%	4.5	1.00%
B	5.50%	4.0	4.50%

Given an expectation that an economic rebound will cause both credit spreads and expected loss rates to fall by one-third, an active manager decides to tilt her credit portfolio toward high yield. Compare the impact of this rebound scenario on an active portfolio (33.3% invested in each of the Ba and B bond categories, with the remaining 33.3% split evenly between A and Baa) versus on an equally weighted passive portfolio.

Solution:

The economic rebound scenario results in the following new OAS and expected losses, with expected excess returns E [ExcessSpread] ≈ Spread_0 – (EffSpreadDur × ΔSpread) – (POD × LGD) in the far right column:

Rating Category	E(OAS)	E(Expected Loss)	E(Excess Spread)
A	0.933%	0.07%	3.898%
Baa	1.333%	0.20%	5.80%
Ba	2.50%	0.67%	8.705%
B	3.667%	3.00%	9.832%

Solve for the passive (equally weighted) portfolio returns versus tactical portfolio returns.

Passive portfolio return: 7.095% (= (3.898% + 5.80% + 8.705% + 9.832%)/4)

Tactical portfolio return: 7.795% (
=3.898%/6 + 5.80%/6 + 8.705%/3 + 9.832%/3).

EXAMPLE 31

Synthetic Credit Strategies: Economic Recovery Scenario

1. As in the prior example, an active fixed-income manager anticipates an economic rebound that is expected to cause high-yield credit curve steepening. The manager chooses a tactical CDX strategy combining 5-year and 10-year credit positions to capitalize on this view. Current market information for these high-yield CDX contracts is as follows:

CDX Contract	Tenor	CDS Spread	$EffSpreadDur_{CDS}$
CDX HY Index	5 years	450 bps	4.637
CDX HY Index	10 years	375 bps	8.656

Describe an appropriate duration-neutral portfolio positioning strategy to capitalize on this view using these CDX HY contracts. Calculate the return assuming that 5-year CDX spreads immediately fall by 175 bps and 10-year spreads decline by 25 bps for an equivalent $10,000,000 notional on the 10-year CDX index contract.

Solution:

The appropriate strategy is to sell protection on the 5-year CDX HY and buy protection on the 10-year CDX HY.

1. Calculate the 5-year CDS contract notional that matches the BPV of a 10-year, $10,000,000 CDS ($BPV_{10yr}$ = $EffSpreadDur_{10yrCDS}$ × notional) using the effective spread duration ratio of 1.8667 ($EffSpreadDur_{10yrCDS}/EffSpreadDur_{5yrCDS}$ = 8.656/4.637) multiplied by $10,000,000 to get $18,667,000.

   Confirm this equivalence by comparing BPV_{5yr} and BPV_{10yr}:

BPV_{5yr}: $8,656 = $18,667,000 × 4.637/10,000

BPV_{10yr}: $8,656 = $10,000,000 × 8.656/10,000

2. Calculate portfolio return for a 175 bp decline in 5-year CDX HY spreads and a 25 bp decline in 10-year CDX HY spreads using Equation 15 ($-\Delta$(CDS Spread) × $\text{EffSpreadDur}_{\text{CDS}}$) multiplied by the CDS notional as follows:

CDX HY 5 year: \$1,514,780 = (−(−1.75%) × 4.637) × \$18,667,000

CDX HY 10-year: −\$216,400 = (−(−0.25%) × 8.656) × (−\$10,000,000)
Portfolio gain: \$1,298,380

= \$1,514,780 − \$216,400.

Note that this equals the contract BPV of \$8,656 multiplied by the 150 bp credit curve steepening.

7 GLOBAL CREDIT STRATEGIES

☐ discuss considerations in constructing and managing portfolios across international credit markets

While yield curve strategies across currencies were covered in an earlier lesson, we now turn to cross-border fixed-income investments in which investors face the risk that they will not receive interest and principal cash flows as expected. Investors distinguish between international credit markets in developed market countries versus emerging or frontier markets. Fixed-income markets in developed countries usually have well-established and liquid derivative and other capital markets and feature a broad range of private and public debt issuers with bonds denominated in a freely floating domestic or other major currency. Emerging or frontier fixed-income markets on the other hand are often dominated by sovereign issuers, state-owned or controlled enterprises, banks, and producers operating in a dominant domestic industry such as basic commodities. As some emerging economies face concentrated risk to a particular commodity or industry, investments across sovereign, bank, and private sector debt could offer little to no diversification. While many emerging-market bonds are denominated in a restricted domestic currency with varying degrees of liquidity, the sovereign government and a select few domestic issuers often issue global bonds in a major foreign currency such as US dollars or euros.

Credit strategies across countries must take these and other individual market differences into consideration. For example, in the case of developed markets, sector composition differences exist. A far higher percentage of the US fixed-income market (and roughly one-third of the Bloomberg Barclays US Aggregate Bond Index) comprises mortgage-backed and other asset-backed instruments versus other developed markets. Investors in developed European and Asian markets seeking commercial or residential real estate exposure might instead consider covered bonds or indirect exposure via bank bonds in markets where securitization is less prevalent. International accounting standards differences between the International Accounting Standards Board's International Financial Reporting Standards and US GAAP in such areas as inventory recognition, restricted cash, and cash flow definitions require adjustment for financial ratio comparisons across jurisdictions. Finally, while most developed markets face common macroeconomic factors that influence the bond term premium and expected returns, such as inflation, monetary policy, and economic growth, differences in the timing and magnitude of market changes, as well as the credit cycle across countries, are often reflected in interest rate differentials, exchange rates, and credit spreads.

EXAMPLE 32

Credit Strategies across Developed Markets

1. An active United States–based credit manager is offered similar US corporate bond portfolio choices to those in an earlier example:

Rating Category	OAS	EffSpreadDur	Expected Loss
A	1.40%	5.5	0.10%
Baa	2.00%	6.0	0.30%
Ba	3.75%	4.5	1.00%
B	5.50%	4.0	4.50%

As in the earlier case, the manager expects an economic rebound but now believes that European economies will experience a stronger recovery than the United States. In particular, European high-yield credit spreads are expected to narrow by 25% in the near term, the euro is expected to appreciate 1% against the US dollar, and all US credit spreads and expected loss rates are expected to decline just 10% over the same period. The euro-denominated 5-year European iTraxx Crossover index (iTraxx-Xover) of liquid high-yield issuers (with a 5% fixed premium) is currently trading at 400 bps with an $\text{EffSpreadDur}_{\text{CDS}}$ of 4.25.

Describe the position the manager would take in iTraxx-Xover to capitalize on the stronger European rebound, and calculate the expected excess return percentage assuming an equally weighted allocation to US corporate bonds and an iTraxx-Xover position that matches that of the US high-yield bond allocation.

Solution:

To capitalize on expected greater euro spread tightening, the manager would sell protection on the iTraxx-Xover index. To calculate expected return, first consider the US corporate bond portfolio. The economic rebound scenario results in the following new OAS and expected losses for the portfolio, with expected excess returns E [ExcessSpread] ≈ Spread_0 −(EffSpreadDur × ΔSpread) − (POD × LGD) in the far right column:

Rating Category	E(OAS)	E(Expected Loss)	E(Excess Spread)
A	1.26%	0.09%	2.08%
Baa	1.80%	0.27%	3.93%
Ba	3.38%	0.90%	4.54%
B	4.95%	4.05%	3.65%

Return on the equally weighted portfolio is equal to 3.30% (= (2.08% + 2.93% + 4.54% + 3.65%)/4). We can estimate the initial iTraxx-Xover price by subtracting the product of $\text{EffSpreadDur}_{\text{CDS}}$ and the difference between the standard coupon (5%) from the market premium of 400 bps as follows:

Original iTraxx-Xover 5-year: 95.75 per \$104.25, or 1.0425 (
=1 + (4.25 × 1.00%))

If European high-yield spreads tighten by 25%, the iTraxx-Xover premium narrows by 100 bps to 300 bps, and the protection seller realizes a gain:

New iTraxx-Xover 5-year: 91.50 per \$108.5, or 1.085 (=1 + (4.25 × 2.00%))

We can calculate the percentage return on the iTraxx-Xover investment in euro terms by dividing the price change by the initial price to get 4.077% (= (1.085 – 1.0425)/1.0425). For a United States–based investor, we must convert the euro return to US dollars as described in an earlier lesson:

$$R_{DC} = (1 + R_{FC})\ (1 + R_{FX}) - 1$$

R_{DC} and R_{FC} are the domestic and foreign currency returns in percent, and R_{FX} is the percentage change of the domestic versus foreign currency.
We solve for US dollar iTraxx-Xover returns as 5.118% (= (1 + 4.077%) × (1 + 1.00%) – 1). Given that iTraxx-Xover carries a weight equal to one-half of the US corporate bond portfolio, the strategy returns 5.86% (or 3.30% + 5.118%/2).

Emerging markets are characterized by higher, more volatile, and less balanced economic growth than developed markets, often in addition to greater geopolitical risk, currency restrictions, and capital controls. Sovereign credit risk is therefore a critical starting point in considering fixed-income investments in emerging markets, where both the ability and willingness of issuers to repay debt is of importance. An earlier lesson outlined in detail sovereign credit risk considerations such as a country's institutional and economic profile, use of monetary and fiscal policy, the exchange rate regime, and external debt status and outlook.

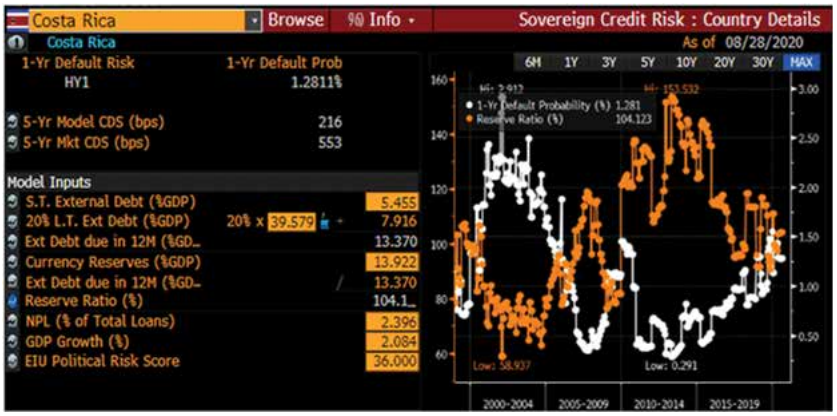
Institutional considerations include political stability, institutional transparency, and adherence to property rights and contract law. Geopolitical risks include such factors as potential conflicts and trade relations, which in some instances could have a greater impact on emerging markets whose economies are highly dependent on energy or other commodity exports. As mentioned earlier, ESG factors are key elements for sustainable, balanced, long-term economic growth.

As sovereign governments tax economic activity within their borders to repay interest and principal, key financial ratios used to assess and compare sovereign creditworthiness are usually measured as a percentage of GDP. For example, government debt to GDP and the annual government budget deficit (or surplus) as a percentage of GDP are common measures of indebtedness and fiscal stability, respectively, for both developed and emerging markets.

Finally, a country's exchange rate regime is a critical element of monetary and external flexibility. Freely floating currency regimes that allow a currency to be held in reserve outside the country enable sovereign governments to pursue an independent and flexible monetary policy. Restrictive or fixed-rate regimes limit policy effectiveness, magnifying the impact of economic crises and increasing the likelihood of financial distress. Emerging markets are usually characterized by non-reserve currency regimes with significant external debt denominated in major foreign currencies, leading analysts to incorporate external debt to GDP and currency reserves as a percentage of GDP as key leverage and liquidity measures of creditworthiness, respectively.

The Bloomberg Sovereign Risk (SRSK) model shown in Exhibit 30 combines quantitative and qualitative factors such as external debt to GDP, currency reserves, GDP growth, and political risk to estimate a sovereign issuer's one-year POD. Similar to the DRSK model discussed earlier, the SRSK model allows users to change model inputs and also derives a "model" CDS spread, which could be compared to the market CDS spread.

Exhibit 30: Bloomberg SRSK Screen



In this example, Costa Rica has a 1.28% one-year default risk and a model CDS spread well below the market CDS spread.

EXAMPLE 33

Sovereign Risk Factors for Emerging Markets

1. A financial analyst is considering the likelihood that an emerging market sovereign issuer of US dollar–denominated bonds is able to meet its interest payments over the next 12 months. Which of the following financial ratios is most appropriate to assess the sovereign borrower's liquidity position?

   A. Government budget deficit/GDP

   B. External debt/GDP

   C. Currency reserves/GDP

Solution:

The correct answer is C. The government budget deficit as a percentage of GDP is a gauge of fiscal stability for the domestic economy, while the external debt-to-GDP ratio is a measure of financial leverage to foreign lenders. Currency reserves as a percentage of GDP measure the available liquidity in foreign currency to meet external obligations.

Several additional considerations are important for investors in emerging market bonds issued by private companies. First, although some local companies might have partial private ownership and publicly traded equity, the sovereign government could exercise controlling influence on the business, including replacing management or ownership groups.

Credit quality in the emerging market credit universe exhibits a high concentration in lower investment-grade and upper high-yield ratings categories. This concentration of credit ratings is largely a reflection of the sovereign ratings of emerging markets but also reflects the fact that a "sovereign ceiling" is usually applied to corporate issuers globally. This ceiling implies that a company's rating is typically no higher than the sovereign credit rating of its domicile.

Finally, relative liquidity conditions and currency volatility are key considerations for international credit investors. In emerging markets, liquidity is often constrained because of a relatively small number of bonds that trade regularly, resulting in investors demanding higher premiums for holding emerging market credit securities. Local bond markets might seem highly liquid and can exceed the trading volume of the local stock exchanges, but such high trading volume could also be inflated by interbank trading by local banks and retail investors. Currency volatility can be particularly significant in emerging markets as a result of restrictive currency regimes and derivative markets. Higher YTMs available in emerging market currencies versus developed markets typically suggest that these emerging currencies will depreciate over time. That said, emerging markets offer investors the opportunity to exploit divergence from interest rate parity conditions (known as the forward rate bias) by investing in higher-yielding currencies, as addressed in earlier lessons. Although temporary deviations from a fixed exchange rate are possible under such regimes, what is more common during economic crises is exchange rate regime change, central bank intervention, and/or devaluation. The following example demonstrates how such factors are considered in emerging market credit strategies.

EXAMPLE 34

Emerging Market Credit Strategy

1. An active United States–based investor is considering a portfolio allocation to the bonds of a major commodities producer headquartered in an emerging market economy. The issuer is a major exporter, and commodity exports comprise a significant proportion of the country's economic growth. Describe how the investor would decide between purchasing a higher-yielding, local-currency-denominated bond and a lower-yielding, US-dollar-denominated bond with otherwise similar features.

Solution:

A United States–based investor seeking to maximize US-dollar-denominated return must consider the relationship between the higher local currency bond YTM, the lower US dollar bond YTM, and the local currency's expected depreciation (or appreciation) versus the US dollar over the investment horizon. While uncovered interest rate parity suggests that local currency depreciation versus the US dollar would offset any benefit of a higher YTM, an investor with a bullish view of the emerging economy's growth prospects would benefit from forward rate bias and earn a higher return in US dollar terms from an unhedged investment in the local currency bond if the local currency were to depreciate less than expected under interest rate parity conditions.

STRUCTURED CREDIT 8

☐ describe the use of structured financial instruments as an alternative to corporate bonds in credit portfolios

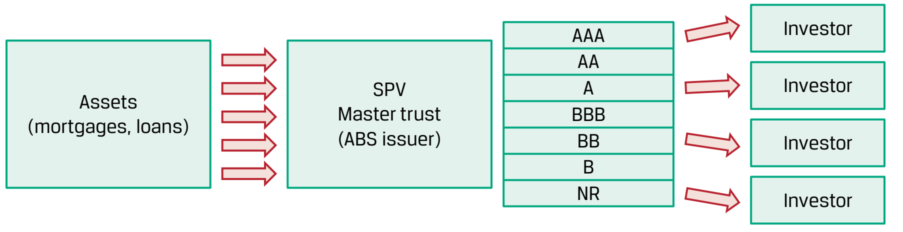
Active managers have access to a wide array of credit management tools beyond individual fixed-income securities that include structured financial instruments. These alternatives to direct bond investments in corporate bonds introduced in earlier lessons are summarized in Exhibit 31.

Exhibit 31: Structured Alternatives to Individual Bonds

Instrument	Description	Exposure	Portfolio Applications
Collateralized Debt Obligations (CDOs)	Fixed-income securities backed by a diversified pool of debt obligations	Redistribute portfolio debt cash flows across ratings spectrum	Create tailored portfolio-based debt exposure categories/profiles unavailable in the cash bond market
Collateralized Loan Obligations (CLOs)	Fixed-income securities backed by a diversified pool of floating-rate leveraged loan obligations	Redistribute portfolio loan cash flows across ratings spectrum	Create tailored portfolio-based loan and interest rate exposure profiles unavailable in the cash bond market
Mortgage-Backed Securities (MBS)	Fixed-income securities backed by a pool of commercial or residential mortgage loans	Provide portfolio-based exposure to real estate cash flows	Offer active managers exposure to real estate and to volatility (prepayment/extension risk) unavailable in the cash bond market
Asset-Backed Securities (ABS)	Fixed-income securities backed by a pool of credit card, auto, and other loans	Provide portfolio-based exposure to consumer loan cash flows	Offer active managers direct exposure to consumer loans and to volatility unavailable in the cash bond market
Covered Bonds	Senior debt obligations backed by pool of commercial/residential mortgages or public sector assets	Provide portfolio-based exposure to real estate cash flows with recourse to issuer	Offer active managers direct exposure to consumer loans and to real estate/public sector cash flows unavailable in the cash bond market

Structured financial instruments can offer active credit managers the ability to access fixed-income cash flows such as commercial or residential real estate, enhance returns by increasing portfolio exposure to interest rate volatility (via mortgage prepayment and extension risk), and add debt exposure created by the redistribution of default risk into different tranches across the credit spectrum. Exhibit 32 shows an illustrative example of the tranching that characterizes ABS and CDO transactions. In this case, the ABS issuer is a special purpose vehicle (SPV) that owns the underlying asset pool and issues debt across several tranches backed by the asset pool cash flows.

Exhibit 32: Illustrative Tranching Example



An earlier lesson addressed the redistribution of default risk from the underlying asset pool. This is achieved by establishing higher-rated tranches via internal credit enhancement or overcollateralization, with successively lower-rated tranches absorbing a greater proportion of the associated default risk. An active investor might overweight default risk by choosing a lower-rated ABS tranche based on a tactical view. For example, such an investor might anticipate lower-than-expected defaults or believe the credit cycle is in recovery mode and that lower-rated tranches will experience greater spread tightening than higher-rated tranches. Alternatively, a portfolio manager might underweight credit exposure using a higher-rated tranche in a downturn.

While covered bonds offer real estate cash flow exposure similar to that of ABS, given the dual recourse (i.e., to both the issuing financial institution and the underlying asset pool), as well as the substitution of non-performing assets, covered bonds usually involve lower credit risk and a lower yield. The following examples demonstrate the role of structured products in active credit portfolios.

EXAMPLE 35

The Role of Structured Products in Active Credit Management

1. An active credit manager anticipates an economic slowdown led by a decline in residential housing prices. Which of the following portfolio positioning strategies involving structured products is the most appropriate to consider under this scenario?

   A. Shift exposure from an A rated tranche of a credit card ABS transaction to a BB rated tranche

   B. Increase exposure to an A rated CDO tranche and reduce exposure to a BBB rated CDO tranche

   C. Increase exposure to an A rated MBS tranche and decrease exposure to a BBB rated MBS tranche

Solution:

The correct answer is C. As the housing sector slows and default rates rise, credit spreads of lower-rated MBS tend to widen by more than those of higher-rated MBS. The investor retains exposure to real estate cash flows while reducing exposure to spread widening. The shift to a BB rated credit card ABS tranche increases credit exposure, while the switch from BBB rated to A rated CDOs represents a reduction in overall market risk rather than a more targeted underweight, as in C.

2. An active fixed-income portfolio manager expects an economic recovery in the near term to be accompanied by rising short-term rates and a flatter benchmark yield curve. Which of the following strategies best positions an active manager to capitalize on this scenario?

   A. Increase exposure to covered bonds and decrease exposure to MBS

   B. Shift exposure from an A rated CDO tranche to a BBB rated CLO tranche

   C. Shift exposure from a BB rated tranche of an automotive ABS transaction to a A rated tranche

Solution:

The correct answer is B. Economic recovery is typically associated with lower defaults and greater credit spread tightening among lower-rated issuers and debt tranches. CLO tranches benefit more from short-term rate rises than CDOs because CLOs comprise leveraged loans based on MRRs plus a credit spread. As for A, a shift to covered bonds from MBS reduces credit risk because of the dual recourse and substitutability of collateral characteristics of covered bonds. In C, credit exposure is reduced, limiting the benefit from credit spread reduction within the portfolio.

FIXED-INCOME ANALYTICS 9

☐ describe key inputs, outputs, and considerations in using analytical tools to manage fixed-income portfolios

Fixed-income analytical tools continue to adapt not only to technological change but also to the market and regulatory environment within which active fixed-income practitioners operate. The inputs and outputs of these models have become more complex as market participants integrate tasks across operational duties and portfolio decision making and execution. These tasks include portfolio construction, risk analytics, trading and settlement, cash and collateral management, daily valuation, portfolio accounting, and regulatory reporting.

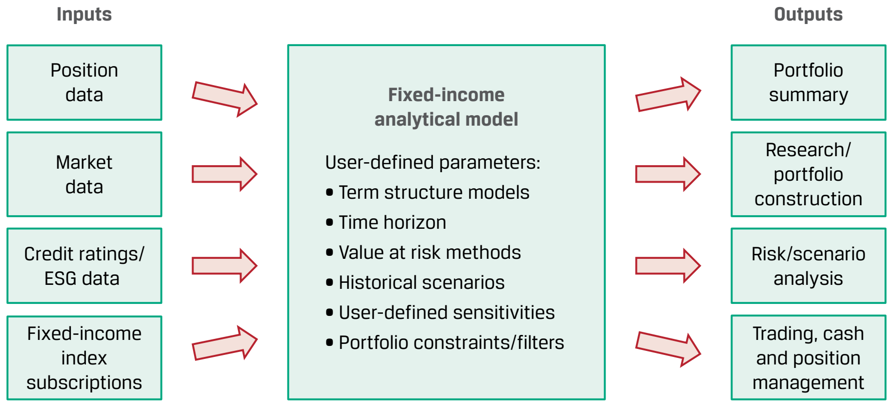
Primary inputs for fixed-income models include all long and short cash bond and derivative positions, repurchase agreements, and cash across currencies. Fixed-income security inputs use CUSIP or ISIN identifiers to capture all relevant features such as interest and principal payment dates, day count conventions, and put–call features. Portfolio derivative and repo position inputs also include details of such agreements, such as settlement dates, option strike prices, and collateral terms necessary to satisfy derivative counterparty or clearing requirements based on market changes.

Real-time market data feeds usually sourced from vendors via application programming interfaces include spot and forward rates, credit curves, implied volatilities, and exchange rates that are used to value historical, existing, and potential future new portfolio positions. These tools value inactively traded fixed-income instruments using matrix pricing (or evaluated pricing) based on observable liquid benchmark YTMs of similar maturity and duration and credit spreads of actively traded bonds with comparable times to maturity, credit quality, and sector. Additional model inputs include index subscriptions, ESG and credit ratings, and issuer balance sheet data. In contrast to more static equity indexes, fixed-income indexes are subject to constant change as a result of both new debt issuance and bond maturities as well as ratings changes, bond callability, and prepayment.

Model assumptions include user-defined parameters such as term structure models, investment time horizon, VaR methodology, historical and/or specific market scenarios, and portfolio filters that could involve inclusion or exclusion of specific sectors or a minimum ESG rating threshold for consideration.

Fixed-income analytical model outputs support each stage of the active portfolio management process, namely portfolio selection and construction, risk analysis of existing and prospective portfolio positions, and trading and position management. A portfolio summary or landing page typically aggregates current portfolio risk and return across sectors, ratings, and currencies versus the benchmark index. Model applications supporting research and portfolio construction allow managers to assess the expected change in portfolio performance by including incremental long or short cash bond, derivative, or structured product positions. Portfolio risk dashboards embedded in these tools provide detailed insight into portfolio duration and convexity as well as tail risk. These statistics are often further disaggregated into key rate duration measures for benchmark rates and credit spreads by maturity. VaR and expected shortfall (or CVaR) are calculated based on user threshold and methodology settings. Finally, trading, cash, and position management outputs quantify existing cash positions, anticipated cash inflows and outflows from existing positions, and liquidity risk. Exhibit 33 summarizes the key elements of a fixed-income portfolio analytics tool.

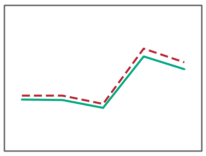
Exhibit 33: Illustrative Portfolio Analytics Tool



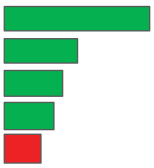
Portfolio summary

Summary Statistics	Portfolio	Index
Returns (YTD)	x.xx%	x.xx%
Returns (30d)	x.xx%	x.xx%
OAS (bps)	x.xx	x.Xx
Effective duration	x.xx	x.xx
Effective convexity	x.xx	x.Xx
Tracking error	x.xx%	–

5-day return



Top 5	%
10Y UST	x.xx%
ABC	x.xx%
XYZ	x.xx%
CDE	x.xx%
30Y FUT	-x.xx%



Currency	Portfolio	Index
USD	x.xx%	x.xx%
EUR	x.xx%	x.xx%
GBP	x.xx%	x.xx%
JPY	x.xx%	x.xx%
BRL	x.xx%	x.xx%

Rating	Portfolio	Index
AAA-AA	x.xx%	x.xx%
A	x.xx%	x.xx%
BBB	x.xx%	x.xx%
BB	x.xx%	x.xx%
B-CCC	x.xx%	x.xx%

Segment	Portfolio	Index
Inv grade corporate	x.xx%	x.xx%
High yield corporate	x.xx%	x.xx%
Sovereign DM	x.xx%	x.xx%
Sovereign EM	x.xx%	x.xx%
Securitized	x.xx%	x.xx%

Key considerations for fixed-income analytical tools include both the accuracy of model inputs and assumptions and the degree of alignment between model outputs and specific fixed-income manager objectives.

Bond price and YTM calculations are affected by assumptions related to the term structure of benchmark rates and volatilities and how they change over time based on term structure models. Model outputs are often tailored to match an active manager's objectives. For example, an index fund manager might seek to minimize the tracking error defined earlier as the deviation of portfolio returns from an index. An active fixed-income manager with fewer constraints might maximize risk-adjusted returns, while estimating and categorizing how each position contributes to active risk taking. For example, performance attribution measures returns from credit, duration, sector, and currency tilts, among other factors. Finally, an active manager facing liability constraints usually models the fixed-income characteristics of obligations to maximize the expected surplus of assets over liabilities. Practitioners applying these tools must both recognize their limitations and anticipate and interpret model results, as in the following example.

EXAMPLE 36

Applying Fixed-Income Analytical Tools

1. An active fixed-income manager is conducting scenario analysis for the MBS component of a portfolio. Which of the following analytical model input changes is most likely to reduce the future value of the MBS subportfolio versus similar option-free bond holdings?

   A. An increase in benchmark yield curve volatility

   B. A decrease in benchmark yield curve volatility

   C. Upward parallel shift in the benchmark yield curve

Solution:

The correct answer is A. The value of a bond with an embedded option is equal to the sum of the value of an option-free bond plus the value to the embedded option. The value of the embedded call option owned by the issuer will increase as volatility rises, reducing the value of the MBS versus a similar option-free bond. Answers B and C are more likely to result in an increase in the value of MBS versus an option-free bond.

SUMMARY

Active spread-based, fixed-income portfolio management involves taking positions in credit and other risk factors that differ from those of an index to generate excess return. The main points of the reading are as follows:

- Yield spreads compensate investors for the risk that they will not receive expected interest and principal cash flows and for the bid–offer cost of buying or selling a bond under current market conditions.
- Two key components of a bond's credit risk are the POD and the LGD.
- Credit spread changes are driven by the credit cycle, or the expansion and contraction of credit over the business cycle, which causes asset prices to change based on default and recovery expectations.
- High-yield issuers experience greater changes in the POD over the credit cycle than investment-grade issuers, with bond prices approaching the recovery rate for distressed debt.
- While fixed-rate bond yield spread measures use actual, interpolated, or zero curve–based benchmark rates to capture relative credit risk, OAS allow comparison between risky option-free bonds and bonds with embedded options.
- FRNs pay periodic interest based on an MRR plus a yield spread.
- Spread duration measures the change in a bond's price for a given change in yield spread, while spread changes for lower-rated bonds tend to be proportional on a percentage rather than an absolute basis.
- Bottom-up credit strategies include the use of financial ratio analysis, reduced form credit models (such as the Z-score model), and structural credit models, including Bloomberg's DRSK model.

- Top-down credit strategies are often based on macro factors and group investment choices by credit rating and industry sector categories.
- Fixed-income factor investing incorporates such factors as size, value, and momentum to target active returns and also increasingly include ESG factors.
- Liquidity risk in credit markets is higher than in equities because of market structure differences and is often addressed using liquid bonds for short-term tactical positioning, less liquid positions for buy-and-hold strategies, and liquid alternatives where active management adds little value.
- Credit market tail risk is usually quantified using VaR or expected shortfall measures and is frequently managed using position limits, risk budgeting, or derivative strategies.
- Credit derivative strategies offer a synthetic liquid alternative to active portfolio managers as a means of over- or underweighting issuers, sectors, and/or maturities across the credit spectrum.
- Credit spread levels and curve slopes change over the credit cycle, with credit curve steepening usually indicating low near-term default expectations and higher growth expectations, while curve flattening, or inversion, suggests rising default expectations and lower future growth.
- Active credit managers can benefit under a stable credit curve scenario by adding spread duration for existing exposures and/or increasing average portfolio credit risk and can capitalize on divergent market views using cash- or derivative-based strategies related to specific issuers, sectors, or the overall credit market.
- Investors in international credit markets distinguish between developed and emerging markets. Developed markets face common macro factors, with market and credit cycle differences affecting relative interest rates, foreign exchange rates, and credit spreads. Emerging markets usually exhibit higher growth combined with greater sovereign and geopolitical risk, currency restrictions, and capital controls.
- Structured financial instruments offer active credit managers access to liquid bond portfolios, fixed-income cash flows derived from real estate and consumer loans, and enhanced returns by adding volatility and/or debt exposure via tranching across the credit spectrum.
- Key considerations for fixed-income analytical tools include the accuracy of model inputs and assumptions as well as alignment between model outputs and fixed-income manager objectives.

REFERENCES

Altman, Edward I. 1968. "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy." *Journal of Finance* 23 (4): 589–609. 10.1111/j.1540-6261.1968.tb00843.x

Israel, Ronen, Diogo Palhares, and Scott Richardson. 2018. "*Common Factors in Corporate Bond Returns.*" *Journal of Investment Management* 16 (2), 17–46. www.aqr.com/-/media/AQR/Documents/Journal-Articles/Common-Factors-in-Corporate-Bond-Returns.pdfMoody's Investors Service. 2018. "Cross-Sector: Annual Default Study: Corporate Default and Recovery Rates, 1920–2017." Data report (15 February).

O'Kane, Dominic and Saurav Sen. 2005. "Credit Spreads Explained." *Journal of Credit Risk* 1 (2): 61–78. 10.21314/JCR.2005.009

PRACTICE PROBLEMS

1. Which of the following statements best describes empirical duration?

   A. A common way to calculate a bond's empirical duration is to run a regression of its price returns on changes in a benchmark interest rate.

   B. A bond's empirical duration tends to be larger than its effective duration.

   C. The price sensitivity of high-yield bonds to interest rate changes is typically higher than that of investment-grade bonds.

2. A junior analyst considers a 10-year high-yield bond issued by EKN Corporation (EKN) position in a high-yield portfolio. The bond has a price of 91.82, a modified duration of 8.47, and a spread duration of 8.47. The analyst speculates on the effects of an interest rate increase of 20 bps and, because of a change in its credit risk, an increase in the EKN bond's credit spread of 20 bps. The analyst comments that because the modified duration and the credit spread duration of the EKN bond are equal, the bond's price will not change (all else being equal) in response to the interest rate and credit spread changes.

   Is the analyst's prediction correct that the EKN bond price will not change in response to the interest rate and credit spread changes, all else being equal?

   A. Yes.

   B. No, the bond price should decrease.

   C. No, the bond price should increase.

3. Which of the following outcomes is most likely if the junior analyst revises the bond's original recovery rate higher?

   A. An increase in the bond's POD

   B. A decrease in the bond's POD

   C. A decrease in the bond's credit spread

4. Which of the following observations on the risks of spread-based fixed-income portfolios is the most accurate?

   A. Because credit spreads equal the product of the LGD and the POD, distinguishing between the credit risk and liquidity risk components of yield spread across all market scenarios is straightforward.

   B. Given that frequent issuers with many bonds outstanding across maturities have their own issuer-specific credit curve, distinguishing between the credit spread and liquidity spread of all bonds for these issuers is straightforward.

   C. The yield spread of a particular bond comprises both credit and liquidity risk and depends on market conditions and the specific supply-and-demand dynamics of each fixed-income security.

The following information relates to questions 5-8

An active portfolio manager observes the following market information related to an outstanding corporate bond and two on-the-run government bonds that pay annual coupons:

Issuer	Term	Coupon	Yield	ModDur
Corporate	12y	3.00%	2.80%	9.99
Government	10y	1.75%	1.85%	9.09
Government	20y	2.25%	2.30%	15.94

The portfolio manager also observes 10-year and 20-year swap spreads of 0.20% and 0.25%, respectively.

5. Calculate the G-spread of the corporate bond.

   A. 0.860%

   B. 0.725%

   C. 0.950%

6. Calculate the I-spread of the corporate bond.

   A. 0.85%

   B. 0.65%

   C. 0.95%

7. Calculate the ASW of the corporate bond.

   A. 0.65%

   B. 0.95%

   C. 0.85%

8. Estimate the corporate bond's percentage price change if the government yield curve steepens, assuming a 0.20% increase in the 20-year YTM and no change to the 10-year government YTM or corporate G-spread.

   A. –0.40%

   B. 0.40%

   C. –0.04%

---

9. Which of the following statements about credit spread measures is most accurate?

   A. The DM is the yield spread over the MRR established upon issuance to compensate investors for assuming an issuer's credit risk.

   B. The Z-DM will be above the DM if the MRR is expected to remain constant over time.

C. The yield spread for a corporate bond will be equal to the G-spread if the government benchmark yield curve is flat.

The following information relates to questions 10-12

An active fixed-income manager is considering two corporate bond positions for an active portfolio. The first bond has a BBB rating with a credit spread of 2.75% and an effective spread duration of 6, and the second bond has a BB rating with a credit spread of 3.50% and an effective spread duration of five years.

10. What is the approximate excess return if the BBB rated bond is held for six months and the credit spread narrows by 40 bps, ignoring spread duration changes and assuming no default losses?

    A. 3.775%

    B. 2.35%

    C. 2.40%

11. What is the instantaneous (holding period of zero) excess return for the BB rated bond if the spread widens by 50 bps?

    A. 3.00%

    B. –2.50%

    C. 2.50%

12. What is the expected excess spread of the BBB rated bond for a 50 bp decline in yield over a one-year holding period if the bond's LGD is 40% and the POD is 0.75%?

    A. 1.95%

    B. 2.45%

    C. 5.45%

---

13. An active manager is considering the senior bonds of one of several corporate issuers. Holding other factors constant, which of the following key financial ratio changes would lead the manager to expect a decrease in the POD for that issuer?

    A. An increase in the issuer's coverage ratio

    B. An increase in the issuer's stock price volatility

    C. An increase in the issuer's leverage ratio

14. Which of the following statements about statistical credit analysis models is most accurate?

    A. Structural credit models solve for the POD using observable company-specific variables such as financial ratios and macroeconomic variables.

B. Reduced-form credit models use market-based variables to estimate an issuer's asset value and the volatility of asset value.

C. Structural credit models define the likelihood of default as the probability of the asset value falling below that of liabilities.

The following information relates to questions 15-17

An investor is faced with an active portfolio decision across three bond rating categories based on the following current market information:

Rating Category	Current OAS	Expected Loss (POD x LGD)	EffSpreadDur
A	1.00%	0.10%	7
BBB	1.75%	0.75%	6
BB	2.75%	2.50%	5

15. Which bond rating category offers the highest expected excess return if credit spreads remain stable under current market conditions?

A. A rated bond category

B. BBB rated bond category

C. BB rated bond category

16. Which active bond portfolio maximizes expected excess return under a stable credit market assumption versus an equally weighted benchmark portfolio across the three rating categories?

A. 50% A rated bonds, 50% BBB rated bonds

B. 50% BBB rated bonds, 50% BB rated bonds

C. 50% A rated bonds, 50% BB rated bonds

17. Which bond rating category offers the highest expected excess return if spreads rise 10% across all ratings categories?

A. A rated bond category

B. BBB rated bond category

C. BB rated bond category

---

18. Which of the following strategies best addresses the liquidity risk of a less frequently traded bond position in an active manager's portfolio?

A. Enter into a receive fixed, pay floating asset swap, unwinding the swap position once the illiquid bond position is sold.

B. Sell single-name CDS protection on the illiquid bond issuer, unwinding the CDS contract when the bond is sold.

C. Allocate the illiquid bond to the buy-and-hold portion of the investment portfolio.

19. Which of the following statements best describes methods for assessing portfolio tail risk?

A. Parametric methods use expected value and standard deviation of risk factors under a normal distribution and are well suited for option-based portfolios.

B. Historical simulation methods use historical parameters and ranking results and are not well suited for option-based portfolios.

C. Monte Carlo methods generate random outcomes using portfolio measures and sensitivities and are well suited for option-based portfolios.

The following information relates to questions 20-21

An investor is considering the portfolio impact of a new 12-year corporate bond position with a $75 million face value, a 3.25% coupon, current YTM of 2.85%, modified duration of 9.887, and a price of 104.0175 per 100 of face value.

20. Which of the following VaR measures is most appropriate for the portfolio manager to use to evaluate how this position would affect portfolio tail risk?

A. CVaR

B. Relative VaR

C. Incremental VaR

21. What is the approximate VaR for the bond position at a 99% confidence interval (equal to 2.33 standard deviations) for one month (with 21 trading days) if daily yield volatility is 1.50 bps and returns are normally distributed?

A. $1,234,105

B. $2,468,210

C. $5,413,133

---

22. Which of the following statements best describes how a single-name CDS contract is priced at inception?

A. If the reference entity's credit spread trades below the standard coupon rate, the CDS contract will be priced at a premium above par because the protection buyer pays a "below market" periodic coupon.

B. If the reference entity's credit spread trades above the standard coupon rate, the CDS contract will be priced at a discount to par because the protection seller effectively receives a "below market" periodic premium.

C. Similar to fixed-rate bonds, CDS contracts are initially priced at par with a fixed coupon and a price that changes over time as the reference entity's credit spreads change.

The following information relates to questions 23-24

An active portfolio manager seeking to purchase single-name CDS protection observes a 1.75% 10-year market credit spread for a private investment-grade issuer. The effective spread duration is 8.75 and CDS basis is close to zero.

23. What should the protection buyer expect to pay or receive to enter a new 10-year CDS contract?

    A. The buyer should receive approximately 6.5625% of the notional.

    B. The buyer should pay approximately 15.3125% of the notional.

    C. The buyer should pay approximately 6.5625% of the notional.

24. Once the manager purchases CDS protection, the issuer's CDS spread immediately falls to 1.60%. What is the investor's approximate mark-to-market gain or loss for a contract notional of €10,000,000?

    A. The manager realizes an approximate loss of €131,250.

    B. The manager realizes an approximate gain of €131,250.

    C. The manager realizes an approximate gain of €525,000.

---

25. Which of the following credit portfolio positioning strategies is the most appropriate to underweight the financial sector versus an index?

    A. Purchase protection on the CDX and sell protection on the CDX Financials subindex.

    B. Sell protection on the CDX and purchase protection on the CDX Financials subindex.

    C. Purchase a payer option on the CDX and sell protection on the CDX Financials subindex.

26. Which of the following phases of the credit cycle typically involves a decline in the number of issuer defaults?

    A. Late expansion phase

    B. Early expansion phase

    C. Peak phase

27. Which of the following regarding the shape of the credit spread curve for high-yield issuers is most accurate?

    A. High-yield credit spread curves change shape more over the cycle than investment-grade ones do and usually invert during the peak phase.

B. Investors should exercise caution in interpreting credit spread curve shape for distressed debt issuers because their bonds tend to trade on a price rather than credit spread basis as the likelihood of default increases.

C. High-yield credit spread curves often invert because of the empirical observation that DTS is the best way to measure high-yield bond price changes.

28. Which of the following statements best describes a credit curve roll-down strategy?

A. Returns from a credit curve roll-down strategy can be estimated by combining the incremental coupon from a longer maturity corporate bond with price appreciation due to the passage of time.

B. A synthetic credit curve roll-down strategy involves purchasing protection using a single-name CDS contract for a longer maturity.

C. A credit curve roll-down strategy is expected to generate a positive return if the credit spread curve is upward sloping.

The following information relates to questions 29-30

An investor observes the following current CDS market information:

CDX Contract	Tenor (years)	CDS Spread	$EffSpreadDur_{CDS}$
CDX IG Index	5	85 bps	4.9
CDX IG Index	10	135 bps	8.9
CDX HY Index	5	175 bps	4.7
CDX HY Index	10	275 bps	8.7

29. Select the most appropriate credit portfolio positioning strategy to capitalize on an expected steepening of the investment-grade credit spread curve.

A. Sell protection on the 10-year CDX IG index and purchase protection on the 5-year CDX IG index using contracts of equal notional value.

B. Sell protection on the 10-year CDX IG index and purchase protection on the 5-year CDX IG index using a contract with a notional amount equal to 1.82 times that of the 10-year contract.

C. Buy protection on the 10-year CDX IG index and sell protection on the 5-year CDX IG index using a contract with a notional amount equal to 1.82 times that of the 10-year contract.

30. Which of the following is the most appropriate credit portfolio positioning strategy to capitalize on an expected economic contraction?

A. Buy protection on the 5-year CDX HY index and sell protection on the 5-year CDX IG index in approximately equal notional amounts.

B. Buy protection on the 10-year CDX IG index and sell protection on the 5-year CDX IG index using a contract with a notional amount equal to 1.82 times that of the 10-year contract.

C. Buy protection on the 10-year CDX HY index and sell protection on the 5-year CDX HY index using a contract with a notional amount equal to 1.85 times that of the 10-year contract.

---

31. Which of the following is the most accurate statement related to international credit markets?

A. Fixed exchange-rate regimes among emerging markets usually reduce the likelihood of financial distress because the domestic currency is tied to a major foreign currency.

B. Although many emerging economies have domestic bond markets that include sovereign, financial, and corporate issuers, investments across these bonds offer less diversification than similar investments in developed markets.

C. Higher domestic currency YTMs among emerging versus developed markets are due to expected currency appreciation resulting from higher economic growth.

The following information relates to questions 32-33

An active United States–based credit manager faces the following US and European investment-grade and high-yield corporate bond portfolio choices:

Rating Category	OAS	EffSpreadDur	Expected Loss
USD IG	1.25%	4.50	0.40%
USD HY	3.00%	5.50	2.25%
EUR IG	1.15%	4.75	0.50%
EUR HY	3.25%	6.00	2.50%

The EUR IG and EUR HY allocations are denominated in euros, and the euro is expected to depreciate by 2% versus the US dollar over the next year.

32. What is the expected unhedged excess return to the United States–based credit manager for an international credit portfolio index equally weighted across the four portfolio choices, assuming no change to spread duration and no changes to the expected loss occur?

A. –0.257%

B. –0.850%

C. 0.750%

33. Which of the following active portfolios is expected to have the highest excess return versus the index if European economies are expected to experience an

earlier and much stronger credit cycle recovery than the United States?

A. EUR HY 50.0%, EUR IG 25.0%, USD IG 12.5%, USD HY 12.5%

B. EUR IG 50.0%, EUR HY 25.0%, USD IG 12.5%, USD HY 12.5%

C. EUR HY 33.3%, US HY 33.3%, EUR IG 16.7%, USD IG 16.7%

---

34. Which of the following statements about the role of structured products in an active credit portfolio is most accurate?

A. Covered bonds perform relatively well in a downturn versus other fixed-income bonds with real estate exposure because a covered bond investor also has recourse to the issuer.

B. Higher-rated ABS tranches are attractive for active investors seeking to overweight default risk when the credit cycle is in recovery.

C. CLO tranches are more advantageous than CDO tranches with similar ratings under an economic slowdown scenario.

35. An active fixed-income manager is evaluating the relative performance of an investment-grade corporate versus a high-yield corporate debt allocation in a fixed-income portfolio. Which of the following analytical model assumption changes is most likely to reduce the future value of the high-yield portfolio relative to the investment-grade holdings?

A. Steepening of the benchmark yield volatility curve

B. Decreased likelihood of an economic slowdown

C. Increased likelihood of a flight to quality associated with bullish benchmark yield curve flattening (long-term rates fall by more than short-term rates do)

SOLUTIONS

1. A is correct. A bond's empirical duration is often estimated by running a regression of its price returns on changes in a benchmark interest rate.

2. B is correct. An increase in interest rates results in a decrease in the bond price. An increase in the credit spread also results in a decrease in the bond price. For the EKN bond, its modified duration shows the effect of the 20 bp increase in interest rates. The approximate percentage price change resulting from the increase in interest rates is –8.47 × 0.0020 = –1.694%. The spread duration shows the effect of the 20 bp increase in the credit spread. The approximate percentage price change resulting from the increase in the credit spread is –8.47 × 0.0020 = –1.694%. The combined effect is a total change of –3.388%, or a price decrease of roughly 3.4%.

3. C is correct. An increase in a bond's recovery rate will lower the loss severity, or LGD, because LGD = (1 – RR). Recall the simple one-period relationship between credit spreads, LGD, and the POD as Spread ≈ LGD × POD. A lower LGD will result in a lower spread.

4. C is correct. A bond's yield spread includes both credit and liquidity risk. Liquidity risk depends on both market conditions and the specific supply-and-demand dynamics of each fixed-income security.

5. A is correct. The G-spread is the difference between the corporate bond YTM and a linear interpolation of the 10-year and 20-year government bond YTMs. To calculate the approximate 12-year government rate, solve for the weights of the 10-year bond as 80% (= (20 – 12)/(20 – 10)) and the 20-year bond as 20% (or (1 – 80%), noting that (80% × 10) + (20% × 20) = 12). The 12-year government rate is 1.94% (or (80% × 1.85%) + (20% × 2.30%)), and the difference between the corporate bond YTM and the 12-year interpolated government rate is 0.860%.

6. B is correct. The I-spread is an estimate of the corporate bond's spread over an interpolated swap benchmark. We can solve for the 10-year and 20-year swap rates as 2.05% (=0.20% + 1.85%) and 2.55% (=0.25% + 2.30%), respectively, by adding the swap spread to the respective government bond. The 12-year swap rate is 2.15% (or (80% × 2.05%) + (20% × 2.55%)), and the difference between the corporate bond YTM and the 12-year interpolated government rate is 0.65%.

7. C is correct. The ASW is an estimate of the spread over MRR versus the bond's original coupon rate to maturity, which is equal to the difference between the corporate bond coupon of 3.00% and the 12-year swap rate of 2.15%, or 0.85%.

8. A is correct. The 20 bp increase in the 20-year government YTM causes the 12-year interpolated government YTM to rise 4 bps to 1.98% (or (80% × 1.85%) + (20% × 2.50%)). The corporate bond percentage price change can be estimated based on the YTM change multiplied by modified duration (–ModDur × ΔYield) familiar from earlier lessons. This percentage price change can be calculated as –0.4% (=–9.99 × 0.04%).

9. C is correct. The yield spread is the simple difference between a bond's all-in YTM and a current on-the-run government bond of similar maturity, while the G-spread is an interpolation of government benchmark yields. If the government bond yield curve is flat, these two measures will equal one another.

10. A is correct. Recall that ExcessSpread ≈ ($Spread_0$/Periods Per Year) – (EffSpreadDur × ΔSpread), so we combine the 6-month return with the spread duration–based price change estimate to get 3.775% (= (2.75% × 0.5) – (6 × –0.4%)).

11. B is correct. The instantaneous holding period return equals –EffSpreadDur × ΔSpread = –5 × 0.5% or –2.50%.

12. C is correct. Using Equation 10 (Spread0 – (EffSpreadDur × ΔSpread) – (POD × LGD)), the expected excess return on the bond is approximately 5.45% (=2.75% – (6 × –0.50%) – (0.75% × 40%)).

13. A is correct. The coverage ratio measures cash flow available to service debt, with a higher ratio indicating a lower probability of financial distress.

14. C is correct. Structural credit models use market-based variables to estimate an issuer's asset value and asset value volatility, defining the likelihood of default as the probability of the asset value falling below that of liabilities, with zero net assets defined as the default threshold.

15. B is correct. Recall that expected excess spread is defined as follows:

    E [ExcessSpread] ≈ $Spread_0$ – (EffSpreadDur × ΔSpread) – (POD × LGD)

    Because ΔSpread = 0, the expected excess spread is the simple difference between current OAS and expected loss, so E[ExcessSpread] is 0.90%, 1.00%, and 0.25% for the A-, BBB-, and B rated categories, respectively.

16. A is correct. E[ExcessSpread] from Question 15 is 0.90%, 1.00%, and 0.25% for the A-, BBB-, and B rated categories, respectively. The excess spread of the 50% A rated and 50% BBB rated portfolio is 0.95% (=(0.9% + 1.00%/2) versus the equally weighted portfolio expected excess return of 0.7167% (=(0.90% + 1.00% + 0.25%)/3) for a positive active return of 0.233%, while B and C return less than the equally weighted benchmark.

17. A is correct. If spreads rise 10% across all ratings categories, we can use E [ExcessSpread] ≈ $Spread_0$ –(EffSpreadDur × ΔSpread) – (POD × LGD) to solve for expected excess spread as follows:

Rating Category	Current OAS	New OAS	Expected Loss (POD × LGD)	EffSpreadDur	E(Excess Spread)
A	1.00%	1.100%	0.10%	7	0.200%
BBB	1.75%	1.925%	0.75%	6	–0.050%
BB	2.75%	3.025%	2.50%	5	–1.125%

18. C is correct. Both A and B represent "long" risk positions that would increase rather than offset the benchmark yield and credit spread risk to the portfolio manager related to the illiquid bond.

19. C is correct. Parametric methods in A are not well suited for non-normally distributed returns or option-based portfolios, while historical simulation assumes no probability distribution and accommodates options.

20. C is correct. The incremental VaR measures how the additional portfolio position would change the overall portfolio's VaR measure.

21. A is correct. The expected change in yield based on a 99% confidence interval for the bond and a 1.50 bps yield volatility over 21 trading days equals 16 bps = (1.50

bps × 2.33 standard deviations × $\sqrt{21}$). We can quantify the bond's market value change by multiplying the familiar (–ModDur × ΔYield) expression by bond price to get \$1,234,105 = (\$75 million × 1.040175 × (–9.887 × .0016)).

22. B is correct. For example, if the reference entity's credit spread trades at 1.50% versus a standard coupon rate of 1.00%, the CDS contract will be priced at a discount equal to the 0.50% difference multiplied by the effective CDS spread duration times the contract notional. Under A, the contract is priced at a premium to par because the protection buyer is receiving an "above market" periodic premium.

23. C is correct. Because the market premium is 0.75% above the 1.00% standard investment-grade CDS coupon, the protection buyer must pay the protection seller 6.5625% (= $\text{EffSpreadDur}_{\text{CDS}}$ × ΔSpread, or 8.75 × 0.75%) of the fixed notional amount upon contract initiation; the initial CDS price is therefore 93.4375 per 100 of notional with a CDS spread of 175 bps.

24. A is correct. The CDS spread decline of 0.15% leads to a new CDS contract price of 94.75 per 100 face value (=1 – ($\text{EffSpreadDur}_{\text{CDS}}$ × ΔSpread) or (8.75 × 0.60%)). The protection buyer (short risk) position therefore realizes an approximate mark-to-market loss of €131,250 (=(94.75 – 93.4375)/100 × €10,000,000) because of the 0.15% decline in CDS spreads.

25. B is correct. Selling protection on the CDX index is a "long" credit spread risk position, while purchasing protection on the CDX Financials subindex is a "short" credit spread risk position, leaving the investor with a long index position without exposure to financial reference entities in the CDX index. Both A and C increase exposure to financial sector issuers.

26. A is correct. The late expansion phase is typically associated with accelerating growth, peak profits, stable leverage, and a decline in defaults.

27. B is correct. Investors should exercise caution in interpreting credit spread curve shape for distressed debt issuers because their bonds tend to trade at a price close to the recovery rate. A is incorrect because the high-yield spread curve tends to invert during a contraction, while C is incorrect because a high-yield curve inversion is related to the relationship between near-term and long-term default as opposed to DTS.

28. C is correct. A credit curve roll-down strategy will generate positive return only under an upward-sloping credit spread curve. As for A, the benchmark yield changes must be separated from changes due to credit spreads, and under B, a synthetic credit roll-down strategy involves selling protection using a single-name CDS contract for a longer maturity.

29. C is correct. The investor benefits from a short risk (as protection buyer) on the 10-year CDX IG index and long risk (as protection seller) on the 5-year CDX IG index, duration matching the notional value by increasing 5-year notional 1.82 times (=8.9/4.9) versus the 10-year.

30. A is correct. Because an economic contraction is often associated with a sharp rise in shorter-term high-yield spreads and spread curve flattening in investment grade and inversion in high yield, the most appropriate choice is to take a short risk (purchase protection) in five-year high-yield spreads and a long position (sell protection) in five-year investment-grade spreads. Answers B and C position the investor to benefit from a steeper investment-grade and high-yield spread curve, respectively.

31. B is correct. Fixed exchange rate regimes in A usually result in greater instability and a higher probability of financial distress, while higher domestic currency YTMs in emerging economies in C are a sign of expected currency depreciation, not appreciation, over time.

32. A is correct. We solve for the excess spread by subtracting Expected Loss from the respective OAS:

Rating Category	OAS	EffSpreadDur	Expected Loss	E(Excess Spread)
USD IG	1.25%	4.5	0.40%	0.85%
USD HY	3.00%	5.5	2.25%	0.75%
EUR IG	1.15%	4.75	0.50%	0.65%
EUR HY	3.25%	6	2.50%	0.75%

Recall that the United States–based investor must convert the euro return to US dollars using $R_{DC} = (1 + R_{FC})\ (1 + R_{FX}) - 1$, so the USD IG and USD HY positions comprising half the portfolio return an average 0.80%, while the EUR IG and EUR HY positions return –1.314% in US dollar terms (= ((1 + ((0.65% + 0.75%)/2)) × 0.98) – 1), so –0.257% = ((0.80% – 1.314%)/2).

33. A is correct. Given that high-yield spreads are expected to fall the most in an economic recovery, the manager should choose the portfolio with the highest percentage of EUR HY credit exposure.

34. A is correct. Covered bonds perform relatively well in a downturn versus other fixed-income bonds with real estate exposure because the investor also has recourse to the issuer.

35. C is correct. Under a "flight to quality" scenario, macroeconomic factors driving government bond YTMs lower cause high-yield bond credit spreads to rise because of an increased likelihood of and expected higher severity of financial distress. This relationship is captured in the difference between empirical and analytical duration measures.

LEARNING MODULE

7

Trade Strategy and Execution

by Bernd Hanke, PhD, CFA, Robert Kissell, PhD, Connie Li, and Roberto Malamut.

Bernd Hanke, PhD, CFA, is at Global Systematic Investors LLP (United Kingdom). Robert Kissell, PhD, is at Molloy College and Kissell Research Group (USA). Connie Li (USA). Roberto Malamut (USA).

LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	discuss motivations to trade and how they relate to trading strategy
☐	discuss inputs to the selection of a trading strategy
☐	compare benchmarks for trade execution
☐	recommend and justify a trading strategy (given relevant facts)
☐	describe factors that typically determine the selection of a trading algorithm class
☐	contrast key characteristics of the following markets in relation to trade implementation: equity, fixed income, options and futures, OTC derivatives, and spot currency
☐	explain how trade costs are measured and determine the cost of a trade
☐	evaluate the execution of a trade
☐	evaluate a firm's trading procedures, including processes, disclosures, and record keeping with respect to good governance

INTRODUCTION

1

This reading discusses trading and execution from a portfolio manager's perspective. The reading covers a broad range of topics related to trade strategy selection and implementation and trade cost measurement and evaluation. Growth in electronic trading has led to increased automation in trading, including the use of algorithmic trading and machine learning to optimize trade strategy and execution. Various markets, including equities, fixed income, derivatives, and foreign exchange, are examined. Adequate trading processes and procedures are also discussed from a regulatory and governance perspective.

Portfolio managers need to work closely with traders to determine the most appropriate trading strategy given their motivation for trading, risk aversion, trade urgency, and other factors, such as order characteristics and market conditions. Trade execution should be well integrated with the portfolio management process, and although trading strategies will vary on the basis of market and security type, all trade activity should be evaluated for execution quality and to assess broker and trade venue performance consistent with the fund's objectives. Additionally, firms should have proper documentation of trade procedures in place to meet regulatory and governance standards.

This reading is organized as follows: Section 2 discusses portfolio manager motivations to trade. Sections 3–5 discuss inputs to trade strategy selection and the trade strategy selection process. Sections 6 and 7 cover the range of trade implementation choices and trading algorithms and provide a comparison of various markets. Sections 8 and 9 explain how trade costs are measured and how to evaluate trade execution. Section 10 provides guidance on evaluating a firm's trading procedures for good governance practices. The final section concludes and summarizes the reading.

2 MOTIVATIONS TO TRADE

☐ discuss motivations to trade and how they relate to trading strategy

Portfolio managers need to trade their portfolio holdings to ensure alignment with the fund's underlying investment strategy and objectives. The reasons for trading, or motivations to trade, and the extent of trading vary by investment strategy and circumstance. Even a passive buy-and-hold index portfolio requires some trading because of corporate actions, fund flows, or changes in the benchmark index. Portfolio managers for actively managed funds have additional reasons for trading based on their changing views for individual assets and market conditions. A portfolio manager's motivation to trade in addition to the fund's investment objectives play an important role in determining an overall trading approach.

Broadly speaking, a portfolio manager's motivation to trade falls into one of the following categories:

- Profit seeking
- Risk management/hedging needs
- Cash flow needs
- Corporate actions/index reconstitutions/margin calls

Profit Seeking

The primary added value that most active managers seek to provide is risk-adjusted outperformance relative to their benchmark. Superior returns originate from a manager having a unique insight that can be capitalized on ahead of the market. Trading in these cases is based on information portfolio managers have uncovered that they believe is not fully recognized by the market and, therefore, offers the potential to earn an excess return from the trade. Active managers will seek to transact in securities believed to be mispriced (under- or overvalued) at more favorable prices before the rest of the market recognizes the mispricing.

To prevent information leakage, or the disclosure of information about their trades, which might alert the market to the mispricing, active managers take steps to hide their trades from other market participants by executing in multiple or less transparent trade venues. *"Lit" markets* (a term referring to illumination), such as exchanges and other displayed venues, provide pre- and post-trade transparency regarding prices, volumes, market spreads, and depth. In contrast, alternative trading systems, such as dark pool trading venues, are available only to select clients and provide far less transparency, reporting only post-trade transactions and quantities. Because of these characteristics, orders in dark pool venues have a higher likelihood of going unfilled since clients receive executions only if an offsetting order arrives while their order is pending. For example, to prevent information about their trading activity from leaking to the market, a manager executing a large, directional trade may choose to execute the order in a less transparent venue.

As their investment views change with changing market and macroeconomic environments, portfolio managers will trade their holdings to align the portfolio with their views. Portfolio managers seeking longer-term profits may have relatively stable views from one period to the next whereas, in contrast, managers seeking shorter-term profits may have more rapidly changing views based on short-term movements in the market or individual securities that require higher turnover and trading.

To capitalize on investment views ahead of the market, trading the order faster, at an accelerated pace, may be needed. Portfolio managers may execute their orders at prices nearer to the market if they believe the information they have uncovered is likely to be realized by the rest of the market in the near term. **Trade urgency** refers to how quickly (aggressively) or slowly (patiently) the order is executed over the trading time horizon. Greater trade urgency is associated with executing over shorter execution horizons, whereas lower trade urgency is associated with executing over longer execution horizons.

A portfolio manager with a short-term event-driven strategy will trade with greater urgency if the expected alpha, or return payoff associated with the investment view over the trading horizon, is likely to be rapidly acted on by other market participants. In this case, the rate or level of expected alpha decay is high. In a trading context, **alpha decay** refers to the erosion or deterioration in short-term alpha once an investment decision is made. Portfolio managers following a longer-term strategy based on company fundamentals will trade more patiently, with less urgency, if the rate or level of expected alpha decay is lower.

Following are examples of short-term and long-term profit-motivated trading with differing levels of trade urgency.

Michigan Index of Consumer Sentiment (short-term profit seeking)

The University of Michigan Index of Consumer Sentiment (ICS) is one of the primary indicators of US consumer confidence. It is based on a nationwide survey of households. The ICS is closely watched by market participants, and changes in the index can prompt significant moves in the US equity market. Since 2007, Thomson Reuters, a financial data vendor, has held the exclusive right to disseminate the ICS. Until mid-2013, the firm had a two-tiered process for disseminating the ICS. A small number of trading clients received the ICS at 9:54:58, or two seconds earlier than the broader market release at 9:55:00. The two-tiered process was abolished in July 2013 after receiving negative public attention. Hu, Pan, and Wang (2017) examined how quickly the information contained in the ICS was incorporated into S&P 500 Index prices during the period of the two-tiered process.[1] They found that most of the

1 Hu, G., J. Pan and J. Wang, 2017. "Early peek advantage? Efficient price discovery with tiered information disclosure". *Journal of Financial Economics* 126(2), 399–421.

price adjustment happened within the first 200 milliseconds. This is an example of profit-driven trading with high associated trade urgency and an extremely short-term execution horizon.

Value manager (long-term profit seeking)

An investment manager following a value strategy might attempt to identify undervalued companies on the basis of such metrics as earnings yields and price-to-book ratios. The manager might favor companies that score well according to these metrics. To capitalize on their views, individual positions may be held for months or years by value managers. Minimal trading is required, and any necessary trading can often be carried out in a more patient manner. Trading in this case has no trade urgency, given the managers' much longer trade execution horizons.

As more news and market information become available on a close-to-real-time basis, combined with the increase in electronic trading, markets have become more competitive. Information is being incorporated into security prices at even faster rates. Surprises in companies' earnings announcements, interest rate changes by central banks, and other macroeconomic announcements are being incorporated into security prices on a nearly instantaneous basis. Portfolio managers trying to act on this information must trade quickly and ahead of others to capitalize on the perceived opportunity. If more immediate execution cannot be achieved at a reasonable trading cost and risk, the trade may not be worthwhile given high rates of alpha decay. Therefore, these trades may be possible only in more liquid markets, such as equities, exchange-traded derivatives, foreign exchange, and fixed-income Treasury. In less liquid markets, such as non-Treasury fixed income or over-the-counter (OTC) markets where more immediate executions cannot be achieved, trades may not be worthwhile. For active managers seeking to maximize net returns to the portfolio, the expected rate of alpha decay of the security being traded is an important trading consideration.

Risk Management/Hedging Needs

As the market and the risk environment change, portfolios need to be traded or rebalanced to remain at targeted risk levels or risk exposures. Risk horizons and risk forecasts used by portfolio managers vary by investment strategy type and by investment time horizon. Fixed-income portfolio managers, for example, may have investment objectives to adhere to target portfolio durations. For these managers, portfolio rebalancing is usually required to match a benchmark duration target over time. Trading may be required because of a changing interest rate environment, a change in the benchmark index, or the passage of time. Equity portfolio managers may wish to manage their portfolio's beta or remain market neutral by hedging market risk and targeting a beta of zero relative to the equity market. To do this, the manager could trade to adjust holdings in the underlying portfolio or trade futures or exchange-traded funds (ETFs) to adjust the fund's equity beta to zero. Similarly, hedge fund managers may wish to maintain exposure to higher market volatility without having a view on directional price movement.

In general, the risks being managed, or hedged, in addition to such factors as security liquidity considerations and the fund's investment mandate, determine whether derivatives can be used or whether trades in the underlying portfolio (cash) securities are necessary. For example, an equity portfolio's beta to a broad equity market may be managed to the portfolio's target beta by trading equity index futures (e.g., S&P 500 futures, FTSE 100 Index futures, or Nikkei 225 futures). Using futures for hedging is often a simpler, more cost-effective approach because many futures contracts are liquid and can be traded at minimal cost. In addition, the standardization of futures contracts makes them attractive to investors. They can also be traded on margin, requiring relatively small amounts of capital. Similarly, for fixed-income strategies in the United States, interest rate risk can often be (at least partially) hedged using futures on Treasury securities, such as T-bond futures. Using liquid derivatives for risk management can provide an inexpensive and straightforward means of hedging versus trading in the underlying cash securities. In addition, the ability to trade derivatives or underlying securities may depend on the fund's investment mandate. In some cases, the fund's investment mandate may not allow the use of derivatives, and the portfolio manager must instead trade ETFs or the underlying to achieve the desired exposures.

For quantitative funds, targeted volatility is usually explicitly stated in the fund's offering documents whereas for fundamental funds, it may be an implicit assumption within the investment process. Regardless of fund type, portfolio managers should understand target risk levels and when changes in the market environment might require trading to adjust portfolio risk back to targeted volatility.

Portfolio managers may also trade to hedge risks when they do not have a view on the specific risk in question. For example, a global fixed-income long/short manager without strong currency views may choose to minimize currency exposure through a currency hedging trade. A fixed-income manager who wants to trade expected changes in the shape of the yield curve may not have a view on the level of the yield curve. In this case, the manager's yield curve trade would incorporate a hedge for duration risk. A manager of a high-yield bond portfolio may need to manage portfolio sector risk as well as geographical risk. Although credit default swaps (CDSs) might be used to manage this type of risk, finding a counterparty for a more specialized CDS can be difficult and costly. Because few derivatives to manage these risks exist, the underlying cash securities are generally traded. Using more illiquid securities for these risk trades generally increases the difficulty and cost of implementation.

A portfolio manager using option strategies may want to hedge the portfolio against certain risk factors: for example, the buyer of a long straddle position (a long position in a call and a put option on the same underlying security, both with the same strike price) who is implementing a view on higher expected volatility, irrespective of whether higher volatility will lead to higher or lower security prices. This is inherently an investment view on volatility that requires hedging directional price movement in the security.

The amount and nature of trading required for risk management generally depend on the risk profile of the portfolio as well as the amount of leverage used in the fund. Although various types of funds permit the use of leverage, leverage is typically used more by hedge funds that hold both long and short positions. For highly levered funds, risk must be monitored closely because the portfolios can quickly accumulate large losses with sudden increases in market risk. This strong risk sensitivity makes trading for risk management crucial.

Cash Flow Needs

A considerable amount of trading for portfolios is neither return seeking nor for risk management purposes but instead is driven by cash flow needs. Cash flow needs may involve high or low trade urgency depending on their nature. For example, collateral/margin calls could require close-to-immediate liquidation, whereas a fund redemption due to longer-term client asset allocation changes might not require immediate liquidation.

This type of trading is often client driven, arising from fund inflows (orders, mandates) and outflows (redemptions, liquidations). Fund inflows and outflows require capital to be invested or positions to be liquidated. To minimize cash drag on a portfolio, or fund underperformance from holding uninvested cash in a rising market, fund inflows may be equitized using futures or ETFs until the next portfolio rebalance or positions in the underlying can be traded. Equitization in this case refers to a strategy of temporarily investing cash using futures or ETFs to gain the desired equity exposure before investing in the underlying securities longer term. Equitization may be required if large inflows into a portfolio are hindered by lack of liquidity in the underlying securities. For example, a large inflow into a small-capitalization equity portfolio often cannot be invested immediately in the underlying stocks owing to limited market liquidity. Instead, the manager may equitize the cash using equity futures or ETFs and then gradually trade into the underlying positions and trade out of the futures/ETF position. For client redemptions, fund holdings may need to be liquidated if redemptions are larger than expected and cannot be funded by portfolio cash or offsetting fund inflows. Currency trades in which one currency needs to be exchanged (traded) into another may be required if fund inflows or outflows are not in the desired currency for receipt or payment. Many funds offer daily liquidity, which means investors can invest or redeem on a daily basis, often without limitation. Cash positions for these funds must be carefully managed in order to satisfy all fund flows and, at the same time, minimize the fund's cash drag. Trading is often required to manage the fund's cash position appropriately.

Hedge funds often have lockup periods in which fund redemptions are made according to a regular schedule, such as calendar quarter-ends. The stated objective is to protect remaining investors from incurring transaction charges resulting from other investors' redemption activity. These types of fund liquidations generally must be requested in advance to allow fund managers time to trade out of potentially illiquid positions and thereby minimize trading costs.

In most cases, client redemptions are based on the fund's net asset value (NAV), where NAV is calculated using the closing price of the listing market for listed securities. Clients receive proceeds based on the fund's NAV calculation. In these cases, trading at the closing price eliminates the risk (to the fund and the trader) associated with executing at prices different from those used to calculate the fund's NAV and resulting redemption proceeds.

Trading to raise or invest cash proceeds may not require specific securities to be traded to meet cash flow needs. Instead, these trades may involve strategically choosing from those securities considered optimal to trade from a risk–return or cost perspective. Trade size and security liquidity considerations play a determining role, and understanding trade-offs between costs, liquidity, and other factors is key. For example, selling a liquid security that generates a substantial tax liability is preferred over selling an illiquid security that has a smaller associated tax liability with substantially higher trading costs that overwhelm any savings in tax liability. Similar considerations apply to risk–return and liquidity trade-offs.

Corporate Actions/Index Reconstitutions/Margin Calls

Trading may also be necessitated by such activity as corporate actions and operational needs (e.g., dividend/coupon reinvestment, distributions, margin calls, and expiration of derivative contracts). The companies held in a manager's portfolio might be undergoing corporate actions, such as mergers, acquisitions, or spinoffs, that require trading. Cash equity dividends or bond coupons may need to be reinvested. For funds that make regular distributions, the timing of distributions may not align with the timing of dividends or coupons received on the individual securities. Therefore, raising proceeds for fund distributions may require individual holdings to be sold to meet distribution needs.

Cash needs can also arise from margin calls on leveraged positions as portfolio managers are asked to increase cash collateral on trades that have moved against them. Margin or collateral calls may drive high levels of trade urgency, given a need for the immediate sale of portfolio holdings. For example, the use of derivatives within a portfolio often requires collateral posting, which can necessitate a move to more liquid government bonds or cash in order to meet or fund collateral requirements.

Long-only managers may manage funds using a market-weighted index as a benchmark (e.g., the S&P 500, the MSCI World Index). If the benchmark constituents change, it could affect the manager's desired portfolio composition. If the manager runs an active portfolio, in the case of a change in index constituents, the manager might choose to sell holdings in a security that has been removed from the benchmark index.

For index tracking portfolios, such index changes as additions, deletions, and constituent weight changes are generally traded in the manager's portfolio to reflect benchmark exposure. Since the fund's NAV is calculated using the official market close for each security, trading index changes at the closing price ensures that the same price is used for fund and benchmark valuation (which also uses the closing price in its calculation) and thus minimizes the fund's tracking error to the benchmark index.

IN-TEXT QUESTION

The trading desk of a large firm receives three orders from the senior portfolio manager. Based on his research, the portfolio manager has identified two investment opportunities: a short-term stock buy and a longer-term stock sell. The third order is to raise proceeds to accommodate an end-of-day client withdrawal from the fund.

Discuss the motivation to trade and the associated trade urgency for each order:

a. Short-term buy

b. Longer-term sell

c. Client withdrawal

Solution:

a. This is a profit-seeking trade because the portfolio manager has identified the short-term buy as an investment opportunity. Short-term profit-seeking trades typically involve higher levels of trade urgency as managers attempt to realize short-term alpha before it dissipates (decays). These managers seek to transact before the rest of the market recognizes the mispricing and as a result are less price sensitive and more aggressive (seek to transact at accelerated rates) in their trading.

b. This is a profit-seeking trade because the portfolio manager has identified the longer-term sell as an investment opportunity. Managers seeking long-term profits are typically more patient in trading and willing to wait for favorable prices by spreading executions over a longer time horizon, which may be days or weeks. Managers trading for long-term profits generally have much lower trade urgency for these orders.

c. This is a cash flow–driven trade arising from the need to raise proceeds for the client withdrawal. For funds that offer daily liquidity, clients can invest and redeem at the end of each trading day. In this case, managers raising proceeds for client withdrawals will generally target end-of-day closing prices to match trade prices to those used to calculate the fund's valuation and redemption proceeds to the client. Hedge funds that hold less liquid positions may allow redemptions only at quarter-end and with a relatively long notice period (e.g., one month), allowing them more time to sell illiquid positions. Client-driven redemptions usually involve much lower levels of trade urgency.

3 TRADING STRATEGIES AND STRATEGY SELECTION

- [ ] discuss inputs to the selection of a trading strategy

Once a portfolio manager has made an investment decision, the portfolio manager and the trader must work together to identify the most appropriate trading strategy to meet the portfolio manager's trade objective given cost, risk, and other considerations. Selecting the appropriate trading strategy involves a number of important trade input considerations to ensure the strategy is transacted in the most efficient manner possible.

Trade Strategy Inputs

In addition to a portfolio manager's motivation to trade, other factors play a role in the selection of a trading strategy by affecting trade urgency, expected costs, and risks for the desired trade. Portfolio managers can manage the trading costs and execution risks they incur through their selection of an appropriate trading strategy.

Key inputs for trade strategy selection include

- order characteristics,
- security characteristics,
- market conditions, and
- individual risk aversion.

Order Characteristics

Order-related considerations include the following:

- **Side:** the side or trade direction of the order—for example, buy, sell, cover, or short
- **Size:** the total amount or quantity of the security being transacted
- **Relative size (% of ADV):** order size as a percentage of the security's average daily volume (ADV)

The side of the order, such as buy or sell, may be important when there is expected price momentum associated with trading the security or when trading a basket of securities where managing the risk of the entire trade list is required. If prices are rising, executing a buy order may take longer than executing a sell order, given the presence of more buyers (liquidity demanders) than sellers (liquidity suppliers) in the market. Trading a list that consists of only buys or only sells will have greater market risk exposure than a list of buys and sells in which the securities have offsetting market risk exposures.

Order size is the amount or quantity of the security being traded. Larger order sizes create greater market impact in trading. Market impact is the adverse price movement in a security caused by trading an order and is one of the most significant costs in trading. Larger orders usually take longer to trade than smaller orders do, and portfolio managers will often trade larger orders in a more patient manner (lower trade urgency) to reduce market impact. All else equal, trading larger order sizes more quickly will increase market impact cost whereas trading smaller order sizes more slowly will decrease market impact cost.

To have a consistent order size measure across securities, portfolio managers often divide the order size by the security's ADV. For example, a 1 million share order in Stock ABC may be much different than a 1 million share order in Stock XYZ. If Stock ABC has an average daily volume of 50 million shares, the 1 million share order represents 2% (1 million/50 million) of ADV. If Stock XYZ has an average daily volume of 4 million shares, its order represents 25% (1 million/4 million) of ADV. The larger the size of the trade expressed as a percentage of ADV, the larger the expected market impact cost.

Security Characteristics

Security-related considerations include the following:

- **Security type:** the type of security being traded (underlying, ETF, American depositary receipt, global depositary receipt)
- **Short-term alpha:** the expected price movement in the security over the trading horizon
- **Price volatility:** the annualized price volatility of the security
- **Security liquidity:** the liquidity profile of the security (e.g., ADV, bid–ask spread, average trade size)

The security type distinguishes the instrument being traded and can include underlying securities, ETFs, American depositary receipts (ADRs), global depositary receipts (GDRs), derivative contracts, and foreign exchange currencies. Identifying the best means of exposure—for example, whether to trade a foreign security in its local market or trade its associated ADR (if US listed) or GDR (if non-US listed)—requires an evaluation of the trade-offs. Trading costs and liquidity will vary by local exchange. Gaining emerging market exposure, in particular, may be less expensive and operationally easier when trading available ADRs and GDRs than when trading the security in the local market. In addition, compliance, regulatory, and custody costs can be lower with ADRs and GDRs.

Short-term alpha in a trading context is the expected movement in security price over the trading horizon (independent of the trade's impact). Short-term alpha (also called *trading alpha* or *trade alpha*) may arise from an appreciation, a depreciation, or a reversion (i.e., reversal) in security price.

Alpha decay is the erosion in short-term alpha that takes place after the investment decision has been made. Alpha decay results from price movement in the direction of the investment forecast and occurs regardless of whether the trade takes place. Alpha decay is a function of the time required for a relevant piece of information (used by a portfolio manager to form her investment view) to be incorporated into a security's price. If this information is rapidly incorporated into the security's price, then its alpha is considered to decay quickly. High rates of alpha decay, or alpha loss, require faster, or more accelerated, trading to realize alpha before it is traded on by other market participants.

Depending on the expected rate of alpha decay, portfolio managers may be better off trading the order faster (higher trade urgency) or slower (lower trade urgency). In an adversely trending market—for example, buying in a rising market or selling in a falling market—portfolio managers may trade at an accelerated rate if less favorable prices are expected later in the trading horizon. In a favorably trending market—for example, buying in a falling market or selling in a rising market—portfolio managers are better off trading more slowly to execute at more favorable prices expected later in the trading horizon. Adverse price movements increase trading costs, whereas favorable price movements decrease trading costs.

The price volatility of a security primarily affects the execution risk of the trade. *Execution risk* is the risk of an adverse price movement occurring over the trading horizon owing to a change in the fundamental value of the security or because of trading-induced volatility. Execution risk is often proxied by price volatility. Securities with higher levels of price volatility have greater exposure to execution risk than securities with lower price volatility.

A security's liquidity profile affects how quickly the trade can be executed, in addition to expected trading cost, and is a significant consideration in determining trade strategy. All else being equal, greater liquidity reduces execution risk and trading costs, such as market impact. Bid–ask spreads indicate round-trip trading costs for trades of a given maximum size (as they are associated with a maximum quantity). As a result, bid–ask spreads indicate both trading costs and the amount of a security that can be traded at a given point in time (market depth), which affects how larger trades might need to be broken down into smaller orders for trading. Average trade sizes observed in past data provide additional information on quantities that can be traded at reasonable trading costs for a given security.

Market Conditions

Inputs relating to market conditions include the following:

- **Liquidity crises:** deviations from expected liquidity patterns due to periods of crisis

Market liquidity refers to the liquidity conditions in the market at the time the order is traded. At the time of trading, current or realized market conditions, such as traded volumes, price volatility, and bid–ask spreads, are additional factors that affect trade strategy selection, given that real-time market conditions are likely to be different from those anticipated and the conditions at the time the investment decision was made.

During market events or crises, the volatility and liquidity of the market and the security will be critical to consider as conditions result in sudden and significant deviations from normal trade patterns. Such seasonal considerations as local market holidays and quarter-end or year-end dates may have more predictability in their liquidity variations and are also important to consider.

Security liquidity will also change over time, often because of changes in market-wide liquidity. For example, in August 2007, stocks with high exposure to widely used quantitative factors became very hard to liquidate as many quantitative asset managers tried to reduce their exposures to certain factors around the same time. In the fall of 2008, during the credit crisis, short selling in certain stocks, mostly financials, was banned. During this time, many structured credit securities became "toxic assets" and became extremely difficult to liquidate.

Even during "normal" market environments, liquidity will vary. For example, over time certain companies reach market values that may result in them being added to or removed from widely used equity indexes. When this happens, their stocks' liquidity often improves or deteriorates as their shares become more widely or more narrowly held. Government bonds are generally liquid as long as they are the most recently issued (so-called on the run) among a particular bond type. However, once they become off-the-run bonds, their liquidity generally decreases.

Moreover, market volatility and liquidity are dynamic. They are also generally negatively related, which becomes apparent especially during periods of crisis, when volatility increases and liquidity decreases. For example, during the 1987 stock market crash, the Long-Term Capital Management crisis in 1998, and the global financial crisis in 2008, market volatility increased sharply and market liquidity collapsed. Portfolio managers can be hurt in such environments: Lower liquidity might suggest a longer trading horizon for order completion, but higher volatility might lead people to speed up their trades and incur higher costs. However, as trading horizon lengthens, market risk increases, particularly during periods of high volatility.

O'Hara and Zhou (2020) analyze liquidity provision during the COVID-19 corporate bond liquidity crisis. During the two weeks leading to Fed interventions, transaction costs increased strongly, dealers shifted from buying to selling, causing dealers' inventories to plummet. Liquidity provisions in electronic customer-to-customer trading increased, though at prohibitively high cost.

User-Based Considerations: Trading Cost Risk Aversion

In addition to order, security, and market considerations, the risk aversion of the individual(s) trading affects trade strategy selection.

Risk aversion is specific to each individual, and in a trading context, it refers to how much risk the portfolio manager or trader is willing to accept during trading. A portfolio manager or trader with a high level of risk aversion is likely to be more concerned about market risk and will tend to trade with greater trade urgency to avoid the greater market exposure associated with trading more patiently. A portfolio manager with a low level of risk aversion might be less concerned about market risk and may tend to trade more patiently (more passively), with lower levels of trade urgency.

Market Impact and Execution Risk

The temporary market impact cost of trading an order is the often short-lived impact on security price from trading to meet the need to buy or sell. For example, in situations where a portfolio manager is looking to buy shares but there are not enough sellers in the market to complete the order, the portfolio manager will need to increase his buying price to attract sellers to complete the order. In situations where a portfolio manager is looking to sell shares but there are not enough buyers in the market to complete the order, the portfolio manager will need to decrease his selling price to attract buyers to complete the order. In these situations, there is usually price reversion after the trade has been completed since the price change was driven by short-term buying or selling pressure rather than a fundamental change in security value. Therefore, post-trade prices should revert, with prices decreasing after buy order completion and increasing after sell order completion.

The permanent component of price change associated with trading an order is the market price impact caused by the information content of the trade. Trading in the market often conveys information to other market participants that the asset may be under- or overvalued. If market participants discover there are more buyers demanding liquidity than sellers supplying liquidity, the market interprets this situation as the pricing being relatively too low and prices will move in the direction of the trade imbalance on average. In this case, market participants will increase their selling price.

If market participants find out that there are more sellers than buyers, the market interprets this situation as the pricing being relatively too high and market participants will decrease their buying price. In other words, market participants may believe there is some information component of the trade that is causing the counterparty to buy or sell shares in the market that they have not yet discovered or incorporated into their own asset valuations. Therefore, market participants will adjust the price at which they are willing to buy or sell to reflect this potential new information.

To minimize information leakage, which may result in market participants adjusting the prices at which they are willing to buy or sell, portfolio managers may attempt to hide their trading activity by executing orders across different venues and using a mix of order types, such as market and limit orders. Market (marketable) orders instruct execution at the best available price at the time of trading, whereas limit orders instruct execution at the best available price as long as the price is equal to or better than the specified limit price—that is, a price equal to or lower than the limit price in the case of buys and equal to or higher in the case of sells. To hide their activity, portfolio managers will also trade less on displayed venues (e.g., exchanges with greater trade transparency regarding the intentions of market participants) and make greater use of dark pool venues.

Execution risk—the risk of adverse price movement during the trading horizon due to a change in the fundamental value of the security—arises as time passes and occurs even if the order is not traded. Trading faster (greater trade urgency) results in lower execution risk because the order is executed over a shorter period of time, which decreases the time the trade is exposed to price volatility and changing market conditions. Trading slower (lower trade urgency) results in higher execution risk because the order is executed over a longer period of time, which increases the time the trade is exposed to price volatility and changing market conditions.

Trader's dilemma.

To alleviate the market impact effect of entering a large order into the market, traders will "slice" the order into smaller pieces to trade over time. This results in a lower market price impact on the value of the asset, but in trading in smaller pieces over time, the fund is exposed to market risk, which could result in an even higher trading cost than if the order was entered into the market in its entirety. This phenomenon is known as the trader's dilemma and is stated as follows:

Trading too fast results in too much market impact, but trading too slow results in too much market risk.

The goal in selecting a trading strategy is to choose the best price–time trade-off given current market conditions and the unique characteristics of the order.

IN-TEXT QUESTION

Discuss how order size and security liquidity considerations affect market impact and execution risk for an order.

Solution:

Trading a large order creates greater market impact than trading a smaller order, all else being equal. To minimize market impact, large orders are often traded over longer trade time horizons, which increases the corresponding execution risk of the order. Smaller orders have less market impact and can be traded more quickly over shorter time horizons, with lower associated execution risk. The liquidity profile of a security has important implications for trading strategy. More liquid securities (higher traded volumes, tighter bid–ask spreads, etc.) have lower levels of market impact and execution risk given that they can be transacted over shorter time horizons with greater certainty of execution. Finally, higher rates of alpha decay would speed up order execution time horizons and increase market impact costs given greater trade order urgency, whereas lower rates of alpha decay would increase trade time horizons and associated execution risk.

REFERENCE PRICES

4

☐ compare benchmarks for trade execution

Reference prices, also referred to as *price benchmarks*, are specified prices, price-based calculations, or price targets used to select and execute a trade strategy. Reference prices are used in determining trade prices for execution strategy and in calculating actual trade costs for post-trade evaluation purposes. Following is a discussion of reference prices used in the selection and execution of a trade strategy.

Reference prices are categorized as follows:

- pre-trade benchmarks, where the reference price for the benchmark is known before trading begins;
- intraday benchmarks, where the reference price for the benchmark is computed on the basis of market prices that occur during the trading period;
- post-trade benchmarks, where the reference price for the benchmark is established after trading is completed; and
- price target benchmarks, where the reference price for the benchmark is specified as a price to meet or beat (transact more favorably).

Pre-Trade Benchmarks

A pre-trade benchmark is a reference price that is known before the start of trading. For example, pre-trade benchmarks include decision price, previous close, opening price, and arrival price. A pre-trade benchmark is often specified by portfolio managers who are buying or selling securities on the basis of decision prices (the price at the time the investment decision was made) or seeking short-term alpha by buying undervalued or selling overvalued securities in the market. Portfolio managers making trading decisions based on quantitative models or portfolio optimizers that use historical trading prices, such as the previous close, as model inputs may also specify a pre-trade benchmark.

Decision price

The **decision price** benchmark represents the security price at the time the portfolio manager made the decision to buy or sell the security. In many situations, portfolio managers have exact records of the price when they decided to buy or sell the security. Quantitative portfolio managers will often have records of their decision price because these prices may be inputs into their quantitative models.

There are times, however, when portfolio managers do not have a record of their decision price. In these situations, portfolio managers may decide to buy or sell securities on the basis of long-term growth prospects or higher-than-expected return potential and will specify the previous close or opening price as their reference price benchmark.

Previous close

The previous close benchmark refers to the security's closing price on the previous trading day. A previous close benchmark is often specified by quantitative portfolio managers who incorporate the previous close in a quantitative model, portfolio optimizer, or screening model. The previous close is often used as a proxy for the decision price by quantitative portfolio managers.

Opening price

An opening price benchmark references the security's opening price for the day. This benchmark price is most often specified by portfolio managers who begin trading at the market open and wish to minimize trading costs. The opening price is often used as a proxy for the decision price by fundamental portfolio managers who are investing in a security for long-term alpha or growth potential. Portfolio managers may choose an opening price instead of the decision price or previous close because, unlike a reference price from the prior day or earlier, the opening price does not have associated overnight risk, or the risk that prices will adjust at market open to incorporate information released after the close of the previous business day.

If the trade is to be executed in the opening auction, then using the opening price as a reference benchmark is not appropriate because the trade itself can influence the reference benchmark. An auction in this case is a market where buyers compete for order execution and orders are aggregated for execution at a single price and point in time. An auction taking place at market open is referred to as an opening auction, and one taking place at market close is a closing auction. The impact of trading any amount of the order in the opening (or closing) auction would be incorporated in the opening (or closing) price auction calculation, thus inappropriately influencing the reference benchmark level.

Arrival price

The **arrival price** is the price of the security at the time the order is entered into the market for execution. Portfolio managers who are buying or selling on the basis of alpha expectations or a current market mispricing will often specify an arrival price benchmark. In these cases, the portfolio manager's goal is to transact at or close to current market prices in order to complete trade execution and realize as much potential alpha as possible. Portfolio managers looking to minimize trading cost will also in many cases specify the arrival price as their benchmark.

Intraday Benchmarks

An intraday price benchmark is based on a price that occurs during the trading period. The most common intraday benchmarks used in trading are volume-weighted average price (VWAP) and time-weighted average price (TWAP).

Portfolio managers often specify an intraday benchmark for funds that are trading passively over the day, seeking liquidity, and for funds that may be rebalancing, executing a buy/sell trade list, and minimizing risk. Portfolio managers who do not expect the security to exhibit any short-term price momentum commonly select an intraday benchmark.

VWAP

The VWAP benchmark price is the volume-weighted average price of all trades executed over the day or the trading horizon. Portfolio managers may specify the VWAP benchmark when they wish to participate with volume patterns over the day.

Portfolio managers who are rebalancing their portfolios over the day and have both buy and sell orders may select the VWAP as a price benchmark. In these situations, the preference is to participate with market volume. Exposure to market risk is reduced in this case by having a two-sided trade list of buys and sells, as opposed to a trade list containing all buys or all sells. Portfolio managers who are rebalancing and using cash from sell orders to purchase buy orders will also often select an intraday benchmark, such as VWAP. Doing so allows the portfolio managers to structure their executions over time to ensure cash received from sell orders is sufficient to fund remaining buy orders. If trades are not executed properly, portfolio managers could be short cash for buy orders and need to raise additional money for order completion.

TWAP

The TWAP benchmark price is defined as an equal-weighted average price of all trades executed over the day or trading horizon. Unlike VWAP, TWAP price does not consider volume traded and is simply the average price of trades executed over the specified time horizon. Portfolio managers may choose TWAP when they wish to exclude potential trade outliers. Trade outliers may be caused by trading a large buy order at the day's low or a large sell order at the day's high. If market participants are not able to fully participate in these trades, then TWAP may be a more appropriate choice. The TWAP benchmark is used by portfolio managers and traders to evaluate fair and reasonable trading prices in market environments with high volume uncertainty and for securities that are subject to spikes in trading volume throughout the day.

Post-Trade Benchmarks

A post-trade benchmark is a reference price that is determined at the end of trading or sometime after trading has completed. The most common post-trade benchmark is closing price. Portfolio managers for funds valued at the closing price on the day or who wish to minimize tracking error to an underlying benchmark price, such as index funds, often select a post-trade reference price, such as the official closing price. In this case, the objective is to target consistency between the trade execution price and the price used in fund valuation and benchmark calculation.

Closing price

The closing price is typically used by index managers and mutual funds that wish to execute transactions at the closing price for the day. For managers with index mandates, where the fund's securities are typically valued using the official market close for each security, it is important to know how close their executions are to the benchmark price, which also uses the official market close in its calculation. A portfolio manager who is managing tracking error to a benchmark will generally select a closing price benchmark since the closing price is the price used to compute the fund's valuation and resulting tracking error to the benchmark.

An advantage of the closing price benchmark is that it provides portfolio managers with the price used for fund valuation and thus minimizes potential tracking error. A disadvantage is that the benchmark price is not known until after trading is completed. Thus, portfolio managers have no way of knowing whether they are performing more or less favorably relative to the benchmark until after trading is completed.

Price Target Benchmarks

Portfolio managers seeking short-term alpha may select an alternative benchmark known as a price target benchmark. In this case, a portfolio manager would like to transact in a security—believed to be undervalued or overvalued—at a more favorable price. For example, if a stock currently trading in the market at $20.00 is believed to be undervalued by $0.50, the portfolio manager will seek to purchase shares by specifying a price target of $20.50 or better (better being lower than $20.50 in the case of a buy). In this example, the benchmark price is specified as the perceived fair value price of $20.50. In this setting, the portfolio manager wishes to purchase as many order shares as possible at a price equal to or better (lower) than the specified price target.

5 TRADING STATEGIES

☐ recommend and justify a trading strategy (given relevant facts)

The primary goal of any trading strategy is to balance the expected costs and risks associated with trading the order in the market consistent with the portfolio manager's trading objectives, risk aversion, and other known constraints. A portfolio manager's motivation to trade, risk aversion, trade urgency for the order, and other factors, such as order size and market conditions at the time of trading, are thus key in determining an appropriate trade strategy.

Will the value in completing the trade dissipate if the trade is not completed in a timely enough manner? Trade urgency, the importance of execution certainty, is critical in determining trade strategy. For alpha-driven trades, trading with greater urgency to maximize short-term alpha capture must be weighed against the costs of trading faster and expected alpha decay. For trades with low or no trade urgency, trading over a longer trade horizon or at the market close may be optimal.

Portfolio managers also have expectations or insights regarding short-term market conditions, such as price trends and market liquidity, particularly if these factors are used in the security selection process. For example, does the stock exhibit momentum, where any observed trend will continue through the end of the day, or does the stock exhibit reversion, where the observed trend is more likely to reverse during the day? Portfolio managers may also have insights into expected trading volumes for assets and whether trading volumes may be expected to continue or may reverse in direction. Traders will also have insights regarding volume patterns and potential information leakage during execution. These expectations combined with actual market conditions at the time of trading help inform an appropriate trade strategy.

The selection of a trade strategy is best illustrated through a discussion of common trade types. Trading strategies for the following types of trades involving equities, fixed income, currency, and derivatives are explained in this section:

- **Short-term alpha:** short-term alpha-driven equity trade (high trade urgency)
- **Long-term alpha:** long-term alpha-driven fixed-income trade (low trade urgency)
- **Risk rebalance:** buy/sell basket trade to rebalance a fund's risk exposure
- **Cash flow driven:** client redemption trade to raise proceeds
- **Cash flow driven:** cash equitization (derivatives) trade to invest a new client mandate

Short-Term Alpha Trade

A portfolio manager has determined that the market has overreacted to weak earnings announced in the pre-market trading session for Stock XYZ. The stock price is trading at a significant discount in the pre-market relative to the portfolio manager's valuation and now represents a significant buying opportunity based on the portfolio manager's analysis. The portfolio manager would like to buy 50,000 shares, which represents 10% of the stock's average daily volume. Based on the heavy pre-market trading, however, the trader believes that this order will only constitute 2% of the day's volume.

The pre-market price is currently $50, down $15 relative to the previous night's close. The portfolio manager believes that the stock's fair value is in the low $60 range and sets her limit price at $60.

In this situation, the portfolio manager believes that the market has overreacted to the weak earnings announced by the company. If she is correct and the market eventually adopts her view going forward, Stock XYZ's price should increase closer to her estimated fair value in the low $60 range. In setting her limit price of $60, the portfolio manager is also specifying the reference price for the trade, which, in this case, represents a price target benchmark.

Given the possibility of short-term price increases in XYZ, this order has associated trade urgency and the trader does not have the benefit of trading the order passively (such as using a VWAP or TWAP participation strategy) during the day, since XYZ's price could increase to fair value at any time. To trade this order, the trader would not likely attempt to use dark pool venues, given their greater risk of unfilled executions if offsetting orders do not arrive. The trader will likely want to trade a portion of the order in the opening auction and then continue trading any residual in the open market. Doing so provides greater execution certainty, which is important in this situation given the trade urgency of the order.

Since the order represents approximately 2% of expected volume, the trader would not likely place the full order into the opening auction. Research shows the US opening auction typically makes up between 1-1.25% of a day's volume, so sending the entire order into the opening auction would result in the ordering being roughly 160%–200% of the expected opening auction volume, on average. Because this is an unusual trading day, the trader could use volume information from pre-market trading and any auction-related data made available by the exchanges to determine the optimal amount to place into the opening auction.

Given the trade urgency of the order, the very liquid market for XYZ, and the order size not being large relative to XYZ's expected volume, the trader could trade any remaining shares using an arrival price trade strategy that would attempt to execute the remaining shares close to market prices at the time the order was received. This strategy could be executed using a programmed strategy to electronically execute, also known as an algorithm, such as an arrival price algorithm. Most importantly, the trader will want to make sure that the orders sent to the auction and traded in the open market use limit prices consistent with the portfolio manager's price view, reflected in her limit price of $60.

Long-Term Alpha Trade

A portfolio manager believes that a company whose bonds he holds is likely to experience a deteriorating credit position over the next year. The deterioration in credit is expected to be gradual as information becomes available over the next several quarters, confirming the company's deteriorating financial position. The portfolio manager's position is not large in aggregate, but the market for these bonds is not very active, with infrequent transactions and low volumes. The portfolio manager approaches the trader to determine how best to liquidate his holdings in the bond so that he can exploit his view while still getting a favorable execution.

Because the market for these bonds is not very liquid, it is likely the trader will need to approach various dealers to get quotes for these bonds. Given the portfolio manager's view that the deterioration in credit will occur gradually over the coming year, there is no order urgency from a trading perspective. Because the position is not large, the trader believes he could execute it over the next day or two if needed.

The trader, however, may not want to execute this quickly for two reasons. First, the sudden trading in an illiquid security may inadvertently leak information, leading the dealer involved to think the order is an information-based trade and consequently to price the trade less favorably for the trader. Second, requiring dealers to take on substantial illiquid inventory exposes them to risk, for which they will demand compensation in the form of inferior (unfavorable) pricing.

Therefore, a reasonable trade approach would be to sell these bonds off gradually over the course of a few days or even weeks, depending on the relative size of the bond holdings and their liquidity. By selling off smaller portions, varying the amounts sold, and trading over a longer execution horizon, the trader can reduce information leakage regarding the order and avoid placing pressure on dealer inventories, which would result in inferior pricing. Using this approach, the dealers will likely provide better (more favorable) initial quotes, and subsequent quotes may also be more favorable if the dealers have enough time between trades to reduce their inventory.

The use of reference prices for fixed-income trades executed over multiple days is not widespread and can be difficult in practice. A decision price, for example, would not only capture market impact and alpha loss but would also reflect unrelated market moves, which can be much larger than the former when a trade is spread out over days or weeks. Impact costs, for example, would decrease as the trade horizon lengthens, whereas price volatility impact would increase with time.

Risk Rebalance Trade

A macro fund manager is concerned that potential trade tariffs and a deteriorating financial situation in a number of key emerging markets may lead to a significant increase in currency volatility. The manager is holding long and short developed market currency positions and has, so far, not seen a significant impact on his fund's valuation because the fund's long and short positions have been constructed to offset one another, immunizing the fund from sudden price moves. The fund's mandate, however, specifies a target risk level of 10%. With the increase in volatility, the fund's risk level is currently closer to 14%. Although the increase has not caused the portfolio to breach any guidelines, the portfolio manager believes that volatility will remain at current levels for the next several months and wishes to reduce risk in a controlled and gradual manner by liquidating positions to bring the fund's volatility back to its target risk level. The portfolio manager approaches a trader to discuss an appropriate strategy.

In this situation, the macro fund manager is holding long and short positions and has no view as to whether the fund's value will rise or fall in the near term owing to the sudden increase in volatility. Consequently, the hedge fund manager simply wishes to reduce current positions (as opposed to rebalancing the fund's relative positions). The holdings in developed market currencies are actively traded, and it is unlikely the positions are large enough that they would dislocate (substantially move) the currency markets, as long as trading is done in an appropriate manner.

Although volatility has significantly increased, the risk exposure of the trade is more limited if the list of buys and sells is balanced in market risk exposure, such as a buy/sell trade list with a net beta of approximately zero (i.e., the trade-weighted average beta of the securities traded is zero). Therefore, the trader does not have the same trade urgency as a trade with a positive or negative net beta, such as one containing all buys or all sells, which might involve significantly more risk arising from exposure to potential market movement. Risk-averse market participants will typically have greater trade urgency for trades that have directional market exposure than for trades that are balanced, or hedged, in market exposure.

Since the portfolio is not in breach of its guidelines and the portfolio manager wishes to reduce risk on a controlled and gradual basis, the trader can trade this order in a passive manner to lower the fund's risk level. In this situation, using a TWAP reference price for the trade and a TWAP algorithm to execute over the next day or two (or longer, depending on the size of the position) would be an appropriate trading strategy. By trading all the orders over the same trading horizon using a TWAP strategy, the trader is maintaining the hedge that exists between the buys and sells, which helps reduce execution risk. And because currency markets in developed economies are very liquid and deep, trading algorithmically will not likely dislocate prices.

Client Redemption Trade

A client has decided to redeem its position in a small-cap/mid-cap value fund managed by ABC Investment Advisers. The fund holdings are US small- and mid-cap stocks, with the only constraints being that the stocks satisfy the criteria of the fund (e.g., stocks meet the definition of a small- or mid-cap stock, stocks are listed on a major exchange). Client redemptions from the fund are done at the fund's net asset value at the close of trading, where the NAV is calculated using the closing price of the stock's listing market. To raise the necessary cash to meet the client redemption request, the portfolio manager asks the trader to sell 0.1% of every position held in the fund.

In this scenario, the client will receive the NAV of the fund *regardless of how well or poorly the trader executes the trade*. Therefore, the trader bears risk (for executing at any price other than the closing price) unless she can guarantee that each position is executed at the closing price. A closing price reference price is, therefore, most appropriate for this trade. On various exchanges such as NASDAQ, the NYSE, the Tokyo Stock Exchange, Deutsche Börse (Xetra) and the Hong Kong Stock Exchange (HKEX), the trader can send the order to the closing auction for these exchanges and receive the auction-guaranteed closing price on all orders submitted to the auction. Such a strategy eliminates all potential risk of executing at prices that are different from those used to calculate the fund's NAV.

However, the trader should make sure that the size of the orders does not have an undue impact on the closing price. Executing a relatively large sell order in the closing auction (e.g., 50% of the closing volume) may lead to a significant price decline at the close, lowering calculated NAV and resulting in less cash being returned to the client.

Following a strategy to receive a guaranteed closing price on all orders submitted eliminates risk to the fund (and trader) since the client is receiving proceeds at NAV. From a fiduciary standpoint, however, trading in a manner that will lead to a poorer (less favorable) execution for a client is inappropriate. An alternative approach that portfolio managers follow when their trades are large relative to expected liquidity in the closing auction is to execute in the market and in the closing auction. For example, they would identify a reasonable amount to send to the closing auction (e.g., 90% of the order to be sent to the closing auction), trade the order remainder in the market prior to the close of trading (e.g., 10% of the order to be traded VWAP in the market up to the close of trading),[2] and then send the identified amount (90% of the order) to the closing auction.

New Mandate Trade

An investment manager has just been awarded a €100 million mandate to track the MDAX Index benchmark with a 3% tracking error. The MDAX Index is a market capitalization weighted index comprised of 50 medium-sized companies in Germany that rank directly below the DAX index (the index comprising the largest 40 companies in Germany) by market capitalization and trading volume. The investment manager and the client have agreed that performance measurement of the mandate will begin at the current day's close. The appropriate reference price for the trade is, therefore, also the closing price. Given the large size of the investment mandate, the trader is

2 Some brokers provide special "close algorithms" that will size the closing auction trade appropriately, route the order into the closing auction, and trade any residual in the open market, effectively automating the strategy discussed in this example.

concerned that trading into the positions at the close of trading will cause significant price impact. The trader would instead prefer to trade into the positions over multiple days. The client, however, requests that the mandate be fully invested as quickly as possible. The portfolio manager for the fund also prefers not to have the fund holding cash, given that the performance evaluation for the mandate begins as of the close of trading. Holding a cash position in the fund exposes the portfolio manager to significant performance risk relative to the fund's MDAX benchmark. For example, if the MDAX increases while the fund is holding cash, the fund's uninvested cash amounts would result in underperformance (arising from cash drag) relative to the MDAX.

The trader can get more immediate exposure to the MDAX by buying €100 million worth of MDAX futures traded on Eurex, a major European derivatives exchange. After establishing this initial exposure, the trader can begin building the underlying stock positions over time and unwinding (selling) the equivalent futures exposure. This approach allows the client mandate to achieve full €100 million exposure to the MDAX, eliminating the opportunity cost of holding cash balances in the fund. This approach also gives the trader additional time to establish the underlying positions, thereby receiving (hopefully) better execution prices. For smaller mandates in more liquid securities, the trader could possibly skip the equitization-via-futures step and instead invest directly in the underlying securities. For larger mandates, however, investing in the index via futures initially is often an effective means to equitize cash and reduce tracking error for the client mandate and fund.

Two considerations should be noted in this situation. First, futures markets may not have closing auctions. If no closing auction exists, the trader will likely want to time the trade as close to the benchmark close as possible; for example, in Germany, trading on Xetra closes at 5:30 p.m. For a small trade that is less than the quoted size, the trader could send a market order at 5:30 p.m. For larger trades or less liquid futures, the trader may trade using a VWAP or TWAP algorithm into the market close. Second, this futures-based strategy assumes the fund's investment mandate allows the use of derivatives. If the fund's mandate does not allow the use of derivatives, such as futures, but does permit ETF usage, the trader could equitize cash using a liquid MDAX ETF.

IN-TEXT QUESTION

A portfolio manager for a global fixed-income index fund is required to trade for quarterly index changes taking place at the end of the trading day. To keep the fund in line with the anticipated index constituent changes, the portfolio manager generates a fund rebalance list consisting of buys and sells. He approaches the senior trader to discuss the best trade strategy for the list.

1. Identify the most appropriate reference price benchmark for his trade.
2. Select and justify the most appropriate trading strategy to execute his trade.

Solution:

1. A closing price is the most appropriate reference price benchmark for an index fund. The portfolio manager needs to trade to maintain the same security holdings and weights as the benchmark index. Since the index fund will be valued using official closing prices, he should select the closing price as the reference price benchmark for trading the rebalance names. By executing the buys and sells at the close, he will be minimizing the fund's potential tracking error to the benchmark index.

The previous close would not be an appropriate reference price benchmark since it would be the security's closing price on the previous trading day. A previous close benchmark is often used by quantitative portfolio managers whose models or optimizers incorporate the previous close as an input or who wish to use this price as a proxy for the decision price. The opening price benchmark would not be an appropriate benchmark because it references the security's opening price on the day and is often selected by portfolio managers and traders who wish to begin trading at the market open. The opening price may also be used as a proxy for the decision price.

2. A market-on-close (MOC) trade strategy would be the most appropriate strategy for his rebalance list. Trading the rebalance list at the market's closing prices best aligns the trade execution prices with the same closing prices used for the fund's NAV and benchmark calculation, thus minimizing tracking error of the fund to the benchmark index.

TRADE EXECUTION 6

☐ describe factors that typically determine the selection of a trading algorithm class

Once the appropriate trade strategy is determined by the portfolio manager and the trader, the trade must be executed in a market and in a manner consistent with the trade strategy chosen. A variety of implementation choices are available based on the specific order, market, and trade strategy involved. Trade implementation choices range from higher-touch approaches, which involve greater degrees of human interaction for order completion, to fully automated trade execution through electronic trading venues with varying levels of trade transparency. Higher-touch orders include principal and agency trades, the main difference being who assumes the risk of trading the order. In **principal trades**, the executing broker assumes all or part of the risk related to trading the order, pricing it into her quoted spread. In **agency trades**, the broker is engaged to find the other side of the trade but acts as an agent only, and risk for trading the order remains with the buy-side portfolio manager or trader. Electronic trading includes alternative or multilateral trading venues (ATS or MTF), direct market access (DMA), and dark pools.

Trade Implementation Choices

In general, trading in large blocks of securities requires a higher-touch approach involving greater human engagement and the need for a dealer or market maker to act as counterparty and principal to trade transactions.[3] For these transactions, also called *principal trades* or *broker risk trades*, market makers and dealers become a disclosed counterparty to their clients' orders and buy securities into or sell securities from their own inventory or book, assuming risk for the trade and absorbing temporary

3 Large trades that exceed the normal trade size in a given security are often referred to as "block trades." Brokers offer dedicated services for block trades where human facilitation is higher than for regular trades, particularly for less liquid securities.

supply–demand imbalances. In the case of a less active security, the expected time to offset the trade for the dealer is longer. For taking on this additional risk, the dealer will demand greater compensation, generally by quoting a wider bid–ask spread.

Markets characterized by dealer-provided quotes may be referred to as *quote-driven*, *over-the-counter*, or *off-exchange markets*. In such bilateral dealer markets, customers trade at prices quoted by dealers. Depending on the instrument traded, dealers may work for commercial banks, investment banks, broker/dealers, or proprietary trading firms. Worldwide, most trading besides that in stocks, ETFs, and exchange-traded derivatives takes place in quote-driven markets, where the matching of buyers and sellers takes longer because of less frequent trading and greater market illiquidity.

In some cases, dealers may be unable or unwilling to hold the securities in their inventories and take on position (principal) risk. In agency trades, dealers try to arrange trades by acting as agents, or brokers, on behalf of the client. Brokers are often used for transactions in securities or markets in which finding a buyer or a seller is difficult.

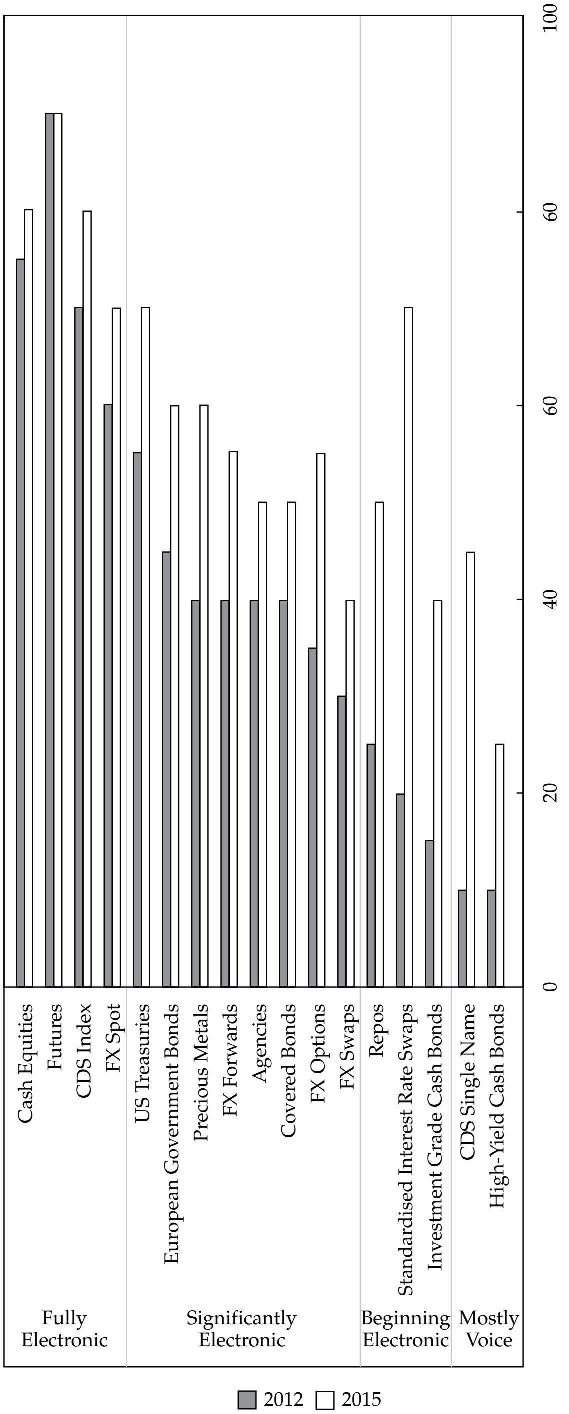
High-touch approaches involve human sell-side traders as intermediaries. These traders, employed by sell-side brokerage firms, may first attempt to fill a customer order by matching it with offsetting orders from other customers before trying to fill it from their own position book. Crossing an order with a broker's own book is known as a broker risk trade or principal trade. If this does not occur, the broker would then route the order to the open market and "slice," or divide, the order into smaller pieces to trade in the market. This approach involves human judgment unique to each trade and is suited to trading illiquid securities in which the execution process is difficult to automate.

A variation of quote-driven markets often used to trade less liquid securities is a **request for quote** (RFQ). In RFQ markets, dealers or market makers do not provide quotes continuously but do so only upon request by a potential buyer or seller. These quotes are nonbinding and are valid only at the time they are provided.

For relatively liquid, standardized securities where continuous two-way trading may exist, buyers and sellers display prices and quantities at which they are willing to transact (limit orders) on an exchange or other multilateral trading venue. In order-driven markets, order-matching systems run by exchanges, brokers, and other alternative trading systems use rules to arrange trades. Trading is done electronically with multiple venues, often through a consolidated limit order book that presents a view of the limit buy (bid)/sell (ask) prices and order sizes for all venues with orders for a security. Centralized clearing for trades exists on those venues. Equities, futures, and exchange-traded options are generally traded using this approach.

Exhibit 1 shows the proportion of trading that was conducted electronically in 2012 and 2015. In most asset classes, electronic trading increased over the period to more than 50% of total trading volume. Markets with higher trading activity have seen strong growth in electronic trading. For example, cash equities and futures are now predominantly traded electronically, whereas some other (generally less liquid) markets, such as high-yield bonds, still feature trading with a high-touch, manual approach.

Exhibit 1: Electronic Trading in Various Asset Classes (in %)



Source: Bank for International Settlements, "Electronic Trading in Fixed-Income Markets," Markets Committee Study Group (2016).

Automated execution approaches work well for liquid securities and most trade sizes other than extremely large orders (relative to the total volume traded of a particular security), which might require a more customized, high-touch approach. *Algorithmic trading*, or the use of programmed strategies to electronically trade orders, is well established in most equity, foreign exchange, and exchange-traded derivative markets. In fixed income, algorithmic execution is mostly limited to trading highly liquid government securities, such as US Treasury securities.

For liquid securities that trade in high volumes, high-touch execution approaches are generally inefficient, opaque, slow, and susceptible to front running. Front running occurs when speculative traders try to profit by buying ahead of other traders' anticipated activity. Front running is illegal in many jurisdictions if the information acted on is improperly obtained. Moreover, given that they require human involvement for each execution, they tend to be costly. Hence, for straightforward trades in liquid securities' low-touch automated execution strategies are often preferred whenever available. These generally involve direct market access (DMA) and/or execution algorithms.

Direct market access (DMA) gives all market participants a way to interact directly with the order book of an exchange, usually through a broker's exchange connectivity. This activity is normally restricted to broker/dealers and market-making firms. With DMA, buy-side firms use a broker's technology infrastructure and market access to execute orders themselves rather than handing orders over to the broker. DMA often involves the use of algorithms.

Alternatively, a broker can be instructed to execute client orders using certain execution algorithms. The desired urgency of an order is a key input for the choice and nature of the execution algorithm.

Algorithmic Trading

Algorithmic trading is the computerized execution of the investment decision following a specified set of trading instructions. An algorithm's programmed strategies used to electronically execute orders will slice larger orders into smaller pieces and trade over the day and across venues to reduce the price impact of the order. The primary goal of algorithmic trading is to ensure that the implementation of the investment decision is consistent with the investment objective of the fund. In this section, we describe factors that help determine the selection of a trading algorithm class.

Trading algorithms are primarily used for two purposes—trade execution and profit generation.

Execution algorithms

An execution algorithm is tasked with transacting an investment decision made by the portfolio manager. The manager determines what to buy or sell on the basis of his investment style and investment objective and then enters the order into the algorithm. The algorithm will then execute the order by following a set of rules specified by the portfolio manager.

Profit-seeking algorithms

A profit-seeking algorithm will determine what to buy and sell and then implement those decisions in the market as efficiently as possible. For example, these algorithms will use real-time price information and market data, such as volume and volatility, to determine what to buy or sell and will then implement the decision consistent with the investment objective. Profit-seeking algorithms are used by electronic market makers, quantitative funds, and high-frequency traders.

This section describes the common classification of execution algorithms and their use.

Execution Algorithm Classifications

Although there are many different types of execution algorithms, they can generally be classified into the following categories.

Scheduled (POV, VWAP, TWAP)

Scheduled algorithms send orders to the market following a schedule that is determined by historical volumes or specified time periods. Scheduled algorithms include *percentage of volume (POV)* algorithms, *volume-weighted average price* algorithms, and *time-weighted average price* algorithms.

POV algorithms (also known as participation algorithms) send orders following a volume participation schedule. As trading volume increases in the market, these algorithms will trade more shares, and as volume decreases, these algorithms will trade fewer shares. Investors specify the POV algorithm through the participation rate, which determines the volume participation strategy. For example, a participation rate of 10% indicates that the algorithm will participate with 10% of the market volume until the order is completed. In this case, for every 10,000 shares that trade in the market, the algorithm will execute 1,000 shares. An advantage of volume participation algorithms is that they will automatically take advantage of increased liquidity conditions by trading more shares when there is ample market liquidity and will not trade in times of illiquidity. While POV algorithms incorporate real-time volume, by following (or chasing) volumes, they may incur higher trading costs by continuing to buy as prices move higher and to sell as prices move lower. An additional disadvantage of these algorithms is that they may not complete the order within the time period specified.

VWAP and TWAP algorithms release orders to the market following a time-specified schedule, trading a predetermined number of shares within the specified time interval; for example, trade 5,000 shares between 10:00 a.m. and 1:00 p.m. An advantage of a time slicing strategy is that it ensures the specified number of shares are executed within the specified time period. A disadvantage of a time slicing strategy is that it will force the trades even in times of insufficient liquidity and will not take advantage of increased liquidity conditions when available.

VWAP algorithms slice the order into smaller amounts to send to the market following a time slicing schedule based on historical intraday volume profiles. These algorithms typically trade a higher percentage of the order at the open and close and a smaller percentage of the order during midday. Because of this, the VWAP curve is said to resemble a U-shaped curve. Following a fixed schedule as VWAP algorithms do may not be optimal for illiquid stocks because such algorithms may not complete the order in cases where volumes are low.

TWAP algorithms slice the order into smaller amounts to send to the market following an equal- weighted time schedule. TWAP algorithms will send the same number of shares and the same percentage of the order to be traded in each time period.

Scheduled algorithms are appropriate for orders in which portfolio managers or traders do not have expectations of adverse price movement during the trade horizon. These algorithms are also used by portfolio managers and traders who have greater risk tolerance for longer execution time periods and are more concerned with minimizing market impact. Scheduled algorithms are often appropriate when the order size is relatively small (e.g., no more than 5%–10% of expected volume), the security is relatively liquid, or the orders are part of a risk-balanced basket and trading all orders at a similar pace will maintain the risk balance.

Liquidity seeking

Liquidity-seeking algorithms, also referred to as *opportunistic algorithms*, take advantage of market liquidity across multiple venues by trading faster when liquidity exists at a favorable price. These algorithms may trade aggressively with offsetting orders when sufficient liquidity is posted on exchanges and alternative trading systems at prices the algorithms deem favorable (a practice called “liquidity sweeping” or “sweeping the book”). These algorithms may also use dark pools and trade large quantities of shares in dark venues when sufficient liquidity is present. If liquidity is not present in the market at favorable prices, these algorithms may trade only a small number of shares. These algorithms will often make greater use of market order types than limit order types.

Liquidity-seeking algorithms are appropriate for large orders that the portfolio manager or trader would like to execute quickly without having a substantial impact on the security price. Liquidity-seeking algorithms are also used when displaying sizable liquidity via limit orders could lead to unwanted information leakage and adverse security price movement. In these cases, the priority is to minimize information leakage associated with order execution and avoid signaling to the market the trading intentions of the portfolio manager or trader. These algorithms are also appropriate for trading securities that are relatively less liquid and thinly traded or when liquidity is episodic (e.g., the order book is typically thin with wide spreads but occasionally experiences tight spreads or thick books).

Arrival price

Arrival price algorithms seek to trade close to current market prices at the time the order is received for execution. Arrival price algorithms will trade more aggressively at the beginning of trading to execute more shares nearer to the arrival price, known as a front-loaded strategy. Arrival price algorithms tend to be time schedule based but can also be volume participation based.

Arrival price algorithms are used for orders in which the portfolio manager or trader believes prices are likely to move unfavorably during the trade horizon. In these cases, the portfolio manager wishes to trade more aggressively to capture alpha ahead of the unfavorable prices expected later in the trade horizon. These algorithms are also used by portfolio managers and traders who are risk averse and wish to trade more quickly to reduce the execution risk associated with trading more passively over longer time horizons. These algorithms are used when the security is relatively liquid or the order is not outsized (e.g., the order is less than 15% of expected volume) such that a participatory strategy is not expected to result in significant market impact from order execution.

Dark strategies/liquidity aggregators

Dark aggregator algorithms execute shares away from “lit” markets, such as exchanges and other displayed venues that provide pre- and post-trade transparency regarding prices, volumes, market spreads, and depth. Instead, these algorithms execute in opaque, or less transparent, trade venues, such as dark pools.

Dark aggregator algorithms are used in trading when portfolio managers and traders are concerned with information leakage that may occur from posting limit orders in lit venues with pre- and post-trade transparency. These algorithms are used when order size is large relative to the market (i.e., a large percentage of expected volume) and when trading in the open market using arrival price or VWAP strategies would lead to significant market impact. These algorithms are appropriate for trading securities that are relatively illiquid or have relatively wide bid–ask spreads. Since trading in dark pools offers less certainty of execution (offsetting orders may never arrive), these algorithms are appropriate for trades in which the trader or portfolio manager does not need to execute the order in its entirety.

Smart order routers

Smart order routers (SORs) determine how best to route an order given prevailing market conditions. The SOR will determine the destination with the highest probability of executing the limit order and the venue with the best market price—known in the United States as the National Best Bid and Offer (NBBO)—for market orders. The SOR continuously monitors real-time data from exchanges and venues and also assesses ongoing activity in dark pools.

SORs are used when a portfolio manager or trader wishes to execute a small order by routing the order into the market as either a market(able) or non-marketable (limit) order.

Market orders.
SORs are used for orders that are sufficiently small that they will not have a large market impact if sent as marketable orders—for example, when the order size is less than the quantity posted at the best bid or offer. SORs are also best used for orders that require immediate execution because of imminent price movement, high portfolio manager or trader risk aversion, or abnormally high risk levels. Using SORs for marketable orders is also appropriate in cases where the market moves quickly, such that having the trader choose the venue(s) could lead to inferior executions (e.g., the trader chooses the venue but the venue with the best price changes before she can send the order).

Limit orders.
SORs are also used for orders that are small enough that posting the order as a limit order will not leak information to the market and move prices (e.g., orders that are similar to those currently posted in the market). In addition, SORs are appropriate for stocks that have multiple markets actively trading the stock and for which it is not obvious to which venues the order should be routed (e.g., there are multiple venues currently posting orders at the trader's limit price).

IN-TEXT QUESTION

A portfolio manager has identified a stock with attractive long-term growth potential and would like to place an order of moderate size, relative to the stock's average traded volume. The stock is very liquid and has attractive short-term alpha potential. The portfolio manager expects short-term buying pressure by other market participants into the market close, ahead of the company's earnings call scheduled later in the day.

1. Explain when the following algorithms are used: (a) arrival price, (b) dark aggregator, and (c) SOR.
2. Discuss which of the three algorithms is most suited to trading this order.

Solution:

1.
   a. Arrival price algorithms are used for relatively liquid securities and when the order is not expected to have a significant market impact. Arrival price algorithms are also used when portfolio managers and traders have higher levels of risk aversion and wish to trade more aggressively at an accelerated pace to reduce the execution risk associated with trading over longer time horizons.
   b. Dark aggregator algorithms are appropriate for trading securities that are relatively illiquid or that have relatively wide bid–ask spreads or for relatively large order sizes in which trading in the open market is expected to have a significant price impact. Additionally, they are used by portfolio managers and traders who are concerned with information leakage that may occur when

posting limit orders in lit venues. Given their higher risk of unfilled executions, these algorithms are also used when the order does not need to be filled in its entirety.

c. Smart order routing systems are used to electronically send small orders into the market. Based on prevailing market conditions, SORs will determine which trade destinations have the highest probability of executing for limit orders and which trading venues have the best market prices for market orders and will route orders accordingly. SORs continuously monitor market conditions in real time in both lit and dark markets.

2. An arrival price algorithm would be most appropriate for trading this order because the portfolio manager has adverse price expectations. In this case, the portfolio manager wants to trade more aggressively to capture alpha ahead of less favorable prices expected later in the day. By trading the order more quickly, the portfolio manager can execute at more favorable prices ahead of the adverse price movement and the less favorable prices expected from other participants' buying pressure into the close, in line with his trade urgency.

Algorithmic Selection

Choosing the best algorithm to execute a given trade can be a difficult and complex decision. There has been a proliferation of choices for the buy-side trader, with multiple broker offerings and multiple algorithm types per broker, such as VWAP, POV, and implementation shortfall. For a given stock, what is the best algorithm to choose? Intuitively, it seems that selecting an algorithm by considering specific characteristics about the stock and its liquidity profile should be superior to selecting an algorithm without regard for these attributes. Additionally, it seems intuitive that stocks with similar characteristics might best be executed in a similar manner. This rationale has motivated firms that provide execution services to apply a machine learning technique called "clustering" to the problem of algorithmic strategy selection.

Clustering, generally used in unsupervised machine learning, groups data objects solely on the basis of information found in the data. The use of clustering for algorithmic strategy selection for stocks will generally include microstructure factors, such as bid–ask spread, trade size, price volatility, tick size, depth of the order book queue, and trading volume. Stocks are characterized from the results of the data analysis (i.e., placed into groups, or clusters, based on similarities informed by the data). For each cluster, the historical executions for each stock are examined for comparative performance. From this analysis, the optimal algorithmic strategy can be selected.

To illustrate a simple intuitive example, stocks with wider bid–ask spreads may be more effectively traded using an algorithm that executes more in off-exchange venues (such as dark pools) since on those venues trading can occur at mid-market if an offsetting order arrives and the cost of crossing the bid–ask spread (buying at the offer or selling at the bid) is high. In contrast, for a cluster of stocks with tight bid–ask spreads, the benefit of trading at mid-market is smaller and the optimal algorithm is likely to trade less on off-exchange/dark venues.

In some cases, the optimal decision may be clear from the data because the performance of one algorithm dominates all other choices. In other cases, even if the optimal choice is unclear, the historical execution data of the given cluster help narrow the research space and form the basis for further optimization using either traditional regression-based or machine learning techniques. Although our example is quite simple and the rationale intuitive, one might ask, if the answer is that obvious, why bother with machine learning at all? In practice, the answers are usually much less obvious and the conditions far more complicated.

High-Frequency Market Forecasting

One of the primary challenges in trading (and investing) is forecasting asset prices. Even for a long-term investor, the ability to forecast short-term market direction can help make execution more efficient.

Building a model to forecast short-term market movements involves two steps: The first is to identify key factors, or predictors (independent variables in a regression context), and the second is to estimate the model. One might identify many (hundreds, if not more) potential predictors; for example, for a period of time, one stock—perhaps for which there has been a significant news release—may "lead" the rest of the market and be a good predictor of short-term movement in other stocks.

LASSO (least absolute shrinkage and selection operator) is a machine learning technique used to help with this identification problem. LASSO is a penalized regression technique that relies on the underlying assumption of sparsity, meaning that at any point in time, even in the presence of many potential predictors, only a handful of variables are significant. LASSO minimizes the residual sum of squares, which has the effect of reducing many of the coefficients to zero, leaving only the most significant variables.

For example, consider a trader building a forecast model to predict the near-term value of the S&P 500 ETF (SPY). There are a multitude of variables that she might want to consider, including the order book imbalance (excess of buys or sells for a given price) on each exchange, SPY trade executions, SPY returns over a number of recent time horizons, and similar attributes for correlated instruments, such as other ETFs, equity index futures contracts, and stocks making up the underlying portfolio of the ETF. It is clear that there are hundreds of potential variables. Working with a regression model to identify the most important variables would likely be unwieldy and challenging, given potential collinearity. Using LASSO, the trader can reduce the problem to a more manageable number of variables.

COMPARISON OF MARKETS

7

☐ contrast key characteristics of the following markets in relation to trade implementation: equity, fixed income, options and futures, OTC derivatives, and spot currency

Although algorithmic trading is common in highly liquid, technologically developed markets, such as equities, trades in other markets require different implementation treatment, with greater human involvement. In this section, we compare and contrast key characteristics relating to trade implementation for the following markets:

- Equities
- Fixed income

- Exchange-traded derivatives (options and futures)
- Off-exchange (OTC) derivatives
- Spot currencies

Equities

Equities are generally traded on exchanges and dark pools. Exchanges are known as lit markets (as opposed to dark markets) because they provide pre-trade transparency—namely, limit orders that reflect trader intentions for trade side (buy or sell), price, and size. Dark pools provide anonymity because no pre-trade transparency exists. However, regardless of the trading venue, transactions and quantities are always reported. On exchanges, trade price, size, quote, and depth of book data are publicly available. However, detailed book data can be costly and may be available only to some market participants.

Most countries with open economies have at least one stock exchange. The United States has a total of 13 stock exchanges. There are more than 50 **alternative trading systems** (ATS)/dark pools globally. In Europe, these alternative trading venues are called **multilateral trading facilities** (MTF) and *systematic internalisers (SI)*. MTFs are operated by investment firms or market operators that bring together multiple third-party buying and selling interests in financial instruments. SIs are single-dealer liquidity pools. In the United States and Canada, these venues are called alternative trading systems (ATS). They are non-exchange trading venues that match buyers and sellers to find counterparties for transactions. They are typically regulated as broker/dealers rather than as exchanges (although an ATS can apply to be regulated as a securities exchange). In the United States, ATS must be approved by the Securities and Exchange Commission (SEC).

In Asia, although trading volume on alternative trading venues has grown rapidly over the last few years, such activity remains less common than in North America and Europe. Even in markets with the highest share of dark pool trading, most equity trading still takes place on traditional exchanges. In emerging markets, dark pool trading volume is minimal compared with trading volume on traditional exchanges.

Equities are the most technologically advanced market. Algorithmic trading is common, and most trades are electronic. Equity exchanges may use different trading systems for stocks depending on their level of liquidity. Large, urgent trades, particularly in less liquid small-cap stocks, are generally executed as high-touch broker risk trades, where the broker acts as dealer and counterparty. Large, non-urgent trades may be executed using trading algorithms (particularly for more liquid large-cap stocks) or, for less liquid securities, a high-touch agency approach. For small trades in liquid securities, most buy-side traders use electronic trading.

In recent years, average trade sizes have generally decreased for most asset classes; market participants break down their trades into smaller pieces that they trade either sequentially on the same trading venue or simultaneously across different venues. In equities, growth in the number of trading venues has resulted in fragmentation of trading and increased competition among trading venues.

Fixed Income

Fixed-income markets are quite different from equity markets. Market transparency and price discovery for fixed-income markets are generally much lower; information available and how quickly it is made available vary by market. Individual bond issuers can have a large number of bonds outstanding with very different features—for example, different maturities, coupons, and optionality. As a result, fixed income is a very heterogeneous asset class that encompasses a large number of individual securities. Institutional investors will often hold bonds until maturity or may trade large quantities infrequently. Trade imbalances often occur in corporate bonds owing to illiquidity. As a result, sourcing market liquidity relies heavily on dealers acting as counterparties (i.e., principal trades), and matching buyers and sellers is generally difficult in the corporate bond market.

Fixed-income securities are generally traded in a bilateral, dealer-centric market structure.[4] Investors will generally get quotes from dealers, often banks, which make markets in the securities. Historically, these quotes were accessed via phone, but they increasingly are disseminated using electronic chat (e.g., Symphony, Bloomberg) or electronic RFQ platforms. Just as it was before the onset of these electronic platforms, dealers do not provide quotes continuously; they provide them only on request by a potential buyer or seller.

There is limited algorithmic trading in bond markets, except for on-the-run (most recently issued) US Treasuries in benchmark maturities and bond and interest rate futures contracts. Although algorithmic/electronic trading in corporate bonds is growing, it remains a relatively low proportion of overall corporate bond trading.[5] The combination of market illiquidity and the large size and low frequency of potential trades creates challenges for algorithmic trading and electronic trading generally. For other fixed-income instruments, high-touch trading persists, particularly for larger trades and less liquid securities. Small trades and large, urgent trades are usually implemented through broker risk trades (via RFQs), where the broker acts as the counterparty, because securities are hard to source otherwise. Large, non-urgent trades are generally implemented using a high-touch approach, with brokers acting as agents to source liquidity (agency trades instead of principal trades).

Exchange-Traded Derivatives

As of 2021, there were fewer than 1,000 liquid and highly standardized exchange-traded derivatives outstanding. The market is very large, and trading volume exceeds several trillion dollars per day according to Bank for International Settlements (BIS) data. Most of the trading volume is concentrated in futures, although the number of futures is considerably smaller than the number of options outstanding. Similar to exchange-traded equities, market transparency is high and trade price, size, quote, and depth of book data are publicly available.

Electronic trading is widespread for exchange-traded derivatives; however, algorithmic trading is not as evolved as in equity markets and is currently used more for trading in futures than in options. Large, urgent trades "sweep the book" where market depth is relatively good. In these cases, trades are executed against the most aggressive limit orders on the other trade side first and then against decreasingly aggressive limit orders until the entire order has been filled. Large, non-urgent trades are generally implemented electronically through trading algorithms. Buy-side traders generally use direct market access, particularly for small trades.

Over-the-Counter Derivatives

In recent years, regulators have been placing pressure on OTC markets to introduce central clearing facilities and to display trades publicly. Although liquidity has increased for more standardized OTC trades that are centrally cleared, liquidity has decreased for OTC instruments not suited to central clearing or trade reporting.

4 Some fixed-income securities trade on exchanges (e.g., the NYSE, the London Stock Exchange, and some Italian exchanges list corporate bonds). However, the volume traded on centralized exchanges is small.

5 As of 2018, Greenwich Associates has estimated that as of 2018, a fifth of all investment-grade US corporate bond trades are now traded electronically—almost double the volume of a decade ago.

OTC derivative markets have historically been opaque, with little public data about prices, trade sizes, and structure details. Regulatory efforts have focused on increasing transparency and reducing counterparty risk in these markets. In the United States, the Dodd–Frank Wall Street Reform and Consumer Protection Act, enacted in 2010, significantly increased post-trade transparency in the OTC derivative markets with the establishment of swap data repositories (SDRs) to which trade details must be submitted. Under the Dodd–Frank regulation, swaps entered into by parties exempt from mandatory clearing and exchange trading (and where at least one counterparty to the swap is a US person) are still subject to data reporting rules. Dodd–Frank forms part of a broader 2009 agreement by the G–20 countries whose primary long-term focus includes the trading of all OTC derivatives on exchanges or other electronic platforms with centralized clearing for all more standardized derivatives.

Trading OTC derivatives takes place through dealers. Because this type of security is typically traded by institutions, trade sizes are relatively large. Large, urgent trades are generally implemented as broker risk trades, where risk is transferred to a broker who takes the contract into his inventory. Large, non-urgent trades are generally implemented using a high-touch agency trade, where the broker attempts to match buyers and sellers directly. Doing so can be difficult, however, since OTC derivatives are often highly customized. Hence, at times, a strong price concession is required to find a buyer or seller. According to the Bank for International Settlements (BIS) the gross market value of OTC derivatives was over $15 trillion in 2020.

Spot Foreign Exchange (Currency)

There is no exchange or centralized clearing place for the majority of spot foreign exchange (currency) trades. Spot currency markets consist of a number of electronic venues and broker markets. The currency market is an entirely OTC market. Despite being a global market, there is almost no cross-border regulation.

The spot currency market consists of multiple levels. The top level is called the interbank market, where participants are mostly large international banks and other financial firms that act as dealers. Trades between these foreign exchange dealers can be extremely large. The next market level is generally made up of small and medium-sized banks and other financial institutions that turn to the dealers in the interbank market for their currency trading needs and that, therefore, pay slightly higher bid–ask spreads. The level below that one consists of commercial companies and retail traders that turn to the second-level institutions for their currency trading. Once again, a higher bid–ask spread applies to these market participants.

The spot currency market is sizable in terms of daily trading volume, with often more than $1 trillion traded per day. Although large, the spot currency market is relatively opaque; there are usually only quotes available and only from some venues.

Electronic trading in currencies has grown substantially over the years in parallel with algorithmic trading strategies of equities. For large, urgent trades, RFQs are generally submitted to multiple dealers competing for a trade. Large, non-urgent trades are mostly executed using algorithms (such as TWAP) or a high-touch agency approach. Small trades are usually implemented using DMA.

IN-TEXT QUESTION

A hedge fund manager has three trades that she would like to execute for her fund. The orders are for:

1. a large, non-urgent sell of OTC options,
2. a large, urgent sell of corporate bonds, and
3. a small, non-urgent buy of six liquid emerging market currencies.

Describe factors affecting trade implementation for each trade.

Solution:

1. A large, non-urgent sell of OTC options would generally involve a broker agency trade in which the broker would act on behalf of the manager to find a matching buyer for the options. Depending on the level of contract customization, however, a significant price concession may be required by the manager to complete order execution.
2. A large, urgent sell of corporate bonds would usually involve a broker risk trade via the RFQ process. Because of corporate bond illiquidity, the likelihood of finding a matching buyer is low. For more immediate (urgent) order execution, a broker would be needed to act as counterparty to the trade, taking the bonds and their associated risk into his inventory.
3. Small, non-urgent trades in foreign exchange are generally executed using direct market access. DMA allows the buy-side trader to electronically route orders using the broker's technology infrastructure and market access and typically involves algorithmic trading.

TRADE COST MEASUREMENT

8

☐ explain how trade costs are measured and determine the cost of a trade

After trade implementation is complete, it is important for portfolio managers and traders to assess the trading that has taken place. Was the trade implemented in a manner consistent with the trade strategy chosen? What costs were incurred from trading the order, where did costs arise, and were these reasonable given market conditions? How well did the trader, broker, or algorithm selected for trade execution perform?

Unfortunately for the portfolio manager, trade implementation is not a frictionless transaction. In economic terms, trade costs are value paid by buyers but not received by sellers and value paid by sellers but not received by buyers. In finance, trade costs represent the amount paid above the investment decision price for buy orders and the discount below the decision price for sell orders. An important aspect of trade cost measurement is to identify where costs arise during implementation of the investment decision. Understanding where these costs arise will help portfolio managers carry out proper trade cost management, more efficient implementation, and better portfolio construction. This ultimately leads to lower trading costs and higher portfolio returns.

Proper trade cost management begins with an understanding of the implementation shortfall formulation.

Implementation Shortfall

The **implementation shortfall** (IS) metric[6] is the most important *ex post* trade cost measurement used in finance. The IS metric provides portfolio managers with the total cost associated with implementing the investment decision. This spans the time the investment decision is made by the portfolio manager up to the completion of the trade by the trader. IS also allows portfolio managers to identify where costs arise during the implementation of the trade.

IS is calculated as the difference between the return for a notional or paper portfolio, where all transactions are assumed to take place at the manager's decision price, and the portfolio's actual return, which reflects realized transactions, including all fees and costs.

Mathematically, IS is calculated as follows:

$$\text{IS} = \text{Paper return} - \text{Actual return}$$

The paper return shows the hypothetical return that the fund would have received if the manager were able to transact all shares at the desired decision price and without any associated costs or fees (i.e., with no friction):

$$\text{Paper return} = (P_n - P_d)(S) = (S)(P_n) - (S)(P_d)$$

Here, S represents the total order shares, $S > 0$ indicates a buy order, $S < 0$ indicates a sell order, P_d represents the price at the time of the investment decision, and P_n represents the current price.

The actual portfolio return is calculated as the difference between the current market price and actual transaction prices minus all fees (e.g., commissions):

$$\text{Actual return} = \left(\sum s_j\right)\left(P_n\right) - \sum s_j p_j - \text{Fees}$$

Here, s_j and p_j represent the number of shares executed and the transaction price of the jth trade, respectively, $\left(\sum s_j\right)$ represents the total number of shares of the order that were executed in the market, and "Fees" includes all costs paid by the fund to complete the order.

This IS formulation decomposes the total cost of the trade into three categories: execution cost, opportunity cost, and fixed fees. **Execution cost** corresponds to the shares that were transacted in the market. Execution cost occurs from the buying and/or selling pressure of the order, which often causes buy orders to become more expensive and sell orders to decrease in value, thus causing the fund to incur higher costs and lower realized returns. Execution cost will also occur owing to price drift over the trading period. For example, buying stocks that are increasing in value over the trading period and selling stocks that are decreasing in value over the trading period.

It is important to note that since there is no guarantee that the portfolio manager will be able to execute the entire order, the number of shares transacted in the market may be less than the original order size—that is, $\sum s_j \leq S$ for a buy order and $\sum s_j \geq S$ for a sell order. **Opportunity cost** corresponds to the unexecuted shares of the order. It is the cost associated with not being able to transact the entire order at the manager's decision price and is due to adverse price movement over the trading period. Opportunity cost may also arise in times of insufficient market liquidity, when the fund is not able to find counterparties to complete the trade. The opportunity cost component provides managers with insight into missed profit opportunity for their investment idea.

The *fixed fees* component includes all explicit fees, such as commissions, exchange fees, and taxes.

6 A.F. Perold, "The Implementation Shortfall: Paper versus Reality," *Journal of Portfolio Management* 14 (Spring 1988): 4–9.

The IS formulation decomposing costs into these categories is calculated as follows:

$$\text{IS} = \underbrace{\sum s_j p_j - \sum s_j p_d}_{\text{Execution cost}} + \underbrace{\left(S - \sum s_j\right)\left(P_n - P_d\right)}_{\text{Opportunity cost}} + \text{Fees}$$

Consider the following facts:

On Monday, the shares of Impulse Robotics close at £10.00 per share.

On Tuesday, before trading begins, a portfolio manager decides to buy Impulse Robotics. An order goes to the trading desk to buy 1,000 shares of Impulse Robotics at £9.98 per share or better, good for one day. The benchmark price is Monday's close at £10.00 per share. No part of the limit order is filled on Tuesday, and the order expires. The closing price on Tuesday rises to £10.05.

On Wednesday, the trading desk again tries to buy Impulse Robotics by entering a new limit order to buy 1,000 shares at £10.07 per share or better, good for one day. During the day, 700 shares are bought at £10.07 per share. Commissions and fees for this trade are £14. Shares for Impulse Robotics close at £10.08 per share on Wednesday.

No further attempt to buy Impulse Robotics is made, and the remaining 300 shares of the 1,000 shares the portfolio manager initially specified are canceled.

The paper portfolio traded 1,000 shares on Tuesday at £10.00 per share. The return on this portfolio when the order is canceled after the close on Wednesday is the value of the 1,000 shares, now worth £10,080, less the cost of £10,000, for a net gain of £80.

The real portfolio contains 700 shares (now worth 700 × £10.08 = £7,056), and the cost of this portfolio is 700 × £10.07 = £7,049, plus £14 in commissions and fees, for a total cost of £7,063. Thus, the total net gain on this portfolio is –£7. The implementation shortfall is the return on the paper portfolio minus the return on the actual portfolio, or £80 – (–£7) = £87.

We can break this IS down further, as follows:

- Execution cost, which is calculated as the difference between the cost of the real portfolio and of the paper portfolio and reflects the execution price paid for the amount of shares in the order actually filled: (700 × £10.07) – (700 × £10.00) = £7,049 – £7,000 = £49.
- Opportunity cost, which is based on the amount of shares left unexecuted and reflects the cost associated with not being able to execute all shares at the decision price: (1,000 shares – 700 shares) × (£10.08 – £10.00) = £24.
- Fixed fees, which are equal to total explicit fees paid: £14.

IS (£) is equal to the sum of execution cost, opportunity cost, and fixed fees: £49 + £24 + £14 = £87. More commonly, the shortfall is expressed as a fraction of the total cost of the paper portfolio trade: £87/£10,000 = 87 bps.

Expanded Implementation Shortfall

Wagner (1991) further expanded the IS measure to decompose the execution cost component into a delay-related cost component and a trading-related cost component.[7] These two decomposed execution components allow portfolio managers to more precisely isolate where their execution costs arise during the implementation cycle and help traders better manage overall execution quality and reduce trading costs.

The expanded implementation shortfall can be broken down as follows:

Expanded IS =

$$\underbrace{\underbrace{\left(\sum s_j\right)p_0 - \left(\sum s_j\right)p_d}_{\text{Delay cost}} + \underbrace{\sum s_j p_j - \left(\sum s_j\right)p_0}_{\text{Trading cost}}}_{\text{Execution cost}} + \underbrace{\left(S - \sum s_j\right)\left(P_n - P_d\right)}_{\text{Opportunity cost}} + \text{Fees}$$

7 Wagner, W. (Ed.), 1991. *The Complete Guide to Security Transactions*. John Wiley.

In this representation, the additional notation p_0 represents the arrival price, and it is defined as the asset price at the time the order was released to the market for execution.

This expanded IS formulation decomposes execution cost further into two categories: delay cost and trading cost. **Delay cost** arises when the order is not submitted to the market in a timely manner and the asset experiences adverse price movement, making it more expensive to transact. Delay cost is often caused by a delay in selecting the most appropriate broker or trading algorithm to execute the order and by adverse price movement (also known as price drift) over the trading period.

Delay cost, however, can be minimized by having proper trading practices in place to provide traders with all the information they need to make an immediate decision, such as pre-trade analysis and post-trade analysis.

For example, consider the same Impulse Robotics example from before but with the following additional fact: *The buy-side trading desk releases the order to the market 30 minutes after receiving it, when the price is £10.03.* We now have additional information that helps identify where costs arise during the implementation of the trade.

The execution cost component in the expanded implementation shortfall can be decomposed into the following:

- Delay cost, which reflects the adverse price movement associated with not submitting the order to the market in a timely manner and is based on the amount of shares executed in the order: (700 × £10.03) – (700 × £10.00) = £7,021 – £7,000 = £21.
- Trading cost, which reflects the execution price paid on shares executed: (700 × £10.07) – (700 × £10.03) = £7,049 – £7,021 = £28.

While,

- Opportunity cost (£24) and fixed fees (£14) remain unchanged.

Therefore, expanded implementation shortfall (£) = £21 + £28 + £24 + £14 = £87.

The expanded IS provides further insight into the causes of trade costs. The delay cost is £21, which accounts for 24.1% (£21/£87) of the total IS cost, whereas the opportunity cost of £24 accounts for 27.6% (£24/£87) of the total IS cost. Quite often, delay cost and opportunity cost account for the greatest quantity of cost during implementation. These costs can often be eliminated with proper transaction cost management techniques.

Improving Execution Performance

In many situations, delay cost arises from a lag in time between when the buy-side trader receives the order from the portfolio manager and when the trader determines which broker or algorithm is most appropriate for the specific order. Delay costs can be reduced by having a process in place that provides traders with broker performance metrics. Traders can then immediately release the order to the broker without any delay or corresponding adverse price movement. In theory, the delay cost component should have an expected value of zero. In practice, however, the delay cost component is often due to the simultaneous buying and selling pressure from multiple funds buying and selling the same stocks on the same side and over similar trading horizons, resulting in adverse price movement over the trading period. Stock alpha may also contribute to the delay cost component.

Portfolio managers can use IS to help determine appropriate order size for the market within the portfolio manager's price range and to minimize the opportunity cost of the order. For example, IS analysis will help portfolio managers determine the number of shares that can be transacted within the manager's price range or better, and if the manager has incremental cash on hand from specifying a smaller order size, she can invest this amount into her next most attractive investment opportunity at presumably better market prices. If the portfolio manager does not perform

IS analysis, she may try to transact a position size that is too large to execute in the market within the desired price range and may not realize this until it is too late to change the investment decision. If the manager knew beforehand that her position size was too large to execute within her price range, she could have reduced the order size for the stock and invested the remaining capital into the next most attractive investment opportunity.

Similar to the delay cost, opportunity cost is not mean zero and often represents a cost to the fund. This is due to two reasons: adverse price movement and illiquidity. First, portfolio managers will often buy shares at a specified price or better. If prices decrease over the trading period, the order will likely be filled. If prices increase by too much, the manager may feel that the asset is no longer an attractive investment opportunity, will cancel the order, and invest in a different asset, thus realizing an opportunity cost. Second, traders may not be able to complete the order if there is insufficient market liquidity. In times of favorable prices, fund managers may be willing to incur additional market impact to attract additional counterparties into the market. But during times of adverse market prices, fund managers may not be as willing to increase their purchase price to attract additional sellers into the market because doing so might increase the stock price to a level where it is no longer deemed an attractive investment opportunity. Thus, the order is less likely to be completed in times of adverse price movement and insufficient market liquidity. Both of these situations result in an opportunity cost to the fund.

Delay Cost

A portfolio manager decides to buy 100,000 shares of RLK at 9:30 a.m., when its price is $30.00. The manager gives the order to his buy-side trader and requests the order be executed in the market at a price no higher than $30.50. The trader is then tasked with determining the best broker and/or the best algorithm to execute the trade. We next discuss two different scenarios to illustrate how a trader's actions can affect the delay cost component.

Scenario 1:

The trader receives the order for 100,000 shares at 9:30 a.m., when its price is $30. The trader is not familiar with RLK and needs to review the stock's liquidity, volatility, and intraday trading patterns and current market conditions. The trader next needs to review the historical performance of brokers trading similar order sizes and trading characteristics. After a thorough review, the trader determines the best broker to execute the order is Broker KRG. The trader then submits the order to Broker KRG at 10:30 a.m. but the market price increases to $30.10. The buy-side trader's delay in submitting the order to the broker is caused by the trader's need to evaluate and determine the best broker to execute the order given the order characteristics and market conditions. This delay costs the fund $0.10 per share. Note that if the price had decreased to $29.90, the delay would have benefited the fund by $0.10 per share.

Scenario 2:

The trader receives the order for 100,000 shares at 9:30 a.m., when the price is $30.00. Because the buy-side trader exercises proper transaction cost management practices, the trader has analyses on hand indicating who is the best broker and what is the best algorithm to execute the order. The trader is able to immediately submit the order to Broker KRG for execution when the market price is $30.00 per share.

Opportunity Cost

The research department of an asset management firm identifies two stocks currently undervalued in the market. Stock ABC is currently trading at $30.00 and is undervalued by $0.50/share. Stock XYZ is also currently trading at $30.00 and is undervalued by $0.40/share.

The portfolio manager has $3 million and is looking to invest in the stock(s) that will provide the highest return for the fund. What stock(s) should she buy?

On the surface, it may appear most appropriate to invest the entire $3 million in Stock ABC because it is the most undervalued ($0.50/share) and represents the highest short-term alpha. However, if the portfolio manager does not incorporate opportunity cost into her analysis, she is unlikely to achieve the highest return for the fund.

The effect of opportunity cost on fund performance is explained in the following two scenarios.

Scenario 1:

The portfolio manager decides to purchase 100,000 shares of ABC because it represents the highest short-term alpha potential. The portfolio manager does not want to purchase shares at a price higher than $30.50, which the research department has determined to be fair value for ABC. The trader tries to execute 100,000 shares of ABC but finds that only 80,000 shares can be executed at an average price of $30.25 before the price increases above $30.50. After ABC reaches a price of $30.50, it remains at this price through the end of the day. Additionally, Stock XYZ closes at its fair value of $30.40.

In this situation, the portfolio manager incurred an opportunity cost of $10,000 (20,000 shares multiplied by $0.50 = $10,000) and realized a profit of $20,000 (80,000 shares multiplied by $0.25 = $20,000).

Since Stock XYZ (which was the second most attractive investment opportunity at the beginning of the day) also increased to its fair value over the day, the portfolio manager is no longer able to invest the residual dollar value in XYZ and capture alpha. Thus, the portfolio manager has missed out on an opportunity to achieve maximum returns.

Scenario 2:

The portfolio manager of the fund exercises proper transaction cost management practices. Based on pre-trade analysis, the manager determines that she can purchase only 80,000 shares of ABC before its price will recover to its fair value of $30.50. Because the manager will not be able to invest all funds into Stock ABC, she decides to invest the residual dollar value into Stock XYZ (the second most attractive asset) and buy 20,000 shares.

In this scenario, the portfolio manager transacts all shares from both orders at prices below the fair value. The manager purchases 80,000 shares of ABC at an average price of $30.25 and purchases 20,000 shares of XYZ at an average price of $30.20. Stock ABC closes at its fair value of $30.50, and Stock XYZ closes at its fair value of $30.40. Since the manager executed all shares, she does not incur any opportunity cost.

The manager realizes an overall profit of $24,000. Stock ABC realized a profit of $20,000 (80,000 shares multiplied by $0.25/share). Stock XYZ realized a profit of $4,000 (20,000 shares multiplied by $0.20/share).

In this scenario, where the portfolio manager practiced proper trading cost management and evaluated opportunity cost prior to submitting the order, she was able to increase portfolio returns by $4,000.

Knowledge of where costs arise during execution allows portfolio managers and traders to take necessary steps to reduce and manage these costs appropriately. For example, the delay cost component can be reduced by knowing beforehand which broker is best suited to execute the trade and/or which algorithm is the most appropriate given the order, price benchmark, and investment objectives. Opportunity cost can be reduced by knowing the order size and share quantity that is most likely to be executed in the market within a specified price range. The trading cost component can also be effectively managed so that it is consistent with the underlying investment objectives of the fund by selecting the proper price benchmarks and trading urgency.

IN-TEXT QUESTION

Implementation Shortfall

A portfolio manager decides to buy 100,000 shares of RLK at 9:00 a.m., when the price is $30.00. He sets a limit price of $30.50 for the order. The buy-side trader does not release the order to the market for execution until 10:30 a.m., when the price is $30.10. The fund is charged a commission of $0.02/share and no other fees. At the end of the day, 80,000 shares are executed and RLK closes at $30.65. Order and execution details are summarized as follows:

Order	
Stock Ticker	RLK
Side	Buy
Shares	100,000
Limit Price	$30.50

Trades	Execution Price	Shares Executed
Trade 1	$30.20	30,000
Trade 2	$30.30	20,000
Trade 3	$30.40	20,000
Trade 4	$30.50	10,000
Total		80,000

- **a.** Calculate execution cost.
- **b.** Calculate opportunity cost.
- **c.** Calculate fixed fees.
- **d.** Calculate implementation shortfall in basis points.
- **e.** Discuss how opportunity cost could be minimized for the trade.
- **f.** Calculate delay cost.
- **g.** Calculate trading cost.
- **h.** Show expanded implementation shortfall in basis points.
- **i.** Discuss how delay cost could be minimized for the trade.

Solution:

- **a.** **Execution cost** is calculated as the difference between the costs of the real portfolio and the paper portfolio. It reflects the execution price(s) paid for the amount of shares in the order that were actually filled, or executed. Execution cost can be calculated as follows:

Execution cost = $\Sigma s_j p_j - \Sigma s_j p_d$

= (30,000 shares × $30.20 + 20,000 shares × $30.30 + 20,000 shares × $30.40 + 10,000 shares × $30.50) – 80,000 × $30.00

= $2,425,000 – $2,400,000

= $25,000

b. **Opportunity cost** is based on the amount of shares left unexecuted in the order and reflects the cost of not being able to execute all shares at the decision price. Opportunity cost can be calculated as follows:

$$\text{Opportunity cost} = \left(S - \Sigma s_j\right)(p_n - p_d)$$
$$= (100{,}000 - 80{,}000)(\$30.65 - \$30.00)$$
$$= \$13{,}000$$

c. **Fixed fees** are equal to total explicit fees paid and can be calculated as follows:

$$\text{Fees} = 80{,}000 \times \$0.02 = \$1{,}600$$

d. **Implementation shortfall** can be calculated as follows:

$$\text{Implementation shortfall (\$)} = \underbrace{\$25{,}000}_{\text{Execution cost}} + \underbrace{\$13{,}000}_{\text{Opportunity cost}} + \underbrace{\$1{,}600}_{\text{Fees}}$$
$$= \$39{,}600$$

The implementation shortfall is expressed in basis points as follows:

$$\text{Implementation shortfall (bps)} = \frac{\text{Implementation shortfall (\$)}}{\text{(Total shares)}\ (p_d)} \times 10{,}000 \text{ bps}$$
$$= \frac{\$39{,}600}{(100{,}000 \times \$30.00)} \times 10{,}000 \text{ bps}$$
$$= 132 \text{ bps}$$

e. **Minimizing opportunity cost:** Based on the decomposition of IS, the portfolio manager incurred an opportunity cost of $13,000 on 20,000 shares. The opportunity cost could be lowered by reducing order quantity to a size that can be absorbed into the market at the portfolio manager's price target or better. In this example, opportunity cost represented 32.8% ($13,000/$39,600) of the total IS cost. If the portfolio manager had known this in advance, he could have reduced the size of the order to 80,000 shares and invested the extra $600,000 (20,000 shares × $30.00/share = $600,000) in his second most attractive investment opportunity.

f. **Delay cost** can be calculated as follows:

$$\text{Delay cost} = \left(\Sigma s_j\right) p_0 - \left(\Sigma s_j\right) p_d$$
$$= 80{,}000 \times \$30.10 - 80{,}000 \times \$30.00 = \$8{,}000$$

g. **Trading cost** can be calculated as follows:

$$\text{Trading cost} = \Sigma s_j p_j - \left(\Sigma s_j\right) p_0$$
$$= (30{,}000 \text{ shares} \times \$30.20 + 20{,}000 \text{ shares} \times \$30.30 + 20{,}000 \text{ shares} \times \$30.40 + 10{,}000 \text{ shares} \times \$30.50) - 80{,}000 \times \$30.10$$
$$= \$2{,}425{,}000 - \$2{,}408{,}000$$
$$= \$17{,}000$$

h. **Expanded implementation shortfall** can be calculated as follows:

$$\text{Expanded IS} = \underbrace{\$8{,}000}_{\text{Delay cost}} + \underbrace{\$17{,}000}_{\text{Trading cost}} + \underbrace{\$13{,}000}_{\text{Opportunity cost}} + \underbrace{\$1{,}600}_{\text{Fees}} = \$39{,}600$$

The delay cost is $8,000, which accounts for 20.2% ($8,000/$39,600) of the total IS cost, whereas the opportunity cost of $13,000 accounts for 32.8% ($13,000/$39,600) of the total IS cost.

i. **Minimizing delay cost:** The delay cost of $8,000 accounts for a sizable portion (20.2%) of the total IS cost and could be minimized by having a process in place that provides the buy-side trader with broker performance metrics. This would allow the trader to quickly identify the best broker and/or algorithm to execute the order given its characteristics and current market conditions, thereby minimizing the time between order receipt and market execution.

EVALUATING TRADE EXECUTION

9

☐ evaluate the execution of a trade

The evaluation of trade execution is also referred to as trade cost evaluation, trade cost analysis (TCA), and post-trade analysis. Its goal is to evaluate and measure the execution quality of the trade and the overall performance of the trader, broker, and/or algorithm. Here, we discuss different methodologies to evaluate the execution of a trade.

Proper trade cost evaluation enables portfolio managers to better manage costs throughout the investment cycle and helps facilitate communication between the portfolio manager, traders, and brokers to better understand how and why costs occur during the implementation of investment decisions. Trade cost analysis also provides the basis for peer group comparisons, allowing a firm's portfolio managers to compare trading performance and costs with a universe of similar funds trading similar securities.

Trade evaluation helps buy-side traders quantify a broker's performance and rank brokers and/or algorithms most appropriate for implementation of different investment decisions. This helps minimize delay costs associated with trading.

Trade cost evaluation calculates trading costs and performance relative to a specified trading cost or trading performance benchmark. Costs are determined by the transaction amount paid above the reference price benchmark for a buy order and the discount below the reference price benchmark for a sell order. It is important that portfolio managers select the reference price for use on the basis of their selected trading price benchmark. For example, if the portfolio manager selected an arrival price benchmark, it is important to perform trade execution evaluation using the arrival price. If the fund manager selected the VWAP price as the price benchmark, then the reference price used in the post-trade analysis should include the VWAP price. If the fund selected a post-trade benchmark, such as the market on close, it is essential that the fund evaluate trading performance using the closing price benchmark.

Although one benchmark is used in execution, to represent the tradable strategy, multiple reference price benchmarks may be used to measure trading cost and to evaluate performance, typically on an intraday basis. For example, to measure trading costs, a pre-trade benchmark, such as the arrival price benchmark, may be used to provide the portfolio manager or trader with the estimated money required to complete the transaction. The trader may also compare the execution price of the order with an intraday benchmark such as the VWAP of the asset over the trading horizon to determine whether she achieved prices consistent with those of other market participants. Additionally, the trader may compare the last trade price of the order with a post-trade benchmark to understand whether there was price reversion after order completion. The use of multiple price benchmarks may provide valuable insights into different aspects of trading execution.

Trade cost calculations are expressed such that a positive value indicates underperformance and represents underperformance compared with the benchmark. A negative value indicates a savings and is a better performance compared with the benchmark. These calculations are as follows:

Cost in total dollars ($):

$$\text{Cost (\$)} = \text{Side} \times \left(\overline{P} - P^*\right) \times \text{Shares}$$

Cost in dollars per share ($/share):

$$\text{Cost (\$/share)} = \text{Side} \times \left(\overline{P} - P^*\right)$$

Cost in basis points (bps):

$$\text{Cost (bps)} = \text{Side} \times \frac{\left(\overline{P} - P^*\right)}{P^*} \times 10{,}000 \text{ bps}$$

$$\text{Side} = \begin{cases} +1 & \text{Buy order} \\ -1 & \text{Sell order} \end{cases}$$

$\overline{P}$ = Average execution price of order

P^* = Reference price

Shares = Shares executed

In most situations, investment professionals express costs in basis points because they represent a standardized measure across order sizes, market prices, and currencies. Portfolio managers will multiply the formulas listed by –1 to represent cost as a negative value and savings as a positive value.

Arrival Price

The arrival price benchmark measures the difference between the market price at the time the order was released to the market and the actual transaction price for the fund. This benchmark is used to measure the trade cost of the order incurred while the order was being executed in the market. This calculation follows the trading cost component from the expanded implementation shortfall formula.

Consider the following facts. A portfolio manager executes a buy order at an average price of $\overline{P}$ = \$30.05. The arrival price at the time the order was submitted to the market was P_0 = \$30.00. The arrival cost expressed in basis points is as follows:

$$\text{Arrival cost (bps)} = \text{Side} \times \frac{\left(\overline{P} - P_0\right)}{P_0} \times 10^4 \text{ bps}$$

$$= +1 \times \frac{(\$30.05 - \$30.00)}{\$30.00} \times 10^4 \text{ bps}$$

$$= 16.7 \text{ bps}$$

Therefore, the fund incurred an arrival cost of 16.7 bps, underperforming the arrival price benchmark by this amount.

VWAP

Portfolio managers use the VWAP benchmark as a measure of whether they received fair and reasonable prices over the trading period. Since the VWAP comprises all market activity over the day, all buying and selling pressure of all other market participants, and market noise, it provides managers with a reasonable indication of the fair cost for market participants over the day. In this situation, the VWAP reference price serves as a performance metric.

Consider the following facts. A portfolio manager executes a buy order at an average price of $\overline{P}$ = $30.05. The VWAP over the trading horizon is $30.04. The VWAP cost benchmark is computed as follows:

$$\text{VWAP cost (bps)} = \text{Side} \times \frac{(\overline{P} - \text{VWAP})}{\text{VWAP}} \times 10^4 \text{ bps}$$
$$= +1 \times \frac{(\$30.05 - \$30.04)}{\$30.04} \times 10^4 \text{ bps}$$
$$= 3.3 \text{ bps}$$

Therefore, the fund underperformed the VWAP by 3.3 bps. In most cases, the order will underperform the VWAP generally because of the bid–ask spread and the buying or selling pressure associated with the order.

TWAP

The TWAP benchmark is an alternative measure to determine whether the fund achieved fair and reasonable prices over the trading period and is used when managers wish to exclude potential trade price outliers.

Consider the following facts. A portfolio manager executes a buy order at an average price of $\overline{P}$ = $30.05. The TWAP over the trading horizon is $30.06. The VWAP cost benchmark is computed as follows:

$$\text{TWAP cost (bps)} = \text{Side} \times \frac{(\overline{P} - \text{TWAP})}{\text{TWAP}} \times 10^4 \text{ bps}$$
$$= +1 \times \frac{(\$30.05 - \$30.06)}{\$30.06} \times 10^4 \text{ bps}$$
$$= -3.3 \text{ bps}$$

Therefore, the fund outperformed the TWAP benchmark by 3.3 bps.

Market on Close

The closing benchmark, also referred to as an MOC benchmark, is used primarily by index managers and mutual funds that wish to achieve the closing price on the day and compare their actual transaction prices with the closing price. These funds will typically be valued using the closing price, and it is important that the portfolio manager perform benchmark analysis using the execution price of the order and the closing price on the day. Doing so ensures that the benchmark cost measure will be consistent with the valuation of the fund. The closing price benchmark is also the benchmark that is consistent with the tracking error calculation. MOC benchmarks are often used in fixed-income trading.

Consider the following facts. A portfolio manager executing a buy order using an MOC strategy transacts the order at an average price of $30.40. The stock's official closing price is $30.50. The closing benchmark cost is calculated as follows:

$$\text{Close (bps)} = \text{Side} \times \frac{(\overline{P} - \text{Close})}{\text{Close}} \times 10^4 \text{ bps}$$
$$= +1 \times \frac{(\$30.40 - \$30.50)}{\$30.50} \times 10^4 \text{ bps}$$
$$= -32.8 \text{ bps}$$

Thus, a closing benchmark cost of –32.8 bps indicates that the order was executed 32.8 bps more favorably than the closing price of the order. In the case of an index fund, the outperformance would contribute positive tracking error for the fund.

Market-Adjusted Cost

The market-adjusted cost is a performance metric used by managers and traders to help separate the trading cost due to trading the order from the general market movement in the security price (i.e., the price movement that would have occurred in the security even if the order was not executed in the market). For example, buying stock in a rising market and selling stock in a falling market will cause the fund to incur higher costs than expected, and selling stock in a rising market and buying stock in a falling market will cause the fund to incur lower costs than expected. A market-adjusted cost benchmark will help isolate the price movement due to the general market from the cost due to the impact of the order.

The market-adjusted cost is calculated by subtracting the market cost due to market movement adjusted for order side from the total arrival cost of the trade. The market cost is computed on the basis of the movement in an index and the stock's beta to that index, as follows:

$$\text{Index cost (bps)} = \text{Side} \times \frac{(\text{Index VWAP} - \text{Index arrival price})}{\text{Index arrival price}} \times 10^4$$

The index VWAP is the volume-weighted price of the index computed over the trading horizon. The index VWAP is often computed using an overall market index or a related ETF to compute a volume-weighted price. Alternatively, portfolio managers and traders may use a sector or industry index instead of the overall market index.

The market-adjusted cost is calculated as follows:

$$\text{Market-adjusted cost (bps)} = \text{Arrival cost (bps)} - \beta \times \text{Index cost (bps)}$$

In this case, β represents the stock's beta to the underlying index. The expectation in this formulation is that the stock would have exhibited price movement based on the market movement and the stock's sensitivity to the index measured via its beta to the index. This formulation thus helps remove the movement in the stock that would have occurred even if the order was not entered into the market.

Buying in a Rising Market

Consider a portfolio manager who executes a buy order at an average price of \$30.50. The arrival price at the time the order was entered into the market was \$30.00. The selected index price at the time of order entry was \$500, and market index VWAP over the trade horizon was \$505. If the stock has a beta to the index of $\beta = 1.25$, the market-adjusted cost can be calculated as follows:

Step 1 Calculate arrival cost.

$$\text{Arrival cost (bps)} = \text{Side} \times \frac{(\bar{P} - P_0)}{P_0} \times 10^4 \text{ bps}$$

$$= +1 \times \frac{(\$30.50 - \$30.00)}{\$30.00} \times 10^4 \text{ bps}$$

$$= 166.7 \text{ bps}$$

Step 2 Calculate index cost.

$$\text{Index cost (bps)} = \text{Side} \times \frac{(\text{Index VWAP} - \text{Index arrival price})}{\text{Index arrival price}} \times 10^4$$

$$= +1 \times \frac{\$505 - \$500}{\$500} \times 10^4$$

$$= 100 \text{ bps}$$

Step 3 Calculate market-adjusted cost.

$$\begin{aligned}\text{Market-adjusted cost (bps)} &= \text{Arrival cost (bps)} - \beta \times \text{Index cost (bps)}\\ &= 166.7 \text{ bps} - 1.25 \times 100 \text{ bps}\\ &= 166.7 \text{ bps} - 125 \text{ bps}\\ &= 41.7 \text{ bps}\end{aligned}$$

The portfolio manager bought stock in a rising market, and prices were generally increasing over the trading horizon because of market movement and the buying pressure of the order. The manager's arrival cost was 166.7 bps, and the market index cost over the period was 100 bps. The stock price would be expected to increase 125 bps over the period on the basis of the movement in the market index and the stock's beta to the index. In this situation, we subtract 125 bps in cost from the arrival cost of 166.7 bps because this amount represents expected market movement not due to the order. The market-adjusted cost due to the order is 41.7 bps, much lower than the total arrival cost.

IN-TEXT QUESTION

Selling in a Falling Market

A portfolio manager executes a sell order at an average price of \$29.50. The arrival price at the time the order was entered into the market was \$30.00. The selected index price at the time of order entry was \$500, and market index VWAP over the trade horizon was \$495. The stock has a beta to the index of 1.25.

1. Calculate arrival cost.
2. Calculate index cost.
3. Calculate market-adjusted cost.

Solution:

1. Calculate arrival cost.

$$\text{Arrival cost (bps)} = \text{Side} \times \frac{(\overline{P} - P_0)}{P_0} \times 10^4 \text{ bps}$$

$$= -1 \times \frac{(\$29.50 - \$30.00)}{\$30.00} \times 10^4 \text{ bps}$$

$$= 166.7 \text{ bps}$$

A positive arrival cost in this case indicates that the fund underperformed the arrival price benchmark.

2. Calculate index cost.

$$\text{Index cost (bps)} = \text{Side} \times \frac{(\text{Index VWAP} - \text{Index arrival price})}{\text{Index arrival price}} \times 10^4$$

$$= -1 \times \frac{\$495 - \$500}{\$500} \times 10^4$$

$$= 100 \text{ bps}$$

3. Calculate market-adjusted cost.

Market-adjusted cost (bps) = Arrival cost (bps) – β × Index cost (bps)

= 166.7 bps – 1.25 × 100 bps

= 166.7 bps – 125 bps

= 41.7 bps

In this example, the arrival cost is calculated to be +166.7 bps, indicating that the order underperformed the arrival price. Although this is true, much of the adverse prices were likely due to market movement rather than inferior performance from the broker or algorithm. This sell order was executed in a falling market, which resulted in an arrival cost of 166.7 bps for the investor. However, an estimated 125 bps of this cost was due to market movement, which would have occurred even if the order had not traded in the market. Thus, the market-adjusted cost for this order is 41.7 bps.

Added Value

Another methodology used by investors to evaluate trading performance is to compare the arrival cost of the order with the estimated pre-trade cost. The expected trading cost is calculated using a pre-trade model and incorporates such factors as order size, volatility, market liquidity, investor risk aversion, level of urgency (i.e., how fast or slow the trade is to be executed in the market), and the underlying market conditions at the time of the trade. If a fund executes at a cost lower than the pre-trade estimate, it is typically considered superior trade performance. If the order is executed at a cost higher than the pre-trade cost benchmark, then the trade is considered to have underperformed expectations. This metric helps fund managers understand the value added by their broker and/or execution algorithms during the execution of the order. The added value metric is computed as follows:

Added value (bps) = Arrival cost (bps) – Est. pre-trade cost (bps)

Consider the following facts. A portfolio manager executes a buy order at an average price of $\overline{P}$ = \$50.35. The arrival price at the time the order was entered into the market was P_0 = \$50.00. Prior to trading, the buy-side trader performs pre-trade analysis of the order and finds that the expected cost of the trade is 60 bps, based on information available prior to trading. The pre-trade adjustment is calculated as follows:

Pre-trade adjustment = Arrival cost – Est. pre-trade cost

We have,

$$\text{Arrival cost (bps)} = \text{Side} \times \frac{\left(\overline{P} - P_0\right)}{P_0} \times 10^4 \text{ bps}$$
$$= +1 \times \frac{(\$50.35 - \$50.00)}{\$50.00} \times 10^4 \text{ bps}$$
$$= 70 \text{ bps}$$

Added value = Arrival cost – Est. pre-trade cost = 70 bps – 60 bps = 10 bps

The pre-trade adjusted cost in this example is 10 bps, indicating that the fund underperformed pre-trade expectations by 10 bps.

Proper trade cost measurement and evaluation are critical to understanding the costs and risks arising from trading. These help inform where a firm's trading activities may be improved through better internal trade management practices, such as the use of appropriate trading partners and venues. Trade governance involves the policies and processes used by firms to manage their trading-related activities.

TRADE GOVERNANCE

10

☐ evaluate a firm's trading procedures, including processes, disclosures, and record keeping with respect to good governance

All asset managers should have a trade policy document that clearly and comprehensively articulates the firm's trading policies and escalation procedures (i.e., calling on higher levels of leadership or management in an organization to resolve issues when they cannot be resolved by standard procedures). Such a document is mandated by major market regulators and regulations, including the SEC in the United States, the updated Markets in Financial Instruments Directive (MiFID II) in the European Union, the Financial Services Agency in Japan, and the Securities and Futures Commission in Hong Kong SAR.

The objective of a trade policy is to ensure the asset manager's execution and order-handling procedures are in line with the duty of best execution that is owed to clients. Any trade policy needs to include several key aspects. These include the following:

- **Meaning of best execution:** A trade policy document should outline the meaning of best execution as defined by the relevant regulatory framework. This meaning may be supplemented by additional details. For example, generally best execution does not just mean achieving the best execution price at the lowest possible cost but also involves achieving the right trade-off between different objectives.
- **Factors determining the optimal order execution approach:** A trade policy document should describe the factors used in determining how an order can be executed in an optimal manner for a given scenario. For example, the optimal execution approach may differ by asset class, level of security liquidity, and security trading mechanism (order-driven markets, quote-driven markets, and brokered markets). The optimal execution approach can also depend on the nature of a manager's investment process.
- **Listing of eligible brokers and execution venues:** A trade policy should allow the investment manager flexibility to use different brokers and trading venues to achieve best execution in a particular scenario. To reduce operational risk, checks should be in place to ensure only reputable brokers and execution venues that meet requirements for reliable and efficient order execution are used.
- **Process to monitor execution arrangements:** Optimal order execution arrangements may change over time as markets and securities evolve. Therefore, continual monitoring of current arrangements is needed. The details of the monitoring process should be outlined in a trade policy document.

Asset managers that aggregate trades for client accounts and funds should have a "trade aggregation and allocation" policy in place. These policies seek to ensure executed orders are allocated fairly to individual clients on a pre-trade and post-trade basis, there are remedies for misallocations, and an escalation policy is in place. For example, if several accounts (e.g., pooled funds or separate accounts) follow the same or a similar investment strategy and have similar trading needs, then pooling the trades for trade execution may make sense in some situations. If a pooled trade is not fully executed, the order amount that is executed generally needs to be allocated to accounts on a pro-rata basis so that no account is disadvantaged relative to the others. In all cases, the aggregation and allocation process should be transparent and provide an audit trail in case questions are raised after the fact.

Firms should have a policy in place for the treatment of trade errors. Errors from trading and any resulting gains/losses need to be disclosed to a firm's compliance department and documented in a trade error log. The trade error log should include any related documentation and evidence that trade errors are resolved in a way that prevents adverse impact for the client.

Meaning of Best Order Execution within the Relevant Regulatory Framework

A trade policy document should outline the meaning of best execution within the relevant regulatory framework. Although there may be slight differences in how best execution is defined by different regulators and in different financial market regulations, the underlying concept requires orders to be executed on terms most favorable to the client, where firms consider the following:

- execution price,
- trading costs,
- speed of execution,
- likelihood of execution and settlement,
- order size, and
- nature of the trade.

Rather than simply trying to obtain the best price at the lowest possible trading cost, best execution involves identifying the most appropriate trade-off between these aspects. For example, although market impact costs can generally be lowered by trading more patiently, patient trading may be suboptimal for an asset manager that uses extremely short-horizon expected return forecasts, which decay quickly.

Factors Used to Determine the Optimal Order Execution Approach

Firms need to have a list of criteria or factors used in determining the optimal order execution approach to achieve the best possible results for clients on a consistent basis.

Best execution requires investment managers to seek the most advantageous order execution for their customers given market conditions. Best execution includes several key factors that brokers examine, track, and document when choosing how to execute an order. An asset manager needs to ensure that after examining these factors, the broker achieved the best possible execution for the client.

At a firm level, execution policy and procedures need to specify the factors or criteria considered in determining the optimal order execution approach in each scenario. These criteria include the following:

- **Urgency of an order:** Does the order need to be executed aggressively at an accelerated pace, or can it be traded over a longer period of time? What is the size of the order relative to the security's normal liquidity?
- **Characteristics of the securities traded:** How liquid are the securities to be traded (e.g., the average daily volume)? Are the securities standardized or highly customized?

- **Characteristics of the execution venues used:** Which type of trading mechanism or venue is used? Are both lit (on-exchange) markets and dark markets available to trade a security?
- **Investment strategy objectives:** Is the investment strategy short term or long term in nature?
- **Rationale for a trade:** Is a trade intended to capture an investment manager's expected return views? Or is it a risk trade or a liquidity trade? Underlying trade objectives may have important implications for the optimal trade approach.

MiFID II, which came into effect in January 2018 and covers the European Economic Area, provides additional regulations on best execution. MiFID II requires firms to take all sufficient steps to obtain the best possible result in executing client orders. The best possible result is not limited to execution price but also includes consideration of cost, speed, likelihood of execution, likelihood of settlement, and any other factors deemed relevant. MiFID II's "all sufficient steps" test sets a higher standard than the previous "all reasonable steps" standard of MiFID I.

MiFID II prohibits the bundling, or combining, of trading commissions with research provided by brokers, known as a soft dollar arrangement. Under MiFID II, investment managers need the firm to pay for broker research costs or establish a research payment account funded by a special charge to clients. Other jurisdictions place limitations on soft dollar arrangements and are expected to follow MiFID II requirements in making execution and research payments explicit and transparent for clients.

Ensuring best execution often requires different criteria for each asset class that should be incorporated into trade policy and procedures. In terms of execution factors, the relative importance of individual factors often differs by asset class. Exhibit 2 shows key considerations by asset class.

Exhibit 2: Key Considerations for Best Execution

Asset Class	Considerations
Equities and Exchange-Traded Options and Futures	An investment manager needs to choose the type of market or venue used for execution. In many cases, there are lit (on-exchange) markets and dark markets available for more liquid securities. Lit markets provide pre-trade and post-trade transparency, whereas dark markets provide post-trade transparency. The liquidity of a security and the percentage of average daily volume traded are critical in the choice of optimal execution algorithm. Historical transaction data—including liquidity characteristics and price volatility—are widely available and can be readily assessed.
Fixed Income	There are two main issues: market transparency and price discovery. Only some of the trading, particularly in corporate bonds, takes place on venues that provide market transparency as well as simultaneous, competitive quotes enabling price discovery, which is a necessary condition to ensure best execution. Generally, trade policy should dictate that, if at all possible, bids/offers should be requested from multiple independent third parties before a trade is executed. This process fosters competition and provides a more precise estimate of the likely market price at a particular time in an effort to achieve the best price possible. If there is no market transparency and if multiple competing quotes cannot or should not be obtained, then a trade policy should outline alternative means to achieve price discovery. These may include data sources (such as TRACE data)* for historical transaction prices or quotes for a given security or comparable securities. In the absence of any relevant transaction prices or quotes, an internal or external pricing model could be used to establish a market price estimate.

Asset Class	Considerations
OTC Derivatives	Broker selection may depend on the exact terms of the proposed OTC derivative instruments, counterparty risk, and a broker's settlement capabilities.
Spot Currencies	Quotes should be requested from multiple independent dealers before a trade is executed. This process fosters competition in an effort to achieve the best price possible.

** In 2002, the National Association of Securities Dealers introduced TRACE (Trade Reporting and Compliance Engine) in an effort to increase price transparency in the US corporate debt market.*

List of Eligible Brokers and Execution Venues

Asset managers should have a list of approved brokers and execution venues for trading and the criteria used to create this list. In determining the list, there should not be discrimination against brokers or execution venues. Any decisions should be made according to the policy and procedures put in place. Creating and maintaining the list should be a collaborative effort shared by portfolio execution, compliance, and risk management. A best practices approach is to create a Best Execution Monitoring Committee within an investment management firm that is responsible for maintaining and updating the list regularly, or as circumstances require, and distributing the list to all parties involved in trade execution.

Although the criteria used to approve an execution venue or broker differ by asset class, the principles behind the decision and the process followed should be consistent across asset classes, broker firms, regions, and jurisdictions. A number of qualitative and quantitative factors are relevant to this decision, such as the following:

- **Quality of service:** Does a broker provide competitive execution compared with an execution benchmark, such as submission price or VWAP?
- **Financial stability:** Will the broker or execution venue be able to fulfill obligations in all market environments? When such brokers as Lehman Brothers and MF Global went bankrupt, it caused substantial disruption to their clients' activities.
- **Reputation:** Does the broker or execution venue uphold high ethical standards and treat clients fairly?
- **Settlement capabilities:** Are the operations supporting the broker/execution venue robust? Can trades be settled in a reliable and efficient manner?
- **Speed of execution:** Can urgent trades be implemented with minimal delay and at the best price possible? What is the maximum volume that can be traded with minimal delay?
- **Cost competitiveness:** Are the explicit costs (such as commissions or exchange fees) competitive?
- **Willingness to commit capital:** Is the broker willing to act as a dealer to facilitate trading for a client? This can be particularly important for less liquid securities that need to be traded in a timely manner.[8]

A sensible trade policy is particularly important in trade venue selection for transactions that are executed off exchange in so-called over-the-counter markets. Best execution is generally harder to measure for these trades, and there are unique risks associated with OTC trading. For example, OTC trades are not subject to any trading

8 In this case, the broker, acting as principal rather than agent, is the counterparty to client transactions. Although this can be useful for clients, potential conflicts of interest may arise, and principal trades should be monitored closely by managers for potential conflicts of interest the broker may have.

venue rules designed to ensure fair and orderly treatment of orders or minimum levels of price transparency. In addition, there may be counterparty and settlement risk for OTC trades.

Process Used to Monitor Execution Arrangements

All brokers and execution venues used by the asset manager should be subject to ongoing monitoring for reputational risk, irregularities (such as trading errors), criminal actions, and financial stability. Brokers and execution venues that no longer meet minimum requirements should be promptly removed from the approved list.

Execution quality on realized transactions through different brokers or execution venues should also be monitored continuously. Systems that allow ongoing monitoring of order execution quality should be in place. Although the specific process may vary by asset class and security type, the underlying principles remain the same. Summary reports of execution quality should be produced, examined, and evaluated on a regular basis.

Checkpoints for trade execution monitoring include the following:

- Trade submission: Has the trading/execution strategy been implemented consistent with the investment process (alpha and risk forecasting horizon, rebalancing frequency, etc.), and is it optimal for the asset type traded?
- What was the execution quality of a trade relative to its benchmark (e.g., arrival price, VWAP, TWAP, market close)?
- Is there an appropriate balance between trading costs and opportunity costs (for non-executed trades)?
- Could better execution have been achieved using a different trading strategy, different intermediaries, or different trading venues?

Asset managers are well advised to have in place the equivalent of a Best Execution Monitoring Committee (BEMC) that has firm-wide responsibility for trade execution monitoring. The BEMC should collaborate with portfolio managers and risk management and legal/compliance departments to ensure potential issues with execution quality are identified, discussed, and acted on in a timely manner.

Trading records and the evaluation of those records should generally be stored and kept accessible by firms for several years (e.g., in the United Kingdom, the requirement is five years). Trading records may be used to do the following:

- **Address client concerns:** For example, trading records can be used as evidence by an investment manager to show clients that their accounts have been treated fairly. This is particularly relevant if an investment manager runs similar strategies that might frequently trade in the same direction. For instance, there may be a need to demonstrate fair trade allocation or that particular strategies are not being favored at the expense of others.
- **Address regulator concerns:** A regulator may be interested in assessing how the investment manager has met best execution standards. In addition, regulators need to monitor market integrity and detect criminal behavior, such as “fake volumes,” “quote stuffing,” and “spoofing,” which are illegal activities in most markets.[9]

9 *Fake volumes* refer to the practice whereby a trading venue or exchange executes transactions with itself (i.e., it is on both sides of a trade) to artificially inflate reported trading volume to attract client business. *Quote stuffing* is a practice that has been used by high-frequency traders that involves entering and withdrawing a large number of orders within an extremely short period of time in an attempt to confuse the market and create trading opportunities for the high-frequency trader. *Spoofing* is a manipulative practice defined as bidding or offering with the intent to cancel before execution. All these practices are attempts to gain an unfair advantage over other market participants by engaging in manipulative behavior.

- **Assist in improving execution quality:** A database of past transactions may be used to analyze and refine the execution process to control and improve trading costs.
- **Monitor the parties involved in trading/order execution:** Trading records can be used to evaluate how performance by brokers and execution venues may compare in execution quality. This helps inform which services should be retained in the future.

These policies and procedures should be outlined in a comprehensive document and reviewed regularly (for example, quarterly) and when the need arises. Updates should be made when circumstances change. This document could be created by a BEMC and should involve portfolio management, risk management, and legal/compliance departments. If no formal committee is tasked with owning this document, then the legal/compliance department might take responsibility, with collaboration from portfolio management and risk management functions.

IN-TEXT QUESTION

Choice of Broker

ABC Asset Management (ABCAM) is one of the world's largest asset managers. ABCAM has been using AAA Brokerage (AAAB) as its exclusive broker for a number of its funds for many years. Other brokers are used only for market segments in which AAAB does not have business operations. The leadership of ABCAM explains its choice of broker by stating, "Because of its long-standing business relationship with AAAB, ABCAM has a uniquely informed insight into the operations of AAAB, which provides greater comfort and assurance that AAAB will fulfill its duties when compared with other brokers."

Discuss whether this practice is permissible and can be justified.

Solution:

ABCAM needs to show that it takes all sufficient steps to ensure best execution for its clients' trades. This includes choosing brokers that provide the best service for potential best execution. In order to justify that AAAB is the right broker to use, ABCAM must demonstrate that it has done comparisons of different brokers, that this analysis is regularly conducted with updates, and that each time AAAB is found to be the best choice for order implementation. A thorough and unbiased analysis is required for this. Stating a subjective opinion, such as the explanation provided by ABCAM leadership, is not sufficient justification.

IN-TEXT QUESTION

Trade Policy Document

For several decades, XYZ Capital has been running enhanced index funds. These funds have low levels of target tracking error compared with their market-weighted benchmarks. The firm's trade policy document has a focus on minimizing trading costs and defines best execution as follows:

> "The firm takes all sufficient steps to obtain the best possible result in executing orders; that is, the firm makes its best attempt to achieve the best execution price and lowest trading cost possible for every transaction. In this way, the firm achieves best execution for its client portfolios."

Discuss whether the trade policy statement is in line with regulatory requirements and client best interests.

Solution:

Achieving the best execution price at the lowest trading cost possible is only part of the best execution effort. To ensure that clients and their portfolios are served in the best manner possible, other factors require consideration. These considerations include the speed of execution, the alignment of execution approach and execution horizon with the investment process, the likelihood of execution to be optimal, and so on. An exclusive focus on best execution price and lowest trading cost is too narrow a definition to achieve best client execution. For example, doing so could leave many trades unexecuted, which would result in increased opportunity costs from lost opportunities that could not be implemented.

SUMMARY

- Portfolio manager motivations to trade include profit seeking, risk management (hedging), liquidity driven (fund flows), and corporate actions and index reconstitutions.
- Managers following a short-term alpha-driven strategy will trade with greater urgency to realize alpha before it dissipates (decays). Managers following a longer-term strategy will trade with less urgency if alpha decay is expected to be slower.
- Trading is required to keep portfolios at targeted risk levels or risk exposures, to hedge risks that may be outside a portfolio manager's investment objectives or that the portfolio manager does not have an investment view on.
- Trading may be liquidity driven resulting from client activity or index reconstitutions. In these cases, managers typically trade using end-of-day closing prices because these prices are used for fund and benchmark valuation.
- Inputs affecting trade strategy selection include the following types: order related, security related, market related, and user based.
- Order characteristics include the side (or trade direction) and size of an order. Percentage of average daily volume is a standardized measure used in trading that indicates what order size can realistically be traded. Large trades are generally traded over longer time horizons to minimize market impact.
- Security characteristics include security type, short-term (trade) alpha, security price volatility, and a security's liquidity profile.
- Market conditions at the time of trading (intraday trading volumes, bid–ask spreads, and security and market volatility) should be incorporated into trade strategy since they can differ from anticipated conditions.
- Market volatility and liquidity vary over time, and liquidity considerations may differ substantially during periods of crisis.
- Individuals with higher levels of risk aversion are more concerned with market risk and tend to trade with greater urgency.

- Market impact is the adverse price impact in a security caused from trading an order and can represent one of the largest costs in trading.
- Execution risk is the adverse price impact resulting from a change in the fundamental value of the security and is often proxied by price volatility.
- Reference price benchmarks inform order trading prices and include pre-trade, intraday, post-trade, and price target benchmarks.
- Managers seeking short-term alpha will use pre-trade benchmarks, such as the arrival price, when they wish to transact close to current market prices (greater trade urgency).
- Managers without views on short-term price movements who wish to participate in volumes over the execution horizon typically use an intraday benchmark, such as VWAP or TWAP.
- Managers of index funds or funds whose valuation is calculated using closing prices typically select the closing price post-trade benchmark to minimize fund risk and tracking error.
- The primary goal of a trading strategy is to balance the expected costs, risks, and alpha associated with trading the order in a manner consistent with the portfolio manager's trading objectives, risk aversion, and other known constraints.
- Execution algorithms can be classified into the following types: scheduled, liquidity seeking, arrival price, dark aggregators, and smart order routers.
- Equities are traded on exchanges and other multilateral trading venues. Algorithmic trading is common, and most trades are electronic, except for very large trades and trades in illiquid securities.
- Fixed-income securities are generally traded not on exchanges but in a bilateral, dealer-centric market structure where dealers make markets in the securities. The majority of fixed-income securities are relatively illiquid, especially if they have been issued in prior periods, so-called off-the-run bonds.
- Most of the trading volume in exchange-traded derivatives is concentrated in futures. Electronic trading is pervasive, and algorithmic trading is growing.
- OTC derivative markets have historically been opaque, with little public data about prices, trade sizes, and structure details. In recent years, regulators have been placing pressure on OTC markets to introduce central clearing facilities and to display trades publicly in an attempt to increase contract standardization and price discovery and reduce counterparty risk.
- There is no exchange or centralized clearing place for the majority of spot currency trades. Spot currency markets consist of a number of electronic venues and broker markets. The currency market is entirely an OTC market.
- The implementation shortfall measure is the standard for measuring the total cost of the trade. IS compares a portfolio's actual return with its paper return (where transactions are based on decision price).
- The IS attribution decomposes total trade cost into its delay, execution, and opportunity cost components.
- Delay cost is the cost associated with not submitting the order to the market at the time of the portfolio manager's investment decision.
- Execution cost is the cost due to the buying and/or selling pressure of the portfolio manager and corresponding market risk.

- Opportunity cost is the cost due to not being able to execute all shares of the order because of adverse price movement or insufficient liquidity.
- Trade evaluation measures the execution quality of the trade and the performance of the trader, broker, and/or algorithm used.
- Various techniques measure trade cost execution using different benchmarks (pre-trade, intraday, and post-trade).
- Trade cost analysis enables investors to better manage trading costs and understand where trading activities can be improved through the use of appropriate trading partners and venues.
- Major regulators mandate that asset managers have in place a trade policy document that clearly and comprehensively articulates a firm's trading policies and escalation procedures.
- The objective of a trade policy is to ensure the asset manager's execution and order-handling procedures are in line with their fiduciary duty owed to clients for best execution.
- A trade policy document needs to incorporate the following key aspects: meaning of best execution, factors determining the optimal order execution approach, handling trading errors, listing of eligible brokers and execution venues, and a process to monitor execution arrangements.

PRACTICE PROBLEMS

The following information relates to questions 1-9

Robert Harding is a portfolio manager at ValleyRise, a hedge fund based in the United States. Harding monitors the portfolio alongside Andrea Yellow, a junior analyst. ValleyRise only invests in equities, but Harding is considering other asset classes to add to the portfolio, namely derivatives, fixed income, and currencies. Harding and Yellow meet to discuss their trading strategies and price benchmarks.

Harding begins the meeting by asking Yellow about factors that affect the selection of an appropriate trading strategy. Yellow tells Harding:

Statement 1	Trading with greater urgency results in lower execution risk.
Statement 2	Trading larger size orders with higher trade urgency reduces market impact.
Statement 3	Securities with high rates of alpha decay require less aggressive trading to realize alpha.

After further discussion about Yellow's statements, Harding provides Yellow a list of trades that he wants to execute. He asks Yellow to recommend a price benchmark. Harding wants to use a benchmark where the reference price for the benchmark is computed based on market prices that occur during the trading period, excluding trade outliers.

Earlier that day before the meeting, Yellow believed that the market had underreacted during the pre-market trading session to a strong earnings announcement from ABC Corp., a company that Yellow and Harding have been thoroughly researching for several months. Their research suggested the stock's fair value was $90 per share, and the strong earnings announcement reinforced their belief in their fair value estimate.

Right after the earnings announcement, the pre-market price of ABC was $75. Concerned that the underreaction would be short-lived, Harding directed Yellow to buy 30,000 shares of ABC stock. Yellow and Harding discussed a trading strategy, knowing that ABC shares are very liquid and the order would represent only about 1% of the expected daily volume. They agreed on trading a portion of the order at the opening auction and then filling the remainder of the order after the opening auction. The strategy for filling the remaining portion of the order was to execute trades at prices close to the market price at the time the order was received.

Harding and Yellow then shift their conversation to XYZ Corp. Harding tells Yellow that, after extensive research, he would like to utilize an algorithm to purchase some shares that are relatively liquid. When building the portfolio's position in XYZ, Harding's priority is to minimize the trade's market impact to avoid conveying information to market participants. Additionally, Harding does not expect adverse price movements during the trade horizon.

Harding and Yellow conclude their meeting by comparing trade implementation for equities with the trade implementation for the new fixed-income, exchange-traded derivatives, and currency investments under consideration. Yellow tells Harding:

Statement 1	Small currency trades and small exchange-traded derivatives trades are typically implemented using the direct market access (DMA) approach.
Statement 2	The high-touch agency approach is typically used to execute large, non-urgent trades in fixed-income and exchange-traded derivatives markets.

The next day, Harding instructs Yellow to revisit their research on BYYP, Inc. Yellow's research leads her to believe that its shares are undervalued. She shares her research with Harding, and at 10 a.m. he instructs her to buy 120,000 shares when the price is $40.00 using a limit order of $42.00.

The buy-side trader releases the order for market execution when the price is $40.50. The only fee is a commission of $0.02 per share. By the end of the trading day, 90,000 shares of the order had been purchased, and BYYP closes at $42.50. The trade was executed at an average price of $41.42. Details about the executed trades are presented in Exhibit 1.

Exhibit 1: BYYP Trade Execution Details

Trades	Execution Price	Shares Executed
Trade 1	$40.75	10,000
Trade 2	$41.25	30,000
Trade 3	$41.50	20,000
Trade 4	$41.75	30,000
Total		90,000

While the buy-side trader executes the BYYP trade, Harding and Yellow review ValleyRise's trade policy document. After reviewing the document, Yellow recommends several changes: 1) add a policy for the treatment of trade errors; 2) add a policy that ensures over-the-counter derivatives are traded on venues with rules that ensure minimum price transparency; and 3) alter the list of eligible brokers to include only those that provide execution at the lowest possible trading cost.

1. Which of Yellow's statements regarding the factors affecting the selection of a trading strategy is correct?

   A. Statement 1

   B. Statement 2

   C. Statement 3

2. Given the parameters for the benchmark given by Harding, Yellow should recommend a benchmark that is based on the:

   A. arrival price.

   B. time-weighted average price.

   C. volume-weighted average price.

3. To fill the remaining portion of the ABC order, Yellow is using:

   A. an arrival price trading strategy.

   B. a TWAP participation strategy.

   C. a VWAP participation strategy.

4. What type of algorithm should be used to purchase the XYZ shares given Harding's priority in building the XYZ position and his belief about potential price movements?

   A. Scheduled algorithm

   B. Arrival price algorithm

   C. Opportunistic algorithm

5. Which of Yellow's statements regarding the trade implementation of non-equity investments is correct?

   A. Only Statement 4

   B. Only Statement 5

   C. Both Statement 4 and Statement 5

6. Based on Exhibit 1, the execution cost for purchasing the 90,000 shares of BYYP is:

   A. $60,000.

   B. $82,500.

   C. $127,500.

7. Based on Exhibit 1, the opportunity cost for purchasing the 90,000 shares of BYYP is:

   A. $22,500.

   B. $60,000.

   C. $75,000.

8. The arrival cost for purchasing the 90,000 shares of BYYP is:

   A. 164.4 bp.

   B. 227.2 bp.

   C. 355.0 bp.

9. As it relates to the trade policy document, ValleyRise should implement Yellow's recommendation related to:

   A. the list of eligible brokers.

   B. a policy for the treatment of trade errors.

   C. a policy for over-the-counter derivatives trades.

The following information relates to questions 10-11

Lindsey Morris is a trader at North Circle Advisors, an investment management firm and adviser to a suite of value-oriented equity mutual funds. Will Beamon, portfolio manager for the firm's flagship large-cap value fund, the Ogive Fund, is explaining its investment strategy and objectives to Morris. Morris wishes to know how the Ogive Fund's underlying trading motivations may impact trade urgency and alpha decay. Beamon notes the following relevant characteristics of the Ogive Fund:

- Seeks long-term outperformance vs. S&P 500 by investing in undervalued companies
- Evaluates company fundamentals to identify persistent mispricing opportunities
- Has a three-year average holding period

10. **Determine**, based on Beamon's description of the Ogive Fund's characteristics, his likely inclination to aggressively implement the fund's strategy. **Justify** your response.

11. Morris next meets Robin Barker, portfolio manager for North Circle Advisors' small-cap value fund, the Pengwyn Fund, which just received a very large cash inflow. Barker expects equity markets will drift higher in the near-term and asks Morris about the best ways to minimize cash drag for the Pengwyn Fund after the inflow.

Describe an appropriate cash management strategy for Barker.

The following information relates to questions 12-13

Last year, Larry Sailors left his trading position at Valley Ranch Partners, a multi-strategy hedge fund, to join North Circle Advisors. Discussing his job experiences with a colleague, Sailors remarks that, prior to starting at North Circle, he didn't fully appreciate the significant differences in trading motivations between the two firms and how such motivations feed into trade strategy. In particular, he notes the following trade characteristics:

Exhibit 1: Features of Trades by Sailors' Employers

Feature	Valley Ranch Partners	North Circle Advisors
Investment Philosophy	Short-term long and short alpha trades across equity and non-equity securities	Long equity value investing
Trade Size	Small	Large
Risk Appetite	Low	Moderate to high

Feature	Valley Ranch Partners	North Circle Advisors
Trading Venue	Listed securities only	Listed and non-listed securities
Bid–Ask Spreads Experienced in Downturn	Moderate-to-wide	Very wide

12. **Identify** one difference between the trading features of Valley Ranch and North Circle, as noted by Sailors, for each trade strategy selection criterion.

Selection Criterion for Trade Strategy	**Identify** one difference between the trading features of Valley Ranch and North Circle, as noted by Sailors, for each trade strategy selection criterion.
Order Characteristics	
Security Characteristics	
Market Conditions	
Individual Risk Aversion	

13. The next day, Sailors is asked to implement the following buy orders, with target execution price set at Last Trade. He is concerned about minimizing execution risk and market impact.

Exhibit 2: Descriptions of Prospective Buy Orders

Stock	Order Size (#)	Last Trade ($)	Avg. Daily Volume (#)	Price Volatility	Bid–Ask Spread ($)
ABC	45,000	$310.10	195,000	Low	$309.75–$310.35
DEF	55,000	$40.45	4,125,260	Low	$40.39–$40.56
XYZ	8,000	$101.94	750,850	High	$100.82–$102.00

Determine which trades are *most likely* to exhibit the greatest execution risk and market impact. **Justify** each selection.

Determine which trades are *most likely* to exhibit the greatest execution risk and market impact. (Circle one in each column)

Execution Risk	Market Impact
ABC	ABC
DEF	DEF
XYZ	XYZ

Justify each selection.

The following information relates to questions 14-20

Michelle Wong is a portfolio manager at Star Wealth Management (SWM), an investment management company whose clients are high-net-worth individuals. Her expertise is in identifying temporarily mispriced equity securities. Wong's typical day includes meeting with clients, conducting industry and company investment analysis, and preparing trade recommendations.

Music Plus

Wong follows the music industry and, specifically, Music Plus. After highly anticipated data about the music industry is released shortly after the market opens for trading, the share price of Music Plus quickly increases to $15.25. Wong evaluates the new data as it relates to Music Plus and concludes that the share price increase is an overreaction. She expects the price to quickly revert back to her revised fair value estimate of $14.20 within the same day. When the price is $15.22, she decides to prepare a large sell order equal to approximately 20% of the expected daily volume. She is concerned about information leakage from a public limit order. Wong's supervisor suggests using algorithmic trading for the sell order of the Music Plus shares.

West Commerce

Later the same day, West Commerce announces exciting new initiatives resulting in a substantial increase in its share price to $27.10. Based on this price, Wong concludes that the stock is overvalued and sets a limit price of $26.20 for a sell order of 10,000 shares. By the time the order is released to the market, the share price is $26.90. The share price closes the day at $26.00. SWM is charged a commission of $0.03 per share and no other fees. Selected data about the trade execution are presented in Exhibit 1.

Exhibit 1: Selected Trade Data: West Commerce Sell Order

Trades	Execution price	Shares executed
Trade 1	$26.80	6,000
Trade 2	$26.30	3,000
Total		9,000

The value of the market index appropriate to West Commerce was 600 when the West Commerce sell order was released to the market, and its volume-weighted average price (VWAP) was 590 during the trade horizon. West Commerce has a beta of 0.9 with the index.

Trading Policies

At the end of the day, Wong meets with a long-term client of SWM to discuss SWM's trade policies. The client identifies two of SWM's trade policies and asks Wong whether these are consistent with good trade governance:

Policy 1 SWM works only with pre-approved brokers and execution venues, and the list is reviewed and updated regularly.

Policy 2 SWM is allowed to pool funds when appropriate, and executed orders are allocated to the accounts on a pro-rata basis.

14. The *most appropriate* price benchmark for the sell order of Music Plus shares is the:

    A. closing price.

    B. decision price.

    C. time-weighted average price (TWAP).

15. The *most* appropriate trading strategy for the sell order of Music Plus shares is:

    A. trading in the open market.

    B. selling at the closing auction for the day.

    C. passive trading over the course of the trading day.

16. The trade algorithm that Wong should consider for the sell order of Music Plus shares is:

    A. a POV algorithm.

    B. an arrival price algorithm.

    C. a liquidity-seeking algorithm.

17. The implementation shortfall, in basis points (bps), for the sell order of West Commerce shares is *closest* to:

    A. 139.

    B. 198.

    C. 206.

18. The delay cost in dollars for the sell order of West Commerce shares is:

    A. $1,800.

    B. $2,000.

    C. $2,700.

19. The market-adjusted cost in basis points for the sell order of West Commerce shares is *closest* to a:

    A. cost of 249 bps.

    B. savings of 50 bps.

    C. savings of 68 bps.

20. Which of SWM's trading policies identified by the client are consistent with good trade governance?

    A. Only Policy 1

    B. Only Policy 2

C. Both Policy 1 and Policy 2

The following information relates to questions 21-23

Although focused on long-term value, North Circle Advisors will exploit temporary mispricings to open positions. For example, portfolio manager Bill Bradley pegged LIM Corporation's fair value per share at $28 yesterday; however, LIM's stock price seems to have overreacted to a competitor announcement prior to market open today. The follow events unfold over the course of the morning:

- PRIOR CLOSE: LIM closed at $30.05
- PRE-MARKET: LIM priced at $20.34
- MARKET OPEN: LIM opens at $22.15
- 10:00 AM: LIM trading at $23.01
- 10:00 AM: Bradley confirms the overreaction with target price of $28
- 10:05 AM: Bradley instructs trader to buy 25,000 shares, with a limit price of $28 when LIM is trading at $23.09
- 10:22 AM: Trader finishes the buy with an average purchase price of $23.45

Bradley and the trader conduct a post-trade evaluation. In picking an appropriate reference price, the trader asks Bradley if that would be a pre-trade, intraday, post-trade, or price target benchmark.

21. **Identify** the likely appropriate price benchmark for the LIM trade. **Justify** your response.

Identify the likely appropriate price benchmark for the LIM trade. (Circle one)

Pre-Trade	Intraday	Post-Trade	Price Target
Justify your response.			

22. Bradley also performs a cost analysis on the LIM trade. Noting the time gap between his trade instructions and the order's submission to the market, Bradley quantifies the cost of the delay.

    Calculate the delay cost incurred in trading the LIM order.

23. Bradley also sees that following a 10 a.m. Federal Reserve press conference, the market rose significantly throughout that day. He wants to separate out the pricing effect of this general market movement from the cost of trading LIM. Bradley and the trader agree to use an arrival price benchmark for this analysis and gather the following data related to a broad market index:

    - Index price at time of order entry: $2,150
    - Index volume-weighted average price over trade horizon: $2,184
    - LIM beta to Index: 0.95

    Calculate the market-adjusted cost of the trade. **Discuss** the finding.

The following information relates to questions 24-25

Beatrice Minchow designs and implements algorithmic trading strategies for Enlightenment Era Partners LLC (EEP). Minchow is working with Portfolio Manager James Bean on an algorithm to implement a sell order for Bean's small position in the lightly-traded shares of public company Dynopax Inc. In a conversation with Minchow, Bean states the following:

- I have no expectations of adverse price movements during the trade horizon and would like to use a scheduled algorithm.
- I want to minimize market impact, but I'm more concerned about getting the sell order completely executed in one day.

Based on Bean's comments, Minchow considers three algorithms: POV, VWAP, and TWAP.

24. **Determine** which algorithm Minchow is likely to use for the Dynopax sell order. **Justify** your response.

Determine which algorithm Minchow is likely to use for the Dynopax sell order. (Circle one)

POV	VWAP	TWAP
Justify your response.		

25. Minchow is also tasked to help EEP exit from a large position in a widely-traded blue chip stock. While the trade is non-urgent, given the position's size, Bean is worried about telegraphing intentions to the market. Minchow discusses alternative trading systems with Bean, highlighting dark pools, and makes the following comments:

- Comment 1: A feature of a dark pool is that transactions and quantities won't be reported.
- Comment 2: While a dark pool does provide anonymity, there is less certainty of execution.

Determine the veracity of each comment. **Justify** each response.

Determine the veracity of each comment. **Justify** each response.

Comment	**Veracity** (Circle one for each row)	**Justification**
1	Correct Incorrect	
2	Correct Incorrect	

The following information relates to questions 26-26

Karen Swanson and Gabriel Russell recently co-founded Green Savanah Securities, an asset management firm conducting various equity and fixed-income strategies. Swanson and Russell are formulating Green Savannah's trade policy. During a meeting, they agree on an initial set of themes regarding trade policy formation:

- Theme 1: We should determine an optimal execution approach and apply that approach to each asset class managed.
- Theme 2: In aggregating trades for pooled accounts, any partially executed orders need to be allocated on a pro-rata basis.
- Theme 3: The principles behind our process to find a broker should be consistent across each asset class managed.
- Theme 4: To act in our clients' best interests, we need to disclose all trade errors to them.

26. **Identify** two inappropriate themes in the partners' set. **Justify** your response.

SOLUTIONS

1. A is correct. Greater trade urgency results in lower execution risk because the order is executed over a shorter period of time, which decreases the time the trade is exposed to price volatility and changing market conditions. In contrast, lower trade urgency results in higher execution risk because the order is executed over a longer period of time, which increases the time the trade is exposed to price volatility and changing market conditions.

2. B is correct. Harding asked Yellow to execute a list of trades, and he wants to use a price benchmark where the reference price for the benchmark is computed based on market prices that occur during the trading period, excluding trade outliers. Portfolio managers often specify an intraday benchmark for funds that are trading passively over the day, seeking liquidity, and for funds that may be rebalancing, executing a buy/sell trade list, and minimizing risk. An intraday price benchmark is based on a price that occurs during the trading period. The most common intraday benchmarks used in trading are volume-weighted average price (VWAP) and time-weighted average price (TWAP). Portfolio managers choose TWAP when they wish to exclude potential trade outliers.

3. A is correct. Given the trade urgency of the order, the very liquid market for ABC shares, and the small order size relative to ABC's expected volume, Yellow is using an arrival price trading strategy that would attempt to execute the remaining shares close to market prices at the time the order is received.

4. A is correct. XYZ shares are relatively liquid, and Harding has prioritized minimizing the trade's market impact to avoid conveying information to market participants. Harding also does not expect adverse price movements during the trade horizon. Scheduled algorithms are appropriate for orders in which portfolio managers or traders do not have expectations for adverse price movement during the trade horizon. These algorithms are also used by portfolio managers and traders who have greater risk tolerance for longer execution time periods and are more concerned with minimizing market impact. Scheduled algorithms are often appropriate when the order size is relatively small (e.g., no more than 5%–10% of expected volume), the security is relatively liquid, or the orders are part of a risk-balanced basket and trading all orders at a similar pace will maintain the risk balance.

5. A is correct. Small currency trades are usually implemented using direct market access (DMA). Buy-side traders generally use DMA for exchange-traded derivatives, particularly for smaller trades.

6. C is correct. Execution cost is calculated as the difference between the cost of the real portfolio and the paper portfolio. It reflects the execution price(s) paid for the number of shares in the order that were actually filled or executed. The execution cost is calculated as:

   Execution cost = $\sum s_j p_j - \sum s_j p_d$

   = [(10,000 shares × \$40.75) + (30,000 shares × \$41.25) + (20,000 shares × \$41.50) + (30,000 shares × \$41.75)] – (90,000 × \$40.00)

   = \$3,727,500 – \$3,600,000

   = \$127,500

7. C is correct. Opportunity cost is based on the number of shares left unexecuted in the order and reflects the cost of not being able to execute all shares at the decision price. The opportunity cost is calculated as:

$$\text{Opportunity cost} = \left(S - \sum s_j\right)\left(P_n - P_d\right)$$
$$= (120{,}000 - 90{,}000) \times (\$42.50 - \$40.00)$$
$$= \$75{,}000$$

8. B is correct. The arrival cost is calculated as:

$$\text{Arrival cost (bp)} = \text{Side} \times \frac{\left(\overline{P} - P_0\right)}{P_0} \times 10^4 \text{ bp}$$
$$= +1 \times \frac{(\$41.42 - \$40.50)}{\$40.50} \times 10^4 \text{ bp}$$
$$= 227.2 \text{ bp}$$

9. B is correct. Firms should have a policy in place for the treatment of trade errors. Errors from trading and any resulting gains/losses need to be disclosed to a firm's compliance department and documented in a trade error log. The trade error log should include any related documentation and evidence that trade errors are resolved in a way that avoids adverse impact to the client.

10. Beamon is likely to take a measured approach in implementing the Ogive Fund's strategy. In particular, trade urgency, which refers to how quickly or slowly an order is executed over the trading time horizon, is likely to be low for the Ogive Fund. Greater trade urgency is associated with executing over shorter horizons, whereas lower trade urgency is associated with executing over longer horizons. To capitalize on views related to mispricing, the Ogive Fund's individual positions may be held for several years. Minimal trading is required, and any necessary trading can often be carried out in a more patient manner. Additionally, the return payoffs associated with the Ogive Fund's long-term investment views and value orientation are not likely to be rapidly acted on by other market participants. Thus, the rate or level of expected alpha decay, which refers to the erosion or deterioration in short-term alpha once an investment decision is made, is low.

11. To minimize cash drag on a portfolio, or fund underperformance from holding uninvested cash in a rising market, Barker may use a strategy known as equitization. In this case, equitization refers to temporarily investing cash using futures or ETFs to gain the desired equity exposure before investing in the underlying securities longer term. Equitization may be required if large inflows into a portfolio are hindered by lack of liquidity in the underlying securities. So, if the Pengwyn Fund's large inflow cannot be invested immediately, Barker can equitize the cash using equity futures or ETFs and then gradually trade into the underlying positions and trade out of the futures/ETF position.

12.

Selection Criterion for Trade Strategy	**Identify** one difference between the trading features of Valley Ranch and North Circle, as noted by Sailors, for each trade strategy selection criterion.
Order Characteristics	Key differences include: (i) the sizes of the orders, with larger orders at North Circle; and (ii) the side of the orders, with North Circle skewing more toward buy orders.

Security Characteristics	Key differences include: (i) security type, with North Circle trading only equities; (ii) short-term alpha focus, with more focus on short-term price movements at Valley Ranch; and (iii) security liquidity, with North Circle buying non-listed securities.
Market Conditions	While both North Circle and Valley Ranch are impacted by market conditions overall, North Circle's investments in non-listed securities are more likely to have a greater potential exposure to adverse market liquidity conditions.
Individual Risk Aversion	The portfolio managers at North Circle and Valley Ranch have different aversions to risk, with North Circle's managers having lower risk aversion than the Valley Ranch managers.

13.

Determine which trades are *most likely* to exhibit the greatest execution risk and market impact. (Circle one in each column)

Execution Risk	Market Impact
ABC	ABC
DEF	DEF
XYZ	XYZ

Justify each selection.

The XYZ trade exhibits the greatest execution risk because XYZ has the highest price volatility of the three stocks. Execution risk is the risk of an adverse price movement occurring over the trading horizon owing to a change in the fundamental value of the security or because of trading-induced volatility. Execution risk is often proxied by price volatility. Securities with higher levels of price volatility have greater exposure to execution risk than securities with lower price volatility.

The ABC trade exhibits the greatest market impact risk as it represents the highest percentage of ADV (45,000 / 195,000 = 23.07%). The permanent component of price change associated with trading an order is the market price impact caused by the information content of the trade. The larger the size of the trade expressed as a percentage of ADV, the larger the expected market impact cost.

14. B is correct. A pre-trade benchmark is often specified by portfolio managers who are buying or selling securities seeking short-term alpha by buying undervalued or selling overvalued securities in the market. Wong believes the stock of Music Plus is overvalued and is seeking short-term alpha with the sell order. Since Wong has an exact record of the price of Music Plus when the decision for the sell order was made ($15.22), the decision price is the most appropriate pre-trade benchmark for the sell order.

    A is incorrect because a closing price is a post-trade benchmark and is typically used by index managers and mutual funds that wish to execute transactions at the closing price for the day. A portfolio manager who is managing tracking error to a benchmark will generally select a closing price benchmark since the closing price is the price used to compute the fund's valuation and resulting tracking error to the benchmark. This is not the objective of the sell order of Music Plus. Wong's objective is to execute the sell trade as quickly as possible to capture the short-term alpha she identified. She expects the price of Music Plus to revert back to $14.20 within the day. Therefore, she will need to execute her trading prior to the price when the market closes; thus, the closing price is not the appropriate price benchmark.

C is incorrect because a TWAP benchmark price is used when portfolio managers wish to exclude potential trade outliers. Trade outliers may be caused by trading a large buy order at the day's low or a large sell order at the day's high. Therefore, a TWAP benchmark is not appropriate for the sell order of Music Plus because Wong would like to execute a large sell order near the day's high price, which would likely be an outlier.

15. A is correct. The sell order for the Music Plus shares has associated high trade urgency because Wong determined that the stock is temporarily overvalued and expects others to realize this quickly. Therefore, the trader does not have the benefit of trading the order passively (such as by using a VWAP or TWAP participation strategy) during the day, since the share price could decrease to fair value at any time. Because the trade order for Music Plus shares is submitted after the market opened that day, the opening auction is not an option and the whole order is traded in the open market.

    B is incorrect because selling at the closing auction for the day is an appropriate trading strategy for trades when the portfolio manager would like to receive proceeds at NAV. An example of such a trade is a trade to meet a redemption request from a client. The trade for Music Plus shares has associated high trade urgency and must be executed as quickly as possible to capture the short-term alpha. Waiting until the closing auction is not an appropriate trading strategy.

    C is incorrect because passive trading is appropriate for trades associated with low trade urgency. The sell order of Music Plus shares has associated high trade urgency because Wong determined that the stock is temporarily overvalued and expects the new data to be reflected in the price by the end of the day. Therefore, the trader does not have the benefit of trading the order passively (such as by using a VWAP or TWAP participation strategy) during the day, since the share price could decrease to fair value at any time.

16. C is correct. Liquidity-seeking algorithms are appropriate for large orders that the portfolio manager or trader would like to execute quickly without having a substantial impact on the security price. The sell order for Music Plus shares is for 20% of the expected volume and therefore is a large order. Liquidity-seeking algorithms are also used when displaying sizable liquidity via limit orders could lead to unwanted information leakage and adverse security price movement. In these cases, the priority is to minimize information leakage associated with order execution and avoid signaling to the market the trading intentions of the portfolio manager or trader. Wong is concerned that a large limit order will reveal to the market her opinion the shares are overvalued.

    A is incorrect because POV algorithms (also known as participation algorithms) send orders following a volume participation schedule. As trading volume increases in the market, these algorithms will trade more shares, and as volume decreases, these algorithms will trade fewer shares. Wong needs to execute the sell order for Music Plus shares as quickly as possible because she expects the new information to be reflected in the share price quickly. Therefore, a POV algorithm is not appropriate.

    B is incorrect because even though arrival price algorithms are used for orders in which the portfolio manager or trader believes prices are likely to move unfavorably and wishes to trade more aggressively to capture alpha, they are used when the security is relatively liquid or the order is not outsized (size less than 15% of the expected volume). The order size for Music Plus shares is large, at 20% of the expected volume.

17. C is correct. The implementation shortfall in basis points is calculated as follows:

$$\text{Implementation shortfall (bps)} = \frac{\text{Implementation shortfall (\$)}}{\text{(Total order shares)}\ (p_d)} \times 10{,}000 \text{ bps}$$

$$\text{Implementaion shortfall}(\$) = \underbrace{\sum s_j p_j - \sum s_j p_d}_{\text{Execution Cost}} + \underbrace{\left(S - \sum s_j\right)\left(P_n - P_d\right)}_{\text{Opportunity Cost}} + \text{Fees.}$$

Fees = Absolute value of $\sum s_j$ × Fee per share

where

$S > 0$ indicates a buy order and $S < 0$ indicates a sell order

P_d represents the price at the time of the investment decision

P_n represents the current price

s_j and p_j represent the number of shares executed and the transaction price of the jth trade

Execution cost = [(–6,000 × 26.80) + (–3,000 × 26.30)] – (–9,000 × 27.10) = 4,200.

Opportunity cost = [–10,000 – (–9,000)] × (26.00 – 27.10) = 1,100.

Fees = 9,000 × 0.03 = 270.

So, the implementation shortfall ($) is calculated as

Implementation shortfall ($) = 4,200 + 1,100 + 270 = 5,570.

Finally, the implementation shortfall (bps) is calculated as

$$\text{Implementation shortfall (bps)} = \frac{5,570}{10,000 \times 27.10} \times 10,000 \text{ bps} \approx 206 \text{ bps}$$

18. A is correct. The delay cost in dollars is calculated as

$$\text{Delay cost} = \left(\sum s_j\right) p_0 - \left(\sum s_j\right) p_d$$

where

$S > 0$ indicates a buy order and $S < 0$ indicates a sell order

p_0 represents the arrival price, defined as the asset price at the time the order was released to the market for execution

p_d represents the price at the time of the investment decision

s_j represents the number of shares executed

Therefore, the delay cost in dollars for the sell order is calculated as

$$\text{Delay cost} = (-9,000 \times 26.90) - (-9,000 \times 27.10) = \$1,800$$

19. B is correct. The market-adjusted cost in basis points is calculated as

$$\text{Market-adjusted cost (bps)} = \text{Arrival cost (bps)} - \beta \times \text{Index cost (bps)}$$

$$\text{Arrival cost (bps)} = \text{Side} \times \frac{(\overline{P} - P_0)}{P_0} \times 10^4 \text{ bps}$$

$$\text{Index cost (bps)} = \text{Side} \times \frac{(\text{Index VWAP} - \text{Index arrival price})}{\text{Index arrival price}} \times 10^4$$

Where

$$\text{Side} = \begin{cases} +1 \text{ Buy Order} \\ -1 \text{ Sell Order} \end{cases}.$$

$\overline{P}$ = Average execution price of order

P_0 = arrival price

Therefore,

$$\text{Average execution price} = \frac{(6{,}000 \times 26.80 + 3{,}000 \times 26.30)}{9{,}000} \approx 26.63$$

$$\text{Arrival cost (bps)} = -1 \times \frac{(26.63 - 26.90)}{26.90} \times 10^4 \text{ bps} = 100.37 \text{ bps}$$

$$\text{Index cost (bps)} = -1 \times \frac{590 - 600}{600} \times 10^4 = 166.67 \text{ bps}$$

$$\text{Market-adjusted cost (bps)} = 100.37 \text{ bps} - 0.9 \times 166.67 \text{ bps} \approx -50 \text{ bps}$$

Since the result is negative, the market-adjusted cost for the sell order of West Commerce is a savings of approximately 50 bps.

20. C is correct. Both of SWM's trading policies are consistent with good governance. Asset managers should have a list of approved brokers and execution venues for trading and the criteria used to create this list. Creating and maintaining the list should be a collaborative effort shared by portfolio execution, compliance, and risk management. A best practices approach is to create a Best Execution Monitoring Committee within an investment management firm that is responsible for maintaining and updating the list regularly, or as circumstances require, and for distributing the list to all parties involved in trade execution. Furthermore, if several accounts follow the same or a similar investment strategy and have similar trading needs, then pooling the trades for trade execution may make sense in some situations. If a pooled trade is not fully executed, the order amount that is executed generally needs to be allocated to accounts on a pro-rata basis so that no account is disadvantaged relative to the others.

21.

Identify the likely appropriate price benchmark for the LIM trade. (Circle one)

Pre-Trade	Intraday	Post-Trade	Price Target

Justify your response.

A pre-trade benchmark is a reference price that is known before the start of the period over which trading will take place. For example, pre-trade benchmarks include decision price, previous close, opening price, and arrival price. A pre-trade benchmark is often specified by portfolio managers who are buying or selling securities on the basis of decision prices. In this case, Bradley's target price had been set based on his valuation principles before the opening, whereas waiting for the other benchmarks as inputs would result in the perceived opportunity expiring before it could be exploited.

For Bradley and his trader, two of these pre-trade benchmarks are potentially appropriate. Those are either the decision price, which was the price when Bradley made the decision to buy or sell the security, or the arrival price, which is the price of the security at the time the order is entered into the market for execution. Portfolio managers who are buying or selling on the basis of alpha expectations or a current market mispricing will often specify an arrival price benchmark.

22. The delay cost reflects the adverse price movement associated with the untimely submission of Bradley's order and is calculated as follows:

$$\text{Delay cost} = \left(\sum s_j\right) p_0 - \left(\sum s_j\right) p_d = (25{,}000 \times 23.09) - (25{,}000 \times 23.01)$$
$$= \$2{,}000.$$

23. Bradley and the trader's analysis will show that the market-adjusted cost calculates as follows:

$$\text{Arrival cost (bps)} = \text{Side} \times \frac{(\overline{P} - P_0)}{P_0} \times 10^4 \text{ bps}$$
$$= +1 \times \frac{(\$23.45 - \$23.09)}{\$23.09} \times 10^4 \text{ bps}$$
$$= 155.91 \text{ bps}.$$

$$\text{Index cost (bps)} = \text{Side} \times \frac{(\text{Index VWAP} - \text{Index arrival price})}{\text{Index arrival price}} \times 10^4 \text{ bps}$$
$$= +1 \times \frac{(\$2{,}184 - \$2{,}150)}{\$2{,}150} \times 10^4 \text{ bps}$$
$$\approx 158.14 \text{ bps}.$$

$$\text{Market-adjusted cost (bps)} = \text{Arrival cost (bps)} - \beta \times \text{Index cost (bps)}$$
$$= 155.91 - 0.95 \times 158.14$$
$$= 155.91 - 150.23$$
$$\approx 5.68 \text{ bps}.$$

LIM's market-adjusted cost is thus significantly lower than the total arrival cost. This indicates that most of the expense associated with buying LIM is due to the effect of buying it in a rising market as opposed to the buying pressure induced by the order itself.

24.

Determine which algorithm Minchow is likely to use for the Dynopax sell order. (Circle one)

POV	VWAP	TWAP

Justify your response.

Regarding Bean's alternatives, VWAP and TWAP algorithms release orders to the market following a time-specified schedule, trading a predetermined number of shares within the specified time interval (e.g., one day). Following a fixed schedule as VWAP algorithms do, however, may not be optimal for certain stocks because such algorithms may not complete the order in cases where volumes are low. Furthermore, while POV algorithms incorporate real-time volume by following (or chasing) volumes, they may not complete the order within the time period specified.

TWAP algorithms, which send the same number of shares and the same percentage of the order to be traded in each time period, will help ensure the specified number of shares are executed within the specified time period. Given Bean's stated priority of complete execution in one day, he is likely to use a TWAP algorithm for the Dynopax sell order.

25.

Determine the veracity of each comment. **Justify** each response.

Comment	**Veracity** (Circle one for each row)	**Justification**

1	Correct Incorrect	Regardless of the trading venue, transactions and quantities are always reported.
2	Correct Incorrect	Dark pools provide anonymity because no pre-trade transparency exists. Exchanges are known as lit markets (as opposed to dark markets) because they provide pre-trade transparency—namely, limit orders that reflect trader intentions for trade side (buy or sell), price, and size. However, with a dark pool, there is less certainty of execution as compared to an exchange.

26. Theme 1 is inappropriate because the optimal execution approach may differ by asset class, level of security liquidity, and security trading mechanism (order-driven markets, quote-driven markets, and brokered markets). Green Savannah's trade policy document should describe the factors used in determining how an order can be executed in an optimal manner for a given scenario.

    Theme 4 is inappropriate because as part of a suitable policy for the treatment of trade errors, those errors and any resulting gains/losses need to be disclosed to Green Savannah's compliance department and documented in a trade error log. The priority is to ensure errors are resolved in a way that prevents adverse impact for the client, not to ensure complete disclosure.

LEARNING MODULE

8

Case Study in Portfolio Management: Institutional

by Gabriel Petre, CFA.

Gabriel Petre, CFA, is at World Bank (USA).

LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	discuss tools for managing portfolio liquidity risk
☐	discuss capture of the illiquidity premium as a long-term investment strategy
☐	analyze asset allocation and portfolio construction in relation to liquidity needs and risk and return requirements and recommend actions to address identified needs
☐	demonstrate the application of the Code of Ethics and Standards of Professional Conduct regarding the actions of individuals involved in manager selection
☐	analyze the costs and benefits of derivatives versus cash market techniques for establishing or modifying asset class or risk exposures
☐	demonstrate the use of derivatives overlays in tactical asset allocation and rebalancing
☐	discuss ESG considerations in managing long-term institutional portfolios

INTRODUCTION

1

The development of a strategic asset allocation (SAA) for long-horizon institutional investors such as university endowments raises special challenges. These include supporting spending policies while ensuring the long-term sustainability of the endowment and establishing optimal exposure to illiquid investment strategies in the context of a diversified portfolio.

Large university endowments typically have significant exposure to illiquid asset classes. The exposure to illiquid asset classes impacts the portfolio's overall liquidity profile and requires a comprehensive liquidity management approach to ensure that liquidity needs can be met in a timely fashion.[1] In addition, capital market conditions and asset prices change, resulting in a need to change asset allocation exposures and/or rebalance the portfolio to maintain a profile close to the strategic asset allocation.

Institutions often use derivatives to manage liquidity needs and implement asset allocation changes. The cash-efficient nature of derivatives and their high levels of liquidity in many markets make them suitable tools for portfolio rebalancing, tactical exposure changes, and satisfying short-term liquidity needs—all while maintaining desired portfolio exposures.

This case study explores these issues from the perspective of a large university endowment undertaking a review of its asset allocation and then implementing proposed allocation changes and a tactical overlay program. Rebalancing needs for the endowment arise because market moves result in the drift of the endowment's asset allocation.

The case is divided into two major sections. The first section addresses issues relating to asset allocation and liquidity management. The case introduces a framework to support the management of liquidity and cash needs in an orderly and timely manner while avoiding disruption to underlying managers and potentially capturing an illiquidity premium. Such concepts as time-to-cash tables and liquidity budgets are explored in detail. Aspects relating to rebalancing and maintaining a risk profile similar to the portfolio's strategic asset allocation over time are also covered.

The second section explores the use of derivatives in portfolio construction from a tactical asset allocation (TAA) overlay and rebalancing perspective. The suitability of futures, total return swaps, and exchange-traded funds (ETFs) is discussed based on their characteristics, associated costs, and desired portfolio objectives. The case also presents a cost–benefit analysis of derivatives and cash markets for implementing rebalancing decisions. Environmental, social, and governance (ESG) considerations arising in the normal course of investing are also explored.

2 BACKGROUND: LIQUIDITY MANAGEMENT

- ☐ discuss tools for managing portfolio liquidity risk
- ☐ discuss capture of the illiquidity premium as a long-term investment strategy

For an institutional investor, such as an endowment or a pension fund, liquidity management refers to the set of policies and practices that ensure that the portfolio complies with investment policy yet can meet cash outflow needs in a timely and orderly manner without incurring excessive costs. Optimal liquidity management helps ensure that distressed sales of illiquid assets are avoided, especially in weak market conditions, and that the portfolio can benefit from the expected illiquidity premium associated with long-term private market allocations.

Historically, the importance of liquidity management was emphasized in the 2008 global financial crisis when many institutional investors with significant allocations to illiquid asset classes and regular cash outflow requirements struggled to meet these requirements.

1 In this context, "liquidity" refers to the ability to exchange assets into cash for an expected value within a known time frame.

During this time, public markets experienced significant losses, liquidity conditions deteriorated, and distributions from many private market investments stopped. For many university endowments, another source of liquidity—donations—also dropped significantly, further amplifying liquidity issues. In some cases, endowments were forced to liquidate securities at steep discounts, drastically cut funding for some programs dependent on endowment distributions, and/or borrow funds collateralized by the endowment, increasing leverage and the portfolio's risk profile.

Institutional investors have several important "tools" at their disposal to manage a portfolio's liquidity risk. These include

- liquidity profiling and time-to-cash tables,
- rebalancing and commitment strategies,
- stress testing analyses, and
- derivatives.

Liquidity Profiling and Time-to-Cash Tables

For any investor, the assessment of liquidity needs starts with identifying potential cash inflows and cash outflows for a defined investment horizon. In the case of endowments, cash outflows include distributions to the university and meeting capital call requirements for illiquid investments (e.g., real assets, private equity, hedge funds, and structured products). Once the sources and uses of cash have been identified, the institutional investor establishes the need for liquidity and the desired liquidity maturity profile for the overall portfolio. As part of this process, a **liquidity classification schedule** (**time-to-cash table**) is created, and an overall **liquidity budget** is defined.[2] The liquidity classification schedule defines portfolio categories (or "buckets") based on the estimated time needed in the normal course of business to convert assets in that particular category into cash. The liquidity budget assigns portfolio weights considered acceptable to each liquidity classification in the time-to-cash table and establishes a liquidity benchmark for the portfolio construction process.

An example of a time-to-cash table is provided in Exhibit 1. It defines liquidity classifications based on the time expected to liquidate an investment without the liquidation having a significant impact on market conditions and the resulting sale price for the investment. The impact on market conditions is based on the expected market price immediately before and after trading if the sell order was executed. In the case of investments managed by third-party managers, the time to cash also depends on the contractual terms governing the type of investment vehicle used. Typically, private investments requiring more than one year to exit are viewed as illiquid. In the case of hedge funds, contractual terms (e.g., lockups, notification periods, withdrawal windows) vary based on the manager and underlying strategy. A manager's ability to deny withdrawal requests during stress periods ("to activate gates") to protect fund investors and prevent forced liquidations will impact time to cash.

Exhibit 1: Time-to-Cash Table and Liquidity Budget

Time to Cash	Liquidity Classification	Liquidity Budget (% of portfolio)
< 1 Week	Highly Liquid	At Least 10%
< 1 Quarter	Moderately Liquid	At Least 35%

2 See also Russell Investments (2013).

Time to Cash	Liquidity Classification	Liquidity Budget (% of portfolio)
< 1 Year	Semi-Liquid	At Least 50%
> 1 Year	Illiquid	Up to 50%

The granularity of a time-to-cash table can vary to include monthly or semiannual categories, depending on the investor's liquidity preferences, liquidity needs, and other circumstances. The core principle is to identify liquidity categories relevant to the types of cash outflows the investor will face and to match overall portfolio characteristics with liquidity needs through the design of the resulting asset allocation. The next step is to define an overall liquidity budget specifying portfolio allocations for the different time-to-cash buckets (as shown in the third column of Exhibit 1).[3] In the case of highly liquid, moderately liquid, and semi-liquid categories, minimum portfolio weights are identified. For the illiquid category, a maximum portfolio weight is identified.

The liquidity budget reflects the acceptable liquidity requirements that the portfolio must meet, even in a liquidity stress scenario. The results of stress test analyses are therefore important inputs in developing the liquidity budget.

To operationalize the concepts represented in the liquidity budget, the institutional investor does an analysis of the underlying liquidity characteristics of the portfolio investments and monitors these characteristics over time. The analysis should look through the broad definition of asset classes to the underlying investments used for exposure. Different investments within the same asset class (such as public equities) might have very different liquidity profiles. Commingled funds (funds that are pooled and managed together in a single account) could be less liquid than ETFs or mutual funds and could have different liquidity profiles than separate accounts. Furthermore, the liquidity profile of similar investment vehicles in the same asset class could differ depending on the underlying strategy used by the investment manager. For example, a commingled fund following a concentrated, small-cap active strategy in emerging market equities might offer investors only quarterly liquidity as compared to a commingled fund investing in large-cap emerging market equities, which might offer monthly or weekly liquidity. For these reasons, it is appropriate to conduct liquidity analysis on a bottom-up basis for each investment, aggregate at the portfolio level, and monitor changes over time to keep the portfolio within liquidity budget parameters. An example of liquidity profiling for a portfolio's underlying investments is shown in Exhibit 2. The portfolio example uses investments in separate accounts, commingled funds, futures, ETFs, and active managers to achieve its asset class exposure to both public and private markets.

3 Mercer (2015).

Exhibit 2: Liquidity Profiling for a Portfolio

Asset Class	Asset Class Allocation (% of portfolio)	Investment Allocation (% of overall portfolio)	Investment Vehicle	Liquidity Classification			
				Highly Liquid	Moderately Liquid	Semi-Liquid	Illiquid
Cash	1%	1%	Separate Account	100%	0%	0%	0%
Fixed Income	14%	5%	Separate Account	100%	0%	0%	0%
		8%	Commingled Fund	100%	0%	0%	0%
		1%	Futures	100%	0%	0%	0%
Domestic Equity	17%	8%	Commingled Fund	0%	50%	50%	0%
		8%	Separate Account	0%	100%	0%	0%
		1%	Futures	100%	0%	0%	0%
International Developed Equity	10%	6%	Commingled Fund	0%	50%	30%	20%
		4%	Separate Account	0%	80%	20%	0%
Emerging Market Equity	12%	9%	Commingled Fund	0%	75%	25%	0%
		3%	ETF	100%	0%	0%	0%
Private Equity	18%	18%	Funds 1–85	0%	0%	0%	100%
Real Assets	13%	4%	Funds 1–8	0%	0%	75%	25%
		6%	Funds 9–33	0%	0%	0%	100%
		3%	Funds 34–50	0%	0%	20%	80%
Diversifying Strategies	15%	4%	Funds 1–5	0%	0%	100%	0%
		6%	Funds 6–11	0%	25%	25%	50%
		5%	Funds 12–19	0%	0%	75%	25%
Overall Portfolio	**100%**	**100%**		**19%**	**26%**	**22%**	**33%**

Rebalancing, Commitments

The discussion so far has focused on liquidity management and the ability of an institutional portfolio to meet cash outflows in an orderly manner as they come due. Another consideration is the impact these changes in the liquidity profile have on the overall risk of the investment portfolio and the ability to keep the portfolio close to desired risk targets. Illiquid assets carry extremely high rebalancing costs. Because asset liquidity tends to decrease in times of market stress, having sufficient liquid assets and rebalancing mechanisms in place is important. This approach will ensure that the portfolio's risk profile remains within acceptable risk targets and does not "drift" as the relative valuations of different asset classes fluctuate during stress periods. Rebalancing mechanisms include the following:

- **Systematic rebalancing policies**. Rebalancing disciplines, such as calendar rebalancing and percent-range rebalancing, are intended to control risk relative to the strategic asset allocation. In these cases, pre-specified tolerance bands for asset class weights are used. The size or width of the bands should consider the underlying volatility of each investment category to minimize transaction costs. This means more-volatile investment categories should usually have wider rebalancing bands. Transaction costs, correlations between asset classes, and investor risk tolerance are other factors that could influence the size of the band selected.

- **Automatic adjustment mechanisms**. These are mechanisms designed to maintain a stable risk profile when exposure drifts from targeted exposure. An example is using adjustments to a public market allocation that is correlated to a private market allocation to rebalance private market risk. This approach uses liquid public assets as a proxy for illiquid private assets. For example, assume private equity investments have an equity beta of 1. In a situation where the allocation to private equity increases by 1% versus the target, the allocation to public equities would automatically be adjusted down by 1% to maintain a stable systematic market risk profile. Note, however, that although systematic market risk is unchanged, the illiquidity risk of the portfolio is now higher. Alternatively, the adjustment could be further refined to maintain a constant equity beta, assuming private equity has a beta to public equities of greater than 1 (caused by leverage, for example).[4] Similar public market proxies can be used to represent private real estate, infrastructure, or other illiquid instruments based on their underlying risk characteristics.

Multi-year funding strategies for private markets that incorporate a steady pace of commitments to reach a target allocation and/or to keep the allocation close to target over time are other means of ensuring that the portfolio remains consistent with desired risk objectives. Private market funds pose specific challenges for investors in maintaining a desired exposure over time because investors do not control the pace at which committed capital is drawn or the pace at which capital distributions are returned. Although unpredictable at an individual fund level, these patterns become more predictable within a portfolio of private market investments.

The objective of a multi-year funding strategy is to design a commitment-pacing strategy that will result in the desired portfolio exposure to the asset class over time. The commitment-pacing strategy translates into an annual level of commitments and is typically the result of a cash flow modeling exercise that takes into account expectations about the speed at which committed capital is drawn, the pace of distributions, the evolution in overall asset size, and other circumstances specific to the investor. The cash flow modeling exercise would project forward the expected asset class exposure (as a percentage of the overall portfolio) at various commitment levels, thus reducing the risk of overshooting the target allocation. Scenario analysis should also be used to consider the impact of different market stress conditions. The evolution of the asset allocation must be monitored over time, with adjustments to the commitment pace made as necessary.

Stress Testing

A robust liquidity framework ensures that liquidity needs can be met in a timely fashion during periods of normal market and stress market conditions. Understanding how the portfolio's liquidity profile could change in addition to how the liquidity needs of the institution could change during stress periods is therefore critical. Comprehensive stress-testing exercises would seek to "stress" (i.e., presume extremely adverse market conditions for) both assets and liabilities simultaneously to understand how these

4 See also Raymond (2009).

might be impacted during stress conditions. With respect to assets, the stress test can cover distributional assumptions regarding prices (e.g., volatility, return), correlations across assets, and liquidity characteristics. Liability shocks can also be factored in, for example, by increasing expected endowment distributions to support the university during the stress periods. The design of the stress tests can be informed by historical events (e.g., the 2008 global financial crisis), statistical models (e.g., extreme value theory), and/or scenario analysis (e.g., analyzing the potential impact of a hypothetical scenario with respect to a set of variables on the overall portfolio).

Derivatives

Derivatives can be used to manage cash outflow needs and changing risk exposures. Derivatives overlay strategies are investment strategies that use derivatives instruments to obtain, offset, or substitute specific asset class or market factor exposure beyond what is provided by the underlying portfolio assets. For example, a derivatives overlay program allows an institutional investor to rebalance exposures to public asset classes (e.g., on a monthly or quarterly basis) while leaving allocations to external active managers unchanged. The cash-efficient nature of derivatives makes them desirable tools for rebalancing. Derivatives overlays can also be used to modify a portfolio's liquidity profile through the use of leverage—for example, using futures contracts (long futures position) to gain economic exposure to US equities and then deploying the cash that is not required for posting margin into other investments with different liquidity profiles or using it to satisfy short-term liquidity needs. Derivatives can also be used to generate additional cash by employing leverage at the overall portfolio level.

Earning an Illiquidity Premium

An attractive feature for investors in illiquid investments, such as private equity or private real estate, is the expectation of extracting an illiquidity premium in addition to premiums associated with underlying market risk factor exposures in an illiquid strategy. The illiquidity premium (also called the liquidity premium) is the expected compensation for the additional risk of tying up capital for a potentially uncertain time period. For long-term institutional investors with long investment horizons and modest interim liquidity needs, exposure to illiquid investments and the illiquidity premium embedded in these is a feasible investment strategy and offers an opportunity to increase the efficiency of the overall portfolio. The higher efficiency can be driven by the following:

1. the risk diversification potential that exists between the illiquid assets and the rest of the investor's investible universe
2. the higher return that can be generated by taking on illiquidity risk (assuming it is adequately priced)
3. a combination of the above

In practice, however, uncertainties exist around the expected size of the illiquidity premium and the ability of institutional investors to extract it that should not be underestimated.

Quantitative estimates for the illiquidity premium suggest evidence of a positive illiquidity premium in private equity and private real estate and of illiquidity premium size being positively correlated to the length of the illiquidity horizon.[5]

5 See also Green (2015).

An alternative approach for estimating the illiquidity risk premium is based on the idea that the size of the discount an investor should receive in return for committing capital for an uncertain period of time can be represented by the value of a put option with an exercise price equal to the marketable price of the illiquid asset at the time of purchase. (The "marketable price" is a hypothetical price at which the illiquid asset could be sold if it were freely traded; it can be estimated by various means.) In this case, the price of the illiquid asset can be derived by subtracting the put price from the marketable price of the asset. If both the marketable price and the illiquid asset price are estimated or known, then the expected return for each can be calculated, with the difference in expected returns representing the illiquidity premium (in %). This approach was initially developed by Chaffe (1993) and later improved upon by Staub and Diermeier (2003). They also find there should be a positive correlation between the length of the illiquidity horizon and the size of the illiquidity premium.

A significant body of literature documents a positive relationship between lack of liquidity and expected returns in the case of public equity. For example, Pastor and Stambaugh (2001) find that expected returns are impacted by systematic liquidity risk and estimate a 3% return over the 1996–2003 period in the United States for a zero-net-investment portfolio that holds low-liquidity stocks long and high-liquidity stocks short.

Overall, though, it is difficult to isolate the illiquidity premium with precision and separate its effects from such other risk factors as the market, value, and size in the case of equity investments. Furthermore, estimates of the illiquidity premium are based on broad market indexes, yet an investor in these asset classes would typically invest in only a small subset of the universe, with the result that individual investment experience could be very different and more susceptible to idiosyncratic factors.[6] These challenges further emphasize the importance of liquidity budgeting in facilitating the capture of the illiquidity premium while controlling for risk.

3 QUADRIVIUM UNIVERSITY INVESTMENT COMPANY CASE: BACKGROUND

☐ analyze asset allocation and portfolio construction in relation to liquidity needs and risk and return requirements and recommend actions to address identified needs

Quadrivium University (QU) is an independent liberal arts college located in a vibrant midsized city with a growing and diverse population. The university was founded in 1916 by James Greaves and Colin Healey, two entrepreneurs with a passion for astronomy and mathematics who settled in the area in the early 1900s. Over time, the university has built an outstanding reputation as one of the top schools in the country. Consistent with the founders' interests, the school's programs in astronomy and mathematics are highly regarded, attracting applicants from all over the world.

The QU endowment was established in 1936 through a USD15 million donation from Healey, whose goal was to provide financial aid to new undergraduate students. A quarter of new students receive Healey grants, and this percentage has increased steadily over time.

6 Ang, Papanikolaou, and Westerfield (2014).

As of the current fiscal year, QU has an endowment of USD8 billion, of which USD6 billion represents funds used for general unrestricted support and unrestricted funds functioning as endowment. The remaining funds have various donor-specified use restrictions. Although a significant portion of the endowment's growth has been from investment returns, the endowment also benefits from a strong and deep alumni network that provides regular donations and access to highly regarded industry contacts and money managers. Exhibit 3 shows the market value of the endowment over recent years, and Exhibit 4 shows the realized investment returns over the same period.

Exhibit 3: Market Value of QU Endowment

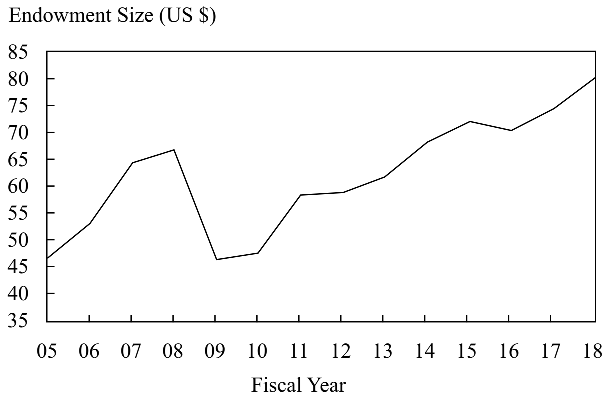
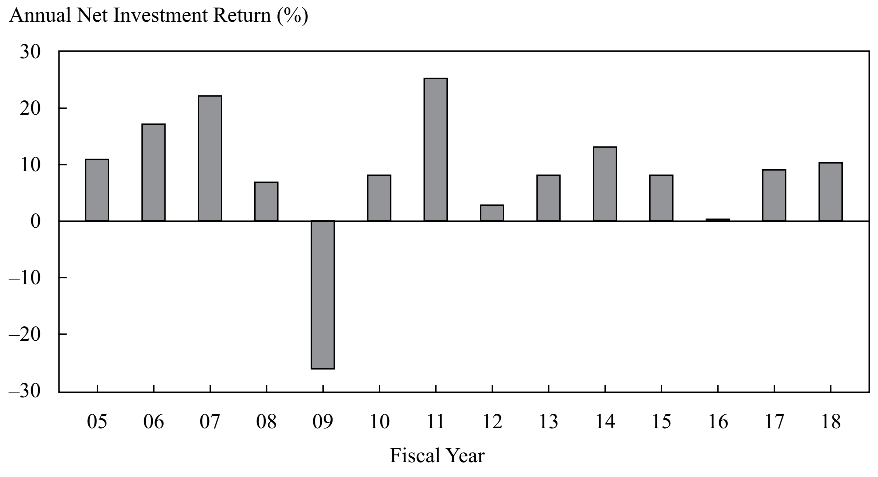


Exhibit 4: Investment Returns for QU Endowment



QU has an annual operating budget of USD554 million, and 70% of the operating budget is used to fund salaries and benefits for faculty and administrative staff. In addition, the budget is used to pay down debt associated with a major upgrade of the main campus facilities, pay expenses associated with the maintenance of physical infrastructure, and fund various research and financial aid programs.

Annual distributions from the endowment provide funding for approximately 60% of the university's operating budget, including its financial aid programs. In absolute dollar terms, the size of annual distributions has increased steadily in the past five years as the size of the endowment fund has grown. Similarly, the percentage of the operating budget covered by distributions from the endowment has increased. The board of the university has recently expressed a preference for a predictable pattern of distributions to allow for better planning of resource deployment through its programs. Consistent with that preference, the spending policy of the endowment was changed following the 2008 global financial crisis. Pre-crisis, the university used a simple spending rule: Spending equaled the long-term desired spending rate of 5% multiplied by the market value of the endowment at the beginning of the fiscal year. Post-crisis, the university changed its spending rule to a geometric smoothing rule, sometimes called the Yale formula.

The current spending rule is designed to produce a 5% long-term spending rate in a way that shields annual distributions from fluctuations in the endowment's market value. The endowment uses a weighted-average formula of the previous year's spending amount and the endowment's market value at the end of the previous fiscal year multiplied by the long-term desired spending rate:

Spending for current fiscal year

= (66% × Spending for previous fiscal year) + 34% × (5% × Endowment market value at the end of previous fiscal year).

For QU, the previous fiscal year's spending was USD308.9 million, while the endowment's market value at the end of the previous fiscal year was USD7,575.1 million. In this case, QU's spending for the current fiscal year would be

Spending for current fiscal year = (66% × USD308.9 million) + 34% × (5% × USD7,575.1 million)

= USD332.6 million.

Consistent with the spending policy, the endowment's investment objective is to achieve long-term returns that support the spending rate while preserving the value of the endowment in real terms over time (thus safeguarding the long-term sustainability of the program). For QU, a 5% spending rate per year combined with long-term expected inflation for colleges and universities of 2%–3% per year translates into a 7%–8% nominal return per year objective over the long term. QU's associated risk objective is 12%–14% annualized return volatility (standard deviation of portfolio returns must be between 12% and 14%).

Quadrivium University Investment Company

Quadrivium University (QU) is overseen by a board of trustees ("the Trustees"), generally consisting of prominent, wealthy alumni who are elected to the position. QU Investment Company (QUINCO) is the university investment office, which manages QU's endowment. The office was established in 1993 at a time when endowment assets were USD1 billion. From a governance perspective, the office is organizationally distinct from the university, although it is not a separate legal entity. The president of the investment office, Aaron Winter, reports to the university president and to the QUINCO board of directors ("the Board"). The Board comprises 11 members appointed by the Trustees. The president of QUINCO, the university president, and the treasurer of the university serve as ex-officio members. The QUINCO Board is responsible for approving investment policy and guidelines and providing guidance on key policy matters. Implementation of the investment policy has been fully delegated to QUINCO staff, who are empowered to make changes to the portfolio within the parameters of the investment guidelines.

QUINCO has 13 investment professionals, who are university employees. The investment model is one where the investment strategy is implemented through external investment managers. The Board has consistently reaffirmed its view that such a model provides greater flexibility for changing investment portfolio exposures when circumstances warrant, while reducing internal staffing needs compared to an in-house investment management model. Internal investment staff are focused on asset allocation, risk management, and selecting, monitoring, and terminating external investment managers.

The following five investment categories are part of the current asset allocation: fixed income, public equities, private equity, real assets (composed primarily of private real estate and natural resources), and diversifying strategies (primarily hedge fund strategies targeting high absolute returns with low correlations to traditional asset classes, such as public equity and fixed income). Alternative investments are considered private equity, real assets, and diversifying strategies. Private equity and real assets are recognized as illiquid (alternative) investments. The investment team is organized by investment category, with a senior portfolio manager leading each area and supported by an analyst. In addition, the team includes a portfolio strategist in charge of asset allocation and risk management, also supported by an analyst, and the president of the office, who acts as the chief investment officer (CIO). Senior portfolio managers have primary responsibility for investment decisions within their investment category, while the portfolio strategist has responsibility for ongoing endowment rebalancing decisions, overlays, and tactical asset allocation tilts. All external investment manager decisions and tactical asset allocation deviations are discussed and approved by the internal investment committee. Winter chairs the committee, which includes all senior portfolio managers and the portfolio strategist. The QUINCO Board is responsible for granting final approval of external investment managers.

Investment Strategy: Background and Evolution

QUINCO has distinguished itself as a steady and progressive institutional investor with a focus on long-term objectives; it is unlikely to make abrupt wholesale changes to its investment strategy. This strategy is, in part, driven by leadership stability, with the investment office having had the same president (Winter's predecessor) for the first 28 years of existence. Another important factor has been an established culture focused on maintaining best-in-class investment practices and institutionalizing that knowledge through robust processes and systems.

For the first years of existence, the endowment invested only in public markets, mostly equities and bonds. In its early days, the belief was that the endowment's limited size and investment resources would present challenges in accessing, monitoring, and properly managing complex, nontraditional investment strategies. Since the late-1990s, as the size of the endowment grew, the QUINCO Board has embraced the belief that exposure to nontraditional, or alternative, asset categories is beneficial for the endowment's long-term prospects—enhancing investment risk diversification and providing potentially higher risk-adjusted returns in a greater variety of market environments. To express this belief, the Board has supported an increase in internal investment expertise by hiring seasoned investment professionals and expanding QUINCO's investment staff. Over the next two decades, the endowment portfolio increased its exposure to such alternative investments as private equity, real assets, and hedge funds.

These investments have performed well for the endowment; in particular, private equity and real assets were very strong contributors to the portfolio return over that period, in line with expectations. In aggregate, however, exposure to alternatives in the portfolio is still below the average exposure of other large university endowments that the Board considers the endowment's relevant peer universe.

The evolution of the endowment's asset allocation is shown in Exhibit 5.

Exhibit 5: Evolution of the SAA

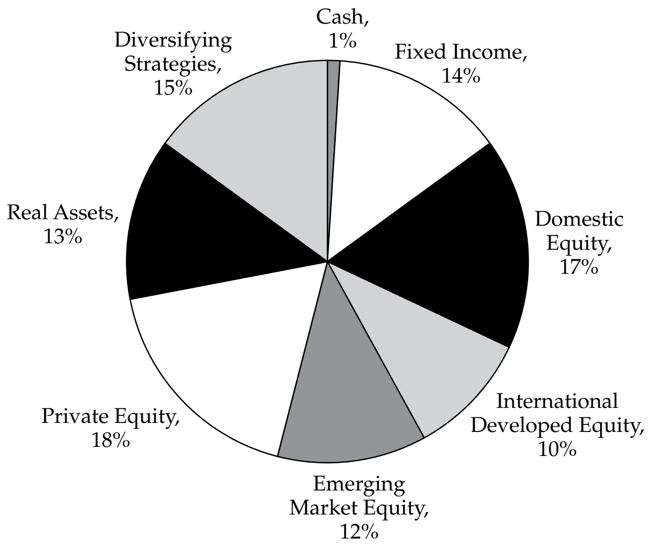
	Evolution of Investment Policy Targets							
	2001	**2004**	**2007**	**2010**	**2013**	**2016**	**2019**	**2022**
Cash	1%	1%	1%	1%	1%	1%	1%	1%
Fixed Income	29%	24%	24%	19%	16%	16%	14%	14%
Domestic Equity	40%	35%	26%	24%	23%	21%	20%	17%
International Developed Equity	24%	24%	20%	17%	15%	15%	12%	10%
Emerging Market Equity	0%	3%	10%	15%	15%	12%	12%	12%
Private Equity	3%	5%	8%	10%	12%	14%	16%	18%
Real Assets	3%	5%	6%	7%	9%	11%	12%	13%
Diversifying Strategies	0%	3%	5%	7%	9%	10%	13%	15%

The QUINCO Board oversees a comprehensive strategic asset allocation review every three years. The most recent review of the asset allocation occurred two years ago. At that time, the Board approved a continued increase to alternative investments at the expense of developed market equities (both domestic and international).

Current Scenario

Winter, a QU alumnus who joined QUINCO five years ago, took over the role of investment office president and CIO last year. This is the first time he will be overseeing an asset allocation review. The endowment's current asset allocation is shown in Exhibit 6.

Exhibit 6: Current Strategic Asset Allocation



Based on discussions with the Board, Winter asks his portfolio strategy team—consisting of team lead Julia Thompson, her asset allocation analyst, and the senior portfolio managers for fixed income and public equities—to address the following considerations during the review process:

- The desired liquidity profile for the endowment and corresponding framework for liquidity management.
- The investment outlook and efficiency of the strategic asset allocation. A long period of falling interest rates and rising asset prices in the developed world drove most traditional asset classes to the upper bounds of historical valuation ranges, lowering future expected returns in these markets.
- The role of TAA in QU endowment's investment strategy. Given the long-term nature of the SAA, some Board members are wondering whether a TAA program might improve risk-adjusted returns for the portfolio.
- Endowment underperformance relative to a peer universe of large endowments. Although the QU endowment had better returns than most of its peers during the 2008 global financial crisis, the portfolio has largely underperformed its peers since then.

4 QUINCO CASE: STRATEGIC ASSET ALLOCATION

☐ analyze asset allocation and portfolio construction in relation to liquidity needs and risk and return requirements and recommend actions to address identified needs

Thompson and the strategy team have completed their analysis, including the considerations raised by Winter and the Board, and are now ready to present to the Board. As part of their work, Thompson updated the long-term, forward-looking capital market assumptions used for the mean–variance optimization process and asset allocation recommendations.

In developing their long-term capital market assumptions, Thompson and the strategy team considered and applied unsmoothing (or de-smoothing) techniques. These techniques were applied to illiquid investments to remove the impact of positive serial correlation on risk estimates caused by stale market pricing. From experience, Thompson knows that the uncertainty of risk and return estimates for illiquid assets is amplified by such aspects as infrequent trading, associated leverage, and long investment horizons. In attempting to estimate risk for illiquid assets, the team's challenges include the availability, quality/reliability, frequency, and non-synchronicity of pricing data. Thompson knows these issues would result in stale pricing or a smoother pattern of reported returns because of fewer data points with lower observed return volatility. If used as an input in their mean–variance optimization models without adjustment, the artificially low volatility would make illiquid asset classes appear more attractive, resulting in higher allocations to illiquid assets in the "optimal" portfolio. To prevent this, Thompson and her team applied unsmoothing techniques to better reflect the underlying risk of illiquid asset classes. After applying unsmoothing techniques to private equity, resulting volatility ends up being significantly higher than volatility that is observed or experienced for these assets. Exhibit 7 and 8 show these updated assumptions.

Exhibit 7: Long-Term Expected Return (Net of Fees) and Volatility Assumptions

Asset Class	Expected Real Return (annual geometric mean, next 10 years)	Expected Nominal Return (annual geometric mean, next 10 years)	Standard Deviation of Returns (annual)	Sharpe Ratio
Cash	0.9%	3.4%	1.7%	
Fixed Income	1.8%	4.3%	6.3%	0.14
Domestic Equity	5.0%	7.6%	18.1%	0.23
International Developed Equity	4.8%	7.4%	19.7%	0.20
Emerging Market Equity	6.0%	8.7%	26.6%	0.19
Private Equity	8.5%	11.2%	24.0%	0.32
Real Assets	4.5%	7.1%	13.3%	0.27
Diversifying Strategies	4.0%	6.6%	10.0%	0.31

Note: Inflation is assumed to be 2.5% per year.

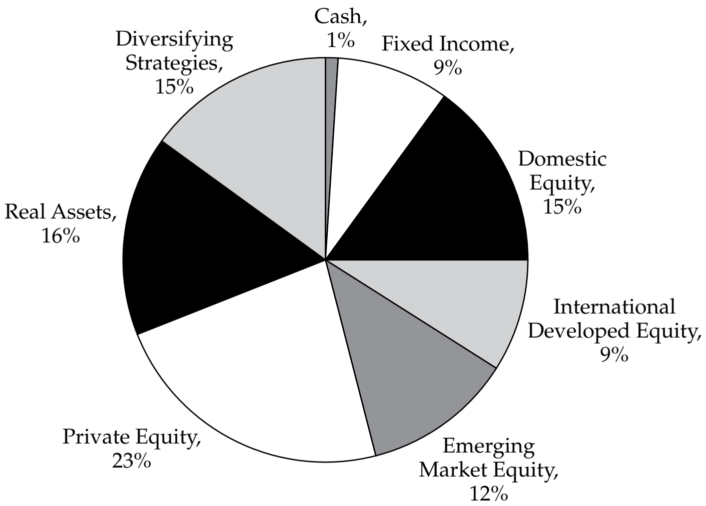
Exhibit 8: Forward-Looking Correlation Matrix

	Cash	Fixed Income	Domestic Equity	International Developed Equity	Emerging Market Equity	Private Equity	Real Assets	Diversifying Strategies
Cash	1.00							
Fixed Income	0.11	1.00						
Domestic Equity	0.03	0.13	1.00					
International Developed Equity	0.02	0.14	0.91	1.00				
Emerging Market Equity	0.04	(0.18)	0.69	0.71	1.00			
Private Equity	0.02	(0.11)	0.68	0.65	0.59	1.00		
Real Assets	0.07	(0.16)	0.35	0.35	0.25	0.42	1.00	
Diversifying Strategies	0.18	0.18	0.40	0.40	0.45	0.35	(0.04)	1.00

Analysis by Thompson and her team uncovered the main reasons for peer underperformance since the 2008 crisis: a lower risk profile of the portfolio and a lower allocation to illiquid investments, in particular, private equity. As a result, an important change proposed by Thompson and the team is an increase in exposure to private markets. The change would increase the private equity allocation from 18% to 23% and the real assets allocation from 13% to 16%. To accommodate both increases, the allocations to public equities and fixed income would decrease. The proposed target allocations are presented in Exhibit 9.

In terms of implementation, Thompson and her team expect that the transition to the higher target allocations in private equity and real assets will occur gradually over the next two to three years.

Exhibit 9: Proposed Strategic Asset Allocation Targets



Optimization results in Exhibit 10 are based on the team's assumptions (Exhibit 7 and 8) and show that a higher allocation to private equity and real assets would improve the expected long-term risk–return profile of the endowment. The team also includes the results of Monte Carlo simulations that show the probability of an erosion in longer-term purchasing power. Thompson notes that the resulting risk profile measured by the volatility is consistent with quantitative guidelines developed for the endowment's risk tolerance. Based on interaction with the Board, the risk tolerance has been specified as a volatility range of 12% to 14% based on long-term measures of risk.

Exhibit 10: Proposed vs. Current SAA: Expected Risk–Return Properties

Portfolio Characteristic	Proposed SAA	Current SAA
Expected nominal return (annual average, geometric, next 10 years)	7.8%	7.5%
Expected real return (annual average, geometric, next 10 years)	5.3%	5.0%
Standard deviation of returns (annual)	13.2%	12.5%
Sharpe ratio	0.34	0.33
Probability of 25% erosion in purchasing power over 20 years with 5% spending rate	30%	35%

Note: The probability of erosion in purchasing power was derived based on a Monte-Carlo simulation with a 20-year investment horizon, assuming expected return and volatility characteristics will be the same as for the next 10 years.

When asked to justify the proposed strategic asset allocation (SAA), including the higher allocation to private markets, Thompson highlights the optimization results from Exhibit 10 to the Board, noting that the primary driver of the proposed asset allocation changes is the expected improvement in the portfolio's long-term risk–return profile.

Thompson is aware that the proposed asset allocation implies a small increase in the endowment's overall risk profile as measured by the volatility of portfolio returns (13.2% for the proposed SAA versus 12.5% for the current portfolio). She believes that the increase in risk is justified by the following:

- Lower return expectations for all asset classes relative to past expectations due to higher current valuations. This implies that a higher level of risk must be taken to achieve the same level of returns. At the time of the most recent review, the then-current SAA had an expected return of 5.3% in real terms, though now it is expected to generate a 5.0% real return going forward. Lower return expectations can be compensated in part only by efficiency improvements in the asset allocation. Although the proposed SAA is slightly more efficient (improved Sharpe ratio by 0.01), this efficiency improvement alone is not enough to generate a 5.3% expected real return for the same level of short-term risk/volatility as the current SAA.
- A portfolio risk profile that is currently more conservative than that of the endowment's peers.
- A lower expected Sharpe ratio (expected risk–return profile) for fixed income (compared with recent history), suggesting that a lower allocation to these strategies might be warranted.
- Monte-Carlo simulations, suggesting that the proposed asset allocation has a higher probability of achieving the real return target over a 20-year horizon, while better preserving the purchasing power of the endowment with the current spending policy of 5%.

IN-TEXT QUESTIONS

1. Discuss arguments in favor of increasing the endowment's allocation to illiquid investments.

   Guideline Answer:

   In general, for a long-horizon institutional investor, the ability to tolerate illiquidity creates an opportunity to improve portfolio diversification and expected returns as well as access a broader set of investment strategies. In mean–variance optimization models, the inclusion of illiquid assets in the eligible investment universe may shift the efficient frontier upwards, theoretically resulting in more-efficient investment portfolios (i.e., portfolios with a higher expected return for a given level of risk).
   Thompson and her team believe the above to be true in the case of QU's endowment. In addition, further arguments are in favor of increasing the allocation to illiquidity risk. Thompson believes the specific circumstances of the endowment continue to support an increase in exposure to illiquid investments. To date, the team's historical experience with illiquid investments has been positive, with strong realized returns. The endowment has been building exposure to these strategies over the past two decades in a gradual manner. As a result, the illiquid portfolios are now well established, mature, and well diversified in terms of fund managers, strategies, and vintages. At the same time, the long presence in the market and the ability to access QU alumni networks have helped the endowment develop a strong network of

connections in the industry and gain access to best-in-class managers in these spaces—building a reputation as a well-informed, patient, and reliable long-term investor. As revealed in the case text, the QU endowment has a lower exposure to illiquid investments than most institutional investor peers with similar risk profiles and objectives. Analysis by Thompson and her team has identified this as one of the reasons for the QU endowment's underperformance in recent years relative to peers.

Thompson and the strategy team should also examine whether the allocation to private equity and real assets is exposed to idiosyncratic risk factors. Avoiding large allocations to a small number of funds helps ensure that idiosyncratic risk factors are largely diversified away.

2. Using additional information provided in Exhibit 10 and your knowledge of illiquid investments from prior curriculum content, justify Thompson's proposed asset allocation and explain the trade-offs involved in terms of portfolio volatility.

Guideline Answer:

As Thompson highlights to the Board, the primary driver of the proposed asset allocation is the expected improvement in the portfolio's long-term risk–return profile. The proposed SAA has a higher expected real return compared to the current SAA (5.3% versus 5.0% in real terms) and a slightly higher Sharpe ratio (0.34 versus 0.33).

The proposed asset allocation also has a higher probability of achieving the endowment's return target over the long term. One way to get a better sense of this is through Monte Carlo simulations. For example, using such simulations, the team concludes that there is a 70% chance of maintaining at least 75% of purchasing power over a 20-year horizon for the proposed SAA versus a 65% chance for the current SAA, assuming a 5% spending rate.

There is an implicit trade-off in this case between the short-term risk measure (volatility) and the long-term risk represented by the probability of purchasing power erosion over a 20-year horizon.

Trade-off 1: Portfolio volatility

Thompson has considered the increase in overall risk profile for the endowment (portfolio return volatility increases from 12.5% to 13.2%) and believes the increase to be justified.

Thompson believes future returns will be lower for all asset classes. Lower return expectations imply that a higher level of risk must be taken to achieve the same level of returns. Although the proposed SAA is slightly more efficient, as indicated by its higher Sharpe ratio, this improvement in portfolio efficiency is not sufficient to generate the 5.3% expected real return for the same level of short-term risk/volatility as the current SAA.

Optimization results also suggest that the proposed asset allocation has a higher probability of achieving the real return target while preserving the purchasing power of the endowment, given the current 5% spending policy. Finally, Thompson also considers that QU's portfolio risk profile is still more conservative than that of its peers.

Trade-off 2: Implementation costs

Thompson and her team analyzed the costs associated with implementing the proposed portfolio allocation changes. Private equity and private real estate strategies typically have higher investment management fees and performance fees than fixed-income and public equity strategies. By using "net of fees" return assumptions, Thompson and her team incorporated the impact of higher expected investment management fees arising from higher allocations to more-illiquid investments.

Before concluding that the QU endowment should adjust its asset allocation to illiquid investments, Thompson should confirm that the resulting risk profile (return volatility of 13.2% and the probability of erosion in purchasing power shown in Exhibit 10) is consistent with the endowment's risk tolerance (willingness and capacity to bear risk). Thompson should also confirm that with the increased allocation to illiquid investments, the resulting asset allocation remains consistent with the liquidity budget.

EXAMPLE 1

COVID-19 Impact on University Endowment Portfolios

The COVID-19 global pandemic severely disrupted almost every aspect of society in 2020, and higher education institutions were certainly no exception. The pandemic brought sudden and significant stress on university operational budgets in the spring of 2020 by immediately adversely impacting revenues and increased costs. Revenues were negatively affected by higher rebates on room and board due to closed campuses, the cancellation of certain revenue-producing education programs, lower enrollment rates, and increased financial support for students, to name a few factors. On the other hand, costs increased significantly as new health protocols needed to be developed, certain facilities had to be reconfigured to allow better social distancing, and online courses and teaching capabilities had to be substantially upgraded. In this tough environment, many universities turned to their endowments to provide increased levels of support for the operations through the annual distribution. A study from the National Association of College and University Business Officers and financial services firm TIAA found that the 705 academic institutions studied, on average, increased the annual distribution from their endowment by 4% in 2020 from fiscal year 2019's level.

Endowments with significant allocations to illiquid assets faced a trifecta of factors stressing portfolio liquidity in the short term and the ability to rebalance to desired risk levels. These factors include the following:

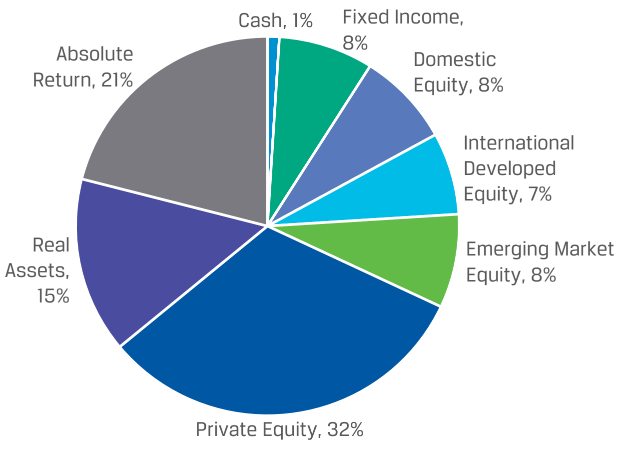
- the need to provide additional support to the university on short notice,
- the mark-to-market negative shock of the pandemic in Q1 of 2020, and
- muted capital distributions from investments in private markets.

This is different from the global financial crisis of 2008 when the stress was induced primarily by the severity and duration of losses in the endowment portfolios. In 2020, the universities' operations experienced major disruptions putting pressure on endowments while portfolio losses were less severe. All this reemphasized the need for endowment portfolios with large exposures to illiquid assets to develop stringent liquidity stress tests to ensure proper liquidity management when needed.

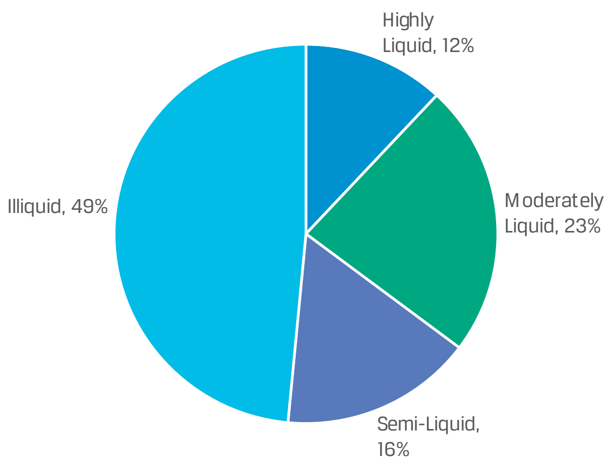
The Crawford University endowment was established three decades ago to support the operations of Crawford University, a fictional private liberal arts institution in the northeastern region of the United States. Over time, Crawford University has come to rely on distributions from the endowment portfolio for significant support on an annual basis, and the endowment has not yet failed to deliver. The endowment's investment strategy has produced stellar returns since inception. To maintain that trend, after the global financial crisis of 2008, and not unlike many of its peers, the endowment increased exposure to private markets and alternatives primarily through illiquid vehicles and further reduced the allocation to traditional asset classes such as fixed income and public equites. To further boost returns, the endowment also invested approximately two-thirds of its public equity allocation into commingled funds with less-liquid redemption terms. As a result, at the onset of the COVID-19 global pandemic, the endowment portfolio had an asset allocation and liquidity profile as shown in Exhibit 20.

Exhibit 11: Crawford University Endowment Asset Allocation and Liquidity Profile

A. Asset Allocation (January 2020)



B. Liquidity Profile (January 2020)



Battered by the severe impact the pandemic had on its operations, the university turned to its endowment for additional support in the first half of 2020 and requested an annual distribution in excess of the long-term average pace of 5% of the endowment's net asset value. At the same time, the endowment was confronting liquidity challenges stemming from its large exposure to illiquid strategies and the mark-to-market impact of the COVID-19-related market shock.

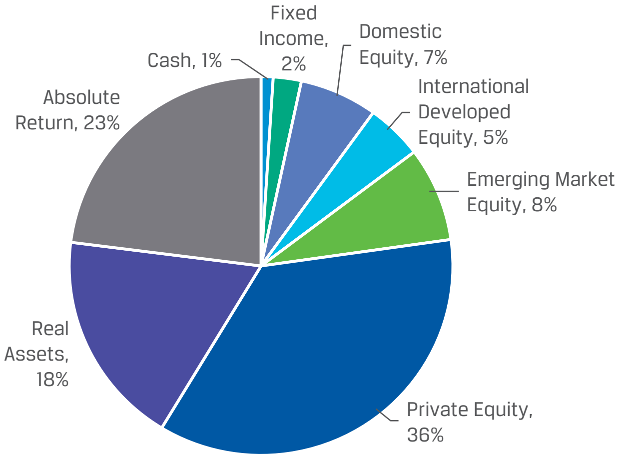
Following the steep decline in risk assets in Q1 of 2020, the pace of distributions from the private equity and the real assets portfolios dried up while the capital calls continued to come. This further stressed the endowment's cash position while further increasing the exposure to illiquid assets as a percentage of the overall portfolio. Given that a large portion of the public equity portfolios were invested in commingled funds with quarterly or semiannual redemption terms, the only reliable sources of cash available on short notice to satisfy liquidity needs were the cash and fixed income allocations. Also, the endowment could not properly rebalance its risk position as needed.

As a result, although public equity and private market valuations partially recovered in Q2, the endowment was forced to draw down its fixed income allocation to satisfy the various cash needs, including the annual disbursement to the university. The forced withdrawals had a significant opportunity cost because fixed income managers had to liquidate positions in spread products (e.g., corporate bonds, mortgage securities) at distressed prices because market liquidity conditions were precarious in the first half of 2020.

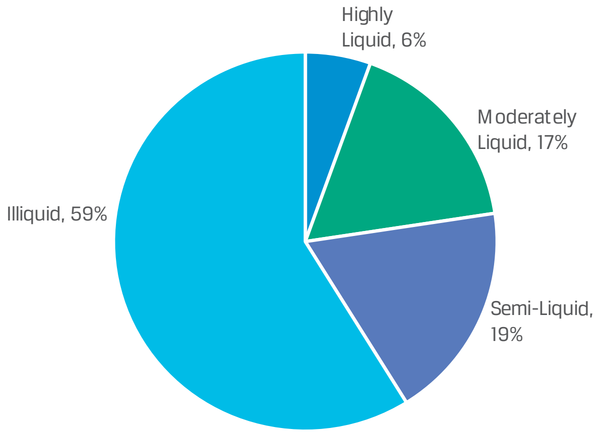
Exhibit 12 shows the resulting asset allocation and liquidity profile of the endowment at the end of Fiscal Year 2020 (30 June 2020).

Exhibit 12: Crawford University Endowment Asset Allocation and Liquidity Profile

A. Asset Allocation (June 2020)



B. Liquidity Profile (June 2020)



By comparing the liquidity profiles before and after the pandemic-related shock, a steep deterioration can be noted in the endowment's overall liquidity as the combined exposure to the highly liquid and moderately liquid strategies dropped by approximately 12% (from 35% to 23%), while the exposure to the illiquid category increased from 49% to 59%. These changes left the endowment in a precarious liquidity position, with limited ability to remedy the situation in the short term. Also worth noting is that the overall risk profile of the asset allocation has increased because of the inability to rebalance the fixed income allocation back to the desired target.

5 QUINCO CASE: LIQUIDITY MANAGEMENT

☐ analyze asset allocation and portfolio construction in relation to liquidity needs and risk and return requirements and recommend actions to address identified needs

Given the increasing complexity of the investment portfolio and the university's reliance on regular distributions from the endowment, QUINCO needs a robust framework for managing liquidity. During her time at QUINCO, Thompson has worked to enhance QUINCO's overall liquidity management framework. This includes improving the tools used in that process and taking a comprehensive, enterprise-wide approach. In her approach, the expected cash outflows and inflows for the endowment portfolio are modeled over various time horizons both under normal circumstances and in periods of severe market stress.

Thompson is concerned that the portfolio's liquidity characteristics will deteriorate in periods of severe market stress. She believes a deterioration in liquidity could potentially occur for the following reasons:

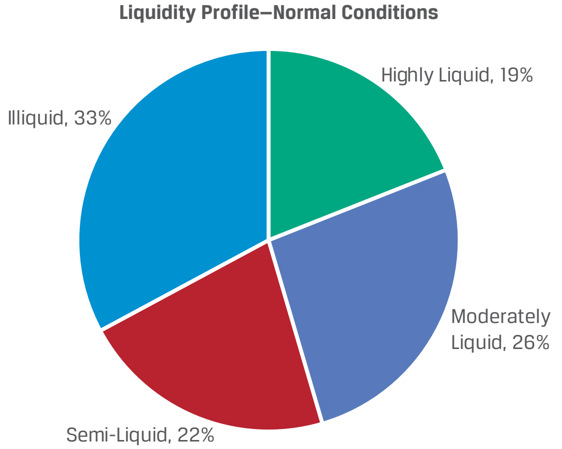
- **Capital calls in private markets exceeding capital distributions.** This would increase the allocation to private markets in the overall portfolio.
- **Activation of gates.** Some investment vehicles that provide quarterly or annual liquidity, such as hedge funds and real estate funds, have provisions in their investment prospectuses that allow the investment manager to refuse investor withdrawal requests (to activate gates) during stress periods to protect remaining investors in the fund. The inability to withdraw from funds leads to a more illiquid profile overall.
- **The smoothing effect.** Investments in private markets tend to incorporate market valuations with a lag that leads to a relative increase in their portfolio weighting during periods of market stress and a relative decrease in the portfolio weighting of more liquid assets. This does not reduce the effective liquidity of the portfolio in dollar terms, but it does impact the percentage of assets in the overall portfolio that could be used to satisfy liquidity needs in periods of market stress.

To address her concerns, Thompson asks her team for an analysis of the current and proposed QU portfolios under normal and various stress market conditions. The team develops two liquidity stress scenarios. The 'Stress" scenario implies primarily a market shock to the portfolio and a drying up of inflows from donations and distributions from private market portfolios. The "High Stress" scenario, in addition to having a more severe market impact, includes assumptions on higher cash outflows in the form of disbursements to the university. The team's analysis of each portfolio's liquidity profile is shown in Exhibit 13 and 12.

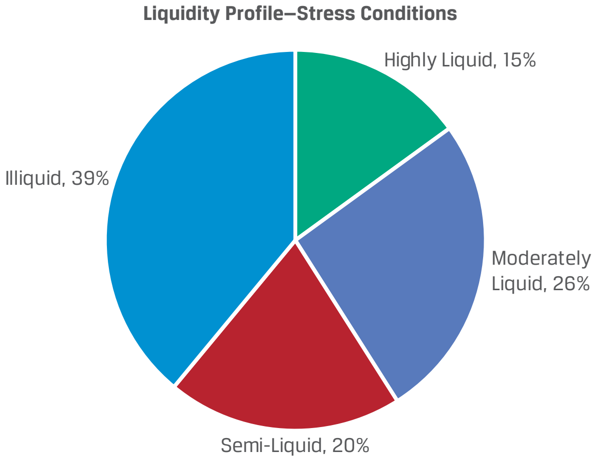
Exhibit 13 shows the current QU portfolio under normal, stress, and high stress market conditions.

Exhibit 13: QU Endowment Liquidity Profile: Current Portfolio (Normal, Stress, and High Stress Conditions)

A. Normal Conditions



B. Stress Conditions



C. High Stress Conditions

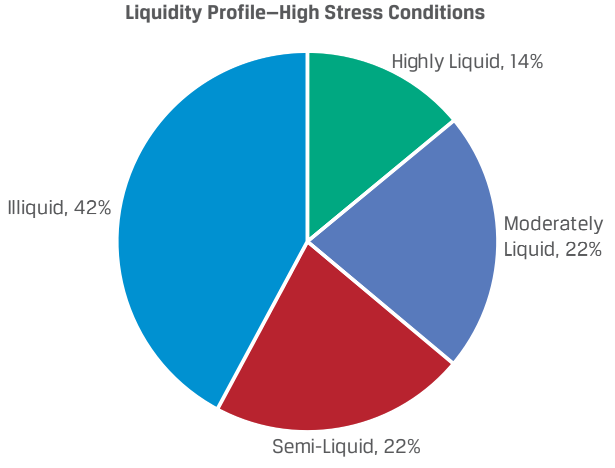
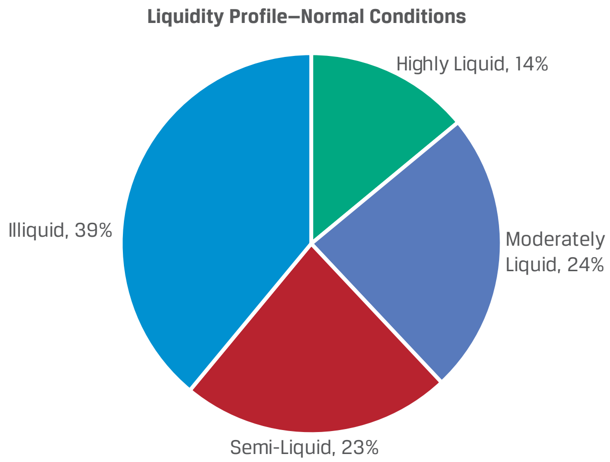


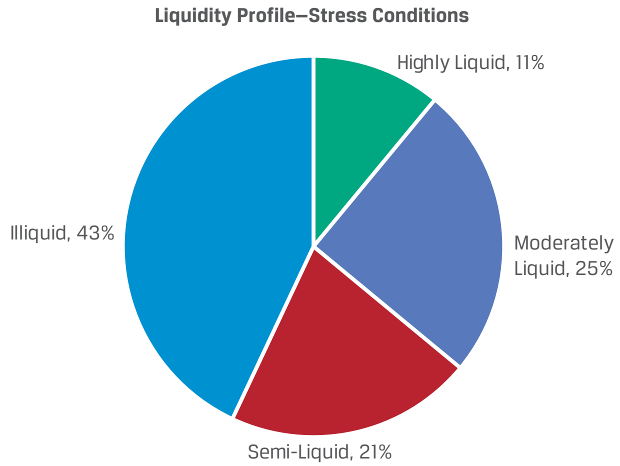
Exhibit 14 shows the proposed QU strategic asset allocation portfolio under normal, stress, and high stress conditions.

Exhibit 14: QU Endowment Liquidity Profile: Proposed Strategic Asset Allocation (Normal, Stress, and High Stress Conditions)

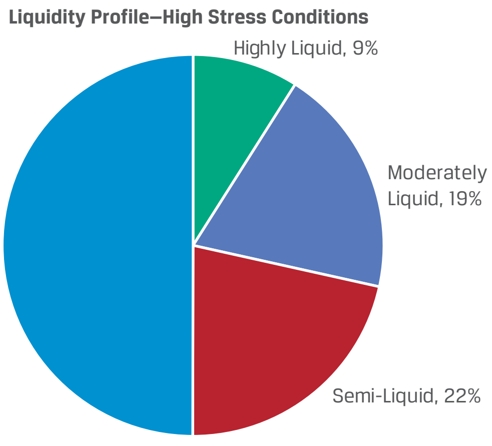
A. Normal Conditions



B. Stress Conditions



C. High Stress Conditions



IN-TEXT QUESTIONS

1. Explain how current spending policy might affect liquidity needs in a market downturn.

   Guideline Answer:

   The design of the spending rate policy incorporates a smoothing, countercyclical element, leading to spending rates below 5% in a period of sustained strong investment returns but higher than 5% in a protracted weak return environment. This design of the spending rate policy exacerbates the endowment's liquidity needs in severe market downturns.

2. Describe various tools that QUINCO might use to manage its portfolio liquidity risk.

   Guideline Answer:

   Among the tools QUINCO could use are cash flow–forecasting and commitment-pacing models, liquidity budgets, and stress test analyses. To begin, Thompson estimates expected cash outflows and inflows. For cash outflows, Thompson projects distributions from the endowment to the university. These uses of cash can then be factored into the estimation of expected outflows and inflows through the spending rate policy in which the university seeks to spend, on average, 5% annually of the endowment while preserving the endowment's purchasing power over time.

   For the private equity and real estate portfolios, Thompson and her team can use cash flow–forecasting models and commitment-pacing models to project the expected increase in the allocation to private markets. These help the team project cash outflows needed for future investment commitments (committed but undrawn capital calls) in private markets. These flows could become particularly relevant in stress periods when distributions from prior investments in those markets might cease because general partners have difficulty exiting investments (because of depressed valuations and lack of transaction activity). Future investment commitments are legal obligations of the endowment, so the staff needs to ensure capital calls are met because the general partner might accelerate capital calls as opportunities arise in depressed markets. Thompson and her team should ensure diversification across fund vintage years to avoid overexposure to particular parts of the economic cycle and should also follow a strategy that commits capital on a steady and regular basis to minimize the need to make large allocation changes (or adjustments) with associated transaction costs. Avoiding large allocations to very few funds will help minimize idiosyncratic portfolio risk. At the same time, cash inflows into the endowment from donors will likely drop significantly during stress periods, further increasing liquidity needs. Liquidating risk assets or high-beta assets after periods of negative return is often not desirable from a valuation standpoint when future returns might be expected to be more attractive, particularly following periods of sharp drawdowns. Given her experience with these markets, Thompson should recognize that the team's approach needs to be flexible. Access to the top private market managers is often highly competitive, and opportunities to invest with these managers might not be available at times when the portfolio is making allocation increases.

   Incorporating this information, Thompson can develop a liquidity budget for the endowment like that shown in Exhibit 1, which specifies minimum acceptable liquidity targets based on the expected time needed to convert portfolio holdings to cash. The liquidity budget should be monitored by

Thompson and her team on a regular basis as part of the liquidity management framework in place at QUINCO. Thompson and her team can also do an analysis of the portfolio's current liquidity characteristics under normal market conditions, like that shown in Exhibit 2.

Thompson and her team should continue to undertake regular stress tests (such as the liquidity profile analysis done by her team) using historical and hypothetical scenarios to estimate how much the liquidity profile of the portfolio could drift under certain assumptions and to assess whether the minimum liquidity budget would still be satisfied. The analysis can also be used to inform the team's asset allocation and implementation decisions for investment vehicles and strategies.

3. What impact will the proposed asset allocation changes have on the endowment's liquidity profile?

   Guideline Answer:

   Compared to the liquidity profile of the current portfolio, the proposed asset allocation implies a shift toward more-illiquid investments, as shown in the following table:

	Current Portfolio				Proposed Portfolio				Proposed vs. Current	
Liquidity Category	**:Normal (%)**	**:Stress (%)**	**:High Stress (%)**	**:High Stress vs. Normal (%)**	**:Normal (%)**	**:Stress (%)**	**:High Stress (%)**	**:High Stress vs. Normal (%)**	**:Normal (%)**	**:High Stress (%)**
High Liquid	19	15	14	-5	14	11	9	-5	-5	-5
Moderately Liquid	26	26	22	-4	24	25	19	-5	-2	-3
Semi-Liquid	22	20	22	0	23	21	22	-1	1	0
Illiquid	33	39	42	9	39	43	50	11	6	8

As a result, a reduction will occur in the highly liquid and liquid categories in the endowment's liquidity profile and a commensurate increase will be seen in the semi-liquid and illiquid categories under all liquidity scenarios but in particular under high stress conditions. The proposed allocation results in an increase in the overall illiquidity profile because a higher percentage of the portfolio will be invested in private equity and private real estate, which are the most illiquid asset classes in the portfolio.

What is important to note is that under a high stress scenario, the proposed allocation would temporarily breach the minimum threshold set in the liquidity budget framework for the highly liquid and moderately liquid categories (9% versus a minimum of 10% and 19% versus a minimum of 35%, respectively) while the illiquid category would reach the upper limit of the liquidity budget at 50%.

Although a temporary breach is understandable under extreme liquidity circumstances, Thompson needs to ensure that even under stress conditions, the proposed allocation continues to adequately satisfy the various liquidity needs of the portfolio for both cash outflows and rebalancing. In this particular circumstance, Thompson and her team might wish to revisit the size of the exposure to less-liquid commingled funds within the public equity allocations to enhance the liquidity profile of the portfolio in periods of extreme liquidity stress. From an ongoing management perspective, and particularly at times when the liquidity profile of the proposed allocation is closer to the minimum thresholds set through the liquidity budget, Thompson and her team should plan to closely monitor the portfolio's liquidity profile and to periodically stress test it to make sure portfolio liquidity remains adequate.

Based on this analysis, the QUINCO Board approves the proposed changes to the asset allocation and instructs the team to proceed with implementation. These changes are also presented to the Quadrivium Trustees as part of the university treasurer's financial report at the Trustees' next regular meeting.

QUINCO CASE: ASSET MANAGER SELECTION

6

- [ ] demonstrate the application of the Code of Ethics and Standards of Professional Conduct regarding the actions of individuals involved in manager selection

Three months have now passed, and Winter, Thompson, and the rest of the QUINCO team have begun implementing changes to the strategic asset allocation by seeking additional external managers. Winter is very pleased with their progress to date but has encountered a somewhat interesting situation.

Among the firms responding to QUINCO's request for proposal (RFP) seeking a new private equity manager is Genex Venture Capital (GVC). GVC is proposing that QUINCO invest in its new "GVC Fund II" offering. GVC is a US-based venture capital fund operating in the biotech space. GVC would be a new relationship for QUINCO. The firm has adopted the CFA Institute Asset Manager Code for its employees. The founder and managing partner at GVC is Virginia Hall, CFA, a prominent alumna of Quadrivium University who was elected to the university's board of trustees three years ago. Hall has made several generous donations to the university over the years, and the building that houses the school's student center and main dining facility is named in her honor. Both the university president and university treasurer have urged Winter to favorably consider GVC's proposal, given Hall's importance to the university. Winter has suspicions that Hall has contacted the university president and treasurer to advocate for her company.

The investment committee narrows the competition for the allocation of QUINCO's private market assets to GVC and Beacher Venture Investments ("Beacher"). Beacher is another venture capital investment firm operating in the same space and is a direct competitor to GVC.

Both GVC and Beacher are invited to make a presentation to QUINCO's investment committee. GVC's presentation is led by Jason Allen, one of Winter's former colleagues from the endowment they both worked for previously. Allen has joined GVC as a managing director as part of GVC's efforts to build the team in preparation for Fund II. Although Allen's presentation on behalf of GVC is thorough and well-documented, Winter is troubled by two aspects. The presentation is targeted to QUINCO but clearly incorporates information that is based on or could have come only from the university treasurer's non-public reports to the Quadrivium board of trustees or another university source. In addition, the performance presentation of GVC's historical returns shows substantially higher returns than performance reported by third-party performance databases.

Of the two finalists, Beacher has a longer track record and is a more established name in the industry; however, some concerns have arisen regarding the historical performance of its previous fund. At the same time, some investment committee members have expressed reservations about GVC's short track record. Given the overlap in sector and strategy between the two firms, the investment committee asks Bud Davis, a CFA charterholder and senior portfolio manager on QUINCO's private equity team, to return with a formal proposal to invest in one of the firms.

Davis presents an update on the fundraising efforts of each firm's fund and notes that GVC is facing challenges in raising the desired fund amount of USD300 million for Fund II. Potential investors are apparently concerned with the significant increase in the size of the fund (Fund I had raised USD100 million) and question whether GVC has the infrastructure to scale operations.

Davis makes a strong case for investing with GVC, highlighting confidence in the manager and their differentiated approach to sourcing and growing portfolio companies in the biotech space. Davis tells the investment committee that because of the longer-than-expected fundraising period, GVC is eager to secure QU's commitment for Fund II; as a result, Davis has negotiated a discount on GVC's investment management fee. Following that discussion, the investment committee approves the recommendation from the team to invest with GVC.

After the decision is made to hire GVC, Winter calls Allen to tell him the good news and offer his congratulations. During the conversation, Allen expresses his satisfaction in having QUINCO as one of the fund's investors and praises Davis's strong commitment and drive. Allen goes on to mention that Davis's spouse, Andrea, is Hall's daughter. Winter expresses his surprise at this fact and later asks Davis about his wife's relationship to Hall. Davis responds that he believes this information is common knowledge and that he thought Winter and members of the QUINCO investment committee knew this information.

IN-TEXT QUESTION

1. What ethical considerations arise regarding the actions and conduct of individuals involved in manager selection?

   Guideline Answer:

   Aaron Winter, QUINCO CIO

   Winter faces several ethical dilemmas in this case. The main issue is the disclosure of a potential conflict of interest, Standard VI(A): Disclosure of Conflicts, regarding the hiring of an external investment manager with close ties to the university. Winter's independence and objectivity, Standard I(B): Independence and Objectivity, in making the hiring recommendation could be compromised by the implicit and explicit pressure he is receiving to hire GVC. He should disclose this conflict to the QUINCO Board as part of the hiring recommendation. He should also disclose that the managing director for GVC is a former colleague because that relationship could also be perceived as impairing his independence and objectivity, creating a conflict of interest. During the presentation, GVC appears to have based its proposal on confidential information, Standard III(E): Preservation of Confidentiality, about the university, potentially obtained by Hall through her role as a Quadrivium Trustee or others at the university. As an employee of the university and QUINCO, Winter should make the board aware of the possible breach of confidentiality. He also apparently has questions about the accuracy of the performance information, Standard I(C): Misrepresentation and Standard III(D): Performance Presentation, presented by GVC but fails to exercise appropriate due diligence, Standard V(A): Diligence and Reasonable Basis, by following up with GVC or investigating further to determine the veracity of the information.

Virginia Hall, CFA, Quadrivium University Trustee and Managing Partner at GVC

Hall has a conflict of interest, Standard VI(A): Conduct as Participants in CFA Institute Programs, if she is pressuring university staff and QUINCO employees to influence the external manager hiring process in her company's favor. Hall's personal/business interests with GVC pose a potential conflict of interest with her duties as a university Trustee. She has a duty as a trustee to act in the best interest of the university without regard to how it might benefit her, but she has an incentive to pressure the university to hire her company. She would be violating her duty of loyalty, Standard IV(A): Loyalty, to the university as a Trustee by putting her firm, and therefore her personal interests, ahead of the interests of the university. She should disclose her potential conflict and recuse herself from any part in the external manager hiring process. In addition, she has potentially gone further by sharing confidential information, Standard III(E): Preservation of Confidentiality, she has received as a trustee with GVC in an effort to assist GVC's response and boost the prospects of her company in being hired—another violation of her duty of loyalty as a Trustee. GVC neglected to disclose the relationship of one employee's relative (Hall's daughter, who is Davis's spouse) with QUINCO.

Quadrivium University President/Quadrivium University Treasurer

The university president and treasurer, as members of the QUINCO Board, have a duty to act in the university's best interests, Standard IV(A): Loyalty, by hiring the external investment managers most appropriate for managing the private equity portion of the university's endowment. In pressuring Winter to hire GVC, they are clearly letting the outside consideration of maintaining good relations with a Trustee influence their hiring decision. They might have also provided confidential information, Standard III(E): Preservation of Confidentiality, to Hall or GVC to assist their bid to become an investment manager for QUINCO. They should disclose their conflict, Standard VI(A): Disclosure of Conflicts, and recuse themselves from decisions where their independence and objectivity, Standard I(B): Independence and Objectivity, are compromised. The university president and treasurer should also have in place a due diligence questionnaire/RFP to raise questions to new managers about potential conflicts of interest.

Jason Allen, Managing Director at GVC

Winter has noticed a discrepancy between the performance history of GVC in the presentation made by Allen and the performance record of the company as reported elsewhere. Allen is possibly inadvertently using inaccurate information or, worse, knowingly misrepresenting the performance record, Standard I(C): Misrepresentation and Standard III(D): Performance Presentation, of GVC.

Bud Davis, CFA, Senior Portfolio Manager at QUINCO

Through his spouse, Davis has a personal relationship with GVC, a company he is tasked with investigating and on which he must provide an opinion as to its potential hiring as an outside manager. This could affect his independence and objectivity, Standard I(B): Independence and Objectivity, and creates, at minimum, the perception of a conflict of interest, Standard VI(A): Disclosure of Conflicts, that should be disclosed when making his recommendation. Davis should not rely on his belief that the relationship is "common knowledge" or widely known but should make an explicit disclosure of this potential conflict.

7 QUINCO CASE: TACTICAL ASSET ALLOCATION

- ☐ analyze the costs and benefits of derivatives versus cash market techniques for establishing or modifying asset class or risk exposures
- ☐ demonstrate the use of derivatives overlays in tactical asset allocation and rebalancing

As part of the investment strategy review, the Board decided to significantly increase the active risk budget assigned to the QUINCO team for use in a new tactical asset allocation (TAA) program. QUINCO's active risk budget measures the deviation of the endowment's portfolio from its investment policy targets and is expressed as an annual tracking error limit. The Board increased QUINCO's active risk budget from 100 bps to 250 bps to allow the team to pursue greater excess returns versus the strategic asset allocation. By taking active risk relative to investment policy benchmarks through external managers in public asset classes as well as TAA positions, the QUINCO team hopes to add additional portfolio performance.

The implementation of the tactical asset allocation program and associated risk budget was fully delegated to Winter and his staff. At that time, the Board also informed him that up to 150 bps (of the 250 bps) active risk budget could be used to implement the TAA program. One consideration the Board discussed was the use of leverage. The TAA program implementation could result in a levered position of the endowment portfolio (because derivatives are likely to be used in implementation and not every overweight exposure would be offset by a corresponding underweight in another asset), so the Board agreed to permit a modest leverage position for the overall portfolio of up to 5% of the portfolio's value.

Winter believes that the tactical asset allocation program will accommodate two types of active decisions:

- Overweight and underweight positions in one or more of the asset classes included in the investment policy portfolio
- Provide exposure to asset classes and/or investment strategies outside the policy portfolio benchmark universe but compliant with the investment policy (e.g., high yield, emerging market, fixed income)

Winter began implementing the TAA program by building on a framework and research by Thompson and the asset allocation team that was informed by external parties (e.g., investment consultants, external tactical asset allocation managers, investment research houses). Using concepts of fair value and mean reversion in financial markets, fair value models were developed for various financial assets. To do this, the framework incorporated economic and financial data that had exhibited predictive power for future returns and risk over an investment horizon of one to three years. Current market pricing was then compared with output from the valuation models to determine whether the deviation from 'fair value' was large enough to be exploited in a cost-efficient manner.

In extensive out-of-sample backtests, the methodology had produced encouraging results. One of the strongest signals suggested that large-cap US equities, characterized broadly by the S&P 500 Index, were significantly below fair value, with mean reversion expected over the next year. Based on this information, Thompson decides to implement a 1% overweight to US equities through a passive exposure.

Thompson is now considering three options to implement her decision: a total return swap, equity futures, and ETFs. Her goal is to implement the overweight position as effectively as possible from a cost and cash usage perspective. Thompson asks her team to look at the associated costs for each option.

The team's cost comparison analysis is shown in Exhibit 15.

Exhibit 15: Cost Comparison Assuming a Fully Funded Mandate

Cost Component	ETF	Futures	Total Return Swap
Commission (round trip)	4.00	2.00	5.00
Management fee (annual)	9.50	0.00	0.00
Bid/offer spread (round trip)	2.50	2.00	6.00
Price impact (round trip)	15.00	10.00	0.00
Mispricing (tracking error, annual)	4.00	8.00	0.00
Cost to roll the futures contract	0.00	20.00	0.00
Funding cost	0.00	0.00	40.00
Total cost	**35.00**	**42.00**	**51.00**

Notes: The exhibit shows the team's cost comparison for the three implementation options—ETFs, futures, and a total return swap—for an USD80 million notional exposure to the S&P 500 Index (assuming a fully funded mandate) over a one-year investment horizon. All numbers are in basis points unless otherwise indicated.

The comparison assumes no leverage for the ETF and that the entire mandate amount (USD80 million) is deposited to earn the three-month market reference rate (MRR) for futures and the total return swap as to offset the three-month MRR component of the implied financing rate (or the funding cost in the case of the swap).

After closely examining the cost comparison analysis, Thompson debates the pros and cons of each option with her team.

From a cash "usage" perspective, ETFs would be least efficient because she would need to finance the full notional value of the ETF or use the margin features of the account. Even when using the margin, regulations would limit the margin to 50% of account value, implying a maximum of two times the leverage ratio. For example, for an USD80 million ETF exposure, the minimum margin that would have to be held in cash would be USD40 million. Thompson knows that using futures and a total return swap could generate a similar economic exposure to ETFs with a much lower capital commitment.

From a liquidity perspective, Thompson likes ETFs and futures, which appear efficient, given their liquid trading and narrow bid–ask spreads. She also values the flexibility they offer to terminate exposure before intended maturity, should the team's views on the market change. Thompson is concerned about the operational implications of holding futures because they require daily monitoring of margin requirements. In addition, she worries about interest rate risk and exposure of QU to counterparty credit risk.

IN-TEXT QUESTION

1. Assuming a fully funded position (no use of leverage), which implementation option should Thompson choose for the 1% tactical overweight to US equities?

   Guideline Answer:

Expected Costs

In the case of the ETF, the most significant cost component is price impact—the expected impact on market price from entering into (buying) and exiting out of (selling) the ETF position. This impact is estimated to be approximately 15 bps. The second largest cost component is the management fee charged by the ETF manager, which is expected to be 9.5 bps.

In the case of futures, the largest cost component is expected to be the cost to roll the futures contract on a quarterly basis (5 bps quarterly or 20 bps annual cost). This cost is driven by the upward-sloping (contango) shape of the yield curve. In addition to the futures roll cost and the price impact, another significant futures cost is the mispricing or tracking error of expected futures performance relative to the underlying index performance. Expected tracking error on the futures contracts is 8 bps.

Finally, for the total return swap, the cost is dominated by the funding cost, which is expected to be 40 bps.

From a total cost perspective, at 35 bps, the ETF offers the most cost-efficient vehicle to implement the tactical overlay, with relatively tight bid–ask spreads that are similar to futures.

Other Considerations

ETFs and futures are typically standardized products that trade on exchanges. Total return swaps are over-the-counter contracts that are negotiated and customizable in such features as maturity, leverage, and cost. ETFs are the least cash-efficient option, requiring the largest cash outlay, and Thompson would be able to gain similar economic exposure with futures and swaps using significantly less cash.

A position in futures contracts would need to be rolled over each quarter to maintain exposure. Given Thompson's concerns about the operational requirements for futures and the need for daily monitoring for margin requirements, a position in futures is likely less desirable to Thompson. For ETFs, ongoing management of the exposure is done by the ETF manager. Futures and ETFs have an associated tracking error versus the index intended to be replicated. For ETFs, the tracking error could result from premiums and discounts to net asset value, cash drag, or regulatory diversification requirements. For futures, the tracking error arises because of liquidity (supply/demand conditions), dividend forecast errors, and interest rate differentials. For total return swaps, the replication is exact; Thompson would receive the total return of the index without incurring any tracking error to the benchmark S&P 500 Index because the swap counterparty is obligated to provide the index return.

However, Thompson is concerned about interest rate risk in the case of futures and swaps. She is also concerned about the counterparty credit risk that QUINCO would be exposed to through a swap, which would additionally create complexities in managing net exposures over the duration of the contract.

To implement the tactical overlay given Thompson's considerations, the ETF provides the most cost-efficient vehicle, with adequate liquidity and relatively tight bid–ask spreads. ETFs also provide Thompson with the flexibility (noted as being important to her) to modify exposure before the end of the one-year horizon should her and her team's investment views change.

After considering with her team, Thompson believes implementing with ETFs appears to be the best option.

Later that day, after further discussion, Thompson and the management team decide to implement the overlay using leverage. Thompson asks her team to complete a cost comparison analysis assuming a permissible leverage level of four times for all three options (meaning that cash needed to support the position would be 25% of the overlay notional amount).[7] The team's work is shown in Exhibit 16.

Exhibit 16: Additional Information with Respect to Impact of Leverage

Cost Component	ETF	Futures	Total Return Swap
Cost of obtaining leverage	187.50	0.00	0.00
Additional financing/funding cost	0.00	150.00	150.00
Total additional cost	187.50	150.00	150.00

Notes: The additional cost components assume four times leverage over a one-year investment horizon. All numbers are in basis points unless otherwise indicated.

The team's assumptions for the analysis are as follows:

- The borrowing cost of obtaining leverage in the case of the ETF is assumed to be three-month MRR + 50 bps.
- The three-month MRR assumption used is 2% (opportunity costs).
- The same MRR was used to calculate the additional implied financing cost in the case of futures and the additional funding cost for the total return swap.
- The analysis focuses on the implementation cost of trade and does not consider the additional return earned by investing the cash that is not needed to support the transaction (75% of the overlay notional amount).

7 Although in the case of the ETF, the leverage at the instrument level might be regulated to not exceed two times (50% margin requirement), for the purposes of this exercise, assume that the endowment can generate leverage at the plan level for ETF usage.

IN-TEXT QUESTION

1. Assuming a permissible leverage level of four times for all three options, and using the information in Exhibit 16, would Thompson change her decision?

Guideline Answer:

As shown in Exhibit 16, the additional information changes the total cost estimates for the different implementation options. In the case of ETFs, to generate four times leverage, 75% of the desired nominal exposure would have to be borrowed to provide an overall exposure four times higher than the original capital. That is, for a desired nominal exposure of USD80 million, borrowing USD60 million (75% of USD80 million) provides four times leverage to an original capital amount of USD20 million.

The additional cost of obtaining leverage for each option would be as follows:

1. ETFs. (USD80 million × 0.75 × 2.5%)/USD80 million = 1.875%.
2. Futures. (USD80 million × 0.75 × 2%)/USD80 million = 1.50%. The additional financing cost for futures in this case (compared to the unlevered option) would occur because 75% of the amount would not be invested in three-month MRR to offset the financing cost, thus increasing the overall cost for the futures.
3. Swaps. (USD80 million × 0.75 × 2%)/USD80 million = 1.50%. The additional financing cost for swaps in this case (compared to the unlevered option) would occur because 75% of the amount would not be invested in three-month MRR to offset the financing cost, thus increasing the overall cost for the swaps.

Total costs for each option (in bps):

	ETF	Futures	Total Return Swap
Unlevered	35.00	42.00	51.00
Incremental cost	187.50	150.00	150.00
Total	222.50	192.00	201.00

Looking at the data, total costs for futures appear to be the lowest cost alternative (192 bps), followed by the total return swap (201 bps). Given a permissible leverage level of four times for all three options, and based on the data in Exhibit 16, ETFs now look to be the most expensive option (222.50 bps).

Given the difference in costs, Thompson would consider implementation through futures. The main consideration between the use of ETFs and futures not captured in the comparative pricing analysis is the additional complexity and operational monitoring associated with a quarterly futures roll. If Thompson and the team can get comfortable with that risk, implementation through futures would be the more efficient option.

Looking at the data, and based on their desire to use leverage, Thompson believes that futures offer the more efficient alternative. She decides to establish a 1% long position to the S&P 500 Index using S&P 500 futures.

QUINCO CASE: ASSET ALLOCATION REBALANCING

8

- ☐ analyze the costs and benefits of derivatives versus cash market techniques for establishing or modifying asset class or risk exposures
- ☐ demonstrate the use of derivatives overlays in tactical asset allocation and rebalancing

Three months have passed since Thompson and the team implemented the tactical overweight position to US equities. To date, the position has been performing well and in line with *ex ante* expectations. Global equity markets have rallied, reflecting a favorable global growth environment, and fixed-income markets have sold off as interest rates rose significantly in anticipation of higher inflationary pressures. As a result, the asset allocation of the endowment has drifted from policy targets.

QUINCO follows a calendar quarter rebalancing policy with a rebalancing corridor for each asset class. The allocation drift of the actual portfolio relative to the SAA is monitored monthly; however, to minimize transaction costs, short of extraordinary market circumstances, rebalancing decisions are implemented at the end of each quarter. For public asset classes, systematic rebalancing occurs when the allocation to these assets is outside the rebalancing corridor at quarter end. When the allocation moves outside the corridor, Thompson and her team do have discretion to rebalance back to the target allocation or to the edge of the corridor.

For illiquid asset classes, given high transaction costs and practical challenges in rebalancing the allocation, rebalancing is normally undertaken through the reinvestment/commitment strategy as allocations approach the upper or lower edges of the corridor. In these cases, the pace of commitments could be altered from the expected pace to gradually shift the overall allocation to illiquid assets over time. The SAA, width of the rebalancing corridor, and current allocation for the various asset classes are shown in Exhibit 17:

Exhibit 17: SAA, Rebalancing Corridors, and Current (Actual) Allocations

	Target Allocation (SAA)	Corridor	Min/Max Target	Current Allocation
Cash	1%	±1%	0%–2%	0.8%
Fixed Income	9%	±3	6%–12%	6.5%
Domestic Equity	15%	±2.5	12.5%–17.5%	17.3%
International Developed Equity	9%	±2%	7%–11%	11.5%
Emerging Market Equity	12%	±2%	10%–14%	13.9%
Private Equity	23%	±5%	18%–28%	19.2%
Real Assets	16%	±3%	13%–19%	13.8%
Diversifying Strategies	15%	±3%	12%–18%	17.1%
Total	**100.0%**			**100.0%**

Thompson observes that the allocation to international developed equity (11.50%) now exceeds the upper end of its corridor (9.00% + 2.00% = 11.00%) by 0.50%, while the allocation to fixed income (6.50%) is below target (9.00%) but still within its rebalancing corridor (6.00%–12.00%).

Current allocations to private equity (19.20%) and real assets (13.80%) are close to the lower ends of their rebalancing corridors of 18.00%–28.00% and 13.00%–19.00%, respectively, as the team works to move toward the new targets approved by the Board in Exhibit 9 (in the very short term, these allocations cannot be increased).

Based on the information in Exhibit 17, Thompson sees a need to decrease the international developed equity allocation and increase the fixed-income allocation by the same amount. She meets with the team to discuss whether they should execute the rebalancing through the cash or derivatives market.

During the discussion, Thompson and her team consider the following factors: transaction costs, tracking error of the implementation vehicle versus the desired index exposure, tracking error implied by the current and post-rebalancing deviations from the target SAA weights, opportunity cost/impact to active strategies due to manager withdrawals and reallocations, implementation speed, and time horizon of the rebalancing trade.

Thompson knows that executing through the cash markets takes longer than executing in the derivatives markets. Still, allocating to, or reallocating from, external managers might be warranted in certain cases, such as when the adjustments are viewed as more permanent and/or more significant in nature (as compared to smaller, more temporary adjustments that could be reversed within a shorter time frame if investment views change).

After meeting with her team, Thompson decides to rebalance back to the upper edge of the corridor (11.00%) by reallocating 0.50% (50 bps) from international developed equities to fixed income. The team's cost analysis is shown in Exhibit 18.

Exhibit 18: Cost Information: 50 bps Rebalancing Option

Cost Component	Cash Market	Futures (Equity/Fixed Income)
Bid/offer spread	5.00	3.00
Price impact (total trades)	5.00	4.00
Mispricing (tracking error, quarterly)	0.00	17.00
Cash drag (impact of timing delays and disruptions to active manager portfolios)	20.00	0.00
Cost of rolling the futures contract	0.00	0.00
Total cost	**30.00**	**24.00**

Notes: This exhibit shows the costs of reallocating 0.5% from international developed equities to fixed income in the cash and futures markets. The analysis assumes a three-month (one quarter) investment horizon because the expectation is that the change in portfolio allocation is for a relatively short time period. Given the length of the investment horizon, no rolling of futures occurs. All numbers are in basis points unless otherwise indicated.

IN-TEXT QUESTIONS

1. Using Exhibit 18, analyze the relative costs of the cash market and derivatives approaches to rebalancing.

   Guideline Answer:

   Looking at the data in Exhibit 18, Thompson can see that the two options appear similar from a cost perspective. The main cost driver associated with rebalancing through the cash market is cash drag (approximately 20 bps) caused by timing delays and disruptions to active manager portfolios.

Rebalancing through cash markets would involve withdrawing funds from international developed equity active managers and increasing funds to current fixed-income managers and/or adding a new fixed-income manager. These activities would generate transaction costs and cash drag because the liquidation process for the equity manager(s) and the investment process for the fixed-income manager(s) would likely not happen simultaneously.

In the case of derivatives (short equity futures position and long fixed-income futures position), the biggest cost component is mispricing or tracking error. Creating a short exposure position for the MSCI EAFE Index (the benchmark for international ex USA and Canada developed-market equities) and a long fixed-income futures position would involve a higher tracking error (17 bps) compared to the tracking error of using one S&P 500 futures contract discussed previously (8 bps). In this case, using multiple futures instruments increases associated tracking error.

2. Explain how considerations of implementation speed and time horizon of the rebalancing trade could affect the implementation choice.

   Guideline Answer:

   An additional factor is speed of implementation. In general, depending on the availability of derivatives for the asset classes involved, rebalancing using derivatives is likely to result in a shorter implementation time frame while leaving the active managers in place. Given high levels of liquidity in the equity futures that would be used for MSCI EAFE Index replication, implementing with derivatives could occur quickly.

   Another important aspect is rebalancing size and expected time horizon of the trade. The larger the rebalancing, the more likely that the rebalance would represent a more permanent realignment, as opposed to a temporary adjustment that could be reversed the next quarter.

   Based on the expected costs and considerations and the relatively small size of the adjustment, using derivatives to rebalance the portfolio appears to be the best option. Implementing with derivatives gives the team the flexibility to tactically adjust exposure to international developed equities if desired and the ability to quickly reverse decisions in full or in part while leaving the current external managers in place.

After further discussion with her team, Thompson decides to instead rebalance the international developed equity allocation back to the target allocation by reallocating 2.5% from the international developed equity allocation into fixed income. The team's current analysis is shown in Exhibit 19.

Exhibit 19: Cost Information on Rebalancing Options

Cost Component	Cash Market	Futures (Equity/Fixed Income)
Bid/offer spread	5.00	4.00
Price impact (total trades)	5.00	4.00
Mispricing (tracking error, annual)	0.00	68.00
Cash drag (impact of timing delays and disruptions to active manager portfolios)	50.00	0.00

Cost Component	Cash Market	Futures (Equity/Fixed Income)
Cost of rolling the futures contract	0.00	6.00
Total cost	**60.00**	**82.00**

Notes: This exhibit shows the costs of reallocating 2.5% from international developed equities to fixed income in the cash and futures markets. The analysis assumes a one-year investment horizon because the expectation is that the change in portfolio allocation is more permanent. Under normal market conditions, these asset classes would not be expected to move outside the corridor again over that investment horizon. All numbers are in basis points unless otherwise indicated.

IN-TEXT QUESTION

1. What implementation option should Thompson use in this case?

   Guideline Answer:

   Based on relative expected costs, Thompson would likely decide to rebalance the portfolio in the cash markets by reallocating between international developed equity and fixed-income investment managers.
   Exhibit 19 shows that the cost of rebalancing back to target allocation using derivatives is higher than implementing through the cash markets. Specifically, the implementation cost with derivatives is 82 bps, while the implementation cost for the cash markets is 60 bps. The higher derivatives cost is primarily caused by expected tracking error of the replication using derivatives, which is 68 bps on an annual basis. In general, the cost of rebalancing through futures is expected to increase with investment time horizon as mispricing or tracking risk increases. In this case, the impact of the cost of rolling the futures is not viewed as material, given that the roll of the short equity futures position would likely offset most of the cost of holding the long fixed-income futures position. With respect to the cash market implementation, given the size of the rebalancing trade (2.5% of the overall portfolio), potential cash drag is expected to increase to 50 bps as compared to the previous scenario.
   Other considerations besides expected cost might be relevant. A faster desired speed of implementation would favor implementation using derivatives, while the size of the planned rebalancing implies a longer time horizon for the trade and favors implementation through the cash market. Based on the facts given, Thompson would likely decide to rebalance the portfolio in the cash markets.

9 QUINCO CASE: ESG INTEGRATION

☐ discuss ESG considerations in managing long-term institutional portfolios

Nine months have passed, and the QUINCO team is facing a new challenge. Earlier in the week, the university president informed Winter of an upcoming student protest planned against the university and the endowment.

Student Activity

The students in the QU Student Association have seen a recent report published by the International Labor Organization (ILO) highlighting social issues in the supply chain of a US-based apparel company named Portro Inc. The report detailed a number of emerging social issues, including terrible labor conditions and allegations of child labor, as well as health and safety issues at two of Portro's largest suppliers. One of the suppliers named is also a supplier for the QU-branded apparel sold at the university stores. The students are further outraged after discovering from various public sources, including QUINCO's annual report, that the endowment is a significant shareholder in Portro Inc.

The students are expected to demand the following actions: The university must drop the supplier, and the endowment must divest its Portro Inc. holdings.

QUINCO ESG Approach

QUINCO has had an ESG responsible investing policy in place for the past seven years. The policy is based on the following considerations and objectives:

- Acknowledgment that ESG factors, along with traditional financial factors affect the risk and return of investments
- Promotion of greater transparency on material ESG issues that impact QUINCO's investment activities
- Pursuit of long-term sustainability for companies and markets in which the endowment invests

Rather than a strategy of exclusion that prohibits a priori investments in certain countries, sectors, or companies, QUINCO's approach focuses on ESG integration. ESG integration is defined as "the explicit and systematic inclusion of ESG factors in investment analysis and investment decisions."[8] Using this approach, the investment committee expects all material factors (ESG and traditional financial factors) to be considered in the investment process. Because the endowment's investment strategy is to use external asset managers, the policy relies on external managers to integrate ESG factors into their investment processes through research, materiality analysis, and active ownership assessment.

At its initiation, however, QUINCO's policy did not specify the tools and analyses required for the endowment to assess ESG manager implementation. Because of this, Winter and his team had struggled in recent years to adequately respond to issues similar to the Portro Inc. case.

To address these considerations, Winter had recently hired an ESG integration specialist, Natalya Long, CFA. Since joining QUINCO, Long has been instrumental in updating the responsible investment policy to include the following:

- Enhanced due diligence in manager selection and monitoring with an ESG element. Specifically, to document
  - whether the manager has a formal ESG integration policy,
  - how the manager incorporates ESG factors into the investment process,

8 CFA Institute and Principles for Responsible Investment (2018, p. 9).

- what the manager's commitment is to timely reporting and disclosure of material ESG issues, and
- how consistent the manager's ESG integration approach is with QUINCO's ESG responsible investing policy.

- Specific recognition of responsible ownership, reporting, and communication as key components of the ESG responsible investing policy. In addition to ESG integration, the responsible ownership component is implemented through proxy voting activities and corporate engagement on ESG issues, such as reporting and disclosure, climate change, and human capital.
- Monitoring of available ESG metrics for the QUINCO portfolio. These include aggregating available data on the carbon footprint and carbon intensity of endowment portfolio companies, developing an analytical framework to assess portfolio sensitivities to a wide range of climate-related risks, and sourcing and comparing ESG ratings or scores for portfolio companies from industry providers with peer companies and the policy benchmark. Trends in metrics for a portfolio company or the portfolio are monitored over time for changes.
- Public demonstration and signaling of commitment to responsible investing by being a signatory to the internationally recognized UN Principles for Responsible Investment (PRI).

The enhancements that Long made to the ESG policy provide the framework for QUINCO and thus Winter's response to the Portro Inc. situation.

QUINCO

Although Winter had known about the ILO report on Portro Inc., he was not aware of the relationship between the supplier and the university stores. He does know the endowment has two sources of potential exposure. Portro Inc. is a constituent in the benchmark index for the US public equity allocation. As a result, most of QUINCO's equity managers in the US portfolio likely have some exposure to the company. Additionally, one of QUINCO's US equity managers runs a concentrated portfolio strategy and holds Portro Inc. as a core holding, with a significant overweight in the company.

The university president recognizes that in regard to QUINCO investment activity, the students' issues cannot be addressed on a stand-alone basis but must be considered within the context of the endowment's responsible investing strategy. He asks Winter to prepare a formal response to the students' grievances consistent with the endowment's ESG responsible investing policies.

Investment Response

The ESG metrics monitoring system had alerted Winter's team to Portro Inc.'s poor ESG ratings versus its peers, specifically with respect to social factors; the issues with Portro's suppliers had been identified for some time. Consequently, as part of the team's systematic manager engagement strategy, these issues had been raised at the most recent quarterly review meeting, which had occurred several weeks before the ILO report was published. At that meeting, the QUINCO US public equity portfolio manager raised the Portro supplier issues to the external manager during the discussion on the overweight position in Portro Inc. The QUINCO team sought to understand whether the external manager could identify the risks arising from the supply chain and then report them and how they would be managed to clients in a timely and transparent manner. The discussions at that time confirmed that even though the external manager did not have a formal ESG integration policy in place, she did have a robust framework for considering ESG factors in the investment analysis. While she was concerned about a short-term negative impact to Portro's valuation, she remained confident in the company's long-term potential, even after accounting for the expected costs of fixing its supply chain problems. She had no plans to reduce position size. She did mention she would be monitoring Portro's management response to the issues in the coming months to determine whether to trim or sell out of the position. After that meeting, the QUINCO team concluded that the external manager had followed an adequate due diligence process that considered material ESG factors alongside traditional financial factors as required by QUINCO's ESG integration framework. However, the QUINCO team felt further manager and corporate engagement was still necessary to address the situation.

Consistent with its responsible ownership strategy, the QUINCO team then prepares to engage with Portro on the specific issues highlighted in the ILO report. This engagement includes joining other like-minded institutional investors in a dialogue with Portro's management (through the convening power of PRI) and/or using proxy voting to support shareholder resolutions aimed at increasing the company's corporate disclosure and reporting transparency regarding human capital management in the supply chain.

At the request of the university president, Winter prepares a formal response to share with the QU Student Association. He summarizes QUINCO's responsible investing policy and its application to the endowment's Portro Inc. holdings. Winter highlights the endowment's long-term commitment to promote the sustainability of the companies and markets in which the endowment invests and to integrate relevant ESG factors into the endowment's investment process. Winter's response also articulates that under the endowment's responsible investing strategy, divestment of the investment is considered a suboptimal risk mitigation strategy to be taken as a last resort. Winter highlights the plan to use the responsible ownership tools, such as proxy voting and manager and corporate engagement, to maintain awareness of Portro's company management on the specific issues at hand and to focus discussion on possible mitigating actions. Once he completes his report, Winter turns his attention to the issue of the supplier's apparel being sold in the university stores. He asks the head of the University Administration Office to immediately remove the merchandise in question from the university stores. He plans to revisit this decision once further progress has occurred with corporate engagement efforts, and then he heads home for the day.

SUMMARY

The QU endowment case study covers important aspects of institutional portfolio management involving the illiquidity premium capture, liquidity management, asset allocation, and the use of derivatives versus the cash market for tactical asset allocation and portfolio rebalancing. In addition, the case examines potential ethical violations in manager selection that can arise in the course of business.

From an asset allocation perspective, the case highlights potential risks and rewards associated with increasing exposure to illiquidity risk through investments such as private equity and private real estate. Although this exposure is expected to generate higher returns and more-efficient portfolios in the long run, significant uncertainties are involved from both a modeling and implementation perspective. Finally, the case highlights social considerations that could arise with investing.

REFERENCES

Ang, Andrew, Dimitris Papanikolaou, and Mark M. Westerfield. 2014. "Portfolio Choice with Illiquid Assets." *Management Science* 60 (11): iv–vi, 2381–2617. . https://pubsonline.informs.org/doi/abs/10.1287/mnsc.2014.1986.10.1287/mnsc.2014.1986

CFA Institute and Principles for Responsible Investment (PRI). 2018. *Guidance and Case Studies for ESG Integration: Equities and Fixed Income*. Charlottesville, VA: CFA Institute.

Chaffe, David B.H., III. 1993. "Option Pricing as a Proxy for Discount for Lack of Marketability in Private Company Valuations." *Business Valuation Review* 12 (4): 182–88. 10.5791/0882-2875-12.4.182

Green, Katie. 2015. "The Illiquidity Conundrum: Does the Illiquidity Premium Really Exist?" Schroders (August). http://www.schroders.com/hu/sysglobalassets/digital/insights/pdfs/the-illiquidity-conundrum.pdf.

Investments, Russell. 2013. "Liquidity Management: A Critical Aspect of a Successful Investment Program for Non-Profit Organizations" (October). https://russellinvestments.com/-/media/files/nz/insights/1310-liquidity-management.pdf.

Mercer. 2015. "Setting an Appropriate Liquidity Budget: Making the Most of a Long Investment Horizon" (February). https://www.mercer.com/content/dam/mercer/attachments/global/investments/setting-an-appropriate-liquidity-budget-mercer-february-2015-a4.pdf.

Pastor, Lubos, and Robert F. Stambaugh. 2001. "Liquidity Risk and Expected Stock Returns." NBER Working Paper w8462. https://ssrn.com/abstract=282688. 10.3386/w8462

Raymond, Donald M. 2009. "Integrating Goals, Structure, and Decision-Making at Canada Pension Plan Investment Board." *Rotman International Journal of Pension Management* 2 (1).

Staub, Renato, and Jeffrey Diermeier. 2003. "Segmentation, Illiquidity and Returns." *Journal of Investment Management* 1 (1).

PRACTICE PROBLEMS

The following information relates to questions 1-2

Joe Bookman is a portfolio manager at State Tech University Foundation and is discussing the USD900 million university endowment with the investment committee.

Exhibit 1 presents selected data on the current university endowment.

Exhibit 1: Selected Data for State Tech University Endowment

Asset Class	Investment Allocation (% of portfolio)	Highly Liquid	Semi-Liquid	Illiquid	Rebalancing Band Policy	Standard Deviation of Returns (annual)
Cash	1%	100%	0%	0%	0%–15%	1.5%
Fixed Income	24%	100%	0%	0%	20%–30%	5.9%
Public Equity	39%	50%	50%	0%	30%–40%	15.4%
Private Equity	21%	0%	0%	100%	20%–25%	27.2%
Real Assets	15%	0%	50%	50%	10%–20%	11.7%

The university investment committee is performing its quarterly assessment and requests that Bookman review the rebalancing band policy.

1. **Identify** which asset class(es) Bookman is *most likely* to note as in need of rebalancing band policy adjustment. **Justify** your selection(s).

Identify which asset class(es) Bookman is *most likely* to note as in need of rebalancing band policy adjustment. [Circle choice(s).]	Justify your selection(s).
Cash	
Fixed Income	
Public Equity	
Private Equity	
Real Assets	

2. The investment committee also asks Bookman to investigate whether the endowment should increase its allocation to illiquid investments to take advantage of higher potential returns. The endowment's liquidity profile policy stipulates that at least 30% of investments must be classified as liquid to support operating expenses; no more than 40% should be classified as illiquid. Bookman decides to perform a bottom-up liquidity analysis to respond to the committee.

   Discuss the elements of Bookman's analysis and the conclusions he will draw from it.

3. Laura Powers is a senior investment analyst at Brotley University Foundation and works for the university endowment. Powers is preparing a recommendation to allocate more funds into illiquid investments for a higher potential return and is discussing the rationale with junior analyst Jasper Heard. Heard makes the following statements to Powers:

Statement 1	The endowment should shift funds into private equity and real estate. Specifically, within these asset classes, the endowment should target shorter-term investments. These investments tend to be the most illiquid and offer the highest liquidity premium.
Statement 2	The endowment should consider low liquidity public equity investments because they are shown to be close substitutes for private equity and real estate investments in terms of liquidity premium.

Determine whether Heard's statements are correct. **Justify** your response.

Determine whether Heard's statements are correct.

Statement 1 (Circle one.)		Statement 2 (Circle one.)	
Correct	Incorrect	Correct	Incorrect
Justify your response.		**Justify** your response.	

4. Mason Dixon, CFA, a portfolio manager with Langhorne Advisors ("Langhorne"), has just completed the RFP for the Academe Foundation's ("the Foundation") USD20 million fixed-income mandate. In the performance section of the RFP, Dixon indicated that Langhorne is a member firm of CFA Institute and has prepared and presented this performance report in compliance with the Global Investment Performance Standards (the GIPS® standards). The performance report presented Langhorne's fixed-income composite returns on the actual net-of-fees basis and benchmark returns, net of Langhorne's highest scheduled fee (1.00% on the first USD5 million; 0.60% thereafter). The report also indicated that as of the most recent quarter, the composite comprised 10 portfolios totaling USD600 million of assets under management.

   Upon returning the completed RFP, Dixon thanked the Foundation's CIO, who is also a charterholder, for considering Langhorne. Dixon also indicated that regardless of the outcome of the manager search, he would like to have the CIO and the Foundation's president join him on Langhorne's corporate jet to spend a day at an exclusive California golf club where the firm maintains a corporate membership.

   Identify the ethical concerns posed by Dixon's actions and conduct.

5. In its quarterly policy and performance review, the investment team for the Peralandra University endowment identified a tactical allocation opportunity in international developed equities. The team also decided to implement a passive 1% overweight (USD5 million notional value) position in the asset class. Implementation will occur by using either an MISC EAFE Index ETF in the cash market or the equivalent futures contract in the derivatives market.

   The team determined that the unlevered cost of implementation is 27 bps in the cash market (ETF) and 32 bps in the derivatives market (futures). This modest cost differential prompted a comparison of costs on a levered basis to preserve liquidity for upcoming capital commitments in the fund's alternative investment asset classes. For the related analysis, the team's assumptions are as follows:

- Investment policy compliant at three times leverage
- Investment horizon of one year
- Three-month MRR of 1.8%
- ETF borrowing cost of three-month MRR plus 35 bps

Recommend the most cost-effective strategy. **Justify** your response with calculations of the total levered cost of each implementation option.

The following information relates to questions 6-7

Rob Smith, as portfolio manager at Pell Tech University Foundation, is responsible for the university's USD3.5 billion endowment. The endowment supports the majority of funding for the university's operating budget and financial aid programs, and it is invested in fixed income, public equities, private equities, and real assets.

The Pell Tech Board is conducting its quarterly strategic asset allocation review. The board members note that although performance has been satisfactory, they have two concerns:

1. Endowment returns have underperformed in comparison to those of university endowments of similar size.
2. Return expectations have shifted lower for fixed-income and public equity investments.

Smith attributes this underperformance to a lower risk profile relative to that of its peers because of a lower allocation to illiquid private equity investments. In response to the board's concerns, Smith proposes an increase in the allocation to the private equity asset class. His proposal uses option price theory for valuation purposes and is supported by Monte Carlo simulations.

Exhibit 1 presents selected data on the current university endowment.

Exhibit 1: Selected Data for Pell Tech University Endowment

Portfolio Characteristic	Current Allocation	Proposed Allocation
Expected return (next 10 years)	7.8%	8.3%
Standard deviation of returns (annual)	13.2%	13.9%
Sharpe ratio	0.44	0.45
Probability of 30% erosion in purchasing power over 10 years	25%	20%

6. **Discuss** Smith's method for estimating the increase in return expectations derived from increasing the endowment allocation to private equity.

7. **Discuss***two* reasons the increased risk profile is appropriate. **Justify** your

response.

The following information relates to questions 8-9

Frank Grides is a portfolio manager for Kemney University Foundation and manages the liquidity profile of the university endowment. This endowment supports some of the funding for the university's operations. It applies the following spending policy designed to produce a 5% long-term spending rate while shielding annual distributions from fluctuations in its market value:

Spending for current fiscal year

= (60% × Spending for previous fiscal year) + [40% × (5% × Endowment market value at the end of previous fiscal year)].

Grides is considering allocating more funds to illiquid investments to capture higher potential returns and is discussing this strategy with senior analyst Don Brodka. Brodka has three related concerns, given that the higher allocation to illiquid investments might

- reduce the liquidity profile of the endowment,
- induce "drift" in the portfolio's risk profile in times of market stress, or
- alter the endowment's overall risk profile.

Assessing his concerns, Brodka performs a stress test on the portfolio with both current and proposed investments.

Exhibit 1 presents selected data on the university endowment.

Exhibit 1: Selected Data for Kemney University Endowment

Liquidity Category	Current Portfolio: Normal	Current Portfolio: Stress	Proposed Portfolio: Normal	Proposed Portfolio: Stress
Highly Liquid	42%	38%	37%	33%
Semi-liquid	31%	28%	31%	28%
Illiquid	27%	34%	32%	39%

8. **Discuss** the relevance of the endowment's spending policy to Brodka's expressed concerns.

9. **Discuss** the actions that Grides should take to alleviate Brodka's concerns.

10. Mason Dixon, CFA, a portfolio manager with Langhorne Advisors ("Langhorne"), has just completed the RFP for the Academe Foundation's ("the Foundation") USD20 million fixed-income mandate. In the performance section of the RFP, Dixon indicated that Langhorne is a member firm of CFA Institute and has prepared and presented this performance report in compliance with the Global Investment Performance Standards (the GIPS® standards). The performance report presented Langhorne's fixed-income composite returns on the actual net-of-fees basis and benchmark returns, net of Langhorne's highest scheduled

fee (1.00% on the first USD5 million; 0.60% thereafter). The report also indicated that as of the most recent quarter, the composite comprised 10 portfolios totaling USD600 million of assets under management.

Upon returning the completed RFP, Dixon thanked the Foundation's CIO, who is also a charterholder, for considering Langhorne. Dixon also indicated that regardless of the outcome of the manager search, he would like to have the CIO and the Foundation's president join him on Langhorne's corporate jet to spend a day at an exclusive California golf club where the firm maintains a corporate membership.

Identify the ethical concerns posed by Dixon's actions and conduct.

11. Clive Staples is a consultant with the Leedsford Organization ("Leedsford"), a boutique investment consulting firm serving large endowments and private foundations. Leedsford consults on tactical asset allocation (TAA) program development and implementation, and on ongoing TAA idea generation.

Staples has just completed his quarterly client review of the Narnea Foundation ("the Foundation"). Based on the Foundation's current asset allocation and Leedsford's updated fair value models, Staples believes an exploitable TAA opportunity exists in US large-cap growth stocks. He recommends a 2% overweight position to the US equities policy allocation through either an unlevered ETF or total return swap exposures to the Russell 1000 Growth Index.

Compare the efficiency of the ETF and total return swap TAA implementation alternatives from the perspectives of capital commitment, liquidity, and tracking error.

Compare the efficiency of the ETF and total return swap TAA implementation alternatives from the perspectives of capital commitment, liquidity, and tracking error.
Capital Commitment:
Liquidity:
Tracking Error:

12. The Lemont Family Foundation ("the Foundation") follows a systematic quarterly rebalancing policy based on rebalancing corridors for each asset class. In the latest quarter, a significant sell-off in US public equities resulted in an unusually large 1.2% underweight position relative to the applicable lower corridor boundary. This is the only policy exception requiring rebalancing attention.

The Foundation's investment team views the sell-off as temporary and remains pleased with the performance of all external managers, including that of its US public equities manager. However, the sell-off has increased the significance of liquidity and flexibility for the team. As a result, the team now considers whether to rebalance through the cash market or the derivatives market.

Determine the *most appropriate* rebalancing choice for the Foundation's investment team. **Justify** your response.

Determine the *most appropriate* rebalancing choice for the Foundation's investment team. (Circle one.)	
Cash Market	Derivatives Market
Justify your response.	

SOLUTIONS

1. **Identify** which asset class(es) Bookman is *most likely* to note as in need of rebalancing band policy adjustment. [Circle choice(s).]

	Justify your selection(s).
Cash Fixed Income Public Equity Private Equity Real Assets	As part of effective portfolio management, rebalancing disciplines, such as calendar rebalancing and percent-range rebalancing, are intended to control risk relative to the strategic asset allocation. In these cases, pre-specified Tolerance bands for asset class weights are used. The size or width of the bands should consider the underlying volatility of each investment category to minimize transaction costs. This means more-volatile investment categories usually have wider rebalancing bands. Cash Rebalancing: In reply to the university investment committee as it performs its quarterly assessment, Bookman notes that the cash asset classes have the lowest standard deviation with one of the widest rebalancing band policies. The cash rebalancing band should be evaluated and suitably reduced. Private Equity Rebalancing: The private equity asset class also has the highest standard deviation with one of the tightest rebalancing band policies. The private equity rebalancing band should be evaluated and suitably expanded.

2. To operationalize the concepts represented in the liquidity budget, it is appropriate to analyze the underlying liquidity characteristics of the portfolio investments and monitor these characteristics over time. The analysis should look beyond the broad definition of asset classes to the underlying investments used for exposure because different investments within the same asset class could have very different liquidity profiles.

   In performing a bottom-up liquidity analysis on the State Tech endowment, Bookman multiplies each asset class allocation by its matching liquidity classification and then aggregates across asset classes. Based on this analysis, 44.5% of investments are currently classified as liquid, and 28.5% are classified as illiquid, calculated as follows:

   Investments classified as liquid

   = (Cash allocation × %Liquid) + (Fixed-income allocation × %Liquid) + (Public equity allocation × %Liquid)

   Investments classified as liquid = (1% × 100%) + (24% × 100%) + (39% × 50%)

   = 44.5%.

   Investments classified as illiquid

   = (Private equity allocation × %Illiquid) + (Real asset allocation × %Illiquid)

Investments classified as illiquid = (21% × 100%) + (15% × 50%) = 28.5%.

The liquid investment allocation of 44.5% is well above the 30% liquid requirement, and the 28.5% illiquid investment allocation is well below the 40% illiquid limit. As a result, there is enough capacity to reallocate more funds from liquid investments into illiquid investments to take advantage of the higher potential returns. Thus, Bookman can recommend that shift.

3. **Determine whether** Heard's statements are correct.

Statement 1 (Circle one.)		Statement 2 (Circle one.)	
Correct	<u>Incorrect</u>	Correct	<u>Incorrect</u>
Justify your response.		**Justify** your response.	
Statement 1 is incorrect because of a misunderstanding of the characteristics of particular investments. The endowment should shift funds into private equity and real estate because these asset classes generally offer a higher return potential due to higher liquidity premiums. However, within these asset classes, the endowment should target longer-term investments, not shorter-term ones. Longer-term investments tend to be the most illiquid and offer the highest liquidity premium. Quantitative estimates for the illiquidity premium suggest evidence of a positive illiquidity premium in private equity and private real estate and of illiquidity premium size being positively correlated to the length of the illiquidity horizon.		Statement 2 is incorrect because of a misinterpretation of the effects of the illiquidity premium. Heard's statement on public equities is partially true, but it does not rely on a fully defensible basis for an investment recommendation. While a significant body of literature documents a positive relationship between lack of liquidity and expected returns in the case of public equity, overall it is difficult to isolate the illiquidity premium with precision and separate its effects from such other risk factors as the market, value, and size in the case of equity investments. Furthermore, estimates of the illiquidity premium are based on broad market indexes, yet an investor in these asset classes would typically invest in only a small subset of the universe, with the result that individual investment experience could be very different and more susceptible to idiosyncratic factors. These challenges further emphasize the importance of liquidity budgeting in facilitating capture of the illiquidity premium while controlling for risk.	

4. Dixon's actions and conduct pose multiple ethical concerns.

   Dixon's claim of compliance statement and cover letter, along with Langhorne's performance report, violate both the CFA Institute Code of Ethics and Standards of Professional Conduct (Code and Standards) and the GIPS standards. Regarding the Code and Standards, Dixon's statement improperly asserts that CFA Institute has designated Langhorne as a "member firm." Membership is held by practitioners as individuals, with no related rights extended to the firms at which they work. With this assertion, Dixon has misrepresented Langhorne's claim of compliance, Standard I(C): Misrepresentation; engaged in conduct that compromised the reputation or integrity of CFA Institute, Standard VII(A): Conduct as Participants in CFA Institute Programs; and misrepresented or exaggerated the meaning or implications of membership in CFA Institute, Standard VII(B): Reference to CFA Institute, the CFA Designation, and the CFA Program.

   Regarding the GIPS standards and the performance report, presenting composite returns on a net-of-fees basis is acceptable under the GIPS standards. However, adjusting benchmark returns with a hypothetical fee for comparative purposes (i.e., composite gross-of-fees returns should be compared to unadjusted benchmark returns) is not appropriate. This adjustment of Langhorne's performance report is invalid under the GIPS standards under Section 4.a.1: Disclosure—Requirements. The 1.00% hypothetical fee deducted from benchmark returns is surely greater than the average fee deducted in arriving at composite net-of-fees returns. An average portfolio size of USD60 million implies a composite fee percentage of roughly 0.63%, or: {(0.0100 × USD5 million) + [0.0060 × (USD60 million – USD5 million)]}/USD60 million = 0.0063 or 0.63%. So, on a relative basis, deducting a larger cost against the benchmark will show Langhorne with a phantom outperformance.

In terms of the Code and Standards, at a minimum, Dixon has presented an inaccurate performance comparison—Standard III(D): Performance Presentation—and might have engaged in misrepresentation to the point of misconduct—Standard I(D): Misconduct—casting a more favorable light on the Langhorne composite net-of-fees returns could be deceitful (Section 0.A.7 under Fundamentals of Compliance—Requirements of the GIPS standards).

Dixon's cover letter invitation for an all-expenses-paid outing to an exclusive golf destination can be construed as an attempt to influence the independence and objectivity of the Foundation's CIO and president—Standard I(B): Independence and Objectivity. While Dixon's invitation was extended "regardless of the outcome of the manager search," the offer could be interpreted as a quid pro quo, with future attractive personal benefits available to the Foundation's executives if a continuing relationship was established by their hiring of Langhorne as a manager.

5. As the lower-cost alternative, the endowment's investment team should implement the 1% overweight position using futures.

   The additional cost of obtaining leverage for each option is as follows:

   ETF: (USD5 million × 0.6667 × 2.15%)/USD5 million = 1.43% (or 143 bps) and

   Futures: (USD5 million × 0.6667 × 1.80%)/USD5 million = 1.20% (or 120 bps),

   where the inputs are derived as follows:

   0.6667 reflects the three times leverage factor (66.67% borrowed and 33.33% cash usage),

   2.15% reflects the ETF borrowing rate (three-month MRR of 1.80% + 35 bps), and

   1.80% reflects the absence of investment income offset (at three-month MRR) versus the unlevered cost of futures implementation.

   The total levered cost of each option is the sum of the unlevered cost plus the additional cost of obtaining leverage:

   ETF: 27 bps + 143 bps = 170 bps and

   Futures: 32 bps + 120 bps = 152 bps.

   This 18 bps cost advantage would make futures the appropriate choice for the endowment's investment team.

6. Private equity is recognized as an illiquid alternative investment and could offer higher returns via a liquidity premium.

   The illiquidity premium (also called the liquidity premium) is the expected compensation for the additional risk of tying up capital for a potentially uncertain time period. It can be estimated, as Smith has done, by using the idea that the size of a discount an investor should receive for such capital commitment is represented by the value of a put option with an exercise price equal to the hypothetical "marketable price" of the illiquid asset as estimated at the time of purchase. Smith can derive the price of the illiquid private equity asset by subtracting the put price from the "marketable price." If both the "marketable price" and the illiquid asset price are estimated or known, then the expected return for each can be calculated, with the difference in expected returns representing the illiquidity premium (in %).

7. Reasons to justify the increased risk profile include the following:

   a. The board members' lower return expectations for public equity and fixed-income asset classes imply that a higher level of risk must be taken to achieve the same level of returns.

   b. For a long-horizon institutional investor such as Pell Tech, the ability to tolerate illiquidity creates an opportunity to improve portfolio diversification and expected returns as well as access a broader set of investment strategies. In mean–variance optimization models, the inclusion of illiquid assets in the eligible investment universe might shift the efficient frontier for the portfolio upward, theoretically resulting in greater efficiency (i.e., higher expected returns will be gained across all given levels of risk).

   c. The portfolio risk profile for the endowment is currently more conservative in comparison to that of peer universities.

   d. Smith's Monte Carlo simulations suggest that the proposed asset allocation has a higher probability of achieving the return target while better preserving the purchasing power of the endowment.

8. In voicing his concerns, Brodka is cautioning that a higher allocation to illiquid investments could have adverse effects on the endowment's spending rate and risk profile. Kemney University's spending policy is an example of a geometric smoothing rule, sometimes called the Yale formula. It is intended to bring about a predictable pattern of distributions for better planning of resource deployment through its programs across varying conditions, even ones as extreme as those of the 2008 global financial crisis.

   While this spending policy would be consistent with an investment objective of achieving long-term returns that support the spending rate while preserving the value of the endowment in real terms over time, the policy design also incorporates a smoothing, countercyclical element. This leads to lower spending rates in a period of sustained strong investment returns but higher spending rates in a protracted weak return environment.

9. As a result of the allocation changes, there will be a reduction in the liquid and semi-liquid categories and an increase in the illiquid category under both normal and stress conditions. The proposed allocation shifting 5% of the endowment's investments from liquid to illiquid assets would result in an increase in the overall illiquidity profile.

   Regarding Brodka's concern about the liquidity profile, Grides needs to ensure that even under stress conditions, the proposed allocation continues to comply with the liquidity budgeting framework in place. From an ongoing management perspective—and particularly at times when the liquidity profile of the proposed allocation is closer to the minimum thresholds set through the liquidity budget—Grides should plan to closely monitor the portfolio's liquidity profile and stress test it periodically to make sure portfolio liquidity remains adequate.

Regarding Brodka's concern of risk profile "drift," illiquid assets carry extremely high rebalancing costs. Because asset liquidity tends to decrease in periods of market stress, having sufficient liquid assets and rebalancing mechanisms in place is important to ensure the portfolio's risk profile remains within acceptable risk targets and does not "drift" as the relative valuations of different asset classes fluctuate during stress periods. Because liquid assets will decrease as a result of the proposed allocation, Grides must ensure that an effective rebalancing mechanism is adopted prior to the investment and is consistently followed thereafter. That mechanism can be either through a systematic discipline, such as calendar rebalancing or percent-range rebalancing that set pre-specified tolerance bands for asset weights, or through an automatic rebalancing method, such as using adjustments to a public market allocation that is correlated to a private market allocation (likely a more illiquid exposure) to rebalance private market risk.

Contrary to its desired intent, and providing grounds for Brodka's concerns, this design would exacerbate the endowment's liquidity needs in severe market downturns. Given the possibility of such adverse events within Kemney's long-term planning horizon, the policy is very relevant as potentially introducing undesired risks.

10. Dixon's actions and conduct pose multiple ethical concerns.

Dixon's claim of compliance statement and cover letter, along with Langhorne's performance report, violate both the CFA Institute Code of Ethics and Standards of Professional Conduct (Code and Standards) and the GIPS standards. Regarding the Code and Standards, Dixon's statement improperly asserts that CFA Institute has designated Langhorne as a "member firm." Membership is held by practitioners as individuals, with no related rights extended to the firms at which they work. With this assertion, Dixon has misrepresented Langhorne's claim of compliance, Standard I(C): Misrepresentation; engaged in conduct that compromised the reputation or integrity of CFA Institute, Standard VII(A): Conduct as Participants in CFA Institute Programs; and misrepresented or exaggerated the meaning or implications of membership in CFA Institute, Standard VII(B): Reference to CFA Institute, the CFA Designation, and the CFA Program.

Regarding the GIPS standards and the performance report, presenting composite returns on a net-of-fees basis is acceptable under the GIPS standards. However, adjusting benchmark returns with a hypothetical fee for comparative purposes (i.e., composite gross-of-fees returns should be compared to unadjusted benchmark returns) is not appropriate. This adjustment of Langhorne's performance report is invalid under the GIPS standards under Section 4.a.1: Disclosure—Requirements. The 1.00% hypothetical fee deducted from benchmark returns is surely greater than the average fee deducted in arriving at composite net-of-fees returns. An average portfolio size of USD60 million implies a composite fee percentage of roughly 0.63%, or: {(0.0100 × USD5 million) + [0.0060 × (USD60 million – USD5 million)]}/USD60 million = 0.0063 or 0.63%. So, on a relative basis, deducting a larger cost against the benchmark will show Langhorne with a phantom outperformance.

In terms of the Code and Standards, at a minimum, Dixon has presented an inaccurate performance comparison—Standard III(D): Performance Presentation—and might have engaged in misrepresentation to the point of misconduct—Standard I(D): Misconduct—casting a more favorable light on the Langhorne composite net-of-fees returns could be deceitful (Section 0.A.7 under Fundamentals of Compliance—Requirements of the GIPS standards).

Dixon's cover letter invitation for an all-expenses-paid outing to an exclusive golf destination can be construed as an attempt to influence the independence and objectivity of the Foundation's CIO and president—Standard I(B): Independence and Objectivity. While Dixon's invitation was extended "regardless of the outcome of the manager search," the offer could be interpreted as a quid pro quo, with future attractive personal benefits available to the Foundation's executives if a continuing relationship was established by their hiring of Langhorne as a manager.

11. **Compare** the efficiency of the ETF and total return swap TAA implementation alternatives from the perspectives of capital commitment, liquidity, and tracking error.

Compare the efficiency of the ETF and total return swap TAA implementation alternatives from the perspectives of capital commitment, liquidity, and tracking error.
Capital Commitment: From a cash "usage" perspective, a Russell 1000 Growth ETF would be less efficient (requiring a larger cash outlay) than a total return swap replicating the Russell 1000 Growth Index. The capital commitment of an unlevered ETF equals the full notional value. In contrast, a total return swap generates a similar economic exposure to ETFs with much lower capital. The cash-efficient nature of derivatives, such as total return swaps, makes them desirable tools for gaining incremental exposure to a particular asset class.
Liquidity: From a liquidity perspective, a Russell 1000 Growth ETF would be more efficient than the total return swap. As exchange-traded standardized products, ETFs enjoy liquid trading and narrow bid–ask spreads. In contrast, total return swaps are over-the-counter contracts (not exchange traded) that are negotiated and customizable on such features as maturity, leverage, and cost.
Tracking Error: From a tracking error perspective, ETFs would be less efficient than the total return swap. A Russell 1000 Growth ETF would have associated tracking error, which could result from premiums and discounts to net asset value, cash drag, or regulatory diversification requirements. In contrast, for total return swaps, the replication is exact. The Foundation would receive the total index return without incurring any tracking error to the benchmark index because the swap counterparty is obligated to provide the index return. This would, however, expose the Foundation to counterparty credit risk and introduce additional complexities in managing net exposure over the duration of the contract.

12. **Determine** the *most appropriate* rebalancing choice for the Foundation's investment team. (Circle one.)

Cash Market	Derivatives Market

Justify your response.

The Foundation's investment team should execute the rebalancing in the derivatives market rather than the cash market. The team could, for example, establish a 1.2% long position to the S&P 500 Index using short-term S&P 500 futures to rebalance the US public equities asset class back to its policy allocation corridor.

Execution in the derivatives market offers the following advantages:

- Quick implementation
- Flexibility to tactically adjust exposure and quickly reverse decisions
- Ability to leave external managers in place
- High levels of liquidity

The team views the sell-off as temporary and is pleased with external manager performance. This suggests that a short-term rebalancing approach is warranted rather than reallocating among managers. Execution in the derivatives market will enable quick rebalancing while leaving current allocations in place.

The sell-off has increased the significance of liquidity and flexibility. The derivatives market offers flexibility to quickly adjust market exposures with high levels of liquidity.

While derivatives can present tracking error and operational risks, the expected short-term nature of the rebalancing serves to contain their effects. The benefits to be gained using derivatives appear to more than outweigh the associated cost and risk.