# 2020 CFA®
PROGRAM EXAM PREP

SchweserNotes™ Level II

## Alternative Investments and Portfolio Management

eBook 5

KAPLAN® SCHWESER

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# LEARNING OUTCOME STATEMENTS (LOS)

# STUDY SESSION 15

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 39. Private Real Estate Investments

The candidate should be able to:

a. classify and describe basic forms of real estate investments. (page 1)
b. describe the characteristics, the classification, and basic segments of real estate. (page 3)
c. explain the role in a portfolio, economic value determinants, investment characteristics, and principal risks of private real estate. (page 4)
d. describe commercial property types, including their distinctive investment characteristics. (page 6)
e. compare the income, cost, and sales comparison approaches to valuing real estate properties. (page 8)
f. estimate and interpret the inputs (for example, net operating income, capitalization rate, and discount rate) to the direct capitalization and discounted cash flow valuation methods. (page 10)
g. calculate the value of a property using the direct capitalization and discounted cash flow valuation methods. (page 10)
h. compare the direct capitalization and discounted cash flow valuation methods. (page 19)
i. calculate the value of a property using the cost and sales comparison approaches. (page 20)
j. describe due diligence in private equity real estate investment. (page 25)
k. discuss private equity real estate investment indexes, including their construction and potential biases. (page 26)
l. explain the role in a portfolio, the major economic value determinants, investment characteristics, principal risks, and due diligence of private real estate debt investment. (page 4)
m. calculate and interpret financial ratios used to analyze and evaluate private real estate investments. (page 27)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 40. Publicly Traded Real Estate Securities

The candidate should be able to:

a. describe types of publicly traded real estate securities. (page 35)
b. explain advantages and disadvantages of investing in real estate through publicly traded securities. (page 36)
c. explain economic value determinants, investment characteristics, principal risks, and due diligence considerations for real estate investment trust (REIT) shares. (page 39)
d. describe types of REITs. (page 41)
e. justify the use of net asset value per share (NAVPS) in REIT valuation and estimate NAVPS based on forecasted cash net operating income. (page 44)
f. describe the use of funds from operations (FFO) and adjusted funds from operations (AFFO) in REIT valuation. (page 48)
g. compare the net asset value, relative value (price-to-FFO and price-to-AFFO), and discounted cash flow approaches to REIT valuation. (page 49)
h. calculate the value of a REIT share using net asset value, price-to-FFO and price-to-AFFO, and discounted cash flow approaches. (page 50)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 41. Private Equity Valuation

The candidate should be able to:

a. explain sources of value creation in private equity. (page 64)
b. explain how private equity firms align their interests with those of the managers of portfolio companies. (page 65)
c. distinguish between the characteristics of buyout and venture capital investments. (page 66)
d. describe valuation issues in buyout and venture capital transactions. (page 71)
e. explain alternative exit routes in private equity and their impact on value. (page 75)
f. explain private equity fund structures, terms, valuation, and due diligence in the context of an analysis of private equity fund returns. (page 76)
g. explain risks and costs of investing in private equity. (page 81)
h. interpret and compare financial performance of private equity funds from the perspective of an investor. (page 83)
i. calculate management fees, carried interest, net asset value, distributed to paid in (DPI), residual value to paid in (RVPI), and total value to paid in (TVPI) of a private equity fund. (page 87)
j. calculate pre-money valuation, post-money valuation, ownership fraction, and price per share applying the venture capital method 1) with single and multiple financing rounds and 2) in terms of IRR. (page 91)
k. demonstrate alternative methods to account for risk in venture capital. (page 97)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 42. Introduction to Commodities and Commodity Derivatives

The candidate should be able to:

a. compare characteristics of commodity sectors. (page 113)
b. compare the life cycle of commodity sectors from production through trading or consumption. (page 116)
c. contrast the valuation of commodities with the valuation of equities and bonds. (page 117)
d. describe types of participants in commodity futures markets. (page 117)
e. analyze the relationship between spot prices and future prices in markets in contango and markets in backwardation. (page 118)
f. compare theories of commodity futures returns. (page 119)
g. describe, calculate, and interpret the components of total return for a fully collateralized commodity futures contract. (page 121)
h. contrast roll return in markets in contango and markets in backwardation. (page 122)
i. describe how commodity swaps are used to obtain or modify exposure to commodities. (page 122)
j. describe how the construction of commodity indexes affects index returns. (page 124)

# STUDY SESSION 16

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 43. Exchange-Traded Funds: Mechanics and Applications

The candidate should be able to:

a. explain the creation/redemption process of ETFs and the function of authorized participants. (page 133)
b. describe how ETFs are traded in secondary markets. (page 135)
c. describe sources of tracking error for ETFs. (page 135)
d. describe factors affecting ETF bid–ask spreads. (page 137)
e. describe sources of ETF premiums and discounts to NAV. (page 138)
f. describe costs of owning an ETF. (page 139)
g. describe types of ETF risk. (page 140)
h. identify and describe portfolio uses of ETFs. (page 142)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 44. Using Multifactor Models

The candidate should be able to:

a. describe arbitrage pricing theory (APT), including its underlying assumptions and its relation to multifactor models. (page 149)
b. define arbitrage opportunity and determine whether an arbitrage opportunity exists. (page 150)
c. calculate the expected return on an asset given an asset's factor sensitivities and the factor risk premiums. (page 152)
d. describe and compare macroeconomic factor models, fundamental factor models, and statistical factor models. (page 154)
e. explain sources of active risk and interpret tracking risk and the information ratio. (page 159)
f. describe uses of multifactor models and interpret the output of analyses based on multifactor models. (page 161)
g. describe the potential benefits for investors in considering multiple risk dimensions when modeling asset returns. (page 166)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 45. Measuring and Managing Market Risk

The candidate should be able to:

a. explain the use of value at risk (VaR) in measuring portfolio risk. (page 173)
b. compare the parametric (variance–covariance), historical simulation, and Monte Carlo simulation methods for estimating VaR. (page 174)
c. estimate and interpret VaR under the parametric, historical simulation, and Monte Carlo simulation methods. (page 174)
d. describe advantages and limitations of VaR. (page 177)
e. describe extensions of VaR. (page 178)
f. describe sensitivity risk measures and scenario risk measures and compare these measures to VaR. (page 179)
g. demonstrate how equity, fixed-income, and options exposure measures may be used in measuring and managing market risk and volatility risk. (page 180)
h. describe the use of sensitivity risk measures and scenario risk measures. (page 181)

i. describe advantages and limitations of sensitivity risk measures and scenario risk measures. (page 182)
j. describe risk measures used by banks, asset managers, pension funds, and insurers. (page 183)
k. explain constraints used in managing market risks, including risk budgeting, position limits, scenario limits, and stop-loss limits. (page 185)
l. explain how risk measures may be used in capital allocation decisions. (page 186)

# STUDY SESSION 17

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 46. Economics and Investment Markets

The candidate should be able to:

a. explain the notion that to affect market values, economic factors must affect one or more of the following: 1) default-free interest rates across maturities, 2) the timing and/or magnitude of expected cash flows, and 3) risk premiums. (page 191)

b. explain the role of expectations and changes in expectations in market valuation. (page 192)

c. explain the relationship between the long-term growth rate of the economy, the volatility of the growth rate, and the average level of real short-term interest rates. (page 192)

d. explain how the phase of the business cycle affects policy and short-term interest rates, the slope of the term structure of interest rates, and the relative performance of bonds of differing maturities. (page 194)

e. describe the factors that affect yield spreads between non-inflation-adjusted and inflation-indexed bonds. (page 195)

f. explain how the phase of the business cycle affects credit spreads and the performance of credit-sensitive fixed-income instruments. (page 196)

g. explain how the characteristics of the markets for a company's products affect the company's credit quality. (page 197)

h. explain how the phase of the business cycle affects short-term and long-term earnings growth expectations. (page 197)

i. explain the relationship between the consumption-hedging properties of equity and the equity risk premium. (page 198)

j. describe cyclical effects on valuation multiples. (page 198)

k. describe the implications of the business cycle for a given style strategy (value, growth, small capitalization, large capitalization). (page 199)

l. describe how economic analysis is used in sector rotation strategies. (page 199)

m. describe the economic factors affecting investment in commercial real estate. (page 199)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 47. Analysis of Active Portfolio Management

The candidate should be able to:

a. describe how value added by active management is measured. (page 207)

b. calculate and interpret the information ratio (*ex post* and *ex ante*) and contrast it to the Sharpe ratio. (page 211)

c. state and interpret the fundamental law of active portfolio management including its component terms—transfer coefficient, information coefficient, breadth, and active risk (aggressiveness). (page 214)

d. explain how the information ratio may be useful in investment manager selection and choosing the level of active portfolio risk. (page 216)

e. compare active management strategies (including market timing and security selection) and evaluate strategy changes in terms of the fundamental law of active management. (page 216)

f. describe the practical strengths and limitations of the fundamental law of active management. (page 219)

*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 48. Trading Costs and Electronic Markets

The candidate should be able to:

a. explain the components of execution costs, including explicit and implicit costs. (page 223)
b. calculate and interpret effective spreads and VWAP transaction cost estimates. (page 225)
c. describe the implementation shortfall approach to transaction cost measurement. (page 228)
d. describe factors driving the development of electronic trading systems. (page 230)
e. describe market fragmentation. (page 231)
f. distinguish among types of electronic traders. (page 231)
g. describe characteristics and uses of electronic trading systems. (page 234)
h. describe comparative advantages of low-latency traders. (page 233)
i. describe the risks associated with electronic trading and how regulators mitigate them. (page 238)
j. describe abusive trading practices that real-time surveillance of markets may detect. (page 239)

The following is a review of the Alternative Investments principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #39.

# READING 39: PRIVATE REAL ESTATE INVESTMENTS

**Study Session 15**

## EXAM FOCUS

This topic review concentrates on valuation of real estate. The focus is on the three valuation approaches used for appraisal purposes, especially the income approach. Make sure you can calculate the value of a property using the direct capitalization method and the discounted cash flow method. Make certain you understand the relationship between the capitalization rate and the discount rate. Finally, understand the investment characteristics and risks involved with real estate investments.

## MODULE 39.1: INTRODUCTION AND COMMERCIAL PROPERTY TYPES

Video covering this content is available online.

**LOS 39.a: Classify and describe basic forms of real estate investments.**

*CFA® Program Curriculum, Volume 6, page 7*

## FORMS OF REAL ESTATE

There are four basic forms of real estate investment that can be described in terms of a two-dimensional quadrant. In the first dimension, the investment can be described in terms of public or private markets. In the private market, ownership usually involves a direct investment like purchasing property or lending money to a purchaser. Direct investments can be solely owned or indirectly owned through partnerships or **commingled real estate funds** (**CREF**). The public market does not involve direct investment; rather, ownership involves securities that serve as claims on the underlying assets. Public real estate investment includes ownership of a **real estate investment trust** (**REIT**), a **real estate operating company** (**REOC**), and mortgage-backed securities.

The second dimension describes whether an investment involves debt or equity. An equity investor has an ownership interest in real estate or securities of an entity that owns real estate. Equity investors control decisions such as borrowing money, property management, and the exit strategy.

A debt investor is a lender that owns a mortgage or mortgage securities. Usually, the mortgage is collateralized (secured) by the underlying real estate. In this case, the lender has a superior claim over an equity investor in the event of default. Since the lender must be repaid first, the value of an equity investor's interest is equal to the value of the property less the outstanding debt.

Each of the basic forms has its own risk, expected returns, regulations, legal issues, and market structure.

Private real estate investments are usually larger than public investments because real estate is indivisible and illiquid. Public real estate investments allow the property to remain undivided while allowing investors divided ownership. As a result, public real estate investments are more liquid and enable investors to diversify by participating in more properties.

Real estate must be actively managed. Private real estate investment requires property management expertise on the part of the owner or a property management company. In the case of a REIT or REOC, the real estate is professionally managed; thus, investors need no property management expertise.

Equity investors usually require a higher rate of return than mortgage lenders because of higher risk. As previously discussed, lenders have a superior claim in the event of default. As financial leverage (use of debt financing) increases, return requirements of both lenders and equity investors increase as a result of higher risk.

Typically, lenders expect to receive returns from promised cash flows and do not participate in the appreciation of the underlying property. Equity investors expect to receive an income stream as a result of renting the property and the appreciation of value over time.

Figure 39.1 summarizes the basic forms of real estate investment and can be used to identify the investment that best meets an investor's objectives.

**Figure 39.1:** Basic Forms of Real Estate Investment

| | Debt | Equity |
|---|---|---|
| Private | Mortgages | Direct investments such as sole ownership, partnerships, and other forms of commingled funds |
| Public | Mortgage-backed securities | Shares of REITs and REOCs |

**LOS 39.b: Describe the characteristics, the classification, and basic segments of real estate.**

*CFA® Program Curriculum, Volume 6, page 9*

## REAL ESTATE CHARACTERISTICS

Real estate investment differs from other asset classes, like stocks and bonds, and can complicate measurement and performance assessment.

- **Heterogeneity.** Bonds from a particular issue are alike, as are stocks of a specific company. However, no two properties are exactly the same because of location, size, age, construction materials, tenants, and lease terms.
- **High unit value.** Because real estate is indivisible, the unit value is significantly higher than stocks and bonds, which makes it difficult to construct a diversified portfolio.
- **Active management.** Investors in stocks and bonds are not necessarily involved in the day-to-day management of the companies. Private real estate investment requires active property management by the owner or a property management company. Property

management involves maintenance, negotiating leases, and collection of rents. In either case, property management costs must be considered.

- **High transaction costs.** Buying and selling real estate is costly because it involves appraisers, lawyers, brokers, and construction personnel.
- **Depreciation and desirability.** Buildings wear out over time. Also, buildings may become less desirable because of location, design, or obsolescence.
- **Cost and availability of debt capital.** Because of the high costs to acquire and develop real estate, property values are impacted by the level of interest rates and availability of debt capital. Real estate values are usually lower when interest rates are high and debt capital is scarce.
- **Lack of liquidity.** Real estate is illiquid. It takes time to market and complete the sale of property.
- **Difficulty in determining price.** Stocks and bonds of public firms usually trade in active markets. However, because of heterogeneity and low transaction volume, appraisals are usually necessary to assess real estate values. Even then, appraised values are often based on similar, not identical, properties. The combination of limited market participants and lack of knowledge of the local markets makes it difficult for an outsider to value property. As a result, the market is less efficient. However, investors with superior information and skill may have an advantage in exploiting the market inefficiencies.

The market for REITs has expanded to overcome many of the problems involved with direct investment. Shares of a REIT are actively traded and are more likely to reflect market value. In addition, investing in a REIT can provide exposure to a diversified real estate portfolio. Finally, investors don’t need property management expertise because the REIT manages the properties.

## PROPERTY CLASSIFICATIONS

Real estate is commonly classified as residential or non-residential. Residential real estate includes single-family (owner-occupied) homes and multi-family properties, such as apartments. Residential real estate purchased with the intent to produce income is usually considered commercial real estate property.

Non-residential real estate includes commercial properties, other than multi-family properties, and other properties such as farmland and timberland.

Commercial real estate is usually classified by its end use and includes multi-family, office, industrial/warehouse, retail, hospitality, and other types of properties such as parking facilities, restaurants, and recreational properties. A *mixed-use development* is a property that serves more than one end user.

Some commercial properties require more management attention than others. For example, of all the commercial property types, hotels require the most day-to-day attention and are more like operating a business. Because of higher operational risk, investors require higher rates of return on management-intensive properties.

Farmland and timberland are unique categories (separate from commercial real estate classification) because each can produce a saleable commodity as well as have the potential for capital appreciation.

**LOS 39.c: Explain the role in a portfolio, economic value determinants, investment characteristics, and principal risks of private real estate.**

**LOS 39.l: Explain the role in a portfolio, the major economic value determinants, investment characteristics, principal risks, and due diligence of private real estate debt investment.**

*CFA® Program Curriculum, Volume 6, pages 13 and 61*

## REASONS TO INVEST IN REAL ESTATE

**Current income.** Investors may expect to earn income from collecting rents and after paying operating expenses, financing costs, and taxes.

**Capital appreciation.** Investors usually expect property values to increase over time, which forms part of their total return.

**Inflation hedge.** During inflation, investors expect both rents and property values to rise.

**Diversification.** Real estate, especially private equity investment, is less than perfectly correlated with the returns of stocks and bonds. Thus, adding private real estate investment to a portfolio can reduce risk relative to the expected return.

**Tax benefits.** In some countries, real estate investors receive favorable tax treatment. For example, in the United States, the depreciable life of real estate is usually shorter than the actual life. As a result, depreciation expense is higher, and taxable income is lower resulting in lower income taxes. Also, REITs do not pay taxes in some countries, which allow investors to escape double taxation (e.g., taxation at the corporate level and the individual level).

## PRINCIPAL RISKS

**Business conditions.** Numerous economic factors—such as gross domestic product (GDP), employment, household income, interest rates, and inflation—affect the rental market.

**New property lead time.** Market conditions can change significantly while approvals are obtained, while the property is completed, and when the property is fully leased. During the lead time, if market conditions weaken, the resultant lower demand affects rents and vacancy resulting in lower returns.

**Cost and availability of capital.** Real estate must compete with other investments for capital. As previously discussed, demand for real estate is reduced when debt capital is scarce and interest rates are high. Conversely, demand is higher when debt capital is easily obtained and interest rates are low. Thus, real estate prices can be affected by capital market forces without changes in demand from tenants.

**Unexpected inflation.** Some leases provide inflation protection by allowing owners to increase rent or pass through expenses because of inflation. Real estate values may not keep up with inflation when markets are weak and vacancy rates are high.

**Demographic factors.** The demand for real estate is affected by the size and age distribution of the local market population, the distribution of socioeconomic groups, and new household

formation rates.

**Lack of liquidity.** Because of the size and complexity of most real estate transactions, buyers and lenders usually perform due diligence, which takes time and is costly. A quick sale will typically require a significant discount.

**Environmental issues.** Real estate values can be significantly reduced when a property has been contaminated by a prior owner or adjacent property owner.

**Availability of information.** A lack of information when performing property analysis increases risk. The availability of data depends on the country, but generally more information is available as real estate investments become more global.

**Management expertise.** Property managers and asset managers must make important operational decisions—such as negotiating leases, property maintenance, marketing, and renovating the property—when necessary.

**Leverage.** The use of debt (leverage) to finance a real estate purchase is measured by the loan-to-value (LTV) ratio. Higher LTV results in higher leverage and, thus, higher risk because lenders have a superior claim in the event of default. With leverage, a small decrease in net operating income (NOI) negatively magnifies the amount of cash flow available to equity investors after debt service.

**Other factors.** Other risk factors, such as unobserved property defects, natural disasters, and acts of terrorism, may be unidentified at the time of purchase.

In some cases, risks that can be identified can be hedged using insurance. In other cases, risk can be shifted to the tenants. For example, a lease agreement could require the tenant to reimburse any unexpected operating expenses.

## The Role of Real Estate in a Portfolio

Real estate investment has both bond-like and stock-like characteristics. Leases are contractual agreements that usually call for periodic rental payments, similar to the coupon payments of a bond. When a lease expires, there is uncertainty regarding renewal and future rental rates. This uncertainty is affected by the availability of competing space, tenant profitability, and the state of the overall economy, just as stock prices are affected by the same factors. As a result, the risk/return profile of real estate as an asset class, is usually between the risk/return profiles of stocks and bonds.

## Role of Leverage in Real Estate Investment

So far, our discussion of valuation has ignored debt financing. Earlier we determined that the level of interest rates and the availability of debt capital impact real estate prices. However, the percentage of debt and equity used by an investor to finance real estate does not affect the property's value.

Investors use debt financing (leverage) to increase returns. As long as the investment return is greater than the interest paid to lenders, there is positive leverage and returns are magnified. Of course, leverage can also work in reverse. Because of the greater uncertainty involved with debt financing, risk is higher since lenders have a superior claim to cash flow.

### LOS 39.d: Describe commercial property types, including their distinctive investment characteristics.

## Commercial Property Types

The basic property types used to create a low-risk portfolio include office, industrial/warehouse, retail, and multi-family. Some investors include hospitality properties (hotels and motels) even though the properties are considered riskier since leases are not involved and performance is highly correlated with the business cycle.

It is important to know that with all property types, location is critical in determining value.

**Office.** Demand is heavily dependent on job growth, especially in industries that are heavy users of office space like finance and insurance. The average length of office leases varies globally.

In a *gross lease*, the owner is responsible for the operating expenses, and in a *net lease*, the tenant is responsible. In a net lease, the tenant bears the risk if the actual operating expenses are greater than expected. As a result, rent under a net lease is lower than a gross lease.

Some leases combine features from both gross and net leases. For example, the owner might pay the operating expenses in the first year of the lease. Thereafter, any increase in the expenses is passed through to the tenant. In a multi-tenant building, the expenses are usually prorated based on square footage.

Understanding how leases are structured is imperative in analyzing real estate investments.

**Industrial.** Demand is heavily dependent on the overall economy. Demand is also affected by import/export activity of the economy. Net leases are common.

**Retail.** Demand is heavily dependent on consumer spending. Consumer spending is affected by the overall economy, job growth, population growth, and savings rates. Retail lease terms vary by the quality of the property as well as the size and importance of the tenant. For example, an anchor tenant may receive favorable lease terms to attract them to the property. In turn, the anchor tenant will draw other tenants to the property.

Retail tenants are often required to pay additional rent once sales reach a certain level. This unique feature is known as a *percentage lease* or *percentage rent*. Accordingly, the lease will specify a minimum amount of rent to be paid without regard to sales. The minimum rent also serves as the starting point for calculating the percentage rent.

For example, suppose that a retail lease specifies minimum rent of $20 per square foot plus 5% of sales over $400 per square foot. If sales were $400 per square foot, the minimum rent and percentage rent would be equivalent ($400 sales per square foot × 5% = $20 per square foot). In this case, $400 is known as the natural breakpoint. If sales are $500 per square foot, rent per square foot is equal to $25 [$20 minimum rent + $5 percentage rent ($500 − $400) × 5%]. Alternatively, rent per square foot is equal to $500 sales per square foot × 5% = $25 because of the natural breakpoint.

**Multi-family.** Demand depends on population growth, especially in the age demographic that typically rents apartments. The age demographic can vary by country, type of property, and locale. Demand is also affected by the cost of buying versus the cost of renting, which is measured by the ratio of home prices to rents. As home prices rise, there is a shift toward renting. An increase in interest rates will also make buying more expensive.

### MODULE QUIZ 39.1

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

1. Which form of investment is *most appropriate* for a first-time real estate investor that is concerned about liquidity and diversification?
   A. Direct ownership of a suburban office building.
   B. Shares of a real estate investment trust.
   C. An undivided participation interest in a commercial mortgage.
2. Which of the following real estate properties is *most likely* classified as commercial real estate?
   A. A residential apartment building.
   B. Timberland and farmland.
   C. An owner-occupied, single-family home.
3. A real estate investor is concerned about rising interest rates and decides to pay cash for a property instead of financing the transaction with debt. What is the *most likely* effect of this strategy?
   A. Inflation risk is eliminated.
   B. Risk of changing interest rates is eliminated.
   C. Risk is reduced because of lower leverage.
4. Which of the following *best* describes the primary economic driver of demand for multi-family real estate?
   A. Growth in savings rates.
   B. Job growth, especially in the finance and insurance industries.
   C. Population growth.
5. Which of the following statements about financial leverage is *most accurate*?
   A. Debt financing increases the appraised value of a property because interest expense is tax deductible.
   B. Increasing financial leverage reduces risk to the equity owner.
   C. For a property financed with debt, a change in NOI will result in a more than proportionate change in cash flow.

## MODULE 39.2: VALUATION APPROACHES, DIRECT CAPITALIZATION, AND NOI

Video covering this content is available online.

**LOS 39.e: Compare the income, cost, and sales comparison approaches to valuing real estate properties.**

*CFA® Program Curriculum, Volume 6, page 25*

## REAL ESTATE APPRAISALS

Since commercial real estate transactions are infrequent, appraisals are used to estimate value or assess changes in value over time in order to measure performance. In most cases, the focus of an appraisal is *market value*; that is, the most probable sales price a typical investor is willing to pay. Other definitions of value include **investment value**, the value or worth that considers a particular investor's motivations; *value in use*, the value to a particular user such as a manufacturer that is using the property as a part of its business; and *assessed* value that is used by a taxing authority. For purposes of valuing collateral, lenders sometimes use a more conservative *mortgage lending value*.

### Valuation Approaches

Appraisers use three different approaches to value real estate: the cost approach, the sales comparison approach, and the income approach.

The premise of the **cost approach** is that a buyer would not pay more for a property than it would cost to purchase land and construct a comparable building. Consequently, under the cost approach, value is derived by adding the value of the land to the current replacement cost of a new building less adjustments for estimated depreciation and obsolescence. Because of the difficulty in measuring depreciation and obsolescence, the cost approach is most useful when the subject property is relatively new. The cost approach is often used for unusual properties or properties where comparable transactions are limited.

The premise of the **sales comparison approach** is that a buyer would pay no more for a property than others are paying for similar properties. With the sales comparison approach, the sale prices of similar (comparable) properties are adjusted for differences with the subject property. The sales comparison approach is most useful when there are a number of properties similar to the subject that have recently sold, as is usually the case with single-family homes.

The premise of the **income approach** is that value is based on the expected rate of return required by a buyer to invest in the subject property. With the income approach, value is equal to the present value of the subject's future cash flows. The income approach is most useful in commercial real estate transactions.

## Highest and Best Use

The concept of highest and best use is important in determining value. The highest and best use of a vacant site is not necessarily the use that results in the highest total value once a project is completed. Rather, the highest and best use of a vacant site is the use that produces the highest implied land value. The implied land value is equal to the value of the property once construction is completed less the cost of constructing the improvements, including profit to the developer to handle construction and lease-out.

**EXAMPLE: Highest and best use**

An investor is considering a site to build either an apartment building or a shopping center. Once construction is complete, the apartment building would have an estimated value of €50 million and the shopping center would have an estimated value of €40 million. Construction costs, including developer profit, are estimated at €45 million for the apartment building and €34 million for the shopping center. Calculate the highest and best use of the site.

**Answer:**

The shopping center is the highest and best use for the site because the €6 million implied land value of the shopping center is higher than the €5 million implied land value of the apartment building as follows:

| | Apartment Building | Shopping Center |
|---|---|---|
| Value when completed | €50,000,000 | €40,000,000 |
| Less: Construction costs | 45,000,000 | 34,000,000 |
| Implied land value | €5,000,000 | €6,000,000 |

Note that the highest and best use is not based on the highest value when the projects are completed but, rather, the highest implied land value.

**LOS 39.f: Estimate and interpret the inputs (for example, net operating income, capitalization rate, and discount rate) to the direct capitalization and discounted cash flow valuation methods.**

**LOS 39.g: Calculate the value of a property using the direct capitalization and discounted cash flow valuation methods.**

*CFA® Program Curriculum, Volume 6, pages 27 and 29*

# INCOME APPROACH

The income approach includes two different valuation methods: the direct capitalization method and the discounted cash flow method. With the *direct capitalization method*, value is based on capitalizing the first year NOI of the property using a capitalization rate. With the *discounted cash flow method*, value is based on the present value of the property's future cash flows using an appropriate discount rate.

Value is based on NOI under both methods. As shown in Figure 39.2, NOI is the amount of income remaining after subtracting vacancy and collection losses, and operating expenses (e.g., insurance, property taxes, utilities, maintenance, and repairs) from potential gross income. NOI is calculated before subtracting financing costs and income taxes.

**Figure 39.2: Net Operating Income**

| | |
|---|---|
| | Rental income if fully occupied |
| + | Other income |
| = | Potential gross income |
| – | Vacancy and collection loss |
| = | Effective gross income |
| – | Operating expense |
| = | Net operating income |

**EXAMPLE: Net operating income**

Calculate net operating income (NOI) using the following information:

| | |
|---|---|
| Property type | Office building |
| Property size | 200,000 square feet |
| Gross rental income | €25 per square foot |
| Other income | €75,000 |
| Vacancy and collection loss | 5% of potential gross income |
| Property taxes and insurance | €350,000 |
| Utilities and maintenance | €875,000 |
| Interest expense | €400,000 |
| Income tax rate | 40% |

**Answer:**

| | |
|---|---|
| Gross rental income | €5,000,000 [200,000 SF × €25] |
| Other income | 75,000 |
| Potential gross income | €5,075,000 |
| Vacancy and collection losses | (253,750)[5,075,000 × 5%] |

| | |
|---|---|
| Operating expenses | (1,225,000)[350,000 + 875,000] |
| Net operating income | €3,596,250 |

Note that interest expense and income taxes are not considered operating expenses.

## The Capitalization Rate

The **capitalization rate**, or cap rate, and the discount rate are not the same rate although they are related. The discount rate is the required rate of return; that is, the risk-free rate plus a risk premium.

The cap rate is applied to first-year NOI, and the discount rate is applied to first-year and future NOI. So, if NOI and value is expected to grow at a constant rate, the cap rate is lower than the discount rate as follows:

cap rate = discount rate − growth rate

Using the previous formula, we can say the growth rate is implicitly included in the cap rate.

The cap rate can be defined as the current yield on the investment as follows:

$$\text{cap rate} = \frac{\text{NOI}_1}{\text{value}}$$

Since the cap rate is based on first-year NOI, it is sometimes called the *going-in cap rate.*

By rearranging the previous formula, we can now solve for value as follows:

$$\text{value} = \text{V}_0 = \frac{\text{NOI}_1}{\text{cap rate}}$$

If the cap rate is unknown, it can be derived from recent comparable transactions as follows:

$$\text{cap rate} = \frac{\text{NOI}_1}{\text{comparable sales price}}$$

It is important to observe several comparable transactions when deriving the cap rate. Implicit in the cap rate derived from comparable transactions are investors' expectations of income growth and risk. In this case, the cap rate is similar to the reciprocal of the price-earnings multiple for equity securities.

**EXAMPLE: Valuation using the direct capitalization method**

Suppose that net operating income for an office building is expected to be $175,000, and an appropriate cap rate is 8%. Estimate the market value of the property using the direct capitalization method.

**Answer:**

The estimated market value is:

$$\text{V}_0 = \frac{\text{NOI}_1}{\text{cap rate}} = \frac{\$175{,}000}{8\%} = \$2{,}187{,}500$$

When tenants are required to pay all expenses, the cap rate can be applied to rent instead of NOI. Dividing rent by comparable sales price gives us the *all risks yield* (ARY). In this case, the ARY is the cap rate and will differ from the discount rate if an investor expects growth in rents and value.

$$\text{value} = \text{V}_0 = \frac{\text{rent}_1}{\text{ARY}}$$

If rents are expected to increase at a constant rate each year, the internal rate of return (IRR) can be approximated by summing the cap rate and growth rate.

### MODULE QUIZ 39.2

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

1. Which real estate valuation method is likely the *most appropriate* for a 40-year-old, owner-occupied single-family residence?
   A. Cost approach.
   B. Sales comparison approach.
   C. Income approach.
2. The Royal Oaks office building has annual net operating income of $130,000. A similar office building with net operating income of $200,000 recently sold for $2,500,000. Using the direct capitalization method, the market value of Royal Oaks is *closest* to:
   A. $1,200,000.
   B. $1,625,000.
   C. $2,500,000.
3. Using the discounted cash flow method, estimate the property value of a building with the following information:

| | |
|---|---|
| NOI for next five years | $600,000 |
| NOI in Year 6 | $700,000 |
| Holding period | 5 years |
| Discount rate | 10% |
| Terminal growth rate | 2% |

   A. $7,707,534.
   B. $8,350,729.
   C. $9,024,472.
4. Which of the following *most accurately* describes the relationship between a discount rate and a capitalization rate?
   A. The capitalization rate is the appropriate discount rate less NOI growth.
   B. The appropriate discount rate is the capitalization rate less NOI growth.
   C. The capitalization rate is the present value of the appropriate discount rate.

# MODULE 39.3: VALUATION USING STABILIZED NOI, MULTIPLIERS, DCF

Video covering this content is available online.

## Stabilized NOI

Recall the cap rate is applied to first-year NOI. If NOI is not representative of the NOI of similar properties because of a temporary issue, the subject property's NOI should be stabilized. For example, suppose a property is temporarily experiencing high vacancy during a major renovation. In this case, the first-year NOI should be stabilized; NOI should be calculated as if the renovation is complete. Once the stabilized NOI is capitalized, the loss in value, as a result of the temporary decline in NOI, is subtracted in arriving at the value of the property.

> **EXAMPLE: Valuation during renovation**
>
> On January 1 of this year, renovation began on a shopping center. This year, NOI is forecasted at €6 million. Absent renovations, NOI would have been €10 million. After this year, NOI is expected to increase 4% annually. Assuming all renovations are completed by the seller at their expense, estimate the value of the shopping center as of the beginning of this year assuming investors require a 12% rate of return.

**Answer:**

The value of the shopping center after renovation is:

$$\frac{\text{stabilized NOI}}{\text{cap rate}} = \frac{10{,}000{,}000}{(12\% - 4\%)} = €125{,}000{,}000$$

Using our financial calculator, the present value of the temporary decline in NOI during renovation is:

N = 1; I/Y = 12, PMT = 0; FV = 4,000,000; CPT → PV = €3,571,429

(In the previous computation, we are assuming that all rent is received at the end of the year for simplicity).

The total value of the shopping center is:

| | |
|---|---|
| Value after renovations | €125,000,000 |
| Loss in value during renovations | (3,571,429) |
| Total value | €121,428,571 |

The gross income multiplier, another form of direct capitalization, is the ratio of the sales price to the property's expected gross income in the year after purchase. The gross income multiplier can be derived from comparable transactions just like we did earlier with cap rates.

$$\text{gross income multiplier} = \frac{\text{sales price}}{\text{gross income}}$$

Once we obtain the gross income multiplier, value is estimated as a multiple of a subject property's estimated gross income as follows:

value = gross income × gross income multiplier

A shortfall of the gross income multiplier is that it ignores vacancy rates and operating expenses. Thus, if the subject property's vacancy rate and operating expenses are higher than those of the comparable transactions, an investor will pay more for the same rent.

## Discounted Cash Flow Method

Recall from our earlier discussion, we determined the growth rate is implicitly included in the cap rate as follows:

cap rate = discount rate − growth rate

Rearranging the previous formula we get:

discount rate = cap rate + growth rate

So, we can say the investor's rate of return includes the return on first-year NOI (measured by the cap rate) and the growth in income and value over time (measured by the growth rate).

$$\text{value} = V_0 = \frac{NOI_1}{(r-g)} = \frac{NOI_1}{\text{cap rate}}$$

where:
r = rate required by equity investors for similar properties
g = growth rate of NOI (assumed to be constant)
r − g = cap rate

### PROFESSOR'S NOTE

This equation should look very familiar to you because it's just a modified version of the constant growth dividend discount model, also known as the Gordon growth model, from the equity valuation portion of the curriculum.

If no growth is expected in NOI, then the cap rate and the discount rate are the same. In this case, value is calculated just like any perpetuity.

## Terminal Cap Rate

Using the discounted cash flow (DCF) method, investors usually project NOI for a specific holding period and the property value at the end of the holding period rather than projecting NOI into infinity. Unfortunately, estimating the property value at the end of the holding period, known as the *terminal value* (also known as *reversion* or *resale*), is challenging. However, since the terminal value is just the present value of the NOI received by the next investor, we can use the direct capitalization method to estimate the value of the property when sold. In this case, we need to estimate the future NOI and a future cap rate, known as the *terminal* or *residual cap rate*.

The terminal cap rate is not necessarily the same as the going-in cap rate. The terminal cap rate could be higher if interest rates are expected to increase in the future or if the growth rate is projected to be lower because the property would then be older and might be less competitive. Also, uncertainty about future NOI may result in a higher terminal cap rate. The terminal cap rate could be lower if interest rates are expected to be lower or if rental income growth is projected to be higher. These relationships are easily mastered using the formula presented earlier (cap rate = discount rate − growth rate).

Since the terminal value occurs in the future, it must be discounted to present. Thus, the value of the property is equal to the present value of NOI over the holding period and the present value of the terminal value.

**EXAMPLE: Valuation with terminal value**

Because of existing leases, the NOI of a warehouse is expected to be $1 million per year over the next four years. Beginning in the fifth year, NOI is expected to increase to $1.2 million and grow at 3% annually thereafter. Assuming investors require a 13% return, calculate the value of the property today assuming the warehouse is sold after four years.

**Answer:**

Using our financial calculator, the present value of the NOI over the holding period is:

N = 4; I/Y = 13, PMT = 1,000,000; FV = 0; CPT → PV = $2,974,471

The terminal value after four years is:

$$V_4 = \frac{NOI_5}{\text{cap rate}} = \frac{\$1{,}200{,}000}{(13\% - 3\%)} = \$12{,}000{,}000$$

The present value of the terminal value is:

N = 4; I/Y = 13, PMT = 0; FV = 12,000,000; CPT → PV = $7,359,825

The total value of the warehouse today is:

| | |
|---|---|
| PV of forecast NOI | $2,974,471 |
| PV of terminal value | 7,359,825 |
| Total value | $10,334,296 |

Note: We can combine the present value calculations as follows:

N = 4; I/Y = 13, PMT = 1,000,000; FV = 12,000,000; CPT → PV = $10,334,296

## Valuation With Different Lease Structures

Lease structures can vary by country. For example, in the U.K., it is common for tenants to pay all expenses. In this case, the cap rate is known as the ARY as discussed earlier. Adjustments must be made when the contract rent (passing or term rent) and the current market rent (open market rent) differ. Once the lease expires, rent will likely be adjusted to the current market rent. In the U.K., the property is said to have *reversionary potential* when the contract rent expires.

One way of dealing with the problem is known as the *term and reversion approach* whereby the contract (term) rent and the reversion are appraised separately using different cap rates. The reversion cap rate is derived from comparable, fully let, properties. Because the reversion occurs in the future, it must be discounted to present. The discount rate applied to the contract rent will likely be lower than the reversion rate because the contract rent is less risky (the existing tenants are not likely to default on a below-market lease).

**EXAMPLE: Term and Reversion Valuation Approach**

A single-tenant office building was leased six years ago at £200,000 per year. The next rent review occurs in two years. The estimated rental value (ERV) in two years based on current market conditions is £300,000 per year. The all risks yield (cap rate) for comparable fully let properties is 7%. Because of lower risk, the appropriate rate to discount the term rent is 6%. Estimate the value of the office building.

**Answer:**

Using our financial calculator, the present value of the term rent is:

N = 2; I/Y = 6, PMT = 200,000; FV = 0; CPT → PV = £366,679

The value of reversion to ERV is:

$$V_2 = \frac{\text{ERV}_3}{\text{ERV cap rate}} = \frac{300{,}000}{7\%} = £4{,}285{,}714$$

The present value of the reversion to ERV is:

N = 2; I/Y = 7, PMT = 0; FV = 4,285,714; CPT → PV = £3,743,309

The total value of the office building today is:

| | |
|---|---|
| PV of term rent | £366,679 |
| PV of reversion to ERV | £3,743,309 |
| Total value | £4,109,988 |

Except for the differences in terminology and the use of different cap rates for the term rent and reversion to current market rents, the term and reversion approach is similar to the valuation example using a terminal value.

A variation of the term and reversion approach is the *layer method*. With the layer method, one source (layer) of income is the contract (term) rent that is assumed to continue in perpetuity. The second layer is the increase in rent that occurs when the lease expires and the rent is reviewed. A cap rate similar to the ARY is applied to the term rent because the term rent is less risky. A higher cap rate is applied to the incremental income that occurs as a result of the rent review.

**EXAMPLE: Layer method**

Let's return to the example that we used to illustrate the term and reversion valuation approach. Suppose the contract (term) rent is discounted at 7%, and the incremental rent is discounted at 8%. Calculate the value of the office building today using the layer method.

**Answer:**

The value of term rent (bottom layer) into perpetuity is:

$$\frac{\text{term rent}}{\text{term rent cap rate}} = \frac{200{,}000}{7\%} = £2{,}857{,}143$$

The value of incremental rent into perpetuity (at time t = 2) is:

$$\frac{\text{ERV}}{\text{ERV cap rate}} = \frac{(300{,}000 - 200{,}000)}{8\%} = £1{,}250{,}000$$

Using our financial calculator, the present value of the incremental rent (top layer) into perpetuity is:

N = 2; I/Y = 8, PMT = 0; FV = 1,250,000; CPT → PV = £1,071,674

The total value of the office building today is:

| | |
|---|---|
| PV of term rent | £2,857,143 |
| PV of incremental rent | 1,071,674 |
| Total value | £3,928,817 |

Using the term and reversion approach and the layer method, different cap rates were applied to the term rent and the current market rent after review. Alternatively, a single discount rate, known as the *equivalent yield*, could have been used. The equivalent yield is an average, although not a simple average, of the two separate cap rates.

Using the discounted cash flow method requires the following estimates and assumptions, especially for properties with many tenants and complicated lease structures:

- *Project income from existing leases.* It is necessary to track the start and end dates and the various components of each lease, such as base rent, index adjustments, and expense reimbursements from tenants.
- *Lease renewal assumptions.* May require estimating the probability of renewal.
- *Operating expense assumptions.* Operating expenses can be classified as fixed, variable, or a hybrid of the two. Variable expenses vary with occupancy, while fixed expenses do not. Fixed expenses can change because of inflation.
- *Capital expenditure assumptions.* Expenditures for capital improvements, such as roof replacement, renovation, and tenant finish-out, are lumpy; that is, they do not occur evenly over time. Consequently, some appraisers average the capital expenditures and deduct a portion each year instead of deducting the entire amount when paid.
- *Vacancy assumptions.* It is necessary to estimate how long before currently vacant space is leased.
- *Estimated resale price.* A holding period that extends beyond the existing leases should be chosen. This will make it easier to estimate the resale price because all leases will reflect current market rents.
- *Appropriate discount rate.* The discount rate is not directly observable, but some analysts use buyer surveys as a guide. The discount rate should be higher than the mortgage rate because of more risk and should reflect the riskiness of the investment relative to other alternatives.

**EXAMPLE: Allocation of operating expenses**

Total operating expenses for a multi-tenant office building are 30% fixed and 70% variable. If the 100,000 square foot building was fully occupied, operating expenses would total $6 per square foot. The building is currently 90% occupied. If the total operating expenses are allocated to the occupied space, calculate the operating expense per occupied square foot.

**Answer:**

If the building is fully occupied, total operating expenses would be $600,000 (100,000 SF × $6 per SF). Fixed and variable operating expenses would be:

| | | |
|---|---|---|
| Fixed | $180,000 | (600,000 × 30%) |
| Variable | 420,000 | (600,000 × 70%) |
| Total | $600,000 | |

Thus, variable operating expenses are $4.20 per square foot ($420,000 / 100,000 SF) if the building is fully occupied. Since the building is 90% occupied, total operating expenses are:

| | | |
|---|---|---|
| Fixed | $180,000 | |
| Variable | 378,000 | (100,000 SF × 90% × $4.20 per SF) |
| Total | $558,000 | |

So, operating expenses per occupied square foot are $6.20 (558,000 total operating expenses / 90,000 occupied SF).

### LOS 39.h: Compare the direct capitalization and discounted cash flow valuation methods.

*CFA® Program Curriculum, Volume 6, page 44*

Under the **direct capitalization method**, a cap rate or income multiplier is applied to first-year NOI. Implicit in the cap rate or multiplier are expected increases in growth.

Under the **discounted cash flow (DCF) method**, the future cash flows, including the capital expenditures and terminal value, are projected over the holding period and discounted to present at the discount rate. Future growth of NOI is explicit in the DCF method.

Because of the inputs required, the DCF method is more complex than the direct capitalization method, as it focuses on NOI over the entire holding period and not just NOI in the first year. DCF does not rely on comparable transactions as long as an appropriate discount rate is chosen. Choosing the appropriate discount rate and terminal cap rate are crucial as small differences in the rates can significantly affect value.

Following are some common errors made using the DCF method:

- The discount rate does not adequately capture risk.
- Income growth exceeds expense growth.
- The terminal cap rate and the going-in cap rate are not consistent.
- The terminal cap rate is applied to NOI that is atypical.
- The cyclicality of real estate markets is ignored.

## MODULE 39.4: VALUATION USING COST APPROACH AND SALES COMPARISON

Video covering this content is

**LOS 39.i: Calculate the value of a property using the cost and sales comparison approaches.** available online.

*CFA® Program Curriculum, Volume 6, page 46*

## Cost Approach

The premise behind the cost approach is that a buyer is unlikely to pay more for a property than it would cost to purchase land and build a comparable building. The cost approach involves estimating the market value of the land, estimating the replacement cost of the building, and adjusting for depreciation and obsolescence. The cost approach is often used for unusual properties or properties where comparable transactions are limited.

**PROFESSOR'S NOTE**

Depreciation for appraisal purposes is not the same as depreciation used for financial reporting or tax reporting purposes. Financial depreciation and tax depreciation involve the allocation of original cost over time. For appraisal purposes, depreciation represents an actual decline in value.

The steps involved in applying the cost approach are as follows:

*Step 1:* **Estimate the market value of the land.** The value of the land is estimated separately, often using the sales comparison approach.

*Step 2:* **Estimate the building's replacement cost.** Replacement cost is based on current construction costs and standards and should include any builder/developer's profit.

**PROFESSOR'S NOTE**

Replacement cost refers to the cost of a building having the same utility but constructed with modern building materials. Reproduction cost refers to the cost of reproducing an exact replica of the building using the same building materials, architectural design, and quality of construction. Replacement cost is usually more relevant for appraisal purposes because reproduction cost may be uneconomical.

*Step 3:* **Deduct depreciation including physical deterioration, functional obsolescence, locational obsolescence, and economic obsolescence.** *Physical deterioration* is related to the building's age and occurs as a result of normal wear and tear over time. Physical deterioration can be curable or incurable. An item is curable if the benefit of fixing the problem is at least as much as the cost to cure. For example, replacing the roof will likely increase the value of the building by at least as much as the cost of the roof. The cost of fixing curable items is subtracted from replacement cost.

An item is incurable if the problem is not economically feasible to remedy. For example, the cost of fixing a structural problem might exceed the benefit of the repair. Since an incurable defect would not be fixed, depreciation can be estimated based on the **effective age** of the property relative to its total **economic life**. For example, the physical depreciation of a property with an effective age of 30 years and a 50-year total economic life is 60% (30 year effective age / 50 year economic life). To avoid double counting, the age/life ratio is multiplied by and deducted from replacement cost minus the cost of fixing curable items.

**PROFESSOR'S NOTE**

The effective age and the actual age can differ as a result of above-normal or below-normal wear and tear. Incurable items increase the effective age of the property.

*Functional obsolescence* is the loss in value resulting from defects in design that impairs a building's utility. For example, a building might have a bad floor plan. As a result of functional obsolescence, NOI is usually lower than it otherwise would be because of lower rent or higher operating expenses. Functional obsolescence can be estimated by capitalizing the decline in NOI.

*Locational obsolescence* occurs when the location is no longer optimal. For example, five years after a luxury apartment complex is completed, a prison is built down the street making the location of the apartment complex less desirable. As a result, lower rental rates will decrease the value of the complex. Care must be taken in deducting the loss in value because part of the loss is likely already reflected in the market value of the land.

*Economic obsolescence* occurs when new construction is not feasible under current economic conditions. This can occur when rental rates are not sufficient to support the property. Consequently, the replacement cost of the subject property exceeds the value of a new building if it was developed.

**EXAMPLE: The cost approach**

Heavenly Towers is a 200,000 square foot high-rise apartment building located in the downtown area.

The building has an effective age of 10 years, while its total economic life is estimated at 40 years. The building has a structural problem that is not feasible to repair. The building also needs a new roof at a cost of €1,000,000. The new roof will increase the value of the building by €1,300,000.

The bedrooms in each apartment are too small and the floor plans are awkward. As a result of the poor design, rents are €400,000 a year lower than competing properties.

When Heavenly Towers was originally built, it was located across the street from a park. Five years ago, the city converted the park to a sewage treatment plant. The negative impact on rents is estimated at €600,000 a year.

Due to recent construction of competing properties, vacancy rates have increased significantly resulting in an estimated loss in value of €1,200,000.

The cost to replace Heavenly Towers is estimated at €400 per square foot plus builder profit of €5,000,000. The market value of the land is estimated at €20,000,000. An appropriate cap rate is 8%. Using the cost approach, estimate the value of Heavenly Towers.

**Answer:**

| | |
|---|---|
| Replacement cost including builder profit [(200,000 SF × €400 per SF) + 5,000,000] | 85,000,000 |
| Curable physical deterioration − new roof | (1,000,000) |
| Replacement cost after curable physical deterioration | €84,000,000 |
| Incurable physical deterioration – structural problem [(10-year effective age / 40 year life) × 84,000,000] | (21,000,000) |
| Incurable functional obsolescence − poor design [400,000 lower rent / 8% cap rate] | (5,000,000) |
| Locational obsolescence − sewage plant [600,000 lower rent / 8% cap rate] | (7,500,000) |
| Economic obsolescence − competing properties | (1,200,000) |
| Market value of land | 20,000,000 |
| Estimated value using the cost approach | €69,300,000 |

**PROFESSOR'S NOTE**

We don't use the €1,300,000 for anything, except to determine that physical deterioration of the new roof is curable.

Because of the difficulty in measuring depreciation and obsolescence, the cost approach is most useful when the subject property is relatively new.

The cost approach is sometimes considered the upper limit of value since an investor would never pay more than the cost to build a comparable building. However, investors must consider that construction is time consuming and there may not be enough demand for another building of the same type. That said, market values that exceed the implied value of the cost approach are questionable.

## Sales Comparison Approach

The premise of the sales comparison approach is that a buyer would pay no more for a property than others are paying for similar properties in the current market. Ideally, the comparable properties would be identical to the subject but, of course, this is impossible since all properties are different. Consequently, the sales prices of similar (comparable) properties are adjusted for differences with the subject property. The differences may relate to size, age, location, property condition, and market conditions at the time of sale. The values of comparable transactions are adjusted upward (downward) for undesirable (desirable) differences with the subject property. We do this to value the comparable as if it was similar to the subject property.

**EXAMPLE: Sales comparison approach**

An appraiser has been asked to estimate the value of a warehouse and has collected the following information:

| Unit of Comparison | Subject Property | Comparable Transactions | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Size, in square feet | 30,000 | 40,000 | 20,000 | 35,000 |
| Age, in years | 5 | 9 | 4 | 5 |
| Physical condition | Average | Good | Average | Poor |
| Location | Prime | Prime | Secondary | Prime |
| Sale date, months ago | | 6 | 18 | 12 |
| Sales price | | $9,000,000 | $4,500,000 | $8,000,000 |

The appraiser's adjustments are based on the following:

- Each adjustment is based on the unadjusted sales price of the comparable.
- Properties depreciate at 2% per annum. Since comparable #1 is four years older than the subject, an upward adjustment of $720,000 is made [$9,000,000 × 2% × 4 years].
- *Condition adjustment*: Good: +5%, average: none; poor: –5%. Because comparable #1 is in better condition than the subject, a downward adjustment of $450,000 is made [$9,000,000 × 5%]. Similarly, an upward adjustment is made for comparable #3 to the tune of $400,000 [$8,000,000 × 5%].
- *Location adjustment*: Prime − none, secondary − 10%. Because both comparable #1 and the subject are in a prime location, no adjustment is made.
- Over the past 24 months, sales prices have been appreciating 0.5% per month. Because comparable #1 was sold six months ago, an upward adjustment of $270,000 is made [$9,000,000 × 0.5% × 6 months].

**Answer:**

Once the adjustments are made for all of the comparable transactions, the adjusted sales price per square foot of the comparable transactions are averaged and applied to the subject property as follows:

| | Comparable Transactions |
|---|---|

| Adjustments | Subject Property | 1 | 2 | 3 |
|---|---|---|---|---|
| Sales price | | $9,000,000 | $4,500,000 | $8,000,000 |
| Age | | +720,000 | –90,000 | – |
| Condition | | –450,000 | – | +400,000 |
| Location | | – | +450,000 | – |
| Sale date | | +270,000 | +405,000 | +480,000 |
| Adjusted sales price | | $9,540,000 | 5,265,000 | $8,880,000 |
| Size in square feet | 30,000 | 40,000 | 20,000 | 35,000 |
| Adjusted sales price per SF | | $238.50 | $263.25 | $253.71 |
| Average sales price per SF | $251.82 | | | |
| Estimated value | $7,554,600 | | | |

The sales comparison approach is most useful when there are a number of properties similar to the subject that have been recently sold, as is usually the case with single-family homes. When the market is weak, there tend to be fewer transactions. Even in an active market, there may be limited transactions of specialized property types, such as regional malls and hospitals. The sales comparison approach assumes purchasers are acting rationally; the prices paid are representative of the current market. However, there are times when purchasers become overly exuberant and market bubbles occur.

## RECONCILIATION OF VALUE

Because of different assumptions and availability of data, the three valuation approaches are likely to yield different value estimates. An important part of the appraisal process involves determining the final estimate of value by reconciling the differences in the three approaches.

An appraiser may provide more, or less, weight to an approach because of the property type or market conditions. For example, an appraiser might apply a higher weight to the value obtained with the sales comparison approach when the market is active with plenty of comparable properties. Alternatively, if the subject property is old and estimating depreciation is difficult, an appraiser might apply a lower weight to the cost method.

### MODULE QUIZ 39.3, 39.4

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

1. You are provided the following data for a property:

| | |
|---|---|
| Building size | 50,000 square feet |
| Replacement cost | €75 per square foot |
| Actual age | 10 years |
| Effective age | 12 years |
| Total economic life | 20 years |
| Economic obsolescence | €400,000 |
| Land market value | €900,000 |

Using the cost approach, the estimated property value is *closest* to:

A. €1,100,000
B. €2,000,000
C. €2,375,000

# MODULE 39.5: DUE DILIGENCE, INDICES, AND RATIOS

Video covering this content is available online.

### LOS 39.j: Describe due diligence in private equity real estate investment.

*CFA® Program Curriculum, Volume 6, page 54*

Real estate investors, both debt and equity, usually perform *due diligence* to confirm the facts and conditions that might affect the value of the transaction. Due diligence may include the following:

- Lease review and rental history.
- Confirm the operating expenses by examining bills.
- Review cash flow statements.
- Obtain an environmental report to identify the possibility of contamination.
- Perform a physical/engineering inspection to identify structural issues and check the condition of the building systems.
- Inspect the title and other legal documents for deficiencies.
- Have the property surveyed to confirm the boundaries and identify easements.
- Verify compliance with zoning laws, building codes, and environmental regulations.
- Verify payment of taxes, insurance, special assessments, and other expenditures.

Due diligence can be costly, but it lowers the risk of unexpected legal and physical problems.

### LOS 39.k: Discuss private equity real estate investment indexes, including their construction and potential biases.

*CFA® Program Curriculum, Volume 6, page 57*

A number of real estate indices are used to track the performance of real estate including appraisal-based indices and transaction-based indices. Investors should be aware of how the indices are constructed as well as their limitations.

## Appraisal-Based Indices

Because real estate transactions covering a specific property occur infrequently, indices have been developed based on appraised values. Appraisal-based indices combine valuations of individual properties that can be used to measure market movements. A popular index in the United States is the NCREIF Property Index (NPI). Members of NCREIF, mainly investment managers and pension fund sponsors, submit appraisal data quarterly, and NCREIF calculates the return as follows:

$$\text{return} = \frac{\text{NOI} - \text{capital expenditures} + (\text{end market value} - \text{beg market value})}{\text{beginning market value}}$$

The index is then value-weighted based on the returns of the separate properties. The return is known as a holding-period return and is equivalent to a single-period IRR.

Earlier, we found that the cap rate is equal to NOI divided by the beginning market value of the property. This is the current yield or income return of the property and is one component of the index equation. The remaining components of the equation produce the capital return.

To have a positive capital return, the market value must increase by more than the capital expenditures.

The index allows investors to compare performance with other asset classes, and the quarterly returns can be used to measure risk (standard deviation). The index can also be used by investors to benchmark returns.

Appraisal-based indices tend to lag actual transactions because actual transactions occur before appraisals are performed. Thus, a change in price may not be reflected in appraised values until the next quarter or longer if a property is not appraised every quarter. Also, appraisal lag tends to smooth the index; that is, reduce its volatility, much like a moving average reduces volatility. Finally, appraisal lag results in lower correlation with other asset classes. Appraisal lag can be adjusted by unsmoothing the index or by using a transaction-based index.

## Transaction-Based Indices

Transaction-based indices can be constructed using a repeat-sales index and a hedonic index.

A *repeat-sales index* relies on repeat sales of the same property. A change in market conditions can be measured once a property is sold twice. Accordingly, a regression is developed to allocate the change in value to each quarter.

A *hedonic index* requires only one sale. A regression is developed to control for differences in property characteristics such as size, age, location, and so forth.

### LOS 39.m: Calculate and interpret financial ratios used to analyze and evaluate private real estate investments.

*CFA® Program Curriculum, Volume 6, page 62*

Lenders often use the **debt service coverage ratio (DSCR)** and the **loan-to-value (LTV)** ratio to determine the maximum loan amount on a specific property. The maximum loan amount is based on the measure that results in the lowest debt.

The DSCR is calculated as follows:

$$\text{DSCR} = \frac{\text{first-year NOI}}{\text{debt service}}$$

Debt service (loan payment) includes interest and principal, if required. Principal payments reduce the outstanding balance of the loan. An interest-only loan does not reduce the outstanding balance. The LTV ratio is calculated as follows:

$$\text{LTV} = \frac{\text{loan amount}}{\text{appraisal value}}$$

**EXAMPLE: Maximum loan amount**

A real estate lender agreed to make a 10% interest-only loan on a property that was recently appraised at €1,200,000 as long as the debt service coverage ratio is at least 1.5 and the loan-to-value ratio does not exceed 80%. Calculate the maximum loan amount assuming the property's NOI is €135,000.

**Answer:**

Using the LTV ratio, the property will support a loan amount of €960,000 [1,200,000 value × 80% LTV ratio].

Using the DSCR, the property will support a debt service payment of €90,000 [135,000 NOI / 1.5]. The corresponding loan amount would be €900,000 [90,000 payment / 10% interest rate].

> In this case, the maximum loan amount is the €900,000, which is the lower of the two amounts.
>
> At €900,000, the LTV is 75% [900,000 loan amount / 1,200,000 value] and the DSCR is 1.5 [135,000 NOI / 90,000 payment].

When debt is used to finance real estate, equity investors often calculate the **equity dividend rate**, also known as the cash-on-cash return, which measures the cash return on the amount of cash invested.

$$\text{equity dividend rate} = \frac{\text{first year cash flow}}{\text{equity}}$$

The equity dividend rate only covers one period. It is not the same as the IRR that measures the return over the entire holding period.

> **EXAMPLE: Equity dividend maximum loan amount**
>
> Returning to the previous example, calculate the equity dividend rate (cash-on-cash return) assuming the property is purchased for the appraised value.
>
> **Answer:**
>
> The €1,200,000 property was financed with €900,000 debt and €300,000 equity. First-year cash flow is €45,000 (135,000 NOI – 90,000 debt service payment). Thus, the equity dividend rate is 15% (45,000 first year cash flow / 300,000 equity).

In order to calculate the IRR with leverage, we need to consider the cash flows over the entire holding period including the change in value of the original investment. Since the property was financed with debt, the cash flows that are received at the end of the holding period (i.e., net sales proceeds) are reduced by the outstanding mortgage balance.

> **EXAMPLE: Leveraged IRR**
>
> Returning to the last example, calculate the IRR if the property is sold at the end of six years for €1,500,000. Assume that NOI growth is zero.
>
> **Answer:**
>
> Over the holding period, annual cash flows of €45,000 are received and, at the end of six years, the sale proceeds of €1,500,000 are reduced by the outstanding mortgage balance of €900,000. Recall that the loan was interest only and, hence, the entire original mortgage amount of €900,000 was outstanding at the end of the holding period. Using our financial calculator, the leveraged IRR is 24.1% as follows:
>
> N = 6; PV = (300,000), PMT = 45,000; FV = 600,000; CPT → I/Y = 24.1%

We can see the effects of leverage by calculating an unleveraged IRR. In this case, the initial cash outflow is higher because no debt is incurred. The annual cash flows are higher because there is no debt service, and the terminal cash flow is higher because no mortgage balance is repaid at the end of the holding period.

Returning to the last example, the unleveraged IRR is 14.2% as follows:

N = 6; PV = (1,200,000), PMT = 135,000; FV = 1,500,000; CPT → I/Y = 14.2%

Notice the leveraged IRR of 24.1% is higher than the unleveraged IRR of 14.2%. As a result, the equity investor benefits by financing the property with debt because of positive leverage. Remember, however, that leverage will also magnify negative returns.

## MODULE QUIZ 39.5

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

1. You just entered into a contract to purchase a recently renovated apartment building, and you are concerned that some of the contractors have not been paid. In performing your due diligence, which of the following procedures should be performed to alleviate your concern?
   A. Have the property surveyed.
   B. Have an environmental study performed.
   C. Search the public records for outstanding liens.
2. Which of the following statements about real estate indices is *most accurate*?
   A. Transaction-based indices tend to lag appraisal-based indices.
   B. Appraisal-based indices tend to lag transaction-based indices.
   C. Transaction-based indices appear to have lower correlation with other asset classes as compared to appraisal-based indices.
3. A lender will make a 10%, interest-only loan on a property as long as the debt service coverage ratio is at least 1.6 and the loan-to-value ratio does not exceed 80%. The maximum loan amount, assuming the property just appraised for $1,500,000 and NOI is $200,000, is *closest* to:
   A. $1,050,000.
   B. $1,200,000.
   C. $1,500,000.

# KEY CONCEPTS

## LOS 39.a

There are four basic forms of real estate investment; private equity (direct ownership), publicly traded equity (indirect ownership), private debt (direct mortgage lending), and publicly traded debt (mortgage-backed securities).

## LOS 39.b

Real estate investments are heterogeneous, have high unit values, have high transaction costs, depreciate over time, are influenced by the cost and availability of debt capital, are illiquid, and are difficult to value.

Real estate is commonly classified as residential and non-residential. Income-producing properties (including income-producing residential properties) are considered commercial real estate.

## LOS 39.c

Reasons to invest in real estate include current income, capital appreciation, inflation hedge, diversification, and tax benefits.

Risks include changing business conditions, long lead times to develop property, cost and availability of capital, unexpected inflation, demographic factors, illiquidity, environmental issues, property management expertise, and the effects of leverage.

Real estate is less than perfectly correlated with the returns of stocks and bonds; thus, adding real estate to a portfolio can reduce risk relative to the expected return.

## LOS 39.d

Commercial property types, and the demand for each is driven by:

- Office—Job growth
- Industrial—The overall economy
- Retail—Consumer spending
- Multi-family—Population growth

## LOS 39.e

*Cost approach*. Value is derived by adding the value of the land to the replacement cost of a new building less adjustments for estimated depreciation and obsolescence.

*Sales comparison approach*. The sale prices of similar (comparable) properties are adjusted for differences with the subject property.

*Income approach*. Value is equal to the present value of the subject's future cash flows over the holding period.

## LOS 39.f

NOI is equal to potential gross income (rental income fully leased plus other income) less vacancy and collection losses and operating expenses.

The cap rate, discount rate, and growth rate are linked.

cap rate = discount rate (r) − growth rate (g)

If the cap rate is unknown, it can be derived from recent comparable transactions as follows:

$$\text{cap rate} = \frac{\text{NOI}_1}{\text{comparable sales price}}$$

The discount rate is the required rate of return of the investor.

discount rate = cap rate + growth rate

## LOS 39.g

Direct capitalization method:

$$\text{value} = \text{V}_0 = \frac{\text{NOI}_1}{\text{cap rate}}$$

Discounted cash flow method:

*Step 1*: Forecast the terminal value at the end of the holding period (use direct capitalization method if NOI growth is constant).

*Step 2*: Discount the NOI over the holding period and the terminal value to present.

## LOS 39.h

Under the direct capitalization method, a cap rate is applied to first-year NOI. Implicit in the cap rate is an expected increase in growth.

Under the DCF method, the future cash flows, including the capital expenditures and terminal value, are projected over the holding period and discounted to present at the discount rate. Future growth of NOI is explicit to the DCF method. Choosing the appropriate discount rate and terminal cap rate are crucial as small differences in the rates can significantly affect value.

## LOS 39.i

Steps involved with applying the cost approach.

*Step 1*: Estimate the market value of the land.

*Step 2*: Estimate the building's replacement cost.

*Step 3*: Deduct physical deterioration (estimate incurable using effective age/economic life ratio), functional obsolescence, locational obsolescence, and economic obsolescence.

With the sales comparison approach, the sales prices of similar (comparable) properties are adjusted for differences with the subject property. The differences may relate to size, age, location, property condition, and market conditions at the time of sale. Once the adjustments are made, the adjusted sales price per square foot of the comparable transactions are averaged and applied to the subject property.

## LOS 39.j

Investors perform due diligence to confirm the facts and conditions that might affect the value of the transaction. Due diligence can be costly, but it lowers risk of unexpected legal and physical problems. Due diligence involves reviewing leases, confirming expenses, performing inspections, surveying the property, examining legal documents, and verifying compliance.

## LOS 39.k

Appraisal-based indices tend to lag transaction-based indices and appear to have lower volatility and lower correlation with other asset classes.

### LOS 39.l

Investors use debt financing (leverage) to increase returns. As long as the investment return is greater than the interest paid to lenders, there is positive leverage and returns are magnified. Leverage results in higher risk.

### LOS 39.m

Lenders often use the debt service coverage ratio and the loan-to-value ratio to determine the maximum loan amount on a specific property. Investors use ratios such as the equity dividend rate (cash-on-cash return), leveraged IRR, and unleveraged IRR to evaluate performance.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 39.1

1. **B** Of the three investment choices, REITs are the most liquid because the shares are actively traded. Also, REITs provide quick and easy diversification across many properties. Neither the direct investment nor the mortgage participation is liquid, and significant capital would be required to diversify the investments. (LOS 39.a)

2. **A** Residential real estate (i.e., an apartment building) purchased with the intent to produce income is usually considered commercial real estate property. Timberland and farmland are unique categories of real estate. (LOS 39.b)

3. **C** An all-cash transaction eliminates financial leverage and lowers risk. Inflation risk is typically lower with a real estate investment, but the risk is not totally eliminated. If interest rates rise, non-leveraged property values are still impacted. Investors require higher returns when rates rise. Resale prices also depend on the cost and availability of debt capital. (LOS 39.c)

4. **C** Demand for multi-family properties depends on population growth, especially in the age demographic that typically rents apartments. (LOS 39.d)

5. **C** Financial leverage magnifies the effect of changing NOI on cash flow because the interest expense owed to lenders is a fixed cost. The use of debt financing does not affect the value of property. Leverage increases (not decreases) risk. (LOS 39.l)

## Module Quiz 39.2

1. **B** The sales comparison approach is likely the best valuation approach because of the number of comparable transactions. The cost approach is not as appropriate because of the difficulty in estimating depreciation and obsolescence of an older property. The income approach is not appropriate because an owner-occupied property does not generate income. (LOS 39.e)

2. **B** The cap rate of the comparable transaction is 8% (200,000 NOI / 2,500,000 sales price). The value of Royal Oaks is $1,625,000 (130,000 NOI / 8% cap rate). (LOS 39.f)

3. **A** The terminal value at the end of five years is $8,750,000 [700,000 year 6 payment / (10% discount rate – 2% growth rate)]. The terminal value is discounted to present and added to the present value of the NOI during the holding period. You can combine both steps using the following keystrokes:

   N = 5; I/Y = 10; PMT = 600,000; FV = 8,750,000; CPT → PV = $7,707,534

   (LOS 39.g)

4. **A** The capitalization rate is the discount rate (required rate of return on equity, *r*) less the constant growth rate in net operating income, *g* (i.e., cap rate = *r* – g). (LOS 39.f)

## Module Quiz 39.3, 39.4

1. **B**

| | | |
|---|---|---|
| Replacement cost | €3,750,000 | [50,000 SF × €75 per SF] |
| Physical deterioration | (2,250,000) | [3,750,000 × (12 eff age / 20 life)] |
| Economic obsolescence | (400,000) | |
| Land value | 900,000 | |
| Total value | €2,000,000 | |

(Module 39.4, LOS 39.i)

## Module Quiz 39.5

1. **C** The public records should be searched for outstanding liens filed by contractors involved in the renovation. An existing lien can result in legal problems for the purchaser and the lender. A survey will not identify outstanding liens. A survey confirms the property boundaries and identifies any easements. (LOS 39.j)

2. **B** Appraisal-based indices tend to lag transaction-based indices because actual transactions occur before appraisals are performed (appraisals are based on transaction data). Appraisal-based indices, not transaction-based indices, appear to have lower correlations with other asset classes. (LOS 39.k)

3. **B** Using the DSCR, the property will support a debt service payment of $125,000 (200,000 NOI / 1.6); thus, the loan amount would be $1,250,000 ($125,000 payment / 10% interest rate). However, using the LTV ratio, the property will only support a loan amount of $1,200,000 (1,500,000 value × 80% LTV). Thus, the maximum loan amount is $1,200,000, which is the lower of the two amounts. (LOS 39.m)

The following is a review of the Alternative Investments principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #40.

# READING 40: PUBLICLY TRADED REAL ESTATE SECURITIES

**Study Session 15**

## EXAM FOCUS

For the exam, be able to describe the different types of publicly traded real estate securities, and understand the advantages and disadvantages of investing in real estate through publicly traded securities. Be able to explain the types of REITs, as well as their economic value determinants, investment characteristics, principal risks, and due diligence considerations. Understand the various approaches to REIT valuation, and be able to calculate the value of a REIT share.

## MODULE 40.1: INTRODUCTION TO REOCS AND REITS, STRUCTURES, TYPES

Video covering this content is available online.

### LOS 40.a: Describe types of publicly traded real estate securities.

*CFA® Program Curriculum, Volume 6, page 80*

Publicly traded real estate securities can take several forms: **real estate investment trusts (REITs)**, **real estate operating companies (REOCs)**, and residential or commercial **mortgage-backed securities (MBS)**.

We can categorize publicly traded real estate securities into two broad groups, debt and equity.

## EQUITY

Publicly traded real estate equity securities represent ownership stakes in properties. Equity REITs and REOCs fall into this category.

**Equity REITs (Real estate investment trusts)**: REITs are tax-advantaged companies (trusts) that are for the most part exempt from corporate income tax. Equity REITs are actively managed, own income-producing real estate, and seek to profit by growing cash flows, improving existing properties, and purchasing additional properties. REITs often specialize in a particular kind of property, while still diversifying holdings by geography and other factors.

**REOCs (Real estate operating companies)**: REOCs are not tax-advantaged; rather, they are ordinary (i.e., taxable) corporations that own real estate. A business will form as a REOC if it is ineligible to organize as REIT. For example, the firm may intend to develop and sell real estate rather than generating cash from rental payments, or the firm may be based in a country that does not allow tax-advantaged REITs.

## DEBT

MBS (mortgage-backed securities) and mortgage REITs fall into this category.

**Residential or commercial mortgage-backed securities (MBS)**: Residential or commercial mortgage-backed securities are publicly traded asset-backed securitized debt obligations that receive cash flows from an underlying pool of mortgage loans. These loans may be for commercial properties (in the case of CMBS) or on residential properties (in the case of RMBS). Real estate debt securities represent a far larger aggregate market value than do publicly traded real estate equity securities.

**Mortgage REITs**: Mortgage REITs invest primarily in mortgages, mortgage securities, or loans that are secured by real estate.

**LOS 40.b: Explain advantages and disadvantages of investing in real estate through publicly traded securities.**

*CFA® Program Curriculum, Volume 6, page 85*

## ADVANTAGES

Investments in REITs and REOCs offer a number of advantages compared to direct investments in physical real estate:

- **Superior liquidity.** Investors in publicly traded real estate securities enjoy far greater liquidity than do investors in physical real estate, because REIT and REOC shares trade daily on a stock exchange. The low liquidity of a direct real estate investment stems from the relatively high value of an individual real estate property and the unique nature of each property.
- **Lower minimum investment.** While a direct investment in a real estate property may require a multi-million dollar commitment, REIT or REOC shares trade for much smaller dollar amounts.
- **Limited liability.** The financial liability of a REIT investor is limited to the amount invested. Other types of investment in real estate, such as a general partnership interest, have potential liabilities greater than the investor's initial investment.
- **Access to premium properties.** Some prestigious properties, such as high-profile shopping malls or other prominent or landmark buildings, are difficult to invest in directly. Shares in REITs that have invested in these properties represent one way to take an ownership stake in these assets.
- **Active professional management.** While a direct investment in properties requires a degree of real estate investment expertise and property management skill, REIT and REOC investments do not. REITs and REOCs employ professional management to control expenses, maximize rents and occupancy rates, and sometimes to acquire additional properties.
- **Protections accorded to publicly traded securities.** REITs and REOCs must meet the same requirements applicable to other publicly traded companies, including rules related to financial reporting, disclosure, and governance. Investors benefit from these securities regulations and from having a board overseeing the management on behalf of

investors. Additionally, having public investors monitor the actions of management and the board of directors leads to financial and operating efficiency.

- **Greater potential for diversification.** Because of the high cost of a single property, it is difficult to achieve adequate diversification though direct investments in real estate. Through REITs, however, an investor can diversify across property type and geographical location.

## REIT-Specific Advantages

The following advantages apply to REITs, but not to REOCs:

- **Exemption from taxation.** As long as certain requirements are met, REITs enjoy favorable taxation, because a major part of REIT distributions are treated as a return of capital and are thus not taxable.
- **Predictable earnings.** The earnings of REITs tend to be relatively consistent over time, because REITs' rental income is fixed by contracts, unlike the income of companies in other industries.
- **High yield.** To maintain their tax-advantaged status, REITs are obligated to pay out most of their taxable income as dividends. Because of this high income payout ratio, the yields of REITs are higher than the yields on most other publicly traded equities.

## DISADVANTAGES

Disadvantages of investing in real estate through publicly traded securities may include:

- **Taxes versus direct ownership.** Depending on local laws, investors that make direct investments in properties may be able to deduct losses on real estate from taxable income or replace one property for a similar property ("like-kind exchange" in the U.S.) without taxation on the gains. For investors in REITs or REOCs, these specific tax benefits are not available.
- **Lack of control.** REIT investors have comparatively little input into investment decisions compared to investors that make direct investments in real estate.
- **Costs of a publicly traded corporate structure.** There are clear benefits from maintaining a publicly traded REIT structure. However, there are also related costs, which may not be worthwhile for smaller REITs.
- **Price is determined by the stock market.** While the appraisal-based value of a REIT may be relatively stable, the market-determined price of a REIT share is likely to be much more volatile. While this relationship suggests a direct real estate investment is less risky, in reality much of this effect results from the underestimation of volatility that is associated with appraised values; appraisals tend to be infrequent and backward-looking, while the stock market is continuous and reflects forward-looking values.
- **Structural conflicts of interest.** When a REIT is structured as an UPREIT or a DOWNREIT there is the potential for conflict of interest. When the opportunity arises to sell properties or take on additional borrowing, a particular action may have different tax implications for REIT shareholders and for the general partners, which may tempt the general partners to act in their own interest, rather than in the interest of all stakeholders.

### PROFESSOR'S NOTE

An UPREIT is an "umbrella partnership" REIT structure, where the REIT is the general partner and holds a controlling interest in a partnership that owns and operates the properties. UPREITs are the most common REIT structure in the United States. In a DOWNREIT, the REIT has an ownership interest in more than one partnership and can own properties both at the partnership level and at the REIT level.

The following disadvantage applies to REITs, but not to REOCs:

- **Limited potential for income growth.** REITs' high rates of income payout limit REITs' ability to generate future growth through reinvestment. This limits future income growth and may dampen the share price of REITs.
- **Forced equity issuance.** In order to maintain financial leverage, REITs frequently participate in bond markets to refinance maturing debt. When credit is difficult to obtain (e.g., during the 2008 credit crisis), a REIT may be forced to issue equity at a disadvantageous price.
- **Lack of flexibility.** The rules that qualify REITs for favorable taxation also have a downside: REITs are prevented from making certain kinds of investments and from retaining most of their income. These limits may prevent REITs from being as profitable as they might otherwise be. REOCs, on the other hand, do not need to meet these requirements, and thus are free to retain income and devote those funds to property development when the REOC managers see attractive opportunities. REOCs are also not restricted in their use of leverage.

**LOS 40.c: Explain economic value determinants, investment characteristics, principal risks, and due diligence considerations for real estate investment trust (REIT) shares.**

*CFA® Program Curriculum, Volume 6, page 90*

## ECONOMIC VALUE DETERMINANTS OF REITS

National GDP growth is the largest driver of economic value for all REIT types. Overall growth in the economy means more jobs, more need for office space, more disposable income, more growth in shopping centers, more demand for hotel rooms from business and leisure travelers, and so on.

In addition to national GDP growth, there are four major economic factors that impact REITs, as shown in Figure 40.1.

**Figure 40.1:** Rank of Most Important Factors Affecting Economic Value for REIT Property Types

| Relative Importance of Factors Affecting REIT Economic Value | | | | |
|---|---|---|---|---|
| **REIT Type** | **Population Growth** | **Job Creation** | **New Space Supply vs. Demand** | **Retail Sales Growth** |
| Shopping/Retail | 3 | 2 | 3 | 1 |
| Office | 3 | 1 | 2 | 4 |
| Residential | 1 | 1 | 3 | 4 |
| Healthcare | 1 | 3 | 2 | 4 |
| Industrial | 2 | 4 | 3 | 1 |
| Hotel | 3 | 1 | 2 | 4 |
| Storage | 1 | 2 | 3 | 4 |

Note: 1 = most important, 4 = least important

Adapted from: Exhibit 6, Level II 2016 Volume 5, Alternative Asset Valuation and Fixed Income. John Wiley & Sons (P&T), pp. 94–95.

## INVESTMENT CHARACTERISTICS OF REITS

- **Exemption from corporate-level income taxes:** As mentioned earlier, the defining characteristic of REITs is that they are exempt from corporate taxation. However, in order to gain this status, REITs are required to distribute almost all of the REITs' otherwise-taxable income, and a sufficient portion of assets and income must relate to rental income-producing real estate.
- **High dividend yield:** To maintain their tax-exempt status, REITs' dividend yields are generally higher than yields on bonds or other equities.
- **Low income volatility:** REITs' revenue streams tend to be relatively stable. This characteristic is due to REITs' dependence on interest and rent as income sources.
- **Secondary equity offerings:** Since REITs distribute most earnings, they are likely to finance additional real estate acquisitions by selling additional shares. For this reason, REITs issue equity more frequently than do non-real estate companies.

## PRINCIPAL RISKS OF REITS

The most risky REITs are those that invest in property sectors where significant mismatches between supply and demand are likely (particularly health care, hotel, and office REITs), as well as those sectors where the occupancy rates are most likely to fluctuate within a short period of time (especially hotels). Other items to consider in assessing the riskiness of a REIT relate to the properties' financing, the leases that are in place, and the properties' locations and quality.

## DUE DILIGENCE CONSIDERATIONS OF REITS

- **Remaining lease terms:** An analyst should evaluate the length of remaining lease terms in conjunction with the overall state of the economy—short remaining lease terms provide an opportunity to raise rents in an expansionary economy, while long remaining lease terms are advantageous in a declining economy or softening rental market. Initial lease terms vary with the type of property—industrial and office buildings and shopping centers generally have long lease terms, while hotels and multi-family residential real estate have short lease terms.
- **Inflation protection:** The level of contractual hedging against rising general price levels should be evaluated—some amount of inflation protection will be enjoyed if leases have rent increases scheduled throughout the term of the lease or if rents are indexed to the rate of inflation.
- **In-place rents versus market rents:** An analyst should compare the rents that a REIT's tenants are currently paying (in-place rents) with current rents in the market. If in-place rents are high, the potential exists for cash flows to fall going forward.
- **Costs to re-lease space:** When a lease expires, expenses typically incurred include lost rent, any new lease incentives offered, the costs of tenant-demanded improvements,

and broker commissions.

- **Tenant concentration in the portfolio:** Risk increases with tenant concentration; a REIT analyst should pay special attention to any tenants that make up a high percentage of space rented or rent paid.
- **Tenants' financial health:** Since the possibility of a major tenant's business failing poses a significant risk to a REIT, it is important to evaluate the financial position of the REIT's largest renters.
- **New competition:** An analyst should evaluate the amount of new space that is planned or under construction. New competition could impact the profitability of existing REIT properties.
- **Balance sheet analysis:** Due diligence should include an in-depth analysis of the REIT's balance sheet, with special focus on the amount of leverage, the cost of debt, and the debt's maturity.
- **Quality of management:** Senior management's performance record, qualifications, and tenure with the REIT should be considered.

**LOS 40.d: Describe types of REITs.**

*CFA® Program Curriculum, Volume 6, page 91*

## SUBTYPES OF EQUITY REITS

The following paragraphs provide more details on several subtypes of equity REITs.

1. **Retail or Shopping Center REITs.** REITs in this category invest in shopping centers of various sizes and sometimes in individual buildings in prime shopping neighborhoods. Regional shopping malls are large enclosed centers where anchor tenants have very long fixed-rate leases, while smaller tenants often pay a "percentage lease," which consists of a fixed rental price (the "minimum lease"), plus a percentage of sales over a certain level. Community shopping centers, such as "big-box centers," consist of stores that surround parking lots. These stores commonly pay pre-determined rents that increase on a schedule. Lease rates and sales per square foot are important factors for analysts to consider when examining a shopping center REIT.
2. **Office REITs.** Office REITs own office properties that typically lease space to multiple business tenants. Leases are long (generally 5 to 25 years) and rents increase over time. In addition to rent, tenants pay a share of property taxes, operating expenses, and other common costs proportional to the size of their unit (i.e., they are net leases). Because of the length of time that it takes to build this type of property, there is often a supply-demand mismatch, resulting in variations in occupancy rates and rents over the economic cycle. In analyzing office REITs, analysts must consider properties' location, convenience and access to transportation, and the quality of the space including the condition of the building.
3. **Residential (Multi-Family) REITs.** This category of REITs invests in rental apartments. Demand for rental apartments tends to be stable; however, lease periods are short (usually one year), so rental income fluctuates over time as competing properties are constructed. Variables that will affect rental income include the overall

strength of the local economy and any move-in inducements offered. Factors to consider when analyzing a residential REIT include local demographic trends, availability of alternatives (i.e., home ownership), any rent controls imposed by the local government, and factors related to the portfolio properties themselves, such as the age of the properties and how appealing they are to renters in the local market compared to other competing properties. Additionally, because rents are typically based on a gross lease, the impact of rising costs must be considered (under a gross lease, operating costs are paid by the landlord). Examples include rising fuel or energy costs, taxes, and maintenance costs.

4. **Health Care REITs.** Health care REITs invest in hospitals, nursing homes, retirement homes, rehab centers, and medical office buildings. REITs in many countries are barred from operating this kind of business themselves. In order to participate in this property sector while maintaining their tax-free status, REITs rent properties to health care providers. Leases in this sector are usually net leases. Health care REITs are relatively unaffected by the overall economy. However, other factors are important, such as government funding of health care, demographic shifts, new construction versus demand, increases in the cost of insurance, and the potential for lawsuits by residents.
5. **Industrial REITs.** Industrial REITs own properties used in activities such as manufacturing, warehousing, and distribution. The value of industrial properties is relatively stable and less cyclical compared to the value of other types of properties, due to long leases (5 to 25 years) which smooths rental income. In analyzing industrial REITs, an analyst needs to closely examine the local market for industrial properties; new properties coming on to the market and the demand for such space by tenants will affect the value of existing properties. Location and availability of transportation links (airports, roads, and ports) are also important considerations for industrial REITs.
6. **Hotel REITs.** A hotel REIT (like a health care REIT) usually leases properties to management companies, so the REIT receives only passive rental income. Hotels are exposed to revenue volatility driven by changes in business and leisure travel, and the sector's cyclical nature is intensified by a lack of long-term leases. In analyzing hotel REITs, analysts compare a number of statistics against industry averages (operating profit margins, occupancy rates, and average room rates). One key metric that is closely followed is RevPAR, the revenue per available room, which is calculated by multiplying the average occupancy rate by the average room rate. Other closely-watched variables are the level of margins, forward bookings, and food and beverage sales. Expenses related to maintaining the properties are also closely monitored. Because of the time lag associated with bringing new hotel properties on-line (up to three years), the cyclical nature of demand needs to be considered. Because of the uncertainty in income, the use of high amounts of leverage in financing hotel properties is risky.
7. **Storage REITs.** Properties owned by storage REITs rent self-storage lockers (also known as mini-warehouses) to individuals and small businesses. Space is rented to users on a monthly basis and under a gross lease. In analyzing storage REITs, it is important to look at the local factors that drive demand for storage, such as housing sales, new business start-ups, demographic trends in the surrounding area, as well as any other competing facilities that are under construction. Seasonal demand should also be considered.

8. **Diversified REITs.** Diversified REITs own more than one category of REIT. While they are uncommon in North America, some investors in Europe and Asia are drawn to the broad nature of these REITs. Because diversified REITs hold a range of property types, when analyzing this class of REIT it is especially important to evaluate management's background in the kinds of real estate invested in.

**Figure 40.2:** Characteristics of REIT Property Subtypes

| Characteristic | | | | |
|---|---|---|---|---|
| **REIT Type** | **Economic Value Determinant** | **Investment Characteristics** | **Principal Risks** | **Due Diligence Considerations** |
| Retail | ■ Retail sales growth<br>■ Job creation | ■ Stable revenue stream over the short term | ■ Depends on consumer spending | ■ Per-square-foot sales and rental rates |
| Office | ■ Job creation<br>■ New space supply vs. demand | ■ Long (5–25 yrs) lease terms<br>■ Stable year-to-year income | ■ Changes in office vacancy and rental rates | ■ New space under construction<br>■ Quality of office space (location, condition of building, and so on) |
| Residential | ■ Population growth<br>■ Job creation | ■ One-year leases<br>■ Stable demand | ■ Competition<br>■ Inducements<br>■ Regional economy<br>■ Inflation in operating costs | ■ Demographics and income trends<br>■ Age and competitive appeal<br>■ Cost of home ownership<br>■ Rent controls |
| Health care | ■ Population growth<br>■ New space supply vs. demand | ■ REITs lease facilities to health care providers.<br>■ Leases are usually net leases. | ■ Demographics<br>■ Government funding<br>■ Construction cycles<br>■ Financial condition of operators<br>■ Tenant litigation | ■ Operating trends<br>■ Government funding trends<br>■ Litigation settlements<br>■ Insurance costs<br>■ Competitors' new facilities vs demand |
| Industrial | ■ Retail sales growth<br>■ Population growth | ■ Less cyclical than some other REIT types<br>■ 5–25 year net leases<br>■ Change in income and values are slow | ■ Shifts in the composition of local and national industrial bases and trade | ■ Trends in tenants' requirements<br>■ Obsolescence of existing space<br>■ Need for new types of space<br>■ Proximity to transportation<br>■ Trends in local supply and demand |
| Hotel | ■ Job creation<br>■ New space supply vs. demand | ■ Variable income<br>■ Sector is cyclical because it is not protected by long-term leases | ■ Exposed to business-cycle<br>■ Changes in business and leisure travel<br>■ Exposure to travel disruptions | ■ Occupancy, room rates, and operating profit margins vs. industry averages<br>■ Revenue per available room (RevPAR)<br>■ Trends in forward bookings<br>■ Maintenance expenditures<br>■ New construction in local markets<br>■ Financial leverage |
| Storage | ■ Population growth<br>■ Job creation | ■ Space is rented under gross leases and on a monthly basis | ■ Ease of entry can lead to overbuilding. | ■ Construction of new competitive facilities<br>■ Trends in housing sales<br>■ Demographic trends<br>■ New business start-up activity<br>■ Seasonal trends in demand for storage facilities that can be significant in some markets |

## MODULE QUIZ 40.1

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

1. Which of the following *least accurately* identifies one of the principal types of publicly traded real estate securities?
   A. Commingled real estate fund (CREF).
   B. Shares of real estate operating companies (REOC).

C. Residential and commercial mortgage-backed securities (MBS).

2. Which of the following statements *most accurately* describes one of the advantages of investing in REITs? REITs:
   A. can pass on tax losses to their investors as deductions from their taxable income.
   B. have lower price and return volatility than a comparable direct investment in properties.
   C. limit investor liability to only the amount of the investor's original capital investment.
3. From the choices given, choose the *most accurate* to complete the following sentence. After overall growth in the economy, the *most* important economic factor affecting a(n):
   A. hotel REIT is job creation.
   B. storage REIT is retail sales growth.
   C. office REIT is population growth.
4. Compared with other publicly traded shares, REITs are *most likely* to offer relatively low:
   A. yields.
   B. stability of income and returns.
   C. growth from reinvested operating cash flows.
5. Which of the following statements *least accurately* describes a feature of the DOWNREIT structure? A DOWNREIT:
   A. is the most common REIT structure in the United States.
   B. may own properties at both the REIT level and the partnership level.
   C. can form partnerships for each property acquisition it undertakes.

# MODULE 40.2: REIT VALUATION NAVPS

Video covering this content is available online.

**LOS 40.e: Justify the use of net asset value per share (NAVPS) in REIT valuation and estimate NAVPS based on forecasted cash net operating income.**

*CFA® Program Curriculum, Volume 6, page 98*

**NAVPS (net asset value per share)** is the (per-share) amount by which assets exceed liabilities, using current market values rather than accounting book values. NAVPS is generally considered the most appropriate measure of the fundamental value of REITs (and REOCs). If the market price of a REIT varies from NAVPS, this is seen as a sign of over- or undervaluation.

## Estimating NAVPS Based on Forecasted Cash Net Operating Income

In the absence of a reliable appraisal, analysts will estimate the value of operating real estate by capitalizing the net operating income. This process first requires the calculation of a market required rate of return, known as the **capitalization rate** ("cap rate"), based on the prices of comparable recent transactions that have taken place in the market.

$$\text{capitalization rate} = \frac{\text{net operating income}}{\text{property value}}$$

Note that the net operating income (NOI) refers to the *expected income in the coming year*. As defined earlier, NOI is the effective gross income less operating expenses (property taxes, insurance, and maintenance expenses), but before interest and income taxes. In the context of a REIT's income statement, NOI is *before* deducting depreciation and the general and administrative expense (G&A). In other words, we can obtain NOI by adding G&A to the REIT's EBITDA. Once a cap rate for the market has been determined, this cap rate can be used to capitalize the NOI:

$$\text{property value} = \frac{\text{net operating income}}{\text{capitalization rate}}$$

In the following example, we show how NAVPS is calculated by capitalizing a rental stream. First, estimated first-year NOI is capitalized using a market cap rate. Next, we add the value of other tangible assets and subtract the value of liabilities to find total net asset value. Net asset value divided by the number of outstanding shares gives us NAVPS.

Note that in calculating cash NOI, we subtract non-cash rent. Non-cash rent is the difference between the average rent over the term of a lease contract (i.e., straight-line rent) versus the amount of cash rent actually received in a period.

**EXAMPLE: Computing NAVPS**

Vinny Cestone, CFA, is undertaking a valuation of the Anyco Shopping Center REIT, Inc. Given the following financial data for Anyco, estimate NAVPS based on forecasted cash net operating income.

**Select Anyco Shopping Center REIT, Inc. Financial Information (in millions)**

| | |
|---|---|
| Last 12-months' NOI | $80 |
| Cash and equivalents | $20 |
| Accounts receivable | $15 |
| Total debt | $250 |
| Other liabilities | $50 |
| Non-cash rents | $2 |
| Full-year adjustment for acquisitions | $1 |
| Land held for future development | $10 |
| Prepaid/other assets (excluding intangibles) | $5 |
| Estimate of next 12 months' growth in NOI | 1.25% |
| Cap rate based on recent comparable transactions | 8.0% |
| Shares outstanding | 15 |

**Answer:**

| | | |
|---|---|---|
| | Last 12-months' NOI | $80 |
| − | Non-cash rents[1] | $2 |
| + | Full-year adjustment for acquisitions[2] | $1 |
| = | Pro forma cash NOI for last 12 months | $79 |
| + | Next 12 months' growth in NOI (@1.25%/yr)[3] | $1 |
| = | Estimated next 12 months' cash NOI | $80 |
| ÷ | Cap rate[4] | 8.0% |
| = | Estimated value of operating real estate[5] | $1,000 |
| + | Cash and equivalents[6] | $20 |
| + | Land held for future development | $10 |
| + | Accounts receivable | $15 |
| + | Prepaid/other assets (excluding intangibles) | $5 |
| = | Estimated gross asset value | $1,050 |
| − | Total debt[7] | $250 |
| − | Other liabilities | $50 |
| = | Net asset value | $750 |

| | | |
|---|---|---|
| ÷ | Shares outstanding | 15 |
| = | Net asset value per share[8] | $50.00 |

Notes:

(1) Non-cash rent (difference between average contractual rent and cash rent paid) is removed.

(2) NOI is increased to represent full-year rent for properties acquired during the year.

(3) Cash NOI is expected to increase by 1.25% over the next year.

(4) Cap rate is based on recent transactions for comparable properties.

(5) Operating real estate value = expected next 12-month cash NOI / 8% capitalization rate.

(6) Add the book value of other assets: cash, accounts receivable, land for future development, prepaid expenses, and so on. Certain intangibles, such as goodwill, deferred financing expenses, and deferred tax assets, if given, are ignored.

(7) Debt and other liabilities are subtracted to get to net asset value.

(8) NAVPS = NAV / number of outstanding shares

### MODULE QUIZ 40.2

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

1. Which of the following statements about the use of net asset value per share (NAVPS) in REIT valuation is *most accurate*? NAVPS is:
   A. the difference between the accounting book values of a real estate company's assets and its liabilities, divided by shares outstanding.
   B. considered to be a superior measure of the net worth of a REIT's shares, compared with book value per share.
   C. exactly equal to the intrinsic value of REIT shares.

## MODULE 40.3: REIT VALUATION FFO/AFFO, DCF

Video covering this content is available online.

### LOS 40.f: Describe the use of funds from operations (FFO) and adjusted funds from operations (AFFO) in REIT valuation.

*CFA® Program Curriculum, Volume 6, page 105*

Analysts calculate and use two measures, FFO and AFFO.

1. **Funds from operations:** FFO adjusts reported earnings and is a popular measure of the continuing operating income of a REIT or REOC. FFO is calculated as follows:

| | |
|---|---|
| | Accounting net earnings |
| + | Depreciation and amortization expense |
| – | Gains from sales of property |
| + | Losses from sales of property |
| = | Funds from operations |

   Depreciation is added back under the premise that accounting depreciation often exceeds economic depreciation for real estate. Gains from sales of property are excluded because these are not considered to be part of continuing income.

2. **Adjusted funds from operations:** AFFO is an extension of FFO that is intended to be a more useful representation of current economic income. AFFO is also known as *cash available for distribution* (CAD) or *funds available for distribution* (FAD). The calculation of AFFO generally involves beginning with FFO and then subtracting non-

cash rent and maintenance-type capital expenditures and leasing costs (such as improvement allowances to tenants or capital expenditures for maintenance).

| | |
|---|---|
| | FFO (funds from operations) |
| – | Non-cash (straight-line) rent adjustment |
| – | Recurring maintenance-type capital expenditures and leasing commissions |
| = | AFFO (adjusted funds from operations) |

Straight-line rent refers not to the cash rent paid during the lease but rather to the average contractual rent over a lease period—the two figures differ by non-cash rent, which reflects contractually-increasing rental rates. Capital expenditures related to maintenance, as well expenses related to leasing the space in properties, are subtracted from FFO because they represent costs that must be expended in order to maintain the value of the properties.

AFFO is considered a better measure of economic income than FFO because AFFO considers the capital expenditures that are required to sustain the property's economic income. However, FFO is more frequently cited in practice, because AFFO relies more on estimates and is considered more subjective.

## LOS 40.g: Compare the net asset value, relative value (price-to-FFO and price-to-AFFO), and discounted cash flow approaches to REIT valuation.

*CFA® Program Curriculum, Volume 6, page 111*

REITs and REOCs are valued using several different approaches.

**Net asset value per share:** The net asset value method of valuation can be used either to generate an absolute valuation or as part of a relative valuation approach. Note, however, that net asset value is an indication of a REIT's assets to a buyer in the private market, which can be quite different from the value public market investors would attach to the REIT. For this reason, there have historically been significant differences (i.e., premiums or discounts) between NAV estimates and the prices at which REITs actually trade.

### PROFESSOR'S NOTE

Relative valuation using NAVPS is essentially comparing NAVPS to the market price of a REIT (or REOC) share. If, in general, the market is trading at a premium to NAVPS, a value investor would select the investments with the lowest premium (everything else held constant).

**Relative value (price-to-FFO** and **price-to-AFFO):** There are three key factors that impact that price-to-FFO and price-to-AFFO of REITs and REOCs:

1. Expectations for growth of FFO or AFFO.
2. The level of risks inherent in the underlying real estate.
3. Risk related to the firm's leverage and access to capital.

**Discounted cash flow approach:** Dividend discount and discounted cash flow models of valuation are appropriate for use with REITs and REOCs, because these two investment structures typically pay dividends and thereby return a high proportion of their income to investors. DDM and DCF are used in private real estate in the same way that they are used to value stocks in general. For dividend discount models, an analyst will typically develop near-term, medium-term, and long-term growth forecasts and then use these values as the basis for two- or three-stage dividend discount models. To build a discounted cash flow model,

analysts will generally create intermediate-term cash flow projections plus a terminal value that is developed using historical cash flow multiples.

### PROFESSOR'S NOTE

We discuss dividend discount models extensively in the study session on equity valuation. Similar to price multiples in equity valuation, price multiples here depend on growth rate and risk. The first factor mentioned previously focuses on growth rate, while the second and third factors focus on risk.

## LOS 40.h: Calculate the value of a REIT share using net asset value, price-to-FFO and price-to-AFFO, and discounted cash flow approaches.

*CFA® Program Curriculum, Volume 6, page 113*

We will demonstrate the calculation of the value of a REIT share using net asset value, price-to-FFO and price-to-AFFO, and discounted cash flow approaches with an example.

**EXAMPLE: Calculating the value of a REIT share**

Lucinda Crabtree, CFA, is an asset manager that is interested in diversifying the portfolio she manages through an investment in an office building REIT.

Crabtree wants to value the potential investment using four different approaches as of the end of 2013, as follows:

Approach 1: Net asset value

Approach 2: Price-to-FFO

Approach 3: Price-to-AFFO

Approach 4: Discounted cash flow

**Selected REIT Financial Information**

| | All amounts in $million |
|---|---|
| Estimated 12 months' cash net operating income (NOI) | $80 |
| Last year's actual funds from operations (FFO) | $70 |
| Cash and equivalents | $65 |
| Accounts receivable | $35 |
| Debt and other liabilities | $400 |
| Non-cash rents | $5 |
| Recurring maintenance-type capital expenditures | $15 |
| Shares outstanding | 10 million shares |
| Expected annual dividend next year (2014) | $5.00 |
| Dividend growth rate in 2015 and 2016 | 2% |
| Dividend growth rate (from 2017 into perpetuity) | 1% |
| Assumed cap rate | 8% |
| Office subsector average P/FFO multiple | 10× |
| Office subsector average P/AFFO multiple | 14× |
| Crabtree's applicable cost of equity capital | 9% |
| Risk-free rate | 2% |

**Approach 1: Value of a REIT share using net asset value approach**

The value per share for this REIT using net asset value valuation is computed as follows:

| | |
|---|---|
| Estimated cash NOI | 80 |
| Assumed cap rate | 8% |
| Estimated value of operating real estate (80 / .08) | 1,000 |
| Plus: cash + accounts receivable | 100 |
| Less: debt and other liabilities | 400 |
| Net asset value | 700 |
| Shares outstanding | 10 |
| NAV / share | $70 |

The REIT share value using the net asset value approach is thus $70. Note that no adjustment for non-cash rents was required in this case because we began with an estimate of cash NOI.

**Approach 2: Value of a REIT share using price-to-FFO approach**

The value per share for this REIT using price-to-FFO valuation is computed as follows:

| | |
|---|---|
| Funds from operations (FFO) | $70 |
| Shares outstanding (millions) | 10 |
| FFO / share = $70 million / 10 million shares | $7 |

Applying the office subsector average P/FFO multiple of 10× yields a value per share of:

$7 × 10 = $70

The REIT share value using the price-to-FFO approach is thus $70.

**Approach 3: Value of REIT share using price-to-AFFO approach**

| | |
|---|---|
| Funds from operations (FFO) | $70 |
| Subtract: non-cash rents | $5 |
| Subtract: recurring maintenance-type capital expenditures | $15 |
| Equals: AFFO | $50 |
| Shares outstanding (million) | 10 |
| AFFO / share = $50 million / 10 million shares | $5 |
| Property subsector average P/AFFO multiple | 14× |

Applying the office subsector average P/AFFO multiple of 14× yields a value per share of $5 × 14 = $70.

The REIT share value using the price-to-AFFO approach is thus $70.

**Approach 4: Value of REIT share using discounted cash flow approach**

| | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| Dividends per share | $5.00 | $5.10 | $5.20 | $5.25 |

Present value in 2016 of dividend stream beginning in 2017 = $5.25 / (0.09 – 0.01) = $65.63

These dividends are discounted at a rate of 9%.

value of a REIT share

= PV(dividends for years 1 through n) + PV(terminal value at the end of year n)

$= PV_{2014\ dividend} + PV_{2015\ dividend} + PV_{2016\ dividend} + PV_{2017\ and\ later\ dividends\ (terminal\ value)}$

$= \$5.00/(1.09) + \$5.10/(1.09)^2 + \$5.20/(1.09)^3 + \$65.63/(1.09)^3$

= $63.61

The REIT share value using the discounted cash flow approach is thus $63.61.

Note that the calculated value of a REIT share is likely to vary, sometimes greatly, depending on which of these approaches is used.

## MODULE QUIZ 40.3

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

1. In the process of calculating adjusted funds from operations (AFFO) from funds from operations (FFO), an analyst is *most likely* to:
   A. add depreciation and amortization.
   B. subtract non-cash rent.
   C. add recurring maintenance-type capital expenditures and leasing commissions.

2. Which statement regarding approaches to REIT valuation is *least accurate*?
   A. AFFO includes a number of adjustments to FFO that result in AFFO approximating continuing cash earnings.
   B. P/AFFO is the most frequently used multiple in analyzing the REIT sector.
   C. Dividend discount models are appropriate for valuing REITs because REITs return most of their income to investors.

**Use the following information for Questions 3 through 6.**

Anna Ginzburg, CFA, is using the following information to analyze a potential investment in an industrial building.

**Selected REIT Financial Information**

| | **All amounts in $million** |
|---|---|
| Estimated 12 months' cash net operating income (NOI) | $40 |
| Funds from operations (FFO) | $30 |
| Cash and equivalents | $30 |
| Accounts receivable | $20 |
| Debt and other liabilities | $250 |
| Non-cash rents | $5 |
| Recurring maintenance-type capital expenditures | $10 |
| Shares outstanding | 10 million shares |
| | |
| Expected annual dividend next year (2014) | $3.00 |
| Dividend growth rate in 2015 and 2016 | 4% |
| Dividend growth rate (from 2017 into perpetuity) | 3% |
| Assumed cap rate | 8% |
| | |
| Office subsector average P/FFO multiple | 12× |
| Office subsector average P/AFFO multiple | 20× |
| | |
| Ginzburg's cost of equity capital | 11% |
| Risk-free rate | 2% |

3. The value of Ginzburg's potential investment using a net asset value (NAV) approach is *closest* to:
   A. $30.
   B. $35.
   C. $40.

4. The value of Ginzburg's potential investment using a price-to-FFO approach is *closest* to:
   A. $30.
   B. $35.
   C. $40.

5. The value of Ginzburg's potential investment using a price-to-AFFO approach is *closest* to:
   A. $30.
   B. $35.
   C. $40.

6. The value of Ginzburg's potential investment using a discounted cash flow approach is *closest* to:
    A. $30.
    B. $35.
    C. $40.

# KEY CONCEPTS

## LOS 40.a

The main types of publicly traded real estate securities are:

- Real estate investment trusts (REITs) which are tax-advantaged companies that own income-producing real estate.
- Real estate operating companies (REOCs) which are non-tax-advantaged companies that own real estate.
- Mortgage-backed securities (MBS) which are investments in residential or commercial mortgages that are backed by real estate.

The main types of REITs are:

- Equity REITs which take ownership stakes in income-producing property.
- Mortgage REITs which invest primarily in mortgages, mortgage securities, or loans that use real estate as collateral.

## LOS 40.b

Advantages of publicly traded real estate securities include:

- Superior liquidity.
- Lower minimum investment.
- Limited liability.
- Access to premium properties.
- Active professional management.
- Protections accorded to publicly traded securities.
- Greater potential for diversification.
- Exemption from taxation.
- Earnings predictability.
- High yield.

Disadvantages of publicly traded real estate securities include:

- Taxes versus direct ownership.
- Lack of control.
- Costs of a publicly traded corporate structure.
- Price is determined by the stock market.
- Structural conflicts of interest.
- Limited potential for income growth.
- Forced equity issuance.
- Lack of flexibility.

## LOS 40.c

Investment characteristics of REITs include:

- Exemption from corporate-level income taxes.
- High dividend yield.
- Low income volatility.
- Frequent secondary equity offerings.

The most risky types of REIT property sectors are those in which significant mismatches between supply and demand are likely to happen (particularly health care, hotel, and office REITs), as well as those sectors where the occupancy rates are most likely to vary over a short period of time (especially hotels).

REIT due diligence considerations:

- Remaining lease terms.
- Inflation protection.
- Occupancy rates and leasing activity.
- In-place rents versus market rents.
- Costs to re-lease space.
- Tenant concentration in the portfolio.
- Tenants' financial health.
- New supply versus demand.
- Balance sheet analysis.
- Quality of management.

## LOS 40.d

Types of REITs include:

- Retail REITs, which own properties used as shopping centers.
- Office REITs, which provide space to multiple business tenants.
- Residential ("multi-family") REITs, which invest in rental apartments.
- Health care REITs, which lease properties to hospitals and nursing homes.
- Industrial REITs, which own properties used in manufacturing, warehousing, and distribution.
- Hotel REITs, which receive passive rental income from hotel management companies.
- Storage REITs, which rent self-storage lockers to individuals and small businesses.
- Diversified REITs, which own multiple types of real estate.

## LOS 40.e

Net asset value per share (NAVPS) is the (per-share) amount by which a REIT's assets exceed its liabilities, using current market value rather than accounting or book values. The REIT or REOC portfolio of operating real estate investments can be valued by capitalizing net operating income:

$$\text{property value} = \frac{\text{net operating income}}{\text{capitalization rate}}$$

| | |
|---|---|
| | Estimated cash NOI |
| ÷ | Assumed cap rate |
| = | Estimated value of operating real estate |

| | |
|---|---|
| + | Cash and accounts receivable |
| − | Debt and other liabilities |
| = | Net asset value |
| ÷ | Shares outstanding |
| = | NAV / share |

## LOS 40.f

| | |
|---|---|
| | Accounting net earnings |
| + | Depreciation expense |
| − | Gains (losses) from sales of property |
| = | Funds from operations |

| | |
|---|---|
| | FFO (funds from operations) |
| − | Non-cash (straight-line) rent adjustment |
| − | Recurring maintenance-type capital expenditures and leasing commissions |
| = | AFFO (adjusted funds from operations) |

## LOS 40.g

Approaches to REIT valuation:

- Net asset value per share: NAVPS is based on market values and is considered to be the fundamental measure of value for REITs and REOCs.
- Relative value: Market-based-multiple approaches including price-to-FFO and price-to-AFFO can be used to value REITs and REOCs.
- Discounted cash flow: Dividend discount models typically include two or three stages, based on near- and long-term growth forecasts. Discounted cash flow models use intermediate-term cash flow projections, plus a terminal value based on historical cash flow multiples.

## LOS 40.h

Price-to-FFO approach:

| | |
|---|---|
| | Funds from operations (FFO) |
| ÷ | Shares outstanding |
| = | FFO / share |
| × | Sector average P/FFO multiple |
| = | NAV / share |

Price-to-AFFO approach:

| | |
|---|---|
| | Funds from operations (FFO) |
| − | Non-cash rents |
| − | Recurring maintenance-type capital expenditures |
| = | AFFO |
| ÷ | Shares outstanding |
| = | AFFO / share |
| × | Property subsector average P/AFFO multiple |
| = | NAV / share |

Discounted cash flow approach:

Value of a REIT share = PV(dividends for years 1 through n) + PV(terminal value at the end of year n)

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 40.1

1. **A** A commingled real estate fund (CREF) is an example of a private real estate investment, not a publicly traded security. The three principal types of publicly traded real estate securities available globally are real estate investment trusts (REITs), real estate operating companies (REOCs), and residential and commercial mortgage-backed securities (MBS). (LOS 40.a)

2. **C** REIT investors have no liability for the REITs in which they invest beyond the original amount invested. REITs and REOCs usually cannot pass on tax losses to their investors as deductions from taxable income. Because REIT prices and returns are determined by the stock market, the value of a REIT is more volatile that its appraised net asset value. (LOS 40.b)

3. **A** After growth in the GDP, the most important factor driving demand for hotel rooms is job creation, because business and leisure travel are closely tied to the size of the workforce. More important to the value of a storage REIT than retail sales growth is population growth. More important to the value of an office REIT than population growth is job creation. (LOS 40.c)

4. **C** When we compare REITs to other kinds of publicly traded shares, REITs offer above-average yields and stable income and returns. Due to their high income-to-payout ratios, REITs have relatively low potential to grow by reinvesting operating cash flows. (LOS 40.c)

5. **A** Most REITs in the United States are structured as UPREITs, not DOWNREITs. The other two statements are true: a DOWNREIT may own properties at both the REIT level and at the partnership level, and may form partnerships for each property acquisition it undertakes. (LOS 40.b)

## Module Quiz 40.2

1. **B** NAVPS is the difference between a REIT's assets and its liabilities, using current market values instead of accounting book values and dividing by the number of shares outstanding. NAVPS is a superior measure of the net worth of a REIT, compared to book value per share which is based on historical cost values. NAV is the largest component of the intrinsic value of a REIT; however, other factors, such as the value of non-asset-based income streams, the value added by management, and the value of any contingent liabilities, also contribute to intrinsic value. (LOS 40.e)

## Module Quiz 40.3

1. **B** To calculate AFFO, we begin with FFO and then deduct non-cash rent, maintenance-type capital expenditures, and leasing commissions. (LOS 40.f)

2. **B** FFO has some shortcomings, but because it is the most standardized method of measuring a REIT's earnings, P/FFO is the most commonly used multiple in analyzing REITs. AFFO is used as a convenient proxy for a "cash flow" multiple because AFFO

is an approximation of cash earnings. Dividend discount models are appropriate methods for valuing REITs because REITs return a significant portion of their income to their investors and tend to be high-dividend payers. (LOS 40.g)

3. **A** The value per share for this REIT using net asset value valuation is computed as follows:

| | |
|---|---|
| Estimated cash NOI | 40 |
| Assumed cap rate | 8% |
| Estimated value of operating real estate (40 / .08) | 500 |
| Plus: cash + accounts receivable | 50 |
| Less: debt and other liabilities | 250 |
| Net asset value | 300 |
| Shares outstanding | 10 |
| NAV / share | $30 |

The REIT share value using the net asset value approach is $30. (LOS 40.h)

4. **B** The value per share for this REIT using price-to-FFO valuation is computed as follows:

| | |
|---|---|
| Funds from operations (FFO) | $30 |
| Shares outstanding (millions) | 10 |
| FFO / share = $30 million / 10 million shares | $3 |

Applying the office subsector average P/FFO multiple of 12× yields a value per share of:

$$\$3 \times 12 = \$36$$

The REIT share value using the price-to-FFO approach is $36. (LOS 40.h)

5. **A** The value per share for this REIT using a price-to-AFFO valuation is computed as follows:

| | |
|---|---|
| Funds from operations (FFO) | $30 |
| Subtract: non-cash rents | $5 |
| Subtract: recurring maintenance-type capital expenditures | $10 |
| Equals: AFFO | $15 |
| Shares outstanding | 10 million |
| AFFO / share = $15 million / 10 million shares | $1.50 |
| Property subsector average P/AFFO multiple | 20× |

Applying the office subsector average P/AFFO multiple of 20× yields a value per share of $1.50 × 20 = $30.

The REIT share value using the price-to-AFFO approach is $30. (LOS 40.h)

6. **C** The value per share for this REIT using a discounted cash flow valuation is computed as follows:

| | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|
| Dividends per share: | $3.00 | $3.12 | $3.24 | $3.34 |

Present value in 2016 of dividends stream beginning in 2017 = $3.34 / (0.11 – 0.03) = $41.78

Present value of all dividends, when discounted at a rate of 11%

$$= PV_{2014\ \text{dividend}} + PV_{2015\ \text{dividend}} + PV_{2016\ \text{dividend}} + PV_{(\text{terminal value})}$$

$= \$3.00/(1.11) + \$3.12/(1.11)^2 + \$3.24/(1.11)^3 + \$41.78/(1.11)^3$

$= \$38.15$

The REIT share value using the discounted cash flow approach is $38.15. (LOS 40.h)

The following is a review of the Alternative Investments principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #41.

# READING 41: PRIVATE EQUITY VALUATION

**Study Session 15**

## EXAM FOCUS

This topic has a great deal of testable material, both conceptual and quantitative. For the exam, know the three sources of value creation in private equity. Know that, relative to buyouts, venture capital concerns companies that are immature and generally more risky. Understand that the drivers of return for buyouts are earnings growth, the increase in multiple upon exit, and the reduction in the debt; whereas for venture capital, it is the pre-money valuation, the investment, and potential subsequent equity dilution.

Be familiar with risks, costs, structure, and terms that are unique to private equity funds. Know how to calculate management fees, carried interest, NAV, DPI, RVPI, and TVPI of a private equity fund. Using both the NPV and IRR venture capital methods, be able to calculate ownership fraction, number of new shares issued, and the price per share for the new investment.

## MODULE 41.1: VALUATION ISSUES

Video covering this content is available online.

## BACKGROUND: PRIVATE EQUITY

Private equity is of increasing importance in the global economy. Private equity firms make investments ranging from investments in early stage companies (called a venture capital investment) to investments in mature companies (generally in a buyout transaction).

The following diagram may help you understand the private equity investment process.

**Figure 41.1:** The Typical Private Equity Investment Transaction

We will use the term *portfolio company* to denote the companies that private equity firms invest in. Portfolio companies are sometimes referred to as investee companies.

We will use the term **private equity firm (PE firm)** to denote the intermediary in the illustrated transaction.

We will use the term *private equity investor* to denote the outside investor who makes an investment in a fund offered by the PE firm.

In this review, we examine the perspective of both private equity firms evaluating investments in portfolio companies and the perspective of an outside investor who is evaluating an investment in a private equity firm.

**LOS 41.a: Explain sources of value creation in private equity.**

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

It is commonly believed that PE firms have the ability to add greater value to their portfolio companies than do publicly governed firms. The sources of this increased value are thought to come from the following:

1. The ability to re-engineer the portfolio company and operate it more efficiently.
2. The ability to obtain debt financing on more advantageous terms.
3. Superior alignment of interests between management and private equity ownership.

## Re-Engineering the Portfolio Company

In order to re-engineer their portfolio companies, many private equity firms have an in-house staff of experienced industry CEOs, CFOs, and other former senior executives. These executives can share their expertise and contacts with portfolio company management.

## Obtaining Favorable Debt Financing

A second source of added value is from more favorable terms on debt financing. During 2006 and the first half of 2007, the availability of cheap credit with few covenants led many private equity firms to use debt for buyout transactions. In PE firms, debt is more heavily utilized and is quoted as a multiple of EBITDA (earnings before interest, taxes, depreciation, and amortization) as opposed to a multiple of equity, as for public firms.

The central proposition of the Modigliani-Miller theorems is that the use of debt versus equity is inconsequential for firm value. However, once the assumption of no taxes is removed from their model, the tax savings from the use of debt (i.e., the interest tax shield) increases firm value. The use of greater amounts of financial leverage may increase firm value in the case of private equity firms. Because these firms have a reputation for efficient management and timely payment of debt interest, this helps to allay concerns over their highly leveraged positions and helps maintain their access to the debt markets.

**PROFESSOR'S NOTE**

The Modigliani-Miller theorems are discussed in detail in the corporate finance portion of the curriculum. In that corporate finance material, they are referred to as propositions.

The use of debt is thought to make private equity portfolio companies more efficient. According to this view, the requirement to make interest payments forces the portfolio companies to use free cash flow more efficiently because interest payments must be made on the debt.

Much of the debt financing for private equity firms comes from the syndicated loan market, but the debt is often repackaged and sold as collateralized loan obligations (CLOs). Private equity firms may also issue high-yield bonds which are repackaged as collateralized debt obligations (CDOs). These transactions have resulted in a large transfer of risk. However, the markets slowed beginning in 2007, creating less availability of financing for large buyouts.

A third source of value added for PE firms is the alignment of interests between private equity owners and the managers of the portfolio companies they own, as discussed in the next LOS.

**LOS 41.b: Explain how private equity firms align their interests with those of the managers of portfolio companies.**

*CFA® Program Curriculum, Volume 6, page 142*

In many private equity transactions, ownership and control are concentrated in the same hands. In buyout transactions, management often has a substantial stake in the company's equity. In many venture capital investments, the private equity firm offers advice and management expertise. The private equity firm can also gain increased control if the venture capital investee company does not meet specified targets.

In private equity firms, managers are able to focus more on long-term performance because, unlike public companies, private companies do not face the scrutiny of analysts, shareholders, and the broader market. This also allows the private equity firms to hire managers that are capable of substantial restructuring efforts.

## Control Mechanisms

Private equity firms use a variety of mechanisms to align the interests of the managers of portfolio companies with the private equity firm's interests. The following contract terms are contained in the **term sheet** that specifies the terms of the private equity firm's investment.

*Compensation*: Managers of the portfolio companies receive compensation that is closely linked to the company's performance, and the compensation contract contains clauses that promote the achievement of the firm's goals.

*Tag-along, drag-along clauses*: Anytime an acquirer acquires control of the company, they must extend the acquisition offer to all shareholders, including firm management.

*Board representation*: The private equity firm is ensured control through board representation if the portfolio company experiences a major event such as a takeover, restructuring, initial public offering (IPO), bankruptcy, or liquidation.

*Noncompete clauses*: Company founders must agree to clauses that prevent them from competing against the firm within a prespecified period of time.

*Priority in claims*: Private equity firms receive their distributions before other owners, often in the form of preferred dividends and sometimes specified as a multiple of their original investment. They also have priority on the company's assets if the portfolio company is liquidated.

*Required approvals*: Changes of strategic importance (e.g., acquisitions, divestitures, and changes in the business plan) must be approved by the private equity firm.

*Earn-outs*: These are used predominantly in venture capital investments. Earn-outs tie the acquisition price paid by the private equity firm to the portfolio company's future performance over a specified time period.

By specifying the appropriate control mechanisms in the investment contract, private equity firms can make investments in companies of considerable risk.

**LOS 41.c: Distinguish between the characteristics of buyout and venture capital investments.**

*CFA® Program Curriculum, Volume 6, page 145*

## Valuation Characteristics of Venture Capital vs. Buyout Investments

Venture capital and buyout are the two main forms of private equity investments. As previously noted, companies financed with venture capital are usually less mature than buyout targets. Venture capital firms usually have a specific industry focus, such as biotechnology, and emphasize revenue growth. When private equity firms make buyout purchases, the emphasis is on EBIT or EBITDA growth, and typically a portfolio of companies with stable earnings growth is purchased.

The following chart summarizes the key differences between venture capital and buyout investments.

**Figure 41.2:** Key Differences Between Venture Capital and Buyout Investments

| Characteristic | Venture Capital Investments | Buyout Investments |
|---|---|---|
| Cash Flows | Low predictability with potentially unrealistic projections | Stable and predictable cash flows |
| Product Market | New product market with uncertain future | Strong market position with a possible niche position |
| Products | Product is based on new technology with uncertain prospects | Established products |
| Asset Base | Weak | Substantial base that can serve as collateral |
| Management Team | New team although individual members typically have a strong entrepreneurial record | Strong and experienced |
| Financial Leverage | Low debt use with a majority of equity financing | High amounts of debt with a large percentage of senior debt and substantial amounts of junior and mezzanine debt |
| Risk Assessment | Risk is difficult to estimate due to new technologies, markets, and company history | Risk can be estimated due to industry and company maturity |
| Exit | Exit via IPO or company sale is difficult to forecast | Exit is predictable |
| Operations | High cash burn rate required due to company and product immaturity | Potential exists for reduction in inefficiencies |
| Working Capital Required | Increasing requirements due to growth | Low requirements |
| Due Diligence Performed by Private Equity Firms | Private equity firms investigate technological and commercial prospects; investigation of financials is limited due to short history | Private equity firms perform extensive due diligence |
| Goal Setting | | |

| | | |
|---|---|---|
| | Goals are milestones set in business plan and growth strategy | Goals reference cash flows, strategic plan, and business plan |
| Private Equity Investment Returns | High returns come from a few highly successful investments with writeoffs from less successful investments | Low variability in the success of investments with failures being rare |

**Figure 41.2:** Key Differences Between Venture Capital and Buyout Investments (continued)

| Characteristic | Venture Capital Investments | Buyout Investments |
|---|---|---|
| Capital Market Presence | Generally not active in capital markets | Active in capital markets |
| Sales Transactions | Most companies are sold as a result of the relationship between venture capital firm and entrepreneurs | Companies are typically sold in an auction-type process |
| Ability to Grow Through Subsequent Funding | Companies are less scalable as subsequent funding is typically smaller | Strong performers can increase subsequent funding amounts |
| Source of General Partner's Variable Revenue | Carried interest is most common, transaction and monitoring fees are less common | Carried interest, transaction fees, and monitoring fees |

Terms related to private equity, such as carried interest, and revenue of private equity general partners are discussed in greater detail in an upcoming LOS.

### PROFESSOR'S NOTE

Many of these characteristics can be more easily remembered if you keep in mind that, relative to companies acquired through buyout, venture capital portfolio companies are immature companies with risky prospects and cash flows. They require a great deal of funding but may have limited access to financing, especially debt. The returns on venture capital come from a small number of highly successful investments.

# GENERAL VALUATION ISSUES FOR PRIVATE EQUITY

Public companies are bought and sold on regulated exchanges daily. Private companies, however, are bought by buyers with specific interests at specific points in time, with each potential buyer possibly having a different valuation for the company. Furthermore, valuing a private company is more difficult than valuing public companies because, as discussed previously, PE firms often transform and reengineer the portfolio company such that future cash flow estimates are difficult to obtain.

## Private Equity Valuation Methodologies

There are six methodologies used to value private equity portfolio companies.

- **Discounted cash flow (DCF) analysis** is most appropriate for companies with a significant operating history because it requires an estimate of cash flows.
- A **relative value** or **market approach** applies a price multiple, such as the price-earnings ratio, against the company's earnings to get an estimate of the company's valuation. This approach requires predictable cash flows and a significant history.
- A third approach uses **real option analysis** and is applicable for immature companies with flexibility in their future strategies.

**PROFESSOR'S NOTE**

Real options are covered in more detail in the topic review on capital budgeting in Corporate Finance.

- The fourth approach uses the **replacement cost** of the business. It is generally not applicable to mature companies whose historical value added would be hard to estimate.
- The last two approaches, the **venture capital method** and the **leveraged buyout method**, are discussed at the end of this review.

## Other Considerations

Other considerations for valuing private equity portfolio companies are control premiums, country risk, and marketability and illiquidity discounts. In buyouts, the private equity investors typically have complete control. In venture capital investments, however, these investors usually have a minority position, and their control of the companies depends on the alignment of their interests with that of controlling shareholders. When valuing companies in emerging markets, country risk premiums may be added, thereby increasing the discount rate applied to the company's cash flows. Illiquidity and marketability discounts refer to the ability and right to sell the company's shares, respectively.

## Price Multiples

To value private equity portfolio companies, many investors use market data from similar publicly traded companies, most commonly the price multiples from comparable public companies. However, it is often difficult to find public companies at the same stage of development, same line of business, same capital structure, and same risk. A decision must also be made as to whether trailing or future earnings are used. For these reasons, a relative value or market approach should be used carefully.

## Discounted Cash Flow Analysis

Market data is also used with discounted cash flow (DCF) analysis, with beta and the cost of capital estimated from public companies while adjusting for differences in operating and financial leverage between the private and public comparables. In DCF analysis, an assumption must be made regarding the company's future value. Typically a terminal value (i.e., an exit value) is calculated using a price multiple of the company's EBITDA.

**PROFESSOR'S NOTE**

Adjusting beta for differences in operating and financial leverage between comparables is covered in more detail in the topic review on return concepts in the equity section of the curriculum.

Given the uncertainty associated with private companies, a variety of valuation techniques is typically applied to a range of different potential scenarios.

# BUYOUT VALUATION ISSUES

## Types of Buyouts

In a buyout transaction, the buyer acquires a controlling equity position in a target company. Buyouts include takeovers, management buyouts (MBOs), and leveraged buyouts (LBOs).

This review focuses on LBOs, in which a high amount of debt is used to finance a substantial portion of the acquisition. The financing of a LBO typically involves senior debt, junk bonds, equity, and mezzanine finance. Mezzanine finance is a hybrid between debt and equity and can be structured to suit each particular transaction.

## Leveraged Buyout (LBO)

The view of an LBO transaction, referred to as the LBO model, is not a form of valuation but rather a method of factoring in the company's capital structure and other parameters to determine the return the private equity firm should expect from the transaction. The objective is not to value the company but to determine the maximum price in negotiation that the private equity firm should pay for its stake.

## LBO Model

The LBO model has three main inputs:

1. The target company's forecasted cash flows.
2. The expected returns to the providers of the financing.
3. The total amount of financing.

The cash flow forecasts are provided by the target's management but scrutinized by the private equity firm. The exit date (when the target company is sold) is evaluated at different dates to determine its influence on the projected returns. The value of the company at that time is forecast using a relative value or market approach.

**LOS 41.d: Describe valuation issues in buyout and venture capital transactions.**

*CFA® Program Curriculum, Volume 6, page 146*

## Exit Value

The exit value can be viewed as:

| | | | | |
|---|---|---|---|---|
| investment cost | + earnings growth | + increase in price multiple | + reduction in debt | = exit value |

As previously mentioned, private equity firms are known for their reengineering and improved corporate governance of target companies, which should result in operational efficiencies and higher earnings growth. As a result, the target company should see an increase in price multiples and increased ability to pay down its debt. Each of the three variables should be examined using scenario analysis to determine the plausibility of their forecasted values and the forecasted exit value. One purpose for calculating the exit value is to determine the investment's internal rate of return sensitivity in the exit year.

**EXAMPLE: Calculating payoff multiples and IRRs for equity investors**

Suppose an LBO transaction is valued at $1,000 million and has the following characteristics (amounts are in millions of dollars):

- Exit occurs in five years at a projected multiple of 1.80 of the company's initial cost.
- It is financed with 60% debt and 40% equity.
- The $400 equity investment is composed of:
  - $310 in preference shares held by the private equity firm.

    - $80 in equity held by the private equity firm.
    - $10 in equity held by management equity participation (MEP).
- Preference shares are guaranteed a 14% compound annual return payable at exit.
- The equity of the private equity firm is promised 90% of the company's residual value at exit after creditors and preference shares are paid.
- Management equity receives the other 10% residual value.
- By exit, the company will have paid off $350 of the initial $600 in debt using operating cash flow.

Calculate the payoff for the company's claimants and the internal rate of return (IRR) and payoff multiple for the equity claimants.

**Answer:**

First calculate the exit value as: $1,000 × 1.8 = $1,800.

Next calculate the claimants' payoffs:

- *Debt*: The claim of debtholders is their initial investment minus the amount that has been paid down: $600 − $350 = $250.
- *Preference shares*: Earn a return of 14% so their claim is: $310 × $(1.14)^5$ = $596.88.
- *Private equity firm*: Receives 90% of the residual exit value: 0.90(1,800 − $250 − $596.88) = $857.81.
- *Management*: Receives 10% of the residual exit value: 0.10(1,800 − $250 − $596.88) = $95.31.

The total investment by the private equity firm is $310 + $80 = $390.

The total payoff is $596.88 + $857.81 = $1454.69.

The payoff multiple for the private equity firm is: 1454.69 / 390 = 3.7.

Using your TI BA II Plus, the IRR is calculated as:

PV = –$390; FV = $1454.69; N = 5; CPT I/Y ⇒ 30.1%.

For the management equity, the IRR is:

PV = –$10; FV = $95.31; N = 5; CPT I/Y ⇒ 57.0%.

The payoff multiple for the management equity program (MEP) is: 95.31 / 10 = 9.5.

In the example, the equity held by the private equity firm and management experiences a significant increase in value. The IRR for each is attractive at 30.1% and 57.0%, respectively.

The components of the return are:

- The return on the preference shares for the private equity firm.
- The increased multiple upon exit.
- The reduction in the debt claim.

In most LBOs, most of the debt is senior debt that will amortize over time. In the preceding example, the debtholders' claim on assets was reduced from $600 to $250. The use of debt in this example is advantageous and magnifies the returns to the equityholders. However, the use of debt also increases risk to the equityholders. Use of debt becomes disadvantageous if a company experiences difficulties and cannot make the payments on the debt. In this case, the equityholders could lose control of the company if it is forced into bankruptcy.

# VALUATION ISSUES IN VENTURE CAPITAL INVESTMENTS

## Pre- and Post-Money Valuation

The two fundamental concepts in venture capital investments are pre-money (PRE) valuation and post-money (POST) valuation. A private equity firm makes an investment (INV) in an

early-stage start-up company.

The post-money valuation of the investee company is:

PRE + INV = POST

The ownership proportion of the venture capital (VC) investor is:

= INV / POST

> **EXAMPLE: Calculating post-money valuation and proportional ownership**
>
> A company is valued at $3,000,000 prior to a capital infusion of $1,000,000 by a VC investor.
>
> **Answer:**
>
> The post-money valuation is:
>
> $3,000,000 + $1,000,000 = $4,000,000
>
> The ownership proportion of the VC investor is:
>
> = $1,000,000 / $4,000,000 = 25%

## Appropriate Methods for Venture Capital Valuation

The pre-money valuation and investment will be negotiated between the investee company and the VC investor. Additionally, the VC investor should keep in mind that his ownership could be diluted in the future due to future financing, conversion of convertible debt into equity, and the issuance of stock options to management.

As discussed previously, it is difficult to forecast the cash flows for a VC portfolio company. Therefore, discounted cash flow analysis (the income approach) is not usually used as the primary valuation method for VC companies. It is also difficult to use a relative value or market approach. This is because a VC company is often unique, and there may be no comparable companies to estimate a benchmark price multiple from. A replacement cost approach may also be difficult to apply. Alternative methodologies include real option analysis and the venture capital method, which will be addressed later in this review.

To estimate the pre-money valuation, the VC investor typically examines the company's intellectual property and capital, the potential for the company's products, and its intangible assets. Sometimes a cap (e.g., $3,000,000) is placed on the pre-money valuation due to its uncertain value.

# VALUATION ISSUES: BUYOUT VS. VENTURE CAPITAL

The following table highlights the different issues when valuing buyouts versus venture capital.

**Figure 41.3:** Valuation Issues for Buyouts vs. Venture Capital Investments

| Valuation Issue | Buyout | Venture Capital |
|---|---|---|
| Applicability of DCF Method | Frequently used to estimate value of equity | Less frequently used as cash flows are uncertain |
| Applicability of Relative Value | Used to check the value from DCF analysis | Difficult to use because there may be no truly comparable companies |

| | | |
|---|---|---|
| Approach | | |
| Use of Debt | High | Low as equity is dominant form of financing |
| Key Drivers of Equity Return | Earnings growth, increase in multiple upon exit, and reduction in the debt | Pre-money valuation, investment, and subsequent dilution |

### PROFESSOR'S NOTE

Valuation methodologies for buyouts need to factor in the level and pattern of leverage over the investment term. Initially, debt levels are high but are expected to decrease to "normal" levels by the time of exit. We address this issue near the end of this topic review.

### MODULE QUIZ 41.1

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

1. Which of the following is *least likely* a source of value creation in private equity firms?
   A. The use of debt with few covenants.
   B. The overutilization of cheap equity financing in private equity firms.
   C. The ability to reengineer companies through the use of an experienced staff of former senior managers.
2. Which of the following is *least likely* to be contained in a private equity term sheet?
   A. Tag-along, drag-along clauses.
   B. Earn-outs that ensure portfolio company manager compensation.
   C. A clause that ensures private equity firm representation on the portfolio company board.
3. Which of the following is *more likely* to be associated with a venture capital investment as compared to a buyout investment?
   A. Valuation using a discounted cash flow model.
   B. High cash burn rate.
   C. Due diligence covering all aspects of the business.
4. Which of the following is *most likely* to be a key driver for the equity return in a buyout opportunity?
   A. The pre-money valuation.
   B. The reduction in debt's claim on assets.
   C. The potential subsequent equity dilution.

# MODULE 41.2: EXIT ROUTES, COSTS, RISKS, AND FINANCIAL PERFORMANCE RATIOS

Video covering this content is available online.

**LOS 41.e: Explain alternative exit routes in private equity and their impact on value.**

*CFA® Program Curriculum, Volume 6, page 149*

## Types of Exit Routes

The exit value is a critical element in the return for the private equity firm and is considered carefully before the investment is undertaken. The means and timing of the exit strongly influence the exit value. There are four exit routes that private equity firms typically use: (1) an initial public offering (IPO), (2) secondary market sale, (3) management buyout (MBO), and (4) liquidation.

## Initial Public Offering (IPO)

In an IPO, a company's equity is offered for public sale. An IPO usually results in the highest exit value due to increased liquidity, greater access to capital, and the potential to hire better quality managers. However, an IPO is less flexible, more costly, and a more cumbersome process than the other alternatives.

IPOs are most appropriate for companies with strong growth prospects and a significant operating history and size. The timing of an IPO is key. After the bursting of the U.S. tech bubble in 2000, the IPO market withered and venture capital firms had to find other means of exit.

## Secondary Market Sale

In a secondary market sale, the company is sold to another investor or to another company interested in the purchase for strategic reasons (e.g., a company in the same industry wishes to expand its market share). Secondary market sales from one investor to another are quite frequent, especially in the case of buyouts. VC portfolio companies are sometimes exited via a buyout to another firm, but VC companies are usually too immature to support a large amount of debt. Secondary market sales result in the second highest company valuations after IPOs.

## Management Buyout (MBO)

In an MBO, the company is sold to management, who utilize a large amount of leverage. Although management will have a strong interest in the subsequent success of the company, the resulting high leverage may limit management's flexibility.

## Liquidation

Liquidation, the outright sale of the company's assets, is pursued when the company is deemed no longer viable and usually results in a low value. There is potential for negative publicity as a result of displaced employees and from the obvious implications of the company's failure to reach its objectives.

## Exit Timing

The timing of the exit is also very important for company value, and the private equity firm should be flexible in this regard. For example, if a portfolio company cannot be sold due to weak capital markets, the private equity firm may want to consider buying another portfolio company at depressed prices, merging the two companies, and waiting until capital market conditions improve to sell both portfolio companies as one.

When an exit is anticipated in the next year or two, the exit valuation multiple can be forecasted without too much error. Beyond this time horizon, however, exit multiples become much more uncertain and stress testing should be performed on a wide range of possible values.

**PROFESSOR'S NOTE**

Don't lose sight of the purpose of valuation: (1) to assess the ability of the portfolio company to generate cash flow and (2) to represent a benchmark for negotiations.

**LOS 41.f: Explain private equity fund structures, terms, valuation, and due diligence in the context of an analysis of private equity fund returns.**

## Limited Partnership

The most common form of ownership structure for private equity funds is the limited partnership. In a limited partnership, the **limited partners (LPs)** provide funding and do not have an active role in the management of the investments. Their liability is limited to what they have invested (i.e., they cannot be held liable for any amount beyond their investment in the fund). The **general partner (GP)** in a limited partnership is liable for all the firm's debts and, thus, has unlimited liability. The GP is the manager of the fund.

Another form of private equity fund structure is the company limited by shares. It offers better legal protection to the partners, depending on the jurisdiction. Most fund structures are closed end, meaning that investors can only redeem the investment at specified time periods.

Private equity firms must both raise funds and manage the investment of those funds. The private equity firm usually spends a year or two raising funds. Funds are then drawn down for investment, after which returns are realized. Most private equity funds last 10 to 12 years but can have their life extended another 2 to 3 years.

## Private Equity Fund Terms

As mentioned previously, private equity investments are often only available to qualified investors, the definition of which depends on the jurisdiction. In the United States, the individual must have at least $1 million in assets.

The terms in a fund prospectus are a result of negotiation between the GP and the LPs. If the fund is oversubscribed (i.e., has more prospective investors than needed), the GP has greater negotiating power.

The terms of the fund should be focused towards aligning the interests of the GP and LPs and specifying the compensation of the GP. The most important terms can be categorized into economic and corporate governance terms.

## Economic Terms of a Private Equity Fund

*Management fees*: These are fees paid to the GP on an annual basis as a percent of committed capital and are commonly 2%. Management fees could instead be based on NAV or paid-in capital.

*Transaction fees*: These are paid by third parties to the GP in their advisory capacity (e.g., for investment banking services, such as arranging a merger). These fees are usually split evenly with the LPs and, when received, are deducted from management fees.

*Carried interest/performance fees*: This is the GP's share of the fund profits and is usually 20% of profits (after management fees).

*Ratchet*: This specifies the allocation of equity between stockholders and management of the portfolio company and allows management to increase their allocation, depending on company performance.

*Hurdle rate*: This is the IRR that the fund must meet before the GP can receive carried interest. It usually varies from 7% to 10% and incentivizes the GP.

*Target fund size*: The stated total maximum size of the PE fund, specified as an absolute figure. It signals the GP's ability to manage and raise capital for a fund. It is a negative signal if actual funds ultimately raised are significantly lower than targeted.

*Vintage*: This is the year the fund was started and facilitates performance comparisons with other funds.

*Term of the fund*: As discussed previously, this is the life of the firm and is usually ten years.

**PROFESSOR'S NOTE**

There are several "capital" terms used throughout this reading. Committed capital is the amount of funds promised by investors to private equity funds. Paid-in capital is the amount of funds actually received from investors (also referred to as invested capital in this reading).

**EXAMPLE: Calculating carried interest with a hurdle rate**

Suppose a fund has committed capital of $100 million, carried interest of 20%, and a hurdle rate of 9%. The firm called 80% of its commitments in the beginning of Year 1. Of this, $50 million was invested in Company A and $30 million in Company B.

At the end of Year 2, a $7 million profit is realized on the exit from Company A. The investment in Company B is unchanged. The carried interest is calculated on a deal-by-deal basis (i.e., the IRR for determining carried interest is calculated for each deal upon exit).

Determine the theoretical carried interest and the actual carried interest.

**Answer:**

The theoretical carried interest is: 20% × $7,000,000 = $1,400,000.

The IRR for Company A is: PV = –$50; FV = $57; N = 2; CPT I/Y ⇒ 6.8%.

Because the 6.8% IRR is less than the hurdle rate of 9%, no carried interest is actually paid.

## Corporate Governance Terms of a Private Equity Fund

The corporate governance terms in the prospectus provide the legal arrangements for the control of the fund and include the following:

*Key man clause*: If a key named executive leaves the fund or does not spend a sufficient amount of time at the fund, the GP may be prohibited from making additional investments until another key executive is selected.

*Performance disclosure and confidentiality*: This specifies the fund performance information that can be disclosed. Note that the performance information for underlying portfolio companies is typically not disclosed.

*Clawback*: If a fund is profitable early in its life, the GP receives compensation from the GP's contractually defined share of profits. Under a clawback provision, if the fund subsequently underperforms, the GP is required to pay back a portion of the early profits to the LPs. The clawback provision is usually settled at termination of the fund but can also be settled annually (also known as true-up).

*Distribution waterfall*: This provision specifies the method in which profits will flow to the LPs and when the GP receives carried interest. Two methods are commonly used. In a deal-by-deal method, carried interest can be distributed after each individual deal. The disadvantage of this method from the LPs' perspective is that one deal could earn $10 million

and another could lose $10 million, but the GP will receive carried interest on the first deal, even though the LPs have not earned an overall positive return.

In the total return method, carried interest is calculated on the entire portfolio. There are two variants of the total return method: (1) carried interest can be paid only after the entire *committed* capital is returned to LPs; or (2) carried interest can be paid when the value of the portfolio exceeds *invested* capital by some minimum amount (typically 20%). Notice that the former uses committed capital whereas the latter uses only the capital actually invested.

*Tag-along, drag-along clauses*: Anytime an acquirer acquires control of the company, they must extend the acquisition offer to all shareholders, including firm management.

*No-fault divorce*: This clause allows a GP to be fired if a supermajority (usually 75% or more) of the LPs agree to do so.

*Removal for cause*: This provision allows for the firing of the GP or the termination of a fund given sufficient cause (e.g., a material breach of fund prospectus).

*Investment restrictions*: These specify leverage limits, a minimum amount of diversification, etc.

*Co-investment*: This provision allows the LPs to invest in other funds of the GP at low or no management fees. This provides the GP another source of funds. The provision also prevents the GP from using capital from different funds to invest in the same portfolio company. A conflict of interest would arise if the GP takes capital from one fund to invest in a troubled company that had received capital earlier from another fund.

**EXAMPLE: Applying distribution waterfalls methods**

Suppose a fund has committed capital of $100 million and carried interest of 20%. An investment of $40 million is made. Later in the year, the fund exits the investment and earns a profit of $22 million.

Determine whether the GP receives any carried interest under the three distribution waterfall methods.

**Answer:**

In the deal-by-deal method, carried interest can be distributed after each individual deal, so carried interest of 20% × $22,000,000 = $4,400,000 is paid to the GP.

In the total return method #1, carried interest can be paid only after the portfolio value exceeds *committed* capital. Committed capital is $100 million and total proceeds from the exit are only $62 million, so no carried interest is paid.

In the total return method #2, carried interest can be paid when the value of the portfolio exceeds *invested* capital by some minimum amount (typically 20%).

Invested capital plus the 20% threshold is: $40,000,000 × 1.20 = $48 million.

The total proceeds from the exit are $62 million, so carried interest of $4,400,000 is paid to the GP.

**EXAMPLE: Applying clawback provision methods**

Continuing with the previous example, suppose that in the second year, another investment of $25 million is exited and results in a loss of $4 million. Assume the deal-by-deal method and a clawback with annual true-up apply.

Determine whether the GP must return any former profits to the LPs.

**Answer:**

In the deal-by-deal method, the GP had received carried interest of $4,400,000.

With a subsequent loss of $4 million, the GP owes the LPs 20% of the loss:

> 20% × $4,000,000 = $800,000

# NET ASSET VALUE (NAV)

Because there is no ready secondary market for private equity investments, they are difficult to value. In a prospectus, however, the valuation is related to the fund's net asset value (NAV), which is the value of fund assets minus liabilities.

## Ways to Determine NAV

The assets are valued by the GP in one of six ways:

1. At cost, adjusting for subsequent financing and devaluation.
2. At the minimum of cost or market value.
3. By revaluing a portfolio company anytime there is new financing.
4. At cost, with no adjustment until exit.
5. By using a discount factor for restricted securities (e.g., those that can only be sold to qualified investors).
6. Less frequently, by applying illiquidity discounts to values based on those of comparable publicly traded companies.

## Issues in Calculating NAV

There are several issues with calculating NAV for a private equity fund:

- First, if the NAV is only adjusted when there are subsequent rounds of financing, then the NAV will be more stale when financings are infrequent.
- Second, there is no definitive method for calculating NAV for a private equity fund because the market value of portfolio companies is usually not certain until exit.
- Third, undrawn LP capital commitments are not included in the NAV calculation but are essentially liabilities for the LP. The value of the commitments depends on the cash flows generated from them, but these are quite uncertain. When a GP has trouble raising funds, this implies that the value of these commitments is low.
- Fourth, the investor should be aware that funds with different strategies and maturities may use different valuation methodologies. In the early stages, a venture capital investment is typically valued at cost. In the later stages, a method based on comparables may be used. Mature funds may use market comparables for their investments that are near exit. Asset price bubbles would inflate the value of these companies.
- Finally, it is usually the GP who values the fund. LPs are increasingly using third parties to value private equity funds.

## Due Diligence of Private Equity Fund Investments

Before investing, outside investors should conduct a thorough due diligence of a private equity fund due to the following characteristics:

- First, private equity funds have returns that tend to persist. Hence, a fund's past performance is useful information. In other words, outperformers tend to keep outperforming and underperformers tend to keep underperforming or go out of business.
- Second, the return discrepancy between outperformers and underperformers is very large and can be as much as 20%.
- Third, private equity investments are usually illiquid, long-term investments. The duration of a private equity investment, however, is usually shorter than expected because when a portfolio company is exited, the funds are immediately returned to the fund investors.

**LOS 41.g: Explain risks and costs of investing in private equity.**

*CFA® Program Curriculum, Volume 6, page 156*

## Post-Investment Investor Expectations

Once an investment is made by a private equity firm, the outside investors in the private equity fund expect to be apprised of the firm's performance. The following material now takes the perspective of this outside investor.

There are two important differences between investing in public equity and in a private equity fund. First, funds are committed in the private investments and later drawn down as capital is invested in portfolio companies. In a public firm, the committed capital is usually immediately deployed. Second, the returns on a private equity investment typically follow a J-Curve pattern through time. Initially, returns are negative but then turn positive as portfolio companies are sold at exit.

Private equity investments are usually regulated such that they are only available to "qualified" investors, usually defined as institutions and wealthy individuals. These regulations exist because of the high risks associated with private equity investing, which are disclosed in the private equity prospectus.

## Risks of Investing in Private Equity

Classifying private equity risks broadly, the categories of private equity risk are general private equity risk (discussed in the following), risks specific to the investment strategy, industry risks, risks specific to the investment vehicle, and any regional or country risk.

## General Risk Factors

The general private equity risk factors are as follows:

*Liquidity risk*: Because private equity investments are not publicly traded, it may be difficult to liquidate a position.

*Unquoted investments risk*: Because private equity investments do not have a publicly quoted price, they may be riskier than publicly traded securities.

*Competitive environment risk*: The competition for finding reasonably-priced private equity investments may be high.

*Agency risk*: The managers of private equity portfolio companies may not act in the best interests of the private equity firm and investors.

*Capital risk*: Increases in business and financial risks may result in a withdrawal of capital. Additionally, portfolio companies may find that subsequent rounds of financing are difficult to obtain.

*Regulatory risk*: The portfolio companies' products and services may be adversely affected by government regulation.

*Tax risk*: The tax treatment of investment returns may change over time.

*Valuation risk*: The valuation of private equity investments reflects subjective, not independent, judgment.

*Diversification risk*: Private equity investments may be poorly diversified, so investors should diversify across investment development stage, vintage, and strategy of private equity funds.

*Market risk*: Private equity is subject to long-term changes in interest rates, exchange rates, and other market risks. Short-term changes are usually not significant risk factors.

## Costs of Private Equity Investing

The costs of investing in private equity are significantly higher than that with publicly traded securities and include the following:

*Transaction costs*: These costs include those from due diligence, bank financing, legal fees from acquisitions, and sales transactions in portfolio companies.

*Investment vehicle fund setup costs*: The legal and other costs of setting up the fund are usually amortized over the life of the fund.

*Administrative costs*: These are charged on a yearly basis and include custodian, transfer agent, and accounting costs.

*Audit costs*: These are fixed and charged annually.

*Management and performance costs*: These are typically higher than that for other investments and are commonly 2% for the management fee and a 20% fee for performance.

*Dilution costs*: As discussed previously, additional rounds of financing and stock options granted to portfolio company management will result in dilution. This is also true for options issued to the private equity firm.

*Placement fees*: Placement agents who raise funds for private equity firms may charge up-front fees as much as 2% or annual trailer fees as a percent of funds raised through limited partners.

**PROFESSOR'S NOTE**

A trailer fee is the compensation paid by the fund manager to the person selling the fund to investors.

**LOS 41.h: Interpret and compare financial performance of private equity funds from the perspective of an investor.**

# INTERNAL RATE OF RETURN (IRR)

The return metric recommended for private equity by the Global Investment Performance Standards (GIPS) is the IRR. The IRR is a cash-weighted (money-weighted) return measure. Although the private equity fund portfolio companies are actually illiquid, IRR assumes intermediate cash flows are reinvested at the IRR. Therefore, the IRR calculation should be interpreted cautiously.

## Gross IRR

The IRR can be calculated gross or net of fees. Gross IRR reflects the fund's ability to generate a return from portfolio companies and is the relevant measure for the cash flows between the fund and portfolio companies.

## Net IRR

Net IRR can differ substantially from Gross IRR because it is net of management fees, carried interest, and other compensation to the GP. Net IRR is the relevant measure for the cash flows between the fund and LPs and is therefore the relevant return metric for the LPs.

# MULTIPLES

Multiples are also used to evaluate fund performance. Multiples are a popular tool of LPs due to their simplicity, ease of use, and ability to differentiate between realized and unrealized returns. Multiples, however, ignore the time value of money.

## Quantitative Measures

The more popular multiples and those specified by GIPS include the following:

**PIC (paid-in capital).** This is the capital utilized by the GP. It can be specified in percentage terms as the paid-in capital to date divided by the committed capital. Alternatively, it can be specified in absolute terms as the cumulative capital utilized or called down.

**DPI (distributed to paid-in capital).** This measures the LP's realized return and is the cumulative distributions paid to the LPs divided by the cumulative invested capital. It is net of management fees and carried interest. DPI is also referred to as the cash-on-cash return.

**RVPI (residual value to paid-in capital).** This measures the LP's unrealized return and is the value of the LP's holdings in the fund divided by the cumulative invested capital. It is net of management fees and carried interest.

**TVPI (total value to paid-in capital).** This measures the LP's realized and unrealized return and is the sum of DPI and RVPI. It is net of management fees and carried interest.

## Qualitative Measures

In addition to quantitative analysis of the fund, the investor should also analyze qualitative aspects of the fund, including the following:

- The realized investments, with an evaluation of successes and failures.
- The unrealized investments, with an evaluation of exit horizons and potential problems.

- Cash flow projections at the fund and portfolio company level.
- Fund valuation, NAV, and financial statements.

As an example, consider a fund that was started before the financial market collapse of 2007. If the RVPI is large relative to the DPI, this indicates that the firm has not successfully harvested many of its investments and that the fund may have an extended J-curve (it is taking longer than realized to earn a positive return on its investments). The investor should carefully examine the GP's valuations of the remaining portfolio companies, potential write-offs, and whether the routes for future exit have dried up.

## Benchmarks

The benchmarking of private equity investments can be challenging. Private equity funds vary substantially from one to another; so before performance evaluation is performed, the investor should have a good understanding of the fund's structures, terms, valuation, and the results of due diligence. Because there are cyclical trends in IRR returns, the Net IRR should be benchmarked against a peer group of comparable private equity funds of the same vintage and strategy.

**PROFESSOR'S NOTE**

The vintage refers to the year the fund was set up.

Note also that the private equity IRR is cash flow weighted whereas most other asset class index returns are time weighted. One solution to this problem has been to convert publicly traded equity benchmark returns to cash weighted returns using the cash flow patterns of private equity funds. This method, however, has some significant limitations.

**EXAMPLE: Comparing the financial performance of private equity funds**

Two private equity funds, Fund A and Fund B, are being considered by an investor.

**Financial Performance of Private Equity Fund A and Fund B**

| | Fund A | Fund B |
|---|---|---|
| Gross IRR | 22.1% | 2.4% |
| Net IRR | 17.6% | –0.3% |
| Performance quartile | 1 | 3 |
| DPI | 1.43 | 0.29 |
| RVPI | 1.52 | 1.03 |
| TVPI | 2.95 | 1.32 |
| Maturity of fund | 6 years | 4 years |

Interpret and compare the financial performance of private equity funds A and B.

**Answer:**

Examining its DPI, Fund A has distributed $1.43 in return for every dollar invested. Additionally, the RVPI implies that it will return $1.52 as other investments are harvested. Its Gross IRR of 22.1% is attractive, and after fees, the Net IRR is 17.6%. The fund ranks in the first quartile in its peer group of the same strategy and vintage.

At four years, Fund B is a less mature fund than Fund A. Fund B's DPI is 0.29, indicating that the realized returns for the fund are not substantial. Unrealized returns (RVPI) indicate that its investments not yet harvested should provide an additional return. The low Gross and Net IRRs indicate that the firm may still be affected by the J-curve, where a fund experiences initial losses before experiencing later profits. Currently, the firm is lagging its peers, as it ranks in the third quartile.

Note that in this illustrative example, we compared two funds of different maturities. As noted, a fund should be benchmarked against peers of the same vintage.

## MODULE QUIZ 41.2

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

1. Which of the following exit routes typically results in the highest exit valuation?
   A. An initial public offering.
   B. A management buyout.
   C. A secondary market sale.
2. Which of the following *best* describes the competitive environment risk of investing in private equity?
   A. The competition for finding reasonably priced private equity investments may be high.
   B. The competition for funds from private equity investors has increased as financial markets have fallen in activity.
   C. The competitive environment in the product markets for portfolio companies has increased due to the economic slowdown.
3. Which of the following *best* describes the placement fee cost of investing in private equity?
   A. The general partner may charge the fund fees for finding prospective portfolio companies.
   B. Investment banking fees are paid when exiting a private equity portfolio company via an IPO.
   C. Placement agents who raise funds for private equity firms may charge up-front or annual trailer fees.
4. What is the most typical organizational structure of a private equity investment?
   A. An S-corporation.
   B. A limited partnership.
   C. A sole proprietorship.
5. A private equity general partner has invested in portfolio Company A that has been funded by private equity Fund A. Portfolio Company A is experiencing financial difficulty, so the general partner uses funds from a newly formed private equity fund, Fund B, to assist the company. Which of the following terms in the private equity prospectus has the general partner *most likely* violated?
   A. The co-investment clause.
   B. The no-fault divorce clause.
   C. The tag-along, drag-along clause.
6. Using the information in the following table, which of the following firms *likely* has the best corporate governance system?
   A. Firm A.
   B. Firm B.
   C. Firm C.

| | Firm A | Firm B | Firm C |
|---|---|---|---|
| Key Man Clause | Yes | Yes | No |
| Management Fees | 1.5% | 2.0% | 2.3% |
| Transaction Fees | The split between LPs and GP is 50/50 | The split between LPs and GP is 50/50 | GP share is 100% |
| Carried Interest | 25% | 20% | 22% |
| Hurdle Rate | 10% | 8% | 9% |
| Clawback Provision | Yes | Yes | No |
| Distribution Waterfall | Total return | Total return | Deal-by-deal |
| Removal for Cause Clause | Yes | No | No |

7. Which of the following *best* describes the method that most private equity funds use to incorporate undrawn capital commitments into NAV calculations?
   A. The GP uses public comparables to determine their value.
   B. There is no straightforward method for calculating the value of the commitments.
   C. The GP estimates the net present value of the capital commitments using the historical record of previous allocations to the portfolio companies.

# MODULE 41.3: FEE AND DISTRIBUTION CALCULATIONS

## LOS 41.i: Calculate management fees, carried interest, net asset value, distributed to paid in (DPI), residual value to paid in (RVPI), and total value to paid in (TVPI) of a private equity fund.

Video covering this content is available online.

*CFA® Program Curriculum, Volume 6, page 161*

In this section, we calculate the quantitative measures previously discussed using an example.

**EXAMPLE: Calculating performance measures**

The GP for private equity Fund C charges a management fee of 2% of paid-in-capital and carried interest of 20%, using the first total return method (i.e., carried interest is paid only when the value of the investment portfolio exceeds committed capital). The total committed capital for the fund was $150 million. The statistics for years 2011–2016 are shown in the following table (in millions).

**Cash Flows for Private Equity Fund C**

| | Capital Called Down | Paid-in Capital | Management Fees | Operating Results | NAV before Distributions | Carried Interest | Distributions | NAV after Distributions |
|---|---|---|---|---|---|---|---|---|
| 2011 | 50 | 50 | 1.0 | –10 | 39.0 | | | 39.0 |
| 2012 | 20 | 70 | 1.4 | –25 | 32.6 | | | 32.6 |
| 2013 | 30 | 100 | 2.0 | 25 | 85.6 | | | 85.6 |
| 2014 | 20 | 120 | 2.4 | 50 | 153.2 | 0.6 | 20 | 132.6 |
| 2015 | 10 | 130 | 2.6 | 60 | 200.0 | 9.4 | 40 | 150.6 |
| 2016 | 10 | 140 | 2.8 | 110 | 267.8 | 13.6 | 80 | 174.2 |

## PROFESSOR'S NOTE

In the table, assume the capital called down, operating results, and distributions were given. The other statistics can be calculated.

Calculate the management fees, carried interest, NAV before distributions, NAV after distributions, distributed to paid in (DPI), residual value to paid in (RVPI), and total value to paid in (TVPI) of private equity Fund C.

**Answer:**

*Paid-in capital*: This is just the cumulative sum of the capital called down. For example, in 2012, it is the sum of the capital called down in 2011 and 2012: \$50 + \$20 = \$70.

*Management fees*: In each year, these are calculated as the percentage fee (here 2%) multiplied by the paid-in capital. For example, in 2012, it is 2% × \$70 = \$1.4.

*Carried interest*: Carried interest is not paid until the GP generates realized and unrealized returns (as reflected in the NAV before distributions) greater than the committed capital of \$150.

In 2014, the NAV before distributions exceeded the committed capital for the first time. In this first year, the carried interest is 20% multiplied by the NAV before distributions minus the committed capital: 20% × (\$153.2 − \$150) = \$0.6.

In subsequent years, it is calculated using the increase in the NAV before distributions. For example, in 2015, it is: 20% × (\$200 − \$153.2) = \$9.4.

*NAV before distributions*: These are calculated as

= NAV after distributions in prior year + capital called down – management fees + operating results

For example in 2015, NAV before distributions is: \$132.6 + \$10 − \$2.6 + \$60 = \$200.

*NAV after distributions*: These are calculated as:

= NAV before distributions – carried interest – distributions

For example in 2015, NAV after distributions is: \$200 − \$9.40 − \$40 = \$150.60.

For DPI, RVPI, and TVPI, we will calculate these as of the most recent year (2016):

*DPI*: The DPI multiple is calculated as the cumulative distributions divided by the paid-in capital: (\$20 + \$40 + \$80) / \$140 = 1.0. This indicates that, in terms of distributed returns, the fund has returned every dollar invested.

*RVPI*: The RVPI multiple is calculated as the NAV after distributions (i.e., the net non-distributed value of the fund) divided by the paid-in capital: \$174.2 / \$140 = 1.24. This indicates that, although the distributed returns are not impressive for this fund, the fund has unrealized profits that should accrue to the LPs as investments are harvested.

*TVPI*: The TVPI multiple is the sum of the DPI and RVPI: 1.0 + 1.24 = 2.24. This indicates that on a realized and unrealized basis, the GP has more than doubled the investment of the LPs.

## MODULE QUIZ 41.3

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

1. Which of the following measures the limited partner's unrealized return in a private equity fund?
   A. The DPI.
   B. The RVPI.
   C. The TVPI.

## PROFESSOR'S NOTE

From this point on, the remainder of the module quizzes in this reading are multi-part questions where questions "nest" on each other—meaning that you need the answer to one question to complete the next. It is unlikely you will encounter this situation on the exam. We recommend that after you complete a question, you check your answer to ensure that you begin the next question with the correct information.

**Use the following information to answer Questions 2 through 10.**

The GP for the private equity fund charges a management fee of 2% and carried interest of 20%, using the first total return method. The total committed capital for the fund was $200 million. The figures in the table are in millions.

| | Capital Called Down | Paid-in Capital | Management Fees | Operating Results | NAV Before Distributions |
|---|---|---|---|---|---|
| 2011 | 60 | 60 | 1.2 | −15 | 43.8 |
| 2012 | 20 | 80 | 1.6 | −20 | 42.2 |
| 2013 | 10 | 90 | 1.8 | 30 | 80.4 |
| 2014 | 20 | 110 | 2.2 | 50 | 148.2 |
| 2015 | 25 | 135 | 2.7 | 70 | 210.5 |
| 2016 | 10 | ? | ? | 120 | ? |

| | Carried Interest | Distributions | NAV After Distributions |
|---|---|---|---|
| 2011 | ? | | 43.8 |
| 2012 | ? | | 42.2 |
| 2013 | ? | | 80.4 |
| 2014 | ? | 30 | 118.2 |
| 2015 | ? | 50 | 158.4 |
| 2016 | ? | 90 | ? |

2. What is the paid-in capital for 2016?
   A. $125.
   B. $142.
   C. $145.
3. What are the management fees for 2016?
   A. $2.7.
   B. $2.9.
   C. $15.4.
4. In what year is carried interest first paid?
   A. 2014.

B. 2015.
C. 2016.

5. What is the NAV before distributions for 2016?
   A. $275.50.
   B. $285.50.
   C. $288.40.
6. What is the carried interest for 2016?
   A. $2.9.
   B. $15.0.
   C. $17.9.
7. What is the NAV after distributions for 2016?
   A. $180.50.
   B. $195.50.
   C. $270.50.
8. What is the DPI after 2016?
   A. 0.62.
   B. 0.83.
   C. 1.17.
9. What is the RVPI after 2016?
   A. 1.24.
   B. 1.35.
   C. 1.97.
10. What is the TVPI after 2016?
    A. 1.76.
    B. 2.41.
    C. 3.14.

## MODULE 41.4: VENTURE CAPITAL FUNDING—SINGLE ROUND

Video covering this content is available online.

### LOS 41.j: Calculate pre-money valuation, post-money valuation, ownership fraction, and price per share applying the venture capital method 1) with single and multiple financing rounds and 2) in terms of IRR.

*CFA® Program Curriculum, Volume 6, page 166*

Here, we describe the valuation of an investment in an existing company using the **venture capital** (VC) **method**.

At the time of a new investment in the company, the discounted present value of the estimated exit value, PV(exit value), is called the **post-money value** (after the investment is made). The value before the investment is made can be calculated as the post-money value minus the investment amount and is called the **pre-money value**.

POST = PV(exit value)

PRE = POST – INV

In order to determine the number of new shares issued to the venture capital firm ($\text{shares}_{VC}$) for an investment in an existing company, we need to determine the fraction of the company value (after the investment is made) that the investment represents. Based on the expected future value of the company (exit value) and the expected or required rate of return on the investment, we can do this in either of two ways with the same result.

The fraction of VC ownership (*f* ) for the VC investment can be computed as:

The first method (**NPV method**):

$$f = \frac{\text{INV}}{\text{POST}}$$

where:
INV = amount of new investment for the venture capital investment.
POS = post-money value after the investment.
$\text{POST} = \frac{\text{exit value}}{(1+r)^n}$

The second method (**IRR method**):

$$f = \frac{\text{FV(INV)}}{\text{exit value}}$$

where:
FV(INV) = future value of the investment in round 1 at the expected exit date.
exit value = value of the company upon exit.

As long as the same compound rate is used to calculate the present value of the exit value and to calculate the future value of the VC investment, the fractional ownership required (*f* ) is the same under either method.

Once we have calculated *f*, we can calculate the number of shares issued to the VC ($\text{shares}_{\text{VC}}$) based on the number of existing shares owned by the company founders prior to investment ($\text{shares}_{\text{Founders}}$).

$$\text{shares}_{\text{VC}} = \text{shares}_{\text{Founders}} \left(\frac{f}{1-f}\right)$$

The price per share at the time of the investment (price) is then simply the amount of the investment divided by the number of new shares issued.

$$\text{price} = \frac{\text{INV}}{\text{shares}_{\text{VC}}}$$

**EXAMPLE: Calculations using the NPV venture capital method and a single financing round**

Ponder Technologies is a biotech company. Ponder's entrepreneur founders believe they can sell the company for $40 million in five years. They need $5 million in capital now, and the entrepreneurs currently hold 1 million shares.

The venture capital firm, VC Investors, decides that given the high risk of this company, a discount rate of 40% is appropriate.

Calculate the pre-money valuation, post-money valuation, ownership fraction, and price per share applying the NPV venture capital method with a single financing round.

**Answer:**

*Step 1*: The post-money (POST) valuation is the present value of the expected exit value (this assumes the investment was made in the company):

$$\text{POST} = \frac{40{,}000{,}000}{(1+0.40)^5} = 7,437,377$$

*Step 2*: The pre-money (PRE) valuation is what the company would hypothetically be worth without the investment:

PRE = 7,437,377 – 5,000,000 = 2,437,377

*Step 3*: To put $5 million in a company worth $7.4 million, the private equity firm must own 67.23% of the company:

$$f = \frac{5{,}000{,}000}{7{,}437{,}377} = 67.23\%$$

Note that under the IRR method, *f* is the same:

$$f = \frac{5 \text{ million}\left(1.40^5\right)}{40 \text{ million}} = 67.23\%$$

*Step 4*: If the entrepreneurs want 1 million shares, the private equity firm must get 2.05 million shares to get 67.23% ownership:

$$\mathrm{S_{VC}} = 1{,}000{,}000\left[\frac{0.6723}{(1-0.6723)}\right] = 2{,}051{,}572$$

*Step 5*: Given a $5 million investment and 2.05 million shares, the stock price per share (P) must be:

$$\mathrm{P} = \frac{5{,}000{,}000}{2{,}051{,}572} = \$2.44 \text{ per share}$$

## MODULE QUIZ 41.4

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

**Use the following information to answer Questions 1 through 5.**

ScaleIt is a startup specializing in mobile applications. The company's founders believe they can sell the company for $50 million in four years. They need $7 million in capital now, and the founders wish to hold 1 million shares. The venture capital investor firm decides that, given the high risk of this company, a discount rate of 45% is appropriate. Use the NPV venture capital method, assuming a single financing round.

1. What is the post-money valuation?
   A. $4,310,922.
   B. $11,310,922.
   C. $50,000,000.
2. What is the pre-money valuation?
   A. $4,310,922.
   B. $7,310,922.
   C. $43,000,000.
3. What is the ownership fraction for the venture capital firm?
   A. 14.00%.
   B. 38.11%.
   C. 61.89%.
4. What is the number of shares for the venture capital firm?
   A. 615,846.
   B. 1,623,983.
   C. 2,603,078.
5. What is the stock price per share?
   A. $2.69.
   B. $4.31.
   C. $11.37.

**Use the following information to answer Questions 6 through 9.**

The venture capital company's founders believe they can sell the company for $70 million in five years. They need $9 million in capital now, and the entrepreneurs wish to hold 1 million shares. The venture capital investor requires a return of 35%. Use the IRR venture capital method,

assuming a single financing round.

6. What is the investor's ownership fraction?
   A. 12.86%.
   B. 42.35%.
   C. 57.65%.
7. What is the stock price per share?
   A. $2.39.
   B. $6.61.
   C. $12.25.
8. What is the post-money valuation?
   A. $6.61 million.
   B. $15.61 million.
   C. $70.00 million.
9. What is the pre-money valuation?
   A. $6.61 million.
   B. $9.00 million.
   C. $61.00 million.

## MODULE 41.5: VENTURE CAPITAL FUNDING—MULTIPLE ROUNDS

Video covering this content is available online.

### PROFESSOR'S NOTE

For the purpose of differentiating terms between multiple rounds of venture capital investment, we are using subscripts 1 and 2 in this section to denote first and second round, respectively. For multiple rounds of VC financing, we work backwards (from last round to first).

If there is a second round of VC financing ($\text{INV}_2$), we can calculate the new fractional ownership from the new investment ($f_2$) and the number of new shares required ($\text{shares}_{\text{VC2}}$) using the NPV method, as:

$$f_2 = \frac{\text{INV}_2}{\text{POST}_2}$$

Where $\text{POST}_2$ is the discounted present value of the company as of the time of the second financing round, its post-money value after the second round investment.

$$\text{POST}_2 = \frac{\text{exit value}}{(1+r_2)^{n2}}$$

and

$$\text{PRE}_2 = \text{POST}_2 – \text{INV}_2$$

$\text{POST}_1$ is the discounted present value of the company as of the time of the first financing round, its post-money value after the first round investment.

$$\text{POST}_1 = \frac{\text{PRE}_2}{(1+r_1)^{n1}}$$

As before, we can calculate the fractional ownership from the first round investment ($f_1$) using the NPV method, as:

$$f_1 = \frac{\text{INV}_1}{\text{POST}_1}$$

The new shares required to be issued to the VC in return for the first round financing amount ($INV_1$) and the price per share can then be calculated as:

$$\text{shares}_{\text{VC1}} = \text{shares}_{\text{Founders}} \left(\frac{f_1}{1-f_1}\right)$$

$$\text{price}_1 = \frac{\text{INV}_1}{\text{shares}_{\text{VC1}}}$$

The new shares required to be issued to the VC in return for the second round financing amount ($INV_2$) and the price per share can also be calculated as:

$$\text{shares}_{\text{VC2}} = (\text{shares}_{\text{VC1}} + \text{shares}_{\text{Founders}}) \left(\frac{f_2}{1-f_2}\right)$$

$$\text{price}_2 = \frac{\text{INV}_2}{\text{shares}_{\text{VC2}}}$$

If the second round of financing is considered less risky than the first round (since the company has survived longer), a different, lower discount rate may be used in calculating the PV of the exit value at the time of the second round of financing. In the following example, we use a discount rate of 30% in calculating the company's value to reflect this fact.

**EXAMPLE: Calculating shares issued and share price for a second round financing**

Suppose that instead of a single round of financing of $5 million, the company will need $3 million in the first round and a second round of financing (three years later) of $2 million to finance company expansion to the size expected at exit.

Use a discount rate of 40% for the first three years and 30% for the last two years. The company is still expected to be worth $40 million after five years, and founders will hold 1 million shares.

The value of the company at the time of the second round of financing (two years remaining to exit) is:

$$\text{POST}_2 = \frac{\text{exit value}}{(1+\text{r}_2)^{\text{n2}}} = \frac{40{,}000{,}000}{(1.30)^2} = 23{,}668{,}639$$

The fractional VC ownership required for the second round investment of $2 million is:

$$f_2 = \frac{\text{INV}_2}{\text{POST}_2} = \frac{2{,}000{,}000}{23{,}668{,}639} = 0.0845 \text{ or } 8.45\%$$

The value of the company before the second round financing would then be:

$\text{PRE}_2 = \text{POST}_2 - \text{INV}_2 = 23{,}668{,}639 - 2{,}000{,}000 = 21{,}668{,}639$

Value of the company at the first round of financing is:

$$\text{POST}_1 = \frac{\text{PRE}_2}{(1+\text{r}_1)^{\text{n1}}} = \frac{21{,}668{,}639}{(1.40)^3} = 7{,}896{,}734$$

The fractional VC ownership required for the first round investment of $3 million is:

$$f_1 = \frac{\text{INV}_1}{\text{POST}_1} = \frac{3{,}000{,}000}{7{,}896{,}734} = 0.38 \text{ or } 38\%$$

Number of shares issued at the time of first round of financing is:

$$\text{shares}_{\text{VC1}} = \text{shares}_{\text{Founders}} \left(\frac{f_1}{1-f_1}\right)$$

$$= 1{,}000{,}000 \left(\frac{0.38}{1-0.38}\right)$$

$$= 612{,}903$$

The price per share at the time of first round of financing is:

$$\text{price}_1 = \frac{\text{INV}_1}{\text{shares}_{\text{VC1}}} = \frac{3{,}000{,}000}{612{,}903} = \$4.89$$

Number of shares issued to the VC firm at the time of the second round of financing is:

$$\begin{aligned}\text{shares}_{\text{VC2}} &= \left(\text{shares}_{\text{VC1}} + \text{shares}_{\text{Founders}}\right)\left(\frac{f_2}{1 - f_2}\right) \\ &= (612{,}903 + 1{,}000{,}000)\left(\frac{0.0845}{1 - 0.0845}\right) = 148{,}870\end{aligned}$$

The price per share at the time of second round of financing is:

$$\text{price}_2 = \frac{\text{INV}_2}{\text{shares}_{\text{VC2}}} = \frac{2{,}000{,}000}{148{,}870} = \$13.43$$

After the second round, the first round investor's share dilutes from $f_1$ to $f_1(1 - f_2)$.

In this example, the dilution takes the investor's share from 38% to 0.38(1 − 0.0845) = 0.3479 or 34.79%.

### LOS 41.k: Demonstrate alternative methods to account for risk in venture capital.

*CFA® Program Curriculum, Volume 6, page 171*

Our previous discussions have been highly dependent on the assumptions, and sensitivity analysis should be used to determine how changes in the input variables will affect company valuation. The discount rate used and the estimate of terminal value will strongly influence the current valuation.

Projections by entrepreneurs are typically overly optimistic and based on an assumption that the company will not fail. Instead of arguing over the validity of the projections with the entrepreneurs, most investors simply apply a high discount rate that reflects both the probability of failure and lack of diversification available in these investments.

## Adjusting the Discount Rate

One approach to arriving at a more realistic valuation is to adjust the discount rate to reflect the risk that the company may fail in any given year. In the following formula, $r^*$ is adjusted for the probability of failure, $q$:

$$r^* = \frac{1+r}{1-q} - 1$$

where:

$r$ = discount rate unadjusted for probability of failure

**EXAMPLE: Adjusting the discount rate for the probability of failure**

Suppose that a private equity investor has a discount rate of 30%. The investor believes, however, that the entrepreneur's projection of the company's success is overly optimistic and that the chance of the company failing in a given year is 25%.

Calculate a discount rate that factors in the company's probability of failure.

**Answer:**

$$r^* = \frac{1+0.30}{1-0.25} - 1 = 73.33\%$$

Alternatively, the investor could have deflated each future cash flow for the cumulative probability that the company will fail. The adjusted discount rate approach is more straightforward.

## Adjusting the Terminal Value Using Scenario Analysis

A second approach to generating a realistic valuation is to adjust the terminal value for the probability of failure or poor results. Typically to obtain the terminal value, the future earnings are estimated and multiplied by an industry multiple. The problem is that almost by definition, early-stage companies are innovative with few true comparables. Price multiples also fluctuate a great deal so that the current multiple may not be indicative of what can be obtained in the future. We should therefore use scenario analysis to calculate an expected terminal value, reflecting the probability of different terminal values under different assumptions.

In theory, we should just determine the present value of future cash flows to get the current value. But estimating future cash flows is subject to error, and this method may not be any better than a price multiple approach.

**EXAMPLE: Using scenario analysis to arrive at an expected terminal value**

In the previous valuation example, we were given a terminal value of $40 million. Assume that the scenario analysis is performed and examines three possible scenarios:

1. The expected earnings are $4 million and the expected price-earnings multiple is 10, resulting in the $40 million (as before).
2. The company is not as successful, and earnings are only $2 million. Growth is slower, so the expected price-earnings multiple is 5. The expected terminal value is $10 million.
3. The company fails, and its terminal value is $0.

If each scenario is equally likely, each possible value is weighted by one-third, and the expected terminal value is:

$$= \frac{1}{3}(\$40) + \frac{1}{3}(\$10) + \frac{1}{3}(\$0) = \$16.7 \text{ million}$$

The terminal value of $16.7 million is then used instead of the $40 million in the previous valuation analysis. This is an alternative to adjusting the discount rate for the probability of failure.

In summary, VC valuation is highly dependent on the assumptions used and how risk is accounted for. Additionally, scenario and sensitivity analysis should be used to determine how changes in the input variables will affect the valuation of the company.

Note that the purpose of the valuation procedures discussed here is not to ascertain the exact value of the company. Rather, the purpose is to place some bounds on the value of the company before negotiations begin between the startup (investee) company and the private equity firm. The final price paid for the investee company will also be affected by the bargaining power of the respective parties.

### MODULE QUIZ 41.5

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

**Use the following information to answer Questions 1 through 6.**

A company's founders believe that their company can be sold for $60 million in four years. The company needs $6 million in capital now and $3 million in three years. The entrepreneurs want to hold 1 million shares. The venture capital firm uses a discount rate of 50% over all four years.

1. What is the post-money valuation at the time of second-round financing?
    A. $17,777,778.
    B. $40,000,000.
    C. $57,000,000.
2. What is the post-money valuation at the time of first-round financing?
    A. $4,962,963.
    B. $9,851,259.
    C. $10,962,963.
3. What is the required fractional ownership for the second-round investors?
    A. 5.00%.
    B. 7.50%.
    C. 16.88%.
4. What is the fractional ownership for the first-round investors, after dilution by the second-round investors?
    A. 50.63%.
    B. 54.73%.
    C. 92.50%.
5. What is the stock price per share after the first round of financing?
    A. $4.96.
    B. $5.85.
    C. $6.00.
6. What is the stock price per share after the second round of financing?
    A. $5.77.
    B. $16.75.
    C. $37.00.
7. A private equity investor has a discount rate of 30%. The investor believes, however, that the entrepreneur's projection of the company's success is overly optimistic and that the chance of the company failing in a given year is 20%. What is the discount rate that factors in the company's probability of failure?
    A. 50.0%.
    B. 62.5%.
    C. 71.4%.

# KEY CONCEPTS

## LOS 41.a

The sources of value creation in private equity are: (1) the ability to reengineer the company, (2) the ability to obtain debt financing on more favorable terms, and (3) superior alignment of interests between management and private equity ownership.

## LOS 41.b

Private equity firms use the following mechanisms to align their interests with those of the managers of portfolio companies:

- Manager's *compensation* tied to the company's performance.
- *Tag-along*, *drag-along* clauses ensure that anytime an acquirer acquires control of the company, they must extend the acquisition offer to all shareholders, including firm management.
- *Board representation* by private equity firm.
- *Noncompete clauses* required for company founders.
- *Priority in claims*. PE firms have priority if the portfolio company is liquidated.
- *Required approval* by PE firm for changes of strategic importance.
- *Earn-outs*. Acquisition price paid is tied to portfolio company's future performance.

## LOS 41.c

Relative to buyouts, venture capital portfolio companies are characterized by: unpredictable cash flows and product demand; weak asset base and newer management teams; less debt; unclear risk and exit; high demand for cash and working capital; less opportunity to perform due diligence; higher returns from a few highly successful companies; limited capital market presence; company sales that take place due to relationships; smaller subsequent funding; and general partner revenue primarily in the form of carried interest.

## LOS 41.d

| Valuation Issue | Buyout | Venture Capital |
|---|---|---|
| Applicability of DCF Method | Frequently used to estimate value of equity | Less frequently used as cash flows are uncertain |
| Applicability of Relative Value Approach | Used to check the value from DCF analysis | Difficult to use because there may be no true comparable companies |
| Use of Debt | High | Low as equity is dominant form of financing |
| Key Drivers of Equity Return | Earnings growth, increase in multiple upon exit, and reduction in the debt | Pre-money valuation, investment, and subsequent equity dilution |

## LOS 41.e

The means and timing of the exit strongly influence the exit value.

The four typical exit routes:

- Initial public offerings usually result in the highest exit value due to increased liquidity, greater access to capital, and the potential to hire better quality managers.

- Secondary market sales to other investors or firms result in the second highest company valuations after IPOs.
- In an MBO, the company is sold to management, who utilize a large amount of leverage.
- A liquidation is pursued when the company is deemed no longer viable and usually results in a low exit value.

## LOS 41.f

The most common form of ownership structure for private equity funds is the limited partnership where limited partners (LPs) provide funding and have limited liability. The general partner (GP) manages the investment fund.

The economic terms in a private equity prospectus address the following issues: management fees; transaction fees; carried interest (the GP's share of the fund profits); ratchet (the allocation of equity between stockholders and management of the portfolio company); hurdle rate (the IRR that the GP must meet before receiving carried interest); target fund size; vintage year; and term of the fund.

The corporate governance terms in the prospectus address the following issues: key man clause (the provisions for the absence of a key named executive); performance disclosure and confidentiality (specifies the fund performance information that can be disclosed); clawback (the provision for when the GP must return profits); distribution waterfall (the method in which profits will flow to the LPs before the GP receives carried interest); tag-along, drag-along clauses (give management the right to sell their equity stake if the private equity firm sells its stake); no-fault divorce (specify when a GP can be fired); removal for cause (provisions for the firing of the GP or the termination of a fund); investment restrictions; and co-investment (allows the LPs to invest in other funds of the GP at low or no management fees).

Valuations are difficult for private equity funds because there is no ready secondary market for their investments. Additional issues with NAV calculations include the following: (1) the NAV will be stale if it is only adjusted when there are subsequent rounds of financing; (2) there is no definitive method for calculating NAV; (3) undrawn LP capital commitments are not included in the NAV calculation but are essentially liabilities for the LP; (4) different strategies and maturities may use different valuation methodologies; and (5) it is the GP who usually values the fund.

Investors should conduct due diligence before investing in a private equity fund due to the persistence in returns in private equity fund returns, the return discrepancies between outperformers and underperformers, and their illiquidity.

## LOS 41.g

The general private equity risk factors are liquidity risk, unquoted investments risk, competitive environment risk, agency risk, capital risk, regulatory risk, tax risk, valuation risk, diversification risk, and market risk.

The costs of investing in private equity are significantly higher than those associated with publicly traded securities and include transactions costs, investment vehicle fund setup costs, administrative costs, audit costs, management and performance fee costs, dilution costs, and placement fees.

## LOS 41.h

The Gross IRR reflects the fund's ability to generate a return from portfolio companies. The Net IRR is the relevant return metric for the LPs and is net of management fees, carried interest, and other compensation to the GP. The Net IRR should be benchmarked against a peer group of comparable private equity funds of the same vintage and strategy.

## LOS 41.i

The following statistics are important for evaluating the performance of a PE fund:

- Management fees are calculated as the percentage fee multiplied by the total paid-in capital.
- The carried interest is calculated as the percentage carried interest multiplied by the increase in the NAV before distributions.
  - The NAV before distributions is calculated as:

    = NAV after distributions in prior year + capital called down – management fees + operating results
  - The NAV after distributions is calculated as:

    = NAV before distributions – carried interest – distributions
- The DPI multiple is the cumulative distributions divided by the paid-in capital.
- The RVPI multiple is the NAV after distributions divided by the paid-in capital.
- The TVPI multiple is the sum of the DPI and RVPI.

## LOS 41.j

Under the NPV method, the proportion of the company ($f$) received for an investment in the company is calculated as the investment amount (INV) divided by the post-money (post-investment) value of the company. The post-money value of the company is calculated by discounting the estimated exit value for the company to its present value PV(exit value), as of the time the investment is made.

$$f = \frac{\text{INV}}{\text{POST}}$$

Alternatively, under the IRR method, we can calculate the fraction, $f$, as the future value of the VC investment at the time of exit (using the discount rate as a compound rate of return), divided by the value of the company at exit:

$$f = \frac{\text{FV(INV)}}{\text{exit value}}$$

Once we have calculated this post-money ownership share, we can calculate the number of shares issued to the venture capital investor for the investment ($\text{shares}_{\text{VC}}$) and the price per share as:

$$\text{shares}_{\text{VC}} = \text{shares}_{\text{Founders}}\left(\frac{f}{1-f}\right)$$

$$\text{price} = \frac{\text{INV}}{\text{shares}_{\text{VC}}}$$

If there is a second round of financing, we first calculate the fraction of the company ($f_2$) purchased for the second round of financing as:

$$f_2 = \frac{INV_2}{POST_2}$$

where:

$$POST_2 = \frac{\text{exit value}}{(1+r_2)^{n2}}$$

and

$$PRE_2 = POST_2 - INV_2$$

We then compute the fractional ownership from the first round of financing as:

$$f_1 = \frac{INV_1}{POST_1}$$

where:

$$POST_1 = \frac{PRE_2}{(1+r_1)^{n1}}$$

We can finally compute the number of shares issued and price per share in each round as:

$$shares_{VC1} = shares_{Founders}\left(\frac{f_1}{1-f_1}\right)$$

$$price_1 = \frac{INV_1}{shares_{VC1}}$$

$$shares_{VC2} = (shares_{VC1} + shares_{Founders})\left(\frac{f_2}{1-f_2}\right)$$

$$price_2 = \frac{INV_2}{shares_{VC2}}$$

## LOS 41.k

The valuation of a venture capital investment is highly dependent on the assumptions used. The risk of the investment can be assessed using two methods.

- In the first approach, the discount rate is adjusted to reflect the risk that the company may fail in any given year:

  $$r^* = \frac{1+r}{1-q} - 1$$

  where:
  r* = discount rate adjusted for probability of failure
  r = discount rate unadjusted for probability of failure
  q = probability of failure in a year
- In the second approach, scenario analysis is used to calculate an expected terminal value, reflecting different values under different assumptions.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 41.1

1. **B** It is actually the overutilization of cheap *debt* financing in private equity firms that leads to value creation. Private equity firms carry more debt than public firms but have a reputation for paying it back. (LOS 41.a)

2. **B** Earn-outs do not ensure portfolio company manager compensation. Earn-outs tie the acquisition price paid by private equity firms to the portfolio company's future performance. These are used predominantly in venture capital investments. (LOS 41.b)

3. **B** Venture capital investments typically have significant cash burn rates. Discounted cash flow analysis is typically used for companies with substantial operating history and is, therefore, more likely to be associated with a buyout investment rather than a venture capital investment. Full due diligence is conducted for a buyout investment. Due diligence for typical venture capital investment is limited to technological feasibility and commercial potential due to limited operating results history. (LOS 41.c)

4. **B** The pre-money valuation, investment, and potential subsequent equity dilution are issues for venture capital equity return. The key drivers of equity return for buyouts are earnings growth, the increase in multiple upon exit, and the reduction in the debt. (LOS 41.d)

## Module Quiz 41.2

1. **A** Initial public offerings usually result in the highest exit value due to increased liquidity, greater access to capital, and the potential to hire better-quality managers. (LOS 41.e)

2. **A** Competitive environment risk examines risk from the perspective of an investor who is considering an investment in private equity. It refers to the fact that the competition for finding reasonably priced private equity investments may be high. (LOS 41.g)

3. **C** Placement fees are those charged by placement agents who raise funds for private equity firms. They may charge up-front fees as much as 2% or annual trailer fees as a percent of funds raised from limited partners. (LOS 41.g)

4. **B** The most typical organizational structure of a private equity investment is a limited partnership. In a limited partnership, the limited partners provide funding and have limited liability. The general partner manages the investment fund. (LOS 41.f)

5. **A** The clause in the private equity prospectus that the general partner has likely violated is the co-investment clause. The co-investment clause prevents the GP from using capital from different funds to invest in the same portfolio company. A conflict of interest arises here because portfolio Company A may be a poor use of the funds from Fund B investors. (LOS 41.f)

6. **A** Firm A likely has the best corporate governance system. A large amount of the GP's compensation comes in the form of incentive-based compensation as the carried interest and hurdle rate necessary to obtain carried interest is the highest, but the

compensation unrelated to performance (the management and transactions fees are the lowest). The clawback provision also incentivizes the GP because they have to return previously received profits.

Furthermore, the key man clause and the removal for cause clause give the LPs the right to dismiss an underperforming GP. The total return distribution waterfall method is used instead of the deal-by-deal method, in which the GP can receive carried interest even in cases when the LPs have not earned a net positive return. (LOS 41.f)

7. **B** There is no straightforward method for calculating the value of the commitments, which are essentially liabilities for the LP. The value of the commitments depends on the cash flows generated from them, but these are quite uncertain. (LOS 41.f)

## Module Quiz 41.3

1. **B** The RVPI (residual value to paid-in capital) measures the limited partner's unrealized return in a private equity fund. It is the value of the LP's holdings in the fund divided by the cumulative invested capital. It is net of management fees and carried interest. The DPI (distributed to paid-in capital) measures the LP's realized return, and the TVPI (total value to paid-in capital) measures both the LP's realized and unrealized return. (LOS 41.i)

2. **C** This is the cumulative sum of the capital called down, and in 2016 is: $135 + $10 = $145. (LOS 41.i)

3. **B** These are calculated as the percentage fee of 2% times the paid-in capital: 2% × $145 = $2.9. (LOS 41.i)

4. **B** Carried interest is not paid until the NAV before distributions exceeds the committed capital of $200 million, which is the year 2015. (LOS 41.i)

5. **B** NAV before distributions is calculated as:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| = | NAV after distributions in prior year | + | capital called down | – | management fees | + | operating results |

For 2016, NAV before distributions is: $158.4 + $10 – $2.9 + $120 = $285.50. (LOS 41.i)

6. **B** It is calculated as the percentage carried interest times the increase in the NAV before distributions. In 2016, it is: 20% × ($285.50 – $210.50) = $15.00. (LOS 41.i)

7. **A** NAV after distributions is calculated as:

| | | | | | |
|---|---|---|---|---|---|
| = | NAV before distributions | – | carried interest | – | distributions |

In 2016, NAV after distributions is: $285.50 – $15.00 – $90 = $180.50. (LOS 41.i)

8. **C** The DPI multiple is calculated as the cumulative distributions divided by the paid-in capital: ($30 + $50 + $90) / $145 = 1.17. The GP has distributed more than the paid-in capital. (LOS 41.i)

9. **A** The RVPI multiple is calculated as the NAV after distributions divided by the paid-in capital: ($180.50) / $145 = 1.24. The net unrealized returns are more than the paid-in capital. (LOS 41.i)

10. **B** The TVPI multiple is the sum of the DPI and RVPI: 1.17 + 1.24 = 2.41.(LOS 41.i)

## Module Quiz 41.4

1. **B** The post-money valuation is the present value of the expected exit value:

$$\text{POST} = \frac{50{,}000{,}000}{(1+0.45)^4} = 11{,}310{,}922$$

(Module 41.3, LOS 41.i)

2. **A** The pre-money valuation is what the company is worth before the investment:

PRE = 11,310,922 – 7,000,000 = 4,310,922

(Module 41.3, LOS 41.i)

3. **C** To put up $7 million in a company worth $11.3 million, the venture capital firm must own 61.89% of the company:

$$f = \frac{7{,}000{,}000}{11{,}310{,}922} = 61.89\%$$

(Module 41.4, LOS 41.j)

4. **B** If the entrepreneurs want 1 million shares, the venture capital firm must receive 1.6 million shares to get 61.89% ownership:

$$\text{Shares}_{\text{VC}} = 1{,}000{,}000\left[\frac{0.6189}{(1-0.6189)}\right] = 1{,}623{,}983$$

(Module 41.4, LOS 41.j)

5. **B** Given a $7 million investment and 1.6 million shares, the stock price per share must be:

$$\text{P} = \frac{7{,}000{,}000}{1{,}623{,}983} = \$4.31 \text{ per share}$$

(Module 41.4, LOS 41.j)

6. **C** First, calculate the investor's expected future wealth (W):

W = 9,000,000 × (1 + 0.35)$^5$ = 40,356,301

Given this expected wealth, we determine the required fractional ownership ( $f$ ) by calculating how much of the terminal value should be the investor's:

$$\text{f} = \frac{40{,}356{,}301}{70{,}000{,}000} = 57.65\%$$

(Module 41.4, LOS 41.j)

7. **B** First, determine the number of shares the venture capital firm ($\text{Shares}_{\text{VC}}$) requires for its fractional ownership:

$$\text{Shares}_{\text{VC}} = 1{,}000{,}000\left[\frac{0.5765}{(1-0.5765)}\right] = 1{,}361{,}275$$

Next, determine the stock price per share (P):

$$\text{P} = \frac{9{,}000{,}000}{1{,}361{,}275} = \$6.61$$

(Module 41.4, LOS 41.j)

8. **B** Divide the investment by the fractional ownership to obtain the post-money (POST) valuation:

$$\text{POST} = \frac{9{,}000{,}000}{0.5765} = 15.61 \text{ million}$$

(Module 41.4, LOS 41.j)

9. **A** Determine the pre-money (PRE) valuation by netting the investment (INV) from the post-money (POST) valuation:

   PRE = 15.61 million – 9 million = 6.61 million

   (Module 41.4, LOS 41.j)

## Module Quiz 41.5

1. **B** Discount the terminal value of the company at exit back to the time of second round financing to obtain the post-money ($POST_2$) valuation:

   $$\text{POST}_2 = \frac{60{,}000{,}000}{(1+0.5000)} = \$40{,}000{,}000$$

   (LOS 41.j)

2. **C** First, calculate the second-round pre-money ($PRE_2$) valuation by netting the second-round investment ($INV_2$) from the post-money ($POST_2$) valuation:

   $PRE_2$ = 40,000,000 – 3,000,000 = $37,000,000

   Next, discount the second-round pre-money valuation back to the time of the first-round financing to obtain the post-money ($POST_1$) valuation:

   $$\text{POST}_1 = \frac{37{,}000{,}000}{(1+0.50)^3} = \$10{,}962{,}963$$

   (LOS 41.j)

3. **B** The required fractional ownership for the second-round investors is:

   $$f_2 = \frac{3{,}000{,}000}{40{,}000{,}000} = 7.50\%$$

   (LOS 41.j)

4. **A** The required fractional ownership for the first-round investors is:

   $$f_1 = \frac{6{,}000{,}000}{10{,}962{,}963} = 54.73\%$$

   The first round investors will be later diluted by the second round investors to an ownership of: 54.73% × (1 – 0.0750) = 50.63%.

   (LOS 41.j)

5. **A** First, determine the number of shares the first-round venture capital investors ($Shares_{VC1}$) need to obtain their fractional ownership:

   $$\text{Share}_{\text{VC1}} = 1{,}000{,}000\left[\frac{0.5473}{(1-0.5473)}\right] = 1{,}208{,}968$$

   To obtain a 54.73% share of the company, the first-round investors must receive 1,208,968 shares.

   Next, determine the stock price per share after the first round of financing ($P_1$):

$$P_1 = \frac{6{,}000{,}000}{1{,}208{,}968} = \$4.96$$

(LOS 41.j)

6. **B** First, determine the number of shares the second-round venture capital investors ($\text{Shares}_{VC2}$) need to obtain their fractional ownership:

$$\text{Shares}_{VC2} = (1{,}000{,}000 + 1{,}208{,}968)\left[\frac{0.0750}{(1 - 0.0750)}\right] = 179{,}106$$

To obtain a 7.50% share of the company, the second-round investors must receive 179,106 shares.

Next, determine the stock price per share after the second round of financing ($P_2$):

$$P_2 = \frac{3{,}000{,}000}{179{,}106} = \$16.75$$

(LOS 41.j)

7. **B** The discount rate that factors in the company's probability of failure is calculated as:

$$r^* = \frac{1+r}{1-q} - 1$$

$$r^* = \frac{1+0.30}{1-0.20} - 1 = 62.5\%$$

(LOS 41.k)

The following is a review of the Alternative Investments principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #42.

# READING 42: INTRODUCTION TO COMMODITIES AND COMMODITY DERIVATIVES

**Study Session 15**

## EXAM FOCUS

This topic review will help you understand different commodity sectors and key factors influencing prices in those sectors. Pay special attention to what backwardation and contango mean in terms of spot and futures prices. You should understand the different components of returns to commodity futures and what determines whether roll return is positive or negative. Finally, familiarize yourself with the Insurance Theory, the Hedging Pressure Hypothesis, and the Theory of Storage and what they say about futures prices.

## MODULE 42.1: INTRODUCTION AND THEORIES OF RETURN

Video covering this content is available online.

### LOS 42.a: Compare characteristics of commodity sectors.

*CFA® Program Curriculum, Volume 6, page 191*

Commodities can be classified by their characteristics into sectors, including:

- Energy—crude oil, natural gas, and refined petroleum products.
- Industrial metals—aluminum, nickel, zinc, lead, tin, iron, and copper.
- Grains—wheat, corn, soybeans, and rice.
- Livestock—hogs, sheep, cattle, and poultry.
- Precious metals—gold, silver, and platinum.
- Softs (cash crops)—coffee, sugar, cocoa, and cotton.

The factors that influence supply and demand and the nature of production differ for these sectors. A summary of these differences can help explain the differences in price dynamics among the sectors.

The **energy sector** comprises crude oil, natural gas, and refined products. It is the sector with the greatest market value and is a very important source of revenue to many countries and regions.

**Crude oil** from different regions has different characteristics. Light oil (low viscosity) and sweet oil (low sulfur content) are less costly to refine and, therefore, sell at a premium relative to heavier or higher sulfur crude oils. Crude oil can be stored indefinitely by keeping it in the ground and is also stored in tanks and aboard tanker ships. Many countries store large amounts of crude oil as strategic reserves.

The supply of crude oil has been augmented by advances in drilling and extraction technology, especially in the 21st century. While global economic growth is an important driver of worldwide demand for oil, other factors have slowed this growth in demand. Improvements in refining technology have tended to increase the output of petroleum distillates from each barrel of crude oil, and improved engines are able to produce more work from each gallon of these distillates.

Economic cycles also affect the demand for oil, which is higher during expansions when credit is widely available and can decrease sharply when contractions lead to reductions in the availability of credit.

Improvements in the efficiency of alternative sources of energy production have also reduced the overall growth in the demand for oil. Increasingly stringent restrictions on oil exploration and production in response to environmental concerns have tended to increase the cost of oil production and decrease supply.

Political risk is an important factor in oil supply. Over half the crude oil supply comes from countries in the Middle East, and conflict there can reduce supply dramatically.

**Refined products** such as gasoline, heating oil, and jet fuel, are only stored for short periods. Refinery output is the relevant supply consideration. The geographic concentration of refinery capacity means that extreme weather in some coastal regions can significantly affect the supply of refined products.

Seasonal factors affect the demand for refined products in that greater vacation travel in the summer months increases gasoline demand, and colder weather in the winter increases the demand for heating oil.

Unlike crude oil, **natural gas** can be used just as it comes out of the ground with very little processing. Transportation costs play an important role in energy pricing. Crude oil can be transported at a relatively low cost on ships, while natural gas must be cooled to its liquid state to be transported by ship, significantly increasing the cost of transport.

The supply of *associated gas*—gas produced in conjunction with the extraction of crude oil—is tied to the production of crude oil. *Unassociated gas* is produced from formations where oil is not present so that its supply is not tied to the demand for and production of crude oil.

Worldwide demand and supply for gas depends on many of the same factors as supply and demand for crude oil, but seasonality due to weather is more pronounced. Cold winters increase the demand for gas for heating fuel. Hot summers increase the demand for gas as well (for cooling) because gas is a primary source of fuel for electrical power generation.

Demand for **industrial metals** is primarily tied to GDP growth and business cycles because these metals are used extensively in construction and manufacturing. Storage of metals is not costly.

Political factors, especially union strikes and restrictive environmental regulations, can have a significant effect on the supply of an industrial metal. Industrial metals must be smelted from mined ore. Both mines and smelters are large-scale operations with high development costs and high fixed costs.

**Grains** are grown over an annual cycle and stored, although multiple crops in a single year are possible in some areas. The risks to grain supply are the usual: droughts, hail, floods, pests, diseases, changes in climate, and so on. It would be difficult to overstate the

importance of grains in feeding the world's population, especially given the potential for political instability when grain stocks are insufficient.

**Precious metals** are used in electronics and for jewelry and can be stored indefinitely. Gold has long been used as a store of value and has provided a hedge against the inflation risk of holding currency. Jewelry demand is high where wealth is being accumulated. Industrial demand for precious metals is sensitive to business cycles.

**Livestock** supply depends on the price of grain, which is the primary input in its production. When increasing grain prices increase the cost of feeding livestock, the rate of slaughter also increases, which leads to a decrease in price. Such a drawdown in population can result in subsequent increases in price over time.

Weather can affect the production of some animals. Disease is a source of significant risk to livestock producers, and some diseases have had a large impact on market prices.

Income growth in developing economies is an important source of growth in demand for livestock. Freezing allows the storage of meat products for a limited amount of time.

**Softs** refers to cotton, coffee, sugar, and cocoa, which are all grown in the warmer climates of the lower latitudes. Just as with grains, weather is the primary factor in determining production and price, but disease is a significant risk as well. Demand increases with increases in incomes in developing economies but is dependent on consumer tastes as well.

### LOS 42.b: Compare the life cycle of commodity sectors from production through trading or consumption.

*CFA® Program Curriculum, Volume 6, page 196*

The life cycle of crude oil begins with the time it takes to drill a well and extract the crude. After being transported, crude oil is typically stored for no more than a few months. The next step is refining the crude oil into various fuels such as gasoline, heating oil, diesel oil, and jet fuel. These fuels must then be transported to the consumer.

Natural gas requires minimal processing after it is extracted. While natural gas often reaches the consumer through a pipeline, it can be cooled to liquid form and transported on specially constructed ships. Energy commodities are delivered year-round, but demand is seasonal to some extent.

The life cycle of industrial metals is straightforward: the extracted ore is smelted into the quality of metal that end users need. Industrial metals can be stored indefinitely in most cases, and the regular flow of output means that end users can meet their needs with monthly deliverable futures contracts.

A key characteristic of industrial metals production is economies of scale due to large, efficient mining and smelting operations. The large size projects required for efficient operation cost billions of dollars and take significant time to construct. Construction of new capacity or facilities when capacity utilization and earnings are high can result in the additional capacity coming online at or past the peak of the economic cycle. Mining and smelting operations are most efficient running near their capacity, so individual producers are hesitant to decrease production when prices fall because the peak of the economic cycle has passed or because facilities growth has created excess capacity in the industry.

Livestock production times vary with animal size, with chickens ready for slaughter after only weeks, hogs in about six months, and cattle after a few years. Freezing allows storage for some period after slaughter and allows international trade in livestock products such as frozen beef. Livestock production has a significant seasonal component.

Grain production is seasonal, so deliverable futures contracts are available on dates to coincide with the harvest. Because planting occurs five months or more before harvest, quantities harvested are set largely by expectations for demand when crops are planted. Grains can be stored for significant time periods after harvest. The six-month offset to harvest times in the northern and southern hemispheres brings crops to markets more frequently.

Production cycles and storage options for softs vary by product. Among softs, coffee offers an example of an agricultural commodity that is harvested somewhere around the world in almost every month. Coffee is stored in warehouses after transport by ship. Local coffee roasters then roast the beans and deliver to end users or to retail sales outlets. Coffee plants can take up to four years to produce the fruit that will become coffee beans, so there is a significant lag between investment in new capacity and increases in supply.

To hedge their price risk, coffee producers can sell in the futures market for delivery to a warehouse, and consumer companies can buy in the futures market and take delivery at the warehouse. Two different types of coffee beans are traded, Robusta and Arabica, with Arabica being the premium product.

### LOS 42.c: Contrast the valuation of commodities with the valuation of equities and bonds.

*CFA® Program Curriculum, Volume 6, page 203*

Unlike stocks and bonds, commodities are physical assets, have no cash flows, and may incur storage and transportation costs.

Stocks and bonds (financial assets) can be valued by calculating the present value of their expected future cash flows (e.g., dividends, interest, etc.). Commodities produce no earnings or cash flows; however, the current (spot) price of a commodity can be viewed as the discounted value of the expected selling price at some future date. Storage costs for commodities can lead to forward prices that are higher the further the forward settlement date is in the future.

### LOS 42.d: Describe types of participants in commodity futures markets.

*CFA® Program Curriculum, Volume 6, page 205*

Participants in commodity futures markets can be categorized as hedgers, traders and investors, exchanges, analysts, and regulators.

Traders and investors in the commodities market can be classified as informed investors—those who provide liquidity to the markets—and arbitrageurs. **Hedgers** are considered informed investors because they either produce or use the commodity. Hedgers reduce their risk by buying (going long) or selling (going short) futures contracts. A corn farmer can reduce the uncertainty about the price she will receive for her corn by selling corn futures. A cattle producer, however, would hedge his price risk by buying corn futures to reduce his uncertainty about the cost of feed for the cattle.

**PROFESSOR'S NOTE**

Hedgers are said to "do in the futures market what they must do in the future." A wheat farmer will need to sell wheat in the future (i.e., after the harvest) and can hedge price risk by selling futures contracts. A grain miller will need to buy wheat in the future and can hedge price risk by buying futures contracts.

**Speculators** take on commodity risk in futures markets and may act as informed investors, seeking to exploit an information or information processing advantage to profit from trading with hedgers. Speculators can also earn profits by providing liquidity to markets: buying futures when short hedgers (commodity producers) are selling and selling futures when long hedgers (commodity users) are buying.

**Arbitrageurs** in the commodity markets are often those in the business of buying, selling, and storing the physical commodities when the difference between spot and futures prices is too large or too small based on the actual cost of storing the commodity. When the difference is too large, an arbitrageur can buy and store the commodity and sell it at its (too high) futures price. When the difference is too small, an arbitrageur can effectively "not store" the commodity by selling from his own inventory and going long futures, replacing the inventory at the future date.

**Commodity exchanges** operate in many of the world's financial centers to reflect the worldwide production and consumption of commodities as well as the globalization of financial markets in general. Investors can trade commodity futures on a smart phone or via a Bloomberg terminal.

**Commodity market analysts**, considered non-market participants, use market information to perform analytical work for various entities including governments, universities, economic forecasters, and commercial data analysis firms.

Various **commodity regulators** are responsible for the regulation of commodities markets around the world. In the U.S., the Commodities Futures Trading Commission (CFTC) is responsible for market regulation.

### LOS 42.e: Analyze the relationship between spot prices and future prices in markets in contango and markets in backwardation.

*CFA® Program Curriculum, Volume 6, page 209*

The difference between the spot (cash) market price and the futures price for a date in the future is referred to as the **basis** of that particular contract. The basis is calculated as the spot price minus the futures price and can be positive or negative. The difference between the futures price of a nearer maturity and the futures price of a more-distant maturity is known as the **calendar spread**.

When futures prices are higher at dates further in the future, the futures market (or futures curve) is said to be in **contango**. In a contango market, the calendar spread and basis are negative. Conversely, if futures prices are lower at dates further in the future, the market is said to be in **backwardation**, and the basis and calendar spread are positive.

When a futures market is in backwardation, long futures positions have a positive returns component (the "roll return," which we will describe later in this topic review). With a futures curve in backwardation, futures prices are lower than spot prices for the commodity.

Since futures prices converge to spot prices over the term of a futures contract, there is a positive returns component from the passage of time.

When a futures market is in contango, so that futures prices are greater than spot prices, there is a negative returns component for long futures positions. As time passes, convergence of futures prices to spot prices (or longer-dated futures prices to nearer-term futures prices) results in a decrease in the value of a long futures position.

### LOS 42.f: Compare theories of commodity futures returns.

*CFA® Program Curriculum, Volume 6, page 213*

Three theories of the determinants of returns on commodities, based on the shape of the futures curve, have been expounded: the Insurance Theory, the Hedging Pressure Hypothesis, and the Theory of Storage.

Economist John Maynard Keynes put forward the **Insurance Theory** of futures returns, which states that the desire of commodity producers to reduce their price risk drives commodity futures returns. Producers face uncertainty about the price they will receive for their output and reduce this uncertainty by selling futures contracts. This selling drives down futures prices. The Insurance Theory states that the futures prices will be less than current spot prices to provide a return to those buying futures from producers (i.e., speculators). In this view, the resulting positive return to the buyers of futures contracts is their return for providing insurance against price uncertainty to producers. Keynes contended that this results in backwardation "normally," and the situation was termed "normal backwardation" based on this theory.

The Insurance Theory was found to be lacking based on two empirical findings. The first finding is that for markets in backwardation, buying futures has not resulted in the extra returns the theory says buyers should receive for providing "insurance." The second finding is that many markets are not in backwardation but are in contango (future prices higher than spot prices), which would imply a negative return for providing insurance to producers.

The **Hedging Pressure Hypothesis** added the hedging behavior of commodity consumers to the Insurance Theory in an attempt to better explain observed futures returns. Just as a wheat farmer faces uncertainty about the price at which he will sell his wheat in the future, a baking company faces uncertainty about the price it will pay for flour in the future. To hedge its price risk, the baking company will go long wheat futures. The more commodity users hedge with long positions (buying futures), the more upward price pressure there is on the futures price. Under the Hedging Pressure Hypothesis, when producers' hedging behavior dominates, the market will be in backwardation, and when users' hedging behavior dominates, the market will be in contango.

Despite the intuitive appeal of the Hedging Pressure Hypothesis, it has some shortcomings. Producers typically face more concentrated price risk than consumers. Individual consumers will spend only a small portion of their income on a single commodity, and for commercial users of the commodity, the actual cost of the commodity may represent only a small portion of the total cost of the production.

Additionally, both producers and consumers may be speculators in the market, not just hedgers. Another problem with the Hedging Pressure Hypothesis is that hedging pressure is

not observable, so we cannot directly test the hypothesis that relative hedging pressure is the cause of backwardation and contango.

The **Theory of Storage** is based on the idea that whether a futures market is in backwardation or contango depends on the relationship between the costs of storing the commodity for future use and the benefits of holding physical inventory of the commodity. When the costs of storage outweigh the benefits of holding physical inventory, futures are more attractive than current inventory, futures will trade at a higher price than spot, and the market will be in contango. Conversely, when the benefits of holding physical inventory outweigh the costs of storage, current possession is more attractive than future possession, spot prices are higher than futures prices, and the market will be in backwardation.

The benefits of having physical inventory available are referred to as a commodity's **convenience yield.** When physical stocks are low and there is a high probability that the commodity will be in short supply, the benefits of holding physical stock (and the convenience yield) are higher.

The Theory of Storage takes both the costs and benefits of holding a commodity into account in the following relation:

$$\text{futures price} = \text{spot price} + \text{storage costs} - \text{convenience yield}$$

Relative to spot prices, futures prices are higher when storage costs are higher, and futures prices are lower when the convenience yield is higher. Further, we can say that the shape of the futures price curve depends on available supply (i.e., current inventory of the commodity) along with expected future supply and demand.

Even with these three theories, we are left without a complete theory of commodity futures returns. "Hedging pressure" and "convenience yield" are not observable, and storage costs are not readily disclosed by participant firms.

## MODULE QUIZ 42.1

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

1. The commodity sector that is *least affected* by weather risk is:
   A. grains.
   B. precious metals.
   C. refined energy products.
2. For which of the following commodities is the production and consumption cycle *least affected* by seasonality?
   A. Hogs.
   B. Coffee.
   C. Natural gas.
3. Which of the following factors is *most likely* to distinguish the valuation of a commodity from the valuation of an equity that pays no dividends?
   A. Holding costs.
   B. Discount rate.
   C. Timing of the future sale.
4. A commodity is *most likely* to be physically stored by a(n):
   A. exchange.
   B. speculator.
   C. arbitrageur.
5. A futures market in backwardation will exhibit:
   A. positive basis and positive calendar spreads.
   B. negative basis and positive calendar spreads.

C. negative basis and negative calendar spreads.

6. Which theory of commodity futures returns is *least likely* to explain why futures markets can be in contango?
   A. Insurance Theory.
   B. Theory of Storage.
   C. Hedging Pressure Hypothesis.

# MODULE 42.2: ANALYZING RETURNS AND INDEX CONSTRUCTION

Video covering this content is available online.

## LOS 42.g: Describe, calculate, and interpret the components of total return for a fully collateralized commodity futures contract.

*CFA® Program Curriculum, Volume 6, page 219*

An investor who desires long exposure to a commodity price will typically achieve this exposure through a derivative investment in forwards or futures. Some physical commodities cannot be effectively purchased and stored long term, and for others, such as precious metals, derivative positions may be a more efficient means of gaining long exposure than purchasing the commodities outright and storing them long term.

The return on a derivatives position is not the same as the return on a commodity itself. The total return on a fully collateralized long futures position has three components: collateral return, price return, and roll return.

To take a position in futures, an investor must post collateral. When a futures portfolio is *fully collateralized*, the investor has posted cash or acceptable securities with a value equal to the notional value (price multiplied by contract size) of the futures contracts in the portfolio. If U.S. Treasury bills are deposited as collateral, the **collateral return** or **collateral yield** is simply the holding period yield on the T-bills.

The **price return** or **spot yield** on an investment in commodity futures is the change in spot prices (which can be proxied by futures prices on near-month contracts).

price return = (current price − previous price) / previous price

Since commodity derivative contracts expire, an investor who wants to maintain a position over time must close out the expiring futures position and reestablish a new position with a settlement date further in the future. This process is referred to as *rolling over* the position and leads to gains or losses which are termed the **roll return** or **roll yield**. The roll return can be positive if the futures price curve is in backwardation or negative if the futures price curve is in contango.

To hold the value of a long position constant, an investor must buy more contracts if the new longer-dated futures are trading at a lower price (market in backwardation) and buy fewer contracts if the new longer-dated futures are trading at a higher price (market in contango). In any event, the roll return on the contracts traded can be calculated as:

$$\text{roll return} = \frac{\text{price of expiring futures contract} - \text{price of new futures contract}}{\text{price of expiring futures contract}}$$

Roll return has a relatively small impact on overall returns on commodity futures over the short term but can have a meaningful impact over longer periods.

### LOS 42.h: Contrast roll return in markets in contango and markets in backwardation.

*CFA® Program Curriculum, Volume 6, page 213*

Consider a situation where the manager of a portfolio of commodity futures contracts is rolling over July corn futures trading at 397 (cents per bushel) into November corn futures trading at 406. The roll return is:

$$\frac{397-406}{397} = -2.27\%$$

With the corn futures market in contango, the roll return is negative.

Now consider a situation where the manager is rolling over July natural gas futures trading at 2.35 (dollars per million cubic feet) into August futures trading at 2.22. In this case the roll return is:

$$\frac{2.35-2.22}{2.35} = 5.53\%$$

Suppose we wanted a specific dollar exposure to natural gas, say $10,000. We would have originally gone long 10,000 / 2.35, or approximately 4,255 contracts. To maintain the dollar exposure upon rolling over into new contracts, we would have gone long 10,000 / 2.22, or approximately 4,504 contracts. Hence, when the contract is in backwardation, the roll return is positive and results in a larger number of long contracts upon rolling over.

If natural gas exposure is 8.5% of the manager's portfolio, we can calculate the **net roll return** for the portfolio as 0.085 × 5.53% = 0.47%.

### LOS 42.i: Describe how commodity swaps are used to obtain or modify exposure to commodities.

*CFA® Program Curriculum, Volume 6, page 226*

**Swaps** can be used to increase or decrease exposure to commodities risk. Swaps are customized instruments created and sold by dealers, who may take on the risk of their swap exposure or hedge their exposure by entering into an offsetting swap contract (in which they have the opposite exposure to the risk factor) or by holding the physical commodity.

Swaps are created for which the payments between the two parties are based on various risk factors such as the excess returns on a commodity, the total return on the commodity, or a measure of price volatility.

In a **total return swap** the swap buyer (the long) will receive periodic payments based on the change in the futures price of a commodity plus the return on the collateral, in return for a series of fixed payments. Each period, the long will receive the total return on holding the commodity times a notional principal amount, net of the payment promised to the short. If the total return is negative, the long makes the promised fixed payment percentage *plus* the negative return percentage on the commodity over the period, times the notional amount.

For example, consider a total return swap on oil with a notional value of $10 million, in which for two years the long must pay 25 basis points monthly and will receive the total return on West Texas Intermediate (WTI) crude oil. If over the first month the price of WTI increases from 41.50 bbl to 42.10 bbl (+1.45%), the long will receive a net payment of (0.0145 − 0.0025) × $10 million = $120,000.

If over the second month the price of WTI decreases from 42.10 to 41.20 (–2.14%), the long must make a payment of (–0.0214 − 0.0025) × $10 million = $239,000 to the short.

Total return swaps are often used by institutions to gain exposure to the price risk of the underlying commodity, avoiding either holding the commodity or managing a long position in futures contracts over time.

**PROFESSOR'S NOTE**

Some of the swaps described here are not constructed with two periodic payment streams and net payments based on the difference between the two payments each period, as we have seen with interest rate, currency, and equity swaps. The swap buyer instead may make a single payment at the initiation of the swap and then receive periodic payments based on the total returns, excess returns, or price volatility of a commodity, essentially "buying" exposure to the underlying risk factor.

In an **excess return swap**, a party may make a single payment at the initiation of the swap and then receive periodic payments of any percentage by which the commodity price exceeds some fixed or benchmark value, times the notional value of the swap. In months in which the commodity price does not exceed the fixed value, no payments are made.

In a **basis swap**, the variable payments are based on the difference between the prices of two commodities. Often the two commodities are one that has liquid traded futures available for hedging and the other (the one the swap buyer actually uses in production) with no liquid futures contracts available. Because the price changes of the two commodities are less than perfectly correlated, the difference between them (the basis) changes over time. By combining a hedge using the liquid futures with a basis swap, the swap buyer can hedge the price risk he faces from the input that does not have a liquid futures market.

In a **commodity volatility swap**, the underlying factor is the volatility of the commodity's price. If the volatility of the commodity's price is higher than the expected level of volatility specified in the swap, the volatility buyer receives a payment. When actual volatility is lower than the specified level, the volatility seller receives a payment. A similar swap settles based on variance in price levels of a commodity, with a swap buyer receiving a payment if the actual variance exceeds the fixed variance established at the onset of the swap. If the actual variance is lower, the variance seller receives a payment.

### LOS 42.j: Describe how the construction of commodity indexes affects index returns.

*CFA® Program Curriculum, Volume 6, page 230*

There are several published commodity indexes. To be most useful, an index should be investable, in that an investor should be able to replicate the index with available liquid futures contracts.

The available commodity indexes differ in the following dimensions:

- Which commodities are included
- The weighting of the commodities in the index
- The method of rolling contracts over as they near expiration
- The method of rebalancing portfolio weights

While no index methodology will consistently outperform another index methodology, differences in methodology do result in returns differences, at least over shorter periods. Over long periods, differences between the mix and weights of constituent commodities in

individual indexes will result in differences between returns, as some commodities outperform others.

Indexes may be equal weighted or weighted on some factor, such as the value of global production of an individual commodity or commodity sector. A production value weighted index will have more exposure to energy than to livestock or softs, for example.

With regard to roll methodology, a passive strategy may be to simply roll the expiring futures contracts into the near-month contract each month. A more active strategy would be to maximize roll return by selecting the further-out contracts with the greatest backwardation or smallest contango.

The frequency of rebalancing will also affect commodity index returns. Rebalancing portfolio weights will decrease returns when prices are trending but increase returns when price changes are choppy and mean-reverting. For this reason, price behavior across rebalancing periods will influence returns. If the prices of a commodity are choppy over short horizons but trending on a longer-term basis, frequent rebalancing may capture gains from mean reversion over the shorter periods but give up some of the gains from the trend of the commodity's price over the longer term.

While differences in index construction methodology will lead to differences among index returns over relatively shorter periods, no one methodology is necessarily superior over longer periods. Correlations between returns on different indexes have been relatively high, while correlations between commodity indexes and returns on stocks and bonds have been low.

## MODULE QUIZ 42.2

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

1. Suppose that a commodity market exhibits the following futures curve on July 1, 20X1:
   - Spot price: 42.0
   - August futures price: 41.5
   - October futures price: 40.8
   - December futures price: 39.7

   An investor establishes a fully collateralized long position on July 1, 20X1, and maintains the position for one year. The futures curve on July 1, 20X2, is identical to the futures curve on July 1, 20X1, and calendar spreads did not change significantly during the year. The investor's total return on the position is *most likely*:

   A. equal to the collateral return.
   B. less than the collateral return.
   C. greater than the collateral return.

2. An investor enters into a swap contract under which the net payment will vary directly with the price of a commodity. This contract is *most accurately* described as a(n):

   A. basis swap.
   B. total return swap.
   C. excess return swap.

# KEY CONCEPTS

## LOS 42.a

Commodity sectors include energy (crude oil, natural gas, and refined petroleum products); industrial metals (aluminum, nickel, zinc, lead, tin, iron, and copper); grains (wheat, corn, soybeans, and rice); livestock (hogs, sheep, cattle, and poultry); precious metals (gold , silver, and platinum); and softs or cash crops (coffee, sugar, cocoa, and cotton).

Crude oil must be refined into usable products but may be shipped and stored in its natural form. Natural gas may be used in its natural form but must be liquefied to be shipped overseas.

Industrial and precious metals have demand that is sensitive to business cycles and typically can be stored for long periods.

Production of grains and softs is sensitive to weather. Livestock supply is sensitive to the price of feed grains.

## LOS 42.b

The life cycle of commodity sectors includes the time it takes to produce, transport, store, and process the commodities.

- Crude oil production involves drilling a well and extracting and transporting the oil. Oil is typically stored for only a short period before being refined into products that will be transported to consumers.
- Natural gas requires little processing and may be transported to consumers by pipeline.
- Metals are produced by mining and smelting ore, which requires producers to construct large-scale fixed plants and purchase equipment. Most metals can be stored long term.
- Livestock production cycles vary with the size of the animal. Meat can be frozen for shipment and storage.
- Grain production is seasonal, but grains can be stored after harvest. Growing seasons are opposite in the northern and southern hemispheres.
- Softs are produced in warm climates and have production cycles and storage needs that vary by product.

## LOS 42.c

In contrast to equities and bonds, which are valued by estimating the present value of their future cash flows, commodities do not produce periodic cash inflows. While the spot price of a commodity may be viewed as the estimated present value of its future selling price, storage costs (i.e., cash outflows) may result in forward prices that are higher than spot prices.

## LOS 42.d

Participants in commodity futures markets include hedgers, speculators, arbitrageurs, exchanges, analysts, and regulators.

Informed investors are those who have information about the commodity they trade. Hedgers are informed investors because they produce or use the commodity. Some speculators act as

informed investors and attempt to profit from having better information or a better ability to process information. Other speculators profit from providing liquidity to the futures markets.

### LOS 42.e

Basis is the difference between the spot price and a futures price for a commodity. Calendar spread is the difference between futures prices for contracts with different expiration dates.

A market is in contango if futures prices are greater than spot prices, or in backwardation if futures prices are less than spot prices. Calendar spreads and basis are negative in contango and positive in backwardation.

### LOS 42.f

Insurance Theory states that futures returns compensate contract buyers for providing protection against price risk to futures contract sellers (i.e., the producers). This theory implies that backwardation is a normal condition.

The Hedging Pressure Hypothesis expands on Insurance Theory by including long hedgers as well as short hedgers. This theory suggests futures markets will be in backwardation when short hedgers dominate and in contango when long hedgers dominate.

The Theory of Storage states that spot and futures prices are related through storage costs and convenience yield.

### LOS 42.g

The total return on a fully collateralized long futures position consists of collateral return, price return, and roll return. Collateral return is the yield on securities the investor deposits as collateral for the futures position. Price return or spot yield is produced by a change in spot prices. Roll return results from closing out expiring contracts and reestablishing the position in longer-dated contracts.

### LOS 42.h

Roll return is positive when a futures market is in backwardation because a long position holder will be buying longer-dated contracts that are priced lower than the expiring contracts. Roll return is negative when a futures market is in contango because the longer-dated contracts are priced higher than the expiring contracts.

### LOS 42.i

Investors can use swaps to increase or decrease exposure to commodities. In a total return swap, the variable payments are based on the change in price of a commodity. In an excess return swap, the variable payments are based on the difference between a commodity price and a benchmark value. In a basis swap, the variable payments are based on the difference in prices of two commodities. In a commodity volatility swap, the variable payments are based on the volatility of a commodity price.

### LOS 42.j

Returns on a commodity index are affected by how the index is constructed. The index components and weighting method affect which commodities have the greatest influence on the index return. The methodology for rolling over expiring contracts may be passive or active. Frequent rebalancing of portfolio weights may decrease index returns in trending markets or increase index returns in choppy or mean-reverting markets.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 42.1

1. **B** Precious metals mining and smelting are less susceptible to changing weather. Weather is an important factor in grain production with both droughts and flooding affecting crop yields. Oil refineries are concentrated in coastal areas where hurricanes and other extreme weather cause periodic refinery shutdowns. (LOS 42.a)

2. **B** Coffee has a long production cycle but is grown at warm latitudes and harvested throughout the year. Livestock production is strongly influenced by seasonality. Natural gas demand has a seasonal component due to its uses for heating and electricity generation for cooling. (LOS 42.b)

3. **A** While a commodity or a nondividend-paying equity security can be valued in terms of the present value of its future sale price, a commodity may have holding costs, such as storage, that can result in a forward price that is higher than the spot price. (LOS 42.c)

4. **C** Arbitrageurs may store a physical inventory of a commodity to exploit differences between spot and futures prices relative to the costs of storing the commodity. (LOS 42.d)

5. **A** In backwardation, longer-dated futures contracts are priced lower than shorter-dated contracts or spot prices, resulting in positive basis and calendar spreads. (LOS 42.e)

6. **A** According to Insurance Theory, backwardation is normal because futures contract buyers should earn a positive return for protecting commodity producers (short hedgers) from price risk. The Hedging Pressure Hypothesis and the Theory of Storage can explain either backwardation or contango. (LOS 42.f)

## Module Quiz 42.2

1. **C** The price return is zero because the spot price is unchanged over the life of the position. The roll return is positive because the market is in backwardation. Therefore the total return (price return + roll return + collateral return) is greater than the collateral return. (LOS 42.g)

2. **B** In a total return swap, the variable payment is based on the price of a commodity. In an excess return swap, the variable payment is based on the amount by which a commodity price is greater than a benchmark, and the payment is zero if the price is less than the benchmark. The variable payment of a basis swap depends on the difference between two commodity prices. (LOS 42.i)

# TOPIC ASSESSMENT: ALTERNATIVE INVESTMENTS

*You have now finished the Alternative Investments topic section. The following topic assessment will provide immediate feedback on how effective your study of this material has been. The test is best taken timed; allow 3 minutes per subquestion (18 minutes per item set). This topic assessment is more exam-like than typical module quizzes or QBank questions. A score less than 70% suggests that additional review of this topic is needed.*

**Use the following information for Questions 1 through 6.**

Eva Williams is an investment manager for Straughn Capital Management (SCM). Williams believes that it would be beneficial to add some alternative investments to SCM's existing portfolio. She has asked Steven Riley, an analyst with the firm, to present some investment ideas to her. Riley is not certain which type of alternative investment might be most suitable for SCM, so he has prepared information regarding three different types of investments. The first investment is a hedge fund. The second investment is an office building in the downtown district of a major city. The third investment is a venture capital fund.

While describing each of the properties, Riley makes the following observations:

*Observation 1*: Commodity investments, such as an investment in precious metals, are a good inflation hedge. Commodities as an asset class are receiving a lot of attention from hedge funds.

*Observation 2*: The value of an office building is heavily influenced by its location. Demand for office space is positively correlated with job growth. Also, the average length of lease terms varies globally. Furthermore, leases can be gross or net leases. In a net lease, the owner is responsible for the operating expense of a real estate property.

*Observation 3*: Similar to hedge funds, venture capital funds tend to be very illiquid. In evaluating venture capital funds, one needs to be careful about the economic terms. For example, the ratchet arrangement specifies the allocation of equity between the general partner and limited partners of the fund. Additionally, carried interest specifies the general partner's share of the fund profits. One should also consider the general partner's ability to raise capital as indicated by the difference between target fund size and funds actually raised.

Riley also provides information for the office building. The building under consideration is 200,000 square feet and has several structural issues that cannot be repaired. The effective age of the building is 12 years. The economic life of the building is 50 years. The elevators in the property need to be replaced at a cost of $1,200,000, but this replacement will increase the value of the building by $1,400,000. The design of the building is inferior to that of newer buildings and hence the rental income is lower by $375,000 per year. Cost of new construction including builder profit is $400 per square foot and the value of the land is estimated at $6,000,000. The applicable cap rate is 7.5%.

Finally, Riley provides information on a specific venture capital deal under consideration by Greenleaf Partners, a venture capital fund. Greenleaf is considering investing $2 million in a startup that is expected to be worth $40 million in seven years. Greenleaf considers 30% an appropriate rate of return given the risk of this investment.

1. Compared to an investment in REOCs, one disadvantage of investing in REITs is:
   A. limited potential for income growth.
   B. greater taxation.
   C. lack of control.

2. Hedge fund managers who believe in the Insurance Theory are *most likely* to take what kind of positions in commodity futures contracts?
   A. Long only.
   B. Short only.
   C. Long or short positions.

3. With respect to observation 2, Riley's assertions regarding office buildings, which statement would be *least accurate*? The statement about:
   A. the length of the lease.
   B. correlation with job growth.
   C. net lease characteristics.

4. With respect to observation 3, Riley's assertions regarding venture capital funds, which statement is *least accurate*? The statement about:
   A. the liquidity of venture capital funds.
   B. ratchet.
   C. the general partner's ability to raise capital.

5. Using the cost approach, the value of the office building is *closest* to:
   A. $54 million.
   B. $55 million.
   C. $61 million.

6. Based on the information provided, the maximum fractional equity ownership allocated to the founders after Greenleaf's $2 million investment is *closest* to:
   A. 30%.
   B. 46%.
   C. 69%.

# TOPIC ASSESSMENT ANSWERS: ALTERNATIVE INVESTMENTS

1. **A** Due to high dividend payout (and low retention rates), REITs have limited potential for income growth. Exemption from taxation is an advantage that REITs enjoy compared to REOCs. Investors in both REITs and REOCs suffer from lack of control. (Study Session 15, Module 40.1, LOS 40.b)

2. **A** The Insurance Theory holds that commodity producers will hedge their commodity price risk. Under the Insurance Theory, the cost of this risk reduction is a premium paid to speculators to entice them to take the long position in futures contracts. Consequently, futures prices should be less than expected spot prices, and a long-only position should result in positive excess returns. (Study Session 15, Module 42.1, LOS 42.f)

3. **C** Net lease entails that the tenant (and not the owner) incurs the operating expense for the property. (Study Session 15, Module 40.1, LOS 40.d)

4. **B** Ratchet determines the allocation of equity between management of the investee company and the stockholders and not the allocation between the general and limited partners of the private equity fund. (Study Session 15, Module 41.2, LOS 41.f)

5. **C**

| | |
|---|---|
| Replacement cost (200,000 sq. ft. @ $400) | $80 million |
| (–) Curable depreciation [elevators] | $1.2 million |
| Replacement cost after curable dep. | $78.8 million |
| (–) Incurable physical deterioration [structural issues] (12 / 50 × 78.8 million) | $18.9 million |
| (–) Incurable functional obsolescence (design) (375,000 lower rent/0.075 cap rate) | $5 million |
| (+) Market value of land | $6 million |
| (=) Value of property | $60.9 million |

(Study Session 15, Module 39.4, LOS 39.i)

6. **C** POST = 6.375 (PV of $40 million in 7 years @ 30%)

Greenleaf's fractional equity ownership = 2 / 6.375 = 31.37%.

Maximum equity allocated to founders = 100 – 31.37 = 68.63%.

(Study Session 15, Module 41.4, LOS 41.j)

The following is a review of the Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #43.

# READING 43: EXCHANGE-TRADED FUNDS: MECHANICS AND APPLICATIONS

**Study Session 16**

## EXAM FOCUS

This topic review covers introductory material on ETFs. Be able to describe costs, risks, and sources of tracking risk for ETFs, as well as sources of discount/premium relative to NAV. Portfolio management applications of ETFs should be well understood.

## MODULE 43.1: ETF MECHANICS AND TRACKING ERROR

Video covering this content is available online.

**Exchange-traded funds (ETFs)** represent shares in an index-tracking (i.e., benchmark) portfolio that trades on secondary markets. While similar to mutual funds, significant differences remain with respect to costs and taxation. While most ETFs are based on direct investments in underlying securities, ETFs can also utilize derivatives, invest via American depositary receipts (ADRs), or use leverage. The issuer (i.e. sponsor or manager) of the ETF allocates the portfolio based on the stated index/style and stands ready to redeem or create new shares in kind.

### LOS 43.a: Explain the creation/redemption process of ETFs and the function of authorized participants.

*CFA® Program Curriculum, Volume 6, page 254*

Unlike open-end mutual funds, ETFs are traded on secondary markets. Therefore, when a shareholder wants to cash out, the shareholder sell his shares at the exchange where the ETF is traded; the ETF issuer is not involved in this transaction.

The ETF issuer designates **authorized participants (APs)**. APs are large broker-dealers that make the market in that ETF as primary market participants. APs are permitted to create additional shares, or redeem existing shares, for a service fee payable to the ETF manager. This creation/redemption process is in-kind: APs deliver a basket of securities (which may include cash) to the issuer in exchange for a number of ETF shares. They may also redeem ETF shares for a basket of securities. The ETF manager publicly discloses the list of required in-kind securities, known as the **creation basket**, each business day. The creation basket serves as a key input in determining the net asset value (NAV) of the ETF. A related term is the **redemption basket**, which is the specific assortment of securities that the AP receives upon redeeming an ETF share.

The lot size in these primary market transactions is the **creation** unit; an ETF issuer specifies the size of a block of ETF shares (commonly 50,000) that can be traded as part of this creation/redemption process.

The in-kind creation/redemption process serves three purposes:

1. *Lower cost:* The creation/redemption process does not force the ETF manager to sell/purchase portfolio investments; the manager does not incur any resulting transaction cost. The ETF manager usually collects a service charge from the AP to cover any incidentals.
2. *Tax efficiency:* A major benefit of the in-kind creation/redemption process is that it is not a taxable event. For a mutual fund, liquidity needs for redemption are often met by the fund manager by selling some of the fund's holdings, which triggers transaction costs as well as potential capital gains taxes. These costs are borne by all the shareholders of the fund (including those that did not redeem shares). Additionally, ETF managers can choose to publish customized redemption baskets, allowing them to target low-basis stocks that will be part of the redemption basket. This increases the tax efficiency (i.e., increases the basis) of the remaining holdings of the ETF.
3. *Keeping market prices in line with NAV:* APs will engage in arbitrage transactions if the ETFs trade at a price significantly different from their NAV. If the ETF trades at a premium, APs can sell the ETF, purchase the creation basket, and recreate those shares. Similarly, if the ETF trades at a significant discount to NAV, the APs can purchase the ETF and redeem the shares.

It should be noted that APs incur transaction costs in creating the creation basket (or selling the redemption basket) in addition to any service fees that the ETF manager charges for creation/redemption. This implies that ETFs should trade within a price band of the NAV, known as the **arbitrage gap**. Because the liquidity of the securities in the basket determines the transaction cost, the arbitrage gap tends to be wider for ETFs with illiquid holdings. Due to difference in time zones, an ETF on a foreign index may exhibit a difference between its NAV and the last closing price when the foreign market was open. This timing difference increases risk for the AP, leading to a wider arbitrage gap. Similarly, ETFs with underlying illiquid securities (e.g., corporate bonds) would also have a wider arbitrage gap, because of the market risk borne by the AP during the time it takes to complete the trade.

APs pass on these costs in the form of bid-ask spreads on ETFs, which means that only transacting shareholders pay these costs, unlike with mutual funds where all shareholders bear this cost. Similarly, unlike mutual funds, ETFs are *tax fair* because redemptions are in kind and do not affect the nontransacting shareholders.

### LOS 43.b: Describe how ETFs are traded in secondary markets.

*CFA® Program Curriculum, Volume 6, page 258*

ETFs trade on secondary markets just as stocks do. In the United States, the **National Security Clearing Corporation (NSCC)** guarantees the performance of parties to a trade on an exchange. The **Depository Trust Company** (DTC), a subsidiary of NSCC, transfers the securities from the account of the seller's broker to the account of buyer's broker at the end of the two-day settlement period. Individual client-level ownership records are maintained by the brokers. Market makers, due to their special significance, and due to the time required by the creation/redemption process, are afforded up to six days to settle their trades.

European markets are fragmented across many exchanges and countries, and ETF investors there tend to be mostly institutional investors. A majority of ETF trades occur in the over-the-counter (OTC) markets, without "live" bid and offer prices. Most European ETFs are listed

on multiple exchanges and may have multiple classes. With 29 central depositories in Europe, the added complexity in settlement may widen the quoted bid-ask spreads.

### LOS 43.c: Describe sources of tracking error for ETFs.

*CFA® Program Curriculum, Volume 6, page 261*

**Tracking difference** is the divergence between an ETF's return (based on its NAV) and the return on the tracked index. This measure provides an indication of the ETF's ability to follow its underlying benchmark. **Tracking error** is the annualized standard deviation of the daily tracking difference. Calculated as a standard deviation, tracking error does not indicate whether the ETF under- or outperformed the index, nor does it reveal the distribution of relative differences in return (i.e., whether the tracking difference occurred over time or was concentrated in a specific period).

As opposed to daily tracking difference, rolling holding periods allow us to evaluate the cumulative effect of portfolio management and expenses over a longer time period. Annual rolling holding period can be compared to an ETF's expense ratio; ETFs generally underperform the benchmark by their expense ratio.

Sources of tracking error include the following:

1. **Fees and expense**. Fees reduce a fund's return.
2. **Sampling and optimization**. ETFs may use statistical techniques to replicate the performance of a benchmark without investing in all the securities that the index covers. Optimization techniques often favor higher-liquidity securities (and larger market cap companies) to minimize transaction cost. As a result, the ETF may impart a size bias relative to the benchmark.
3. **Depository receipts (DRs)**. Foreign index ETFs often invest in DRs (rather than less-liquid securities traded on local exchanges). Any difference between the price of DRs and corresponding security (e.g., due to time zone differences in capturing price data) may contribute to tracking error of the ETF. Furthermore, sometimes an ETF may invest in other (sector) ETFs, and thus inherit the tracking errors of those ETFs.
4. **Index changes**. Index providers will occasionally rebalance or reorganize their indexes. ETF managers often use the creation/redemption process to rebalance the ETF portfolio to reflect this change in the index. The resulting delays from the use of the creation/redemption process contributes to tracking error. Because changes to an index are relatively infrequent, this component is often the smallest contributor to total tracking error.
5. **Regulatory and tax requirements**. In some countries, tax rates for foreign investors and domestic investors differ, leading to a difference in after-tax returns between an ETF and the index that it tracks.
6. **Fund accounting practices**. The time of the day when ETF NAV is calculated versus when the index provider performs this computation can lead to differences in calculated returns. Additionally, ETFs with foreign-currency-denominated holdings may use exchange rate values captured at a different time than the rate used by the index provider.
7. **Asset manager operations**. ETF managers may try to lower their cost by lending their shares to short sellers, and by foreign dividend capture (i.e., by working with foreign

governments to minimize the taxes on distributions received). These methods tend to improve ETF performance relative to their benchmark.

### MODULE QUIZ 43.1

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

1. Z&E ETF is currently trading at $23.45 per share. Its NAV is $23.00. Beta Bank, an authorized participant in the ETF, would *most likely*:
   A. do nothing.
   B. redeem shares if the arbitrage gap is more than $0.45.
   C. create shares if the arbitrage gap is less than $0.45.
2. The arbitrage gap on an ETF is *most likely* to be negatively related to:
   A. the liquidity of the securities underlying the index that the ETF is trading.
   B. the service fees that the AP has to pay to the ETF manager for creation/redemption.
   C. the timing difference between when the ETF trades and when the securities underlying the tracked index trade.
3. The authorized participants (APs) in an ETF are *most likely* to be required to settle their ETF trades in:
   A. one day.
   B. two days.
   C. six days.
4. Tracking error for an exchange-traded fund is *most accurately* described as:
   A. the difference between the ETF's return and the return on the underlying index. id="page_136" title="136"
   B. the annualized difference between the ETF's returns and the return on underlying index adjusted for ETF expenses.
   C. the annualized standard deviation of the difference between daily returns on the ETF and the daily returns of its underlying index.
5. Which of the following is *least likely* to be a source of tracking error?
   A. Fund accounting practices.
   B. Creation/redemption processes.
   C. Asset manager operations.

## MODULE 43.2: SPREADS, PRICING RELATIVE TO NAV, AND COSTS

Video covering this content is available online.

### LOS 43.d: Describe factors affecting ETF bid–ask spreads.

*CFA® Program Curriculum, Volume 6, page 268*

The primary factors affecting ETF spreads are the liquidity and the market structure of the underlying securities.

- Spreads on fixed-income ETFs tend to be larger than those for large-cap equity ETFs.
- When ETFs and underlying securities trade in different markets and time zones, the spreads are narrower during the overlapping time period when both markets are open.
- Specialized ETFs, such as those that track commodities, volatility futures, or small-cap stocks, tend to have wider spreads.
- Thinly-traded ETFs, regardless of the liquidity of the underlying, also command a higher spread.

A market maker can offset an ETF transaction either with another counterparty in the secondary market or via the creation/redemption process in the primary market. Quoted

spreads depend on whether the dealer is reasonably assured of completing an offsetting trade in the near future in the secondary market. APs can also undertake redemption/creation transactions in the primary market.

maximum spread =

creation/redemption fees plus other trading costs

+ spread of the underlying securities

+ risk premium for carrying the trade until close of trading

+ AP's normal profit margin

– discount based on probability of offsetting the trade in secondary market

Note that the posted bid-ask prices are for smaller order sizes, while larger trades are best handled via negotiation. For larger trades, the negotiated spreads vary based on liquidity conditions and volatility in the market. Spreads widen during volatile times or when significant new information is expected to be released to the market.

### LOS 43.e: Describe sources of ETF premiums and discounts to NAV.

*CFA® Program Curriculum, Volume 6, page 270*

The NAV of an ETF is generally its fair value. If the ETF and the underlying securities trade on the same exchange, all closing prices are contemporaneously determined and any timing-related noise in pricing is eliminated. Exchanges publish intraday **indicated NAVs (iNAVs)**, which are the fair value estimates during the trading day.

An ETF trading at a price above (below) NAV is said to be trading at a premium (discount). The premium or discount is calculated as a proportion of the NAV.

Using closing prices:

ETF premium (discount) % = (ETF price – NAV per share) / NAV per share

Sources of premiums or discounts include the following:

- **Timing differences**. ETFs on foreign securities may experience gaps between the time the ETF is traded and the time when the underlying trades in a foreign market. These timing differences can cause a discrepancy between the NAV and the ETF's trading price. NAV may be based on the market's estimate of what those foreign securities would trade at if their local market was still open.

  Similarly, OTC bonds that do not trade on an exchange will not have a true closing price; hence, the price of an ETF that comprises such bonds may not be equal to estimated NAV. Fair value estimates of nontraded bonds are often determined by pricing services that may base fair value estimates on bid prices of comparable bonds. If these bid prices are low due to higher dealer risk of carrying those bonds in inventory, the closing ETF price would be higher than the NAV based on these fair value estimates.

- **Stale pricing**. Infrequently traded ETFs may reflect noncurrent prices and, therefore, their value may differ from NAV. Suppose the last ETF trade occurred at 2:00 pm ET and the markets (for the ETF and the underlying) closed at 4:00 pm ET. The NAV

calculated based on the closing prices of the underlying may differ from the stale price (i.e., the 2:00 pm price) of the ETF.

ETF prices may be more informative than NAV or iNAV when (1) the market for the underlying is closed, (2) underlying securities are highly volatile or illiquid, or (3) there is a time lag between the pricing of the ETF and the pricing of underlying.

### LOS 43.f: Describe costs of owning an ETF.

*CFA® Program Curriculum, Volume 6, page 273*

ETF costs include management fees and trading costs. Because the market for ETF providers is highly competitive, and because ETFs are passively managed, management fees for ETFs tend to be lower than those for mutual funds.

Trading costs include brokerage or commission fees and bid-ask spreads. Additionally, larger orders may incur price-impact costs depending on the liquidity of the secondary market. The premium/discount relative to NAV can be another hidden part of the trading cost (that is realized if the said premium/discount reverses over the holding period).

The portfolio turnover of ETFs results in an implicit cost which acts as a drag on returns for the investor. ETFs that track stable indices will have lower portfolio turnover cost; this cost is negligible for most ETFs.

Because trading costs are only incurred at the time of the transaction, annualized trading cost diminishes over a longer holding period. For investors that trade frequently, the spread and commission (part of trading cost) are far more important components of the total cost. For long-term, buy-and-hold investors, management fees are a more important component of the cost:

total cost = round-trip trading cost + management fees

round-trip trading cost = round-trip commission + spread

**EXAMPLE: Cost of investing in ETFs**

Z&E ETF is quoted at a bid-ask spread of 0.15%. ETF commissions are 0.10% of the trade value. Management fees are 0.08% per year.

Calculate the cost of holding the ETF for 3 months, for 1 year, and for 5 years. For the 5-year holding period, also calculate the average annual total cost.

**Answer:**

Round-trip commission = 2 × 0.10% = 0.20%

Round-trip trading cost = round-trip commission + spread = 0.20% + 0.15% = 0.35%

Holding cost for 3 months = round-trip trading cost + management fees = 0.35% + (3/12) × 0.08% = 0.37%

Holding cost for 1 year = 0.35% + 0.08% = 0.43%

Holding cost for 5 years = 0.35% + (5 × 0.08%) = 0.75%.

Average annual cost (for 5-year holding period) = 0.75% / 5 = 0.15%

As can be seen in the previous example, for shorter holding periods, trading cost dominates the cost of ETF ownership. Short-term tactical traders may prefer to trade in high-liquidity,

lower trading cost ETFs even if they have higher management fees. Conversely, long-term investors are likely to seek out ETFs with low management fees.

### MODULE QUIZ 43.2

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

1. The maximum quoted spread on an ETF is *most likely* to be negatively related to:
   A. the AP's profit margin.
   B. the quoted spreads of securities underlying the tracked index.
   C. the probability of completing an offsetting trade in the secondary market.
2. If an ETF is trading at a price above its iNAV, it is *most likely*:
   A. overvalued.
   B. trading at a premium.
   C. trading at a discount.
3. Of the various components of ETF cost, a long-term buy-and-hold investor is *most likely* to focus on:
   A. management fees.
   B. trading costs.
   C. creation/redemption service fees.

## MODULE 43.3: ETF RISKS AND PORTFOLIO APPLICATIONS

Video covering this content is available online.

### LOS 43.g: Describe types of ETF risk.

*CFA® Program Curriculum, Volume 6, page 275*

Risks of investing in an ETF include the following:

- **Counterparty risk**. Some ETF legal structures expose the investors to counterparty risk. **Exchange-traded notes (ETNs)**, for example, have high counterparty risk. In the case of an ETN, an issuer (typically a bank) issues unsecured debt obligations that promise to pay the return on an index less management fees (just like a regular ETF). Consider, for example, a large bank that wants to issue unsecured debt at a fixed interest rate. If the fixed interest rate that the market demands is significantly higher than the swap fixed rate for same maturity, the bank may instead issue an ETN that pays the return on an equity index. The bank then would simultaneously enter into an equity swap as the equity return receiver and the (swap) fixed rate payer. The index return received is used to service the ETF, and the bank's effective borrowing cost becomes the swap fixed rate (we will assume that the ETN management fees cover the actual cost of the structure).

  The concern here is that the bank may default, resulting in losses for the ETN investor (e.g., Lehman Brothers defaulted on three ETNs in 2008). Investors can estimate the counterparty credit risk by the credit default spreads (CDS spread) of the issuing bank: large CDS spreads indicate high counterparty risk. In general, a one-year CDS spread above 5% is considered to be very risky.

- **Settlement risk**. ETFs using OTC derivative contracts as part of their strategy expose investors to the settlement risk of such contracts. ETFs mitigate settlement risk by frequent (e.g., daily or weekly) settlement, and/or by requiring collateral to be posted.

- **Security lending**. Like mutual funds, ETFs may lend their securities to short sellers for a fee. These lending agreements are overcollateralized, and the collateral is invested in short-term risk-free securities. Lending fees are often lucrative and are usually passed on to the ETF investors, offsetting the fund's operating expenses. The (rather insignificant) risk of the security borrower defaulting is, however, borne by the ETF investors.
- **Fund closures**. Similar to mutual fund closures, ETF closures involve selling the underlying holdings and making cash distributions to the investors, potentially with adverse tax consequences for them. *Soft closures* entail creation halts and changes in investment strategy. Closures may be triggered by changes in regulation, competitive pressures, or issuer merger. Increased competition may force ETFs that fail to attract sufficient capital to close prematurely.

  In addition to fund closures, investors may also be exposed to the risk of creation/redemption halts. Particular to ETNs, this risk arises when the issuer is no longer interested in additional borrowings. When creations are halted, ETNs may trade at a significant premium to their NAV as the arbitrage mechanism breaks down.

  Another reason for fund closure is that the issuer may want to change investment strategy. This results in closing down of the fund tracking the original strategy and opening of a new fund tracking a different strategy. This is rather uncommon, as, more typically, issuers make minor changes in investment strategy, requiring small adjustments to portfolio composition rather than fund closure.

- **Expectation-related risk**. ETFs based on complex strategies (e.g., inverse or leveraged ETFs) may introduce the investor to risks that they may not fully comprehend (i.e., the outcomes may differ from investors' expectations). These complex ETFs might use derivative products to implement their investment strategy that must reset daily (i.e., have daily settlement).

  For example, an ETF with NAV of $100 delivering two times the S&P 500 return would enter into a swap with a notional twice the NAV of the ETF (reset daily). Suppose that the daily return is +5% on the first day, and –5% on the next day. The NAV would grow to 100 + (2 × 5%) = $110 on the first day. On the second day, the NAV would decline by 10% or 110 × (1 – 0.10) = $99. A less-sophisticated investor might expect the NAV to finish unchanged by these offsetting returns.

  The compounding effects of leveraged ETFs make them unsuitable for buy-and-hold investors with investment horizons exceeding one month.

### LOS 43.h: Identify and describe portfolio uses of ETFs.

*CFA® Program Curriculum, Volume 6, page 279*

Due to their low costs, tax efficiency, and wide variety, ETFs are suitable for numerous portfolio strategies. Some of them are described in the following.

1. **Efficient portfolio management**, including the following:
   a. *Portfolio liquidity management:* Managers can quickly equitize excess cash by investing it in ETFs, in order to reduce cash drag on the portfolio. Because of

their superior liquidity, ETFs have a lower transaction cost as compared to other securities; portfolio allocations to ETFs can be used to cover future cash outflows.

b. *Portfolio rebalancing:* ETFs can be used to cost-effectively rebalance portfolios to target specific asset class weights. ETFs can also be shorted to quickly reduce the weight of a specific sector or asset class.

c. *Portfolio completion:* ETFs can be used to fill temporary gaps in portfolio allocation. Gaps can arise due to manager turnover (when the new manager has different macro views) or when the existing manager's allocation differs from the investor's desired exposure. Suppose for example that a manager moves out of small-caps; an investor seeking continued exposure to small-caps can invest a portion of her portfolio in a small-cap ETF. Similarly, investors in an actively managed fund could use ETFs to adjust overall exposure to suit their individual preferences.

d. *Transition management:* A new manager might temporarily invest in ETFs as she winds down the portfolio allocations of the old manager, so as to maintain market exposure during the transition period.

It should be noted that ETFs may not be suitable for very large asset owners: separately managed accounts (SMAs) may be able to operate at a cost even lower than the ETF fees. Furthermore, SMAs can be customized (as opposed to the rigid allocations of ETFs). Finally, regulators often require public disclosure of large ETF holdings, which SMAs may not want to do.

2. **Asset class exposure management.** The wide variety of ETFs, including asset class, subclass, and sector, allow a manager to implement a variety of strategies suitable for their clients. Often, ETFs provide significant cost advantages relative to investing in the underlying securities. For example, it is easier to trade fixed-income ETFs versus the underlying bonds (which tend to be relatively illiquid). Strategies include the following:

   a. *Core exposure to an asset class or sub-asset class:* Portfolio allocations to passive indices of various asset classes/subclasses can be cost-effectively implemented using ETFs. Portfolios can be broadly diversified by investing in different sectors of equity asset class, commodities, bonds, etc. Targeted strategic allocation to a specific subsector can also be implemented for an investor based on suitability (e.g., an investor seeking exposure to precious metals).

   b. *Tactical strategies:* Managers can temporarily rotate money into/out of sectors expected to perform better/worse using ETFs. Thematic ETFs can also be used to select subsectors (e.g., ecommerce versus the broad technology sector) that are expected to outperform. ETFs selected for short-term tactical strategies are selected based on lower trading cost and liquidity rather than low management fees. (Liquidity is evaluated using the ratio of average dollar volume to average assets—higher is better).

3. **Active investing.** While ETFs have historically been used for passive allocation to asset classes, newer varieties of ETFs with an active component have gained traction, especially for fixed income. These ETFs are constructed based on predefined rules rather than manager discretion. Smart beta ETFs, for example, may use quantitative screens or use weights based on company fundamentals (e.g., dividend yield).

a. *Factor (smart beta) ETFs:* Benchmarked to an index that is created with predefined rules (e.g., with screens and weightings). The ETF strategy is based on return drivers (i.e., factors such as size and momentum). Within a single factor, competing ETF managers' offerings may differ based on the factor chosen or the weights assigned to portfolio holdings (e.g., equal weighted versus cap-weighted). Long-term buy-and-hold investors seeking a desired factor exposure may choose to invest in these ETFs in the expectation of outperformance of those factors. Multifactor ETFs provide exposure to several factors and can dynamically change portfolio weights based on market opportunities. Performance of these ETFs depends on whether the ETF (via its rules) was successful in gaining exposure to that factor, and whether the chosen exposure was rewarded by the market.

b. *Risk management:* Some ETFs are constructed to provide higher or lower risk relative to a passive index. Low volatility ETFs, for example, use rules to construct portfolios with low relative return volatility. Some ETFs may be constructed to hedge specific risks; currency-hedged global equity ETFs provide international equity exposure but without the added currency risk. Similarly, duration-risk-hedged high-yield corporate bond ETFs only provide exposure to credit risk while hedging the interest rate risk.

c. *Alternatively weighted ETFs:* Constructed using portfolio weights that differ from standard market cap weights (e.g., equally weighted, weightings based on fundamentals).

d. *Discretionary active ETFs:* Actively managed and are similar to closed-end mutual funds. The largest of these are fixed-income ETFs, which include exposures to senior bank loans, mortgage securities, and floating rate notes.

e. *Dynamic asset allocation and multi-asset strategies:* Dynamic top-down asset allocation ETFs that invest in stocks and bonds based on risk/return forecasts. These are popular among global asset managers and hedge funds for their discretionary asset allocation.

With a wide variety of "alternative" ETFs available, investors should perform due diligence regarding index construction methodology and performance history to determine suitability.

## MODULE QUIZ 43.3

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

1. Exchange-traded notes are *most likely* to be described as having a high:
   A. settlement risk.
   B. counterparty risk.
   C. fund closure risk.

2. Inverse leveraged ETFs are *most likely* to be described as having a high:
   A. expectation-related risk.
   B. counterparty risk.
   C. fund closure risk.

3. Smart beta strategies are *most likely* to be used by investors seeking to:
   A. outperform the benchmark.
   B. match the benchmark risk.
   C. trade for tactical purposes.

4. Active ETF strategies are *most likely* to be used:
   A. for fixed income rather than for equity.
   B. for tactical trading.

C. to reduce the tracking risk.

# KEY CONCEPTS

## LOS 43.a

Authorized participants (APs) can create additional shares by delivering the creation basket to the ETF manager. Redemption is similarly conducted by tendering ETF shares and receiving a redemption basket. These primary market transactions are in kind and require a service fee payable to the ETF issuer, shielding the nontransacting shareholders from the costs and tax consequences of creation/redemption. The creation/redemption process ensures that market prices of ETFs stay within a narrow band of the NAV.

## LOS 43.b

ETFs are traded just like other shares on the secondary markets. Market fragmentation may widen the quoted spreads for European ETFs.

## LOS 43.c

Tracking error is the annualized standard deviation of the daily tracking difference. Sources of tracking error include fees and expenses of the fund, sampling, and optimization used by the fund, the fund's investment in depository receipts (DRs) (as opposed to the underlying shares directly), changes in the index, regulatory and tax requirements, fund accounting practices, and asset manager operations.

## LOS 43.d

ETF spreads are positively related to the cost of creation/redemption, the spread on the underlying securities, the risk premium for carrying trades until close of trade, and the APs' normal profit margin. ETF spreads are negatively related to the probability of completing an offsetting trade on the secondary market. Creation/redemption fees and other trading costs can influence spreads as well.

## LOS 43.e

$$\text{ETF premium (discount) \%} = (\text{ETF price} - \text{NAV}) / \text{NAV}$$

Sources of premium or discount include timing difference for ETFs with foreign securities traded in different time zones and stale pricing for infrequently traded ETFs.

## LOS 43.f

ETF costs include trading cost and management fees. Short-term investors focus on lower trading costs while longer-term, buy-and-hold investors seek lower management fees. Trading costs tend to be lower for more-liquid ETFs. Liquidity is evaluated using the ratio of average dollar volume to average assets (higher is better).

## LOS 43.g

Risks of investing in ETFs include counterparty risk (common for ETNs), fund closures, and expectation-related risk.

## LOS 43.h

Portfolio uses of ETFs include the following:

1. Efficient portfolio management, including liquidity management, portfolio rebalancing, portfolio completion, and transition management.

2. Asset class exposure management, including core exposure to an asset class or sub-asset class as well as tactical strategies.
3. Active investing, including smart beta, risk management, alternatively weighted ETFs, discretionary active ETFs, and dynamic asset allocation.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 43.1

1. **C** The AP would earn a profit by selling the shares in the market at $23.45 while creating shares at $23.00 plus costs. These costs (or arbitrage gap) would have to be less than $0.45 per share for the AP to make a profit. (LOS 43.a)

2. **A** The arbitrage gap varies with transaction costs, service fees payable to the ETF manager, and the timing difference between when the ETF trades and when the underlying securities trade (due to time zone differences for foreign securities). Illiquid securities will generally have higher transaction costs and hence higher arbitrage gaps, while liquid securities will have a lower arbitrage gap. (LOS 43.a)

3. **C** APs are typically given 6 days to complete settlement, reflecting the amount of time needed for creation/redemption. (LOS 43.b)

4. **C** Tracking error is the annualized standard deviation of the daily tracking difference, which is the difference between daily returns on an ETF and daily returns of the underlying index. (LOS 43.c)

5. **B** The creation/redemption process may actually mitigate tracking error when the index changes. The other two are sources of tracking error. (LOS 43.c)

## Module Quiz 43.2

1. **C** A higher probability of completing an offsetting trade results in a reduction (i.e., discount) in the quoted spreads. The other two components are *positively* related to the quoted spread. (LOS 43.d)

2. **B** ETFs trading at a price above their iNAV are said to be trading at a premium. The ETF need not be overvalued; the premium may be the result of timing differences. (LOS 43.e)

3. **A** While all costs are important, long-term investors should be more concerned with recurring annual management fees as opposed to one-time trading costs. Creation/redemption fees are paid by the AP to the ETF manager and are reflected in the quoted spread (which is part of trading costs). (LOS 43.f)

## Module Quiz 43.3

1. **B** While ETNs are exposed to counterparty, fund closure, and settlement risks, the most severe is counterparty risk whereby the ETN issuer may default. (LOS 43.g)

2. **A** A Inverse and leveraged ETFs may not be well understood by their investors, leading to a gap between expectation and actual outcome; this is expectation-related risk. (LOS 43.g)

3. **A** Smart beta strategies are active ETF strategies that seek to outperform the benchmark. Long-term buy-and-hold investors seeking a desired factor exposure may

choose to invest in these ETFs in the expectation of outperformance of that factor. (LOS 43.h)

4. **A** Due to the low liquidity of most fixed-income securities, active fixed-income ETFs are more popular than active equity ETFs. Generally, active ETFs are suitable for long-term buy-and-hold investors. Because active strategies seek to beat the benchmark, tracking risk is expected to be higher than for passive ETFs. (LOS 43.h)

The following is a review of the Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #44.

# READING 44: USING MULTIFACTOR MODELS

**Study Session 16**

## EXAM FOCUS

Factor models are important in understanding risk exposures and in asset selection. Be able to construct arbitrage portfolios and be familiar with different multifactor models (and their differences), how they can be used, and their advantages over CAPM. Also understand the application of multifactor models to return and risk decomposition and the use of multifactor models in portfolio construction, including the use of factor portfolios in making bets on a specific risk factor.

## MODULE 44.1: MULTIFACTOR MODELS

Video covering this content is available online.

### LOS 44.a: Describe arbitrage pricing theory (APT), including its underlying assumptions and its relation to multifactor models.

*CFA® Program Curriculum, Volume 6, page 297*

**Arbitrage pricing theory (APT)** was developed as an alternative to the capital asset pricing model. It is a linear model with multiple systematic risk factors priced by the market. However, unlike CAPM, APT does not identify the specific risk factors (or even the number of factors).

## Assumptions of Arbitrage Pricing Theory (APT)

1. *Unsystematic risk can be diversified away in a portfolio.* Investors have the choice of a large number of assets such that unsystematic risk can be diversified by forming portfolios of assets. This is a reasonable assumption and is supported by empirical evidence.
2. *Returns are generated using a factor model.* Unfortunately, the APT provides little practical guidance for the identification of the risk factors. The lack of clarity for the risk factors is a major weakness of the APT.
3. *No arbitrage opportunities exist.* An arbitrage opportunity is defined as an investment opportunity that bears no risk and no cost, but provides a profit. This assumption implies that investors will undertake infinitely large positions (long and short) to exploit any perceived mispricing, causing asset prices to adjust immediately to their equilibrium values.

The asset pricing model developed by the arbitrage pricing theory is called the *arbitrage pricing model*.

## The APT Equation

The APT describes the equilibrium relationship between expected returns for well-diversified portfolios and their multiple sources of systematic risk.

$$E(R_P) = R_F + \beta_{P,1}(\lambda_1) + \beta_{P,2}(\lambda_2) + \ldots + \beta_{P,k}(\lambda_k)$$

Each λ stands for the expected risk premium associated with each risk factor. $\lambda_j$ equals the risk premium for a portfolio (called a *pure factor portfolio*) with factor sensitivity equal to 1 to factor *j* and factor sensitivities of zero for the remaining factors. Remember that a risk premium is the difference between the expected return and the risk-free rate ($R_F$). It is the extra expected return from taking on more risk.

Each β represents the factor sensitivity of portfolio P to that risk factor. Each factor in the arbitrage pricing model is "priced," meaning that each risk premium is statistically and economically significant. Unlike the CAPM, the APT does *not* require that one of the risk factors is the market portfolio. This is a major advantage of the arbitrage pricing model.

**PROFESSOR'S NOTE**

The CAPM can be considered a special restrictive case of the APT in which there is only one risk factor, and where that one factor is restricted to be the market risk factor.

## LOS 44.b: Define arbitrage opportunity and determine whether an arbitrage opportunity exists.

*CFA® Program Curriculum, Volume 6, page 298*

The method for exploiting arbitrage opportunities in the APT framework is detailed in the following example.

**EXAMPLE: Exploiting an arbitrage opportunity**

Suppose your investment firm uses a single-factor model to evaluate assets. Consider the following data for portfolios A, B, and C:

| Portfolio | Expected Return | Factory Sensitivity (beta) |
|---|---|---|
| A | 10% | 1.0 |
| B | 20% | 2.0 |
| C | 13% | 1.5 |

**Calculate** the arbitrage opportunity from the data provided.

**Answer:**

By allocating 50% of our funds to portfolio A and 50% to portfolio B, we can obtain a portfolio (D) with beta equal to the portfolio C beta (1.5):

Beta for portfolio D = 0.5(1) + 0.5(2) = 1.5

While the betas for portfolios D and C are identical, the expected returns are different:

Expected return for portfolio D = 0.5(0.10) + 0.5(0.20) = 0.15 = 15%

Therefore, we have created portfolio D that has the same risk as portfolio C (beta = 1.5) but has a higher expected return than portfolio C (15% versus 13%). By purchasing portfolio D and short-selling portfolio C, we expect to earn a 2% return (15% minus 13%).

**PROFESSOR'S NOTE**

Recall that a portfolio beta equals the weighted average of the individual asset betas, and, likewise, the portfolio expected return equals the weighted average of the individual asset

expected returns.

The portfolio that is long portfolio D and short portfolio C is called the arbitrage portfolio. We have invested nothing upfront because we can use the proceeds of the short sale on portfolio C to purchase portfolio D, and we have undertaken no net systematic risk. The overall beta of our investment equals the difference in betas between our long and short positions: 1.5 – 1.5 = 0. As investors exploit the arbitrage opportunity, prices of assets in portfolio C will drop and the (future) expected return for portfolio C will rise to its equilibrium value.

**PROFESSOR'S NOTE**

Generally, we want to go *long* assets that have a *high* ratio of return-per-unit-of-factor-exposure, and *short* assets that have a *low* return-to-factor-exposure ratio.

The APT assumes there are no market imperfections preventing investors from exploiting arbitrage opportunities. As a result, extreme long and short positions are permitted and mispricing will disappear immediately. Therefore, all arbitrage opportunities such as the one described in the previous example would be exploited and eliminated immediately.

## LOS 44.c: Calculate the expected return on an asset given an asset's factor sensitivities and the factor risk premiums.

*CFA® Program Curriculum, Volume 6, page 299*

Given a portfolio's factor exposures (betas) and factor risk premiums, we can easily compute the portfolio's expected return as shown in the following example.

**EXAMPLE: Calculating expected returns from the arbitrage pricing model**

An investment firm employs a two-factor APT model. The risk-free rate equals 5%. Determine the expected return for the Invest Fund using the following data:

| | Factor 1 | Factor 2 |
|---|---|---|
| Invest Fund factor betas | 1.50 | 2.00 |
| Factor risk premiums | 0.0300 | 0.0125 |

**Answer:**

Using the two-factor APT model, the expected return for the Invest Fund (IF) equals:

$$E(R_{IF}) = 0.05 + 1.5(0.03) + 2(0.0125) = 0.12 = 12\%$$

We can also use factor models to compute the parameter values given expected returns and factor exposures.

**EXAMPLE: Calculating APT parameters given expected returns**

1. Given a one-factor model and the following information, calculate the risk-free rate and the factor risk premium.

| Portfolio | Expected Return | Factor Sensitivity |
|---|---|---|
| A | 7.0% | 1.0 |
| B | 7.8% | 1.2 |

2. Verify that portfolio C with an expected return of 6.2% and factor sensitivity of 0.8 is priced correctly.

**Answer:**

1. Expected return = risk-free rate + factor sensitivity × risk premium

   Therefore, given the information for portfolios A and B:

   $0.07 = R_f + 1.0 \times \lambda$; $R_f = 0.07 - \lambda$

   Substituting this information for portfolio B:

   $0.078 = (0.07 - \lambda) + 1.2\lambda$; $\lambda = 0.04$ or 4%

   $R_f = 0.07 - \lambda = 0.07 - 0.04 = 0.03$ or 3%

2. Expected return for portfolio C = 0.03 + (0.8 × 0.04) = 6.2%. Hence, portfolio C is correctly priced.

## MODULE QUIZ 44.1

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

1. Which of the following *least accurately* identifies an assumption made by the APT?
   A. Asset returns are described by a factor model.
   B. Unsystematic risk can be diversified away.
   C. Arbitrage will force risk premia on systematic risk to be zero.

2. Eileen Bates, CFA has collected information on the following three portfolios:

| Portfolio | Expected Return | Factor Sensitivity |
|---|---|---|
| A | 10% | 1.20 |
| B | 20% | 2.00 |
| C | 13% | 1.76 |

   An arbitrage strategy would *most likely* involve a short position in which portfolio?
   A. Portfolio A
   B. Portfolio B
   C. Portfolio C

3. Catalyst Fund uses a two-factor model to analyze asset returns.

| | Factor 1 | Factor 2 |
|---|---|---|
| Stock A factor sensitivities | 0.88 | 1.10 |
| Factor risk premiums | 0.03 | 0.01 |

   Given that the risk-free rate equals 5%, the expected return for the stock A is *closest* to:
   A. 4.2%.
   B. 8.7%.
   C. 9.2%.

# MODULE 44.2: MACROECONOMIC FACTOR MODELS, FUNDAMENTAL FACTOR MODELS, AND STATISTICAL FACTOR MODELS

Video covering this content is available online.

### LOS 44.d: Describe and compare macroeconomic factor models, fundamental factor models, and statistical factor models.

The CAPM could be described as a single-factor model because it assumes asset returns are explained by a single factor: the return on the market portfolio. A *multifactor model* assumes asset returns are driven by more than one factor. There are three general classifications of multifactor models: (1) **macroeconomic factor models**, (2) **fundamental factor models**, and (3) **statistical factor models**:

1. *Macroeconomic factor models* assume that asset returns are explained by surprises (or "shocks") in macroeconomic risk factors (e.g., GDP, interest rates, and inflation). Factor surprises are defined as the difference between the realized value of the factor and its consensus predicted value.

**PROFESSOR'S NOTE**

The key to macroeconomic factor models is that the variables that explain returns reflect not the value of the macroeconomic variable itself, but rather the unexpected part (i.e., the surprise), because we assume that the expected value has already been reflected in stock prices. For example, if the government announces that GDP grew at an annual rate of 1.5% and the consensus prediction was 2.5%, the surprise was negative 1%. The 2.5% consensus forecast was already reflected in market prices, so the negative surprise, which was bad news to the market, should cause stock prices to fall (i.e., the expected return will be negative).

2. *Fundamental factor models* assume asset returns are explained by multiple firm-specific factors (e.g., P/E ratio, market cap, leverage ratio, and earnings growth rate).
3. *Statistical factor models* use statistical methods to explain asset returns. Two primary types of statistical factor models are used: factor analysis and principal component models. In factor analysis, factors are portfolios that explain covariance in asset returns. In principal component models, factors are portfolios that explain the variance in asset returns. The major weakness is that the statistical factors do not lend themselves well to economic interpretation. Therefore, *statistical* factors are *mystery* factors.

Because of the popularity of macroeconomic factor and fundamental factor models, we will provide a more expanded discussion of these models.

# MACROECONOMIC FACTOR MODELS

The following model is an example of a two-factor macroeconomic model in which stock returns are explained by surprises in GDP growth rates and credit quality spreads:

$$R_i = E(R_i) + b_{i1}F_{GDP} + b_{i2}F_{QS} + \varepsilon_i$$

where:

$R_i$ = return for Asset i

$E(R_i)$ = expected return for Asset i (in the absence of any surprises)

$F_{GDP}$ = surprise in the GDP rate

$F_{QS}$ = surprise in the credit quality spread (BB-rated bond yield − Treasury bond yield)

$b_{i1}$ = GDP surprise sensitivity of Asset i

$b_{i2}$ = credit quality spread surprise sensitivity of Asset i

$\varepsilon_i$ = firm-specific surprise (unrelated to the two macro factors)

Let's take a closer look at each of the components:

- Each “F” is a factor surprise, the difference between the predicted value of the factor and the realized value.
- Each “b” is the sensitivity of the stock to that surprise. The higher the sensitivity, the larger the change in return for a given factor surprise.
- The firm-specific surprise captures the part of the return that can’t be explained by the model. It represents unsystematic risk related to firm-specific events like a strike or a warehouse fire.

**EXAMPLE: Compute a stock return using a macroeconomic factor model**

The following two-factor model is used to explain the returns for Media Tech (MT):

$$R_{MT} = E(R_{MT}) + b_{MT,1}F_{GDP} + b_{MT,2}\,F_{QS} + \varepsilon_{MT}$$

The expected return for Media Tech equals 10%. Over the past year, GDP grew at a rate that was 2 percentage points higher than originally expected, and the quality spread was 1 percentage point lower than originally expected. Media Tech’s sensitivity to the GDP rate factor equaled 2, and its sensitivity to the quality spread factor equaled –0.5. Over the past year, Media Tech also experienced a 2% company-unique surprise return (i.e., unrelated to the two macro factors). Construct the macroeconomic factor model for Media Tech, and calculate its return for the year.

**Answer:**

The two-factor model for Media Tech is:

$R_{MT}$ = 0.10 + 2(0.02) – 0.50(–0.01) + 0.02 =
0.100 (the expected return)
+ 0.040 (the return from the positive GDP surprise)
+ 0.005 (the return from the positive quality spread surprise)
+ 0.020 (the return from unexpected firm specific events)
= 0.165, or 16.5%

The Media Tech return was higher than originally expected because MT was positively affected by higher-than-expected economic growth (GDP), lower-than-expected credit quality risk spreads (QS), and positive company-specific surprise events.

**PROFESSOR’S NOTE**

Be careful to interpret the signs properly. A decrease in the quality spread (a surprise less than zero) is good news for MT stock because it has a negative sensitivity to the factor. When credit quality spreads increase, MT’s return goes down, and when credit quality spreads decrease, MT’s return goes up.

The main features of the macroeconomic factor model include the systematic or priced risk factors and the factor sensitivities.

## Priced Risk Factors

A risk that does not affect many assets (i.e., an *unsystematic risk*) can usually be diversified away in a portfolio and will not be priced by the market. “Not priced” means investors cannot expect to be rewarded for being exposed to that type of risk.

The factors in our example model, GDP and credit quality spread shocks, are *systematic* risk factors, meaning that they will affect even well-diversified portfolios. Since they cannot be avoided, systematic factors represent priced risk (i.e., risk for which investors can expect compensation).

## Factor Sensitivities

In a macroeconomic multifactor model, asset returns are a function of unexpected surprises to systematic factors, and different assets have different *factor sensitivities*. For example, retail stocks are very sensitive to GDP growth and, hence, have a large sensitivity to the GDP factor. Small, unexpected changes in GDP growth cause large changes in retail stock prices because changes in income affect retail spending. Other stocks are less sensitive to GDP and have smaller GDP factor sensitivities. Retail grocer stocks, for example, do not react as much to changes in GDP because spending on food items is less sensitive to changes in national income. The factor sensitivities of the model can be estimated by regressing historical asset returns on the corresponding historical macroeconomic factors.

# FUNDAMENTAL FACTOR MODELS

Consider the following fundamental factor model:

$$R_i = a_i + b_{i1}F_{P/E} + b_{i2}F_{SIZE} + \varepsilon_i$$

where:

$R_i$ = return for stock i

$F_{P/E}$ = return associated with the P/E factor

$F_{SIZE}$ = return associated with the SIZE (market capitalization) factor

$a_i$ = intercept

$b_{i1}$ = standardized sensitivity of stock i to the P/E factor

$b_{i2}$ = standardized sensitivity of stock i to the SIZE factor

$\varepsilon_i$ = portion of asset i return not explained by the factor model

Let's take a closer look at each of the components of a fundamental factor model.

*Standardized sensitivities* ($b_{i1}$ and $b_{i2}$). Sensitivities in most fundamental factor models are not regression slopes. Instead, the fundamental factor sensitivities are standardized attributes (similar to z-statistics from the standard normal distribution). For example, the standardized P/E sensitivity in a fundamental factor model is calculated as:

$$b_{i1} = \frac{(P/E)_i - \overline{P/E}}{\sigma_{P/E}}$$

where:

$(P/E)_i$ = P/E for stock i

$\overline{P/E}$ = average P/E calculated across all stocks

$\sigma_{P/E}$ = standard deviation of P/E ratios across all stocks

Also note that by standardizing the factor sensitivity, we measure the number of standard deviations that each sensitivity is from the average. For example, a stock with a standardized P/E sensitivity of 2.0 has a P/E that is 2 standard deviations above the mean; a stock with a sensitivity of –1.5 has a P/E that is one and a half standard deviations below the mean. This standardization process allows us to use fundamental factors measured in different units in the same factor model. For example, P/E ratios are usually greater than 1.00, while dividend yields are in percentages (i.e., less than 1.00). The one exception is factors for binary variables (e.g., industry classification).

**EXAMPLE: Calculating a standardized sensitivity in a fundamental factor model**

The P/E for stock i is 15.20, the average P/E for all stocks is 11.90, and the standard deviation of P/E ratios is 6.30. Calculate the standardized sensitivity of stock i to the P/E factor.

**Answer:**

The sensitivity of stock i to the P/E factor is:

$$\beta_{i,\frac{P}{E}} = \frac{15.20 - 11.90}{6.30} = 0.52$$

Therefore, the P/E ratio for the stock is 0.52 standard deviations higher than the average stock P/E.

*Factor returns* ($F_{P/E}$ *and* $F_{SIZE}$). The fundamental factors are rates of return associated with each factor (e.g., the difference in rate of return between low and high P/E stocks). The return difference between low and high P/E stocks is commonly referred to as the return on a factor mimicking portfolio. In practice, the values of the fundamental factors are estimated as slopes of cross-sectional regressions in which the dependent variable is the set of returns for all stocks and the independent variables are the standardized sensitivities.

*Intercept term* ($a_i$). In fundamental factor models, the factors are not return surprises. Hence, the expected factor values are not zero, and the intercept term is no longer interpreted as the expected return.

## The Macroeconomic Factor Model vs. the Fundamental Factor Model

The key differences between the macroeconomic factor model and the fundamental factor model can be summarized as follows:

- *Sensitivities*. The standardized sensitivities in the fundamental factor model ($b_{i1}$ and $b_{i2}$) are calculated directly from the attribute (e.g., P/E) data—they are not estimated. This contrasts with the macroeconomic factor model, in which the sensitivities are regression slope estimates.
- *Interpretation of factors*. The macroeconomic factors ($F_{GDP}$ and $F_{QS}$) are surprises in the macroeconomic variables (e.g., inflation shock and interest rate shock). In contrast, the fundamental factors ($F_{P/E}$ and $F_{SIZE}$) are rates of return associated with each factor and are estimated using multiple regression.
- *Intercept term*. The intercept in the macroeconomic factor model equals the stock's expected return (based on market consensus expectations of the macro factors) from an equilibrium pricing model like the APT. In contrast, the intercept of a fundamental factor model with standardized sensitivities has no economic interpretation; it is simply the regression intercept necessary to make the unsystematic risk of the asset equal to zero.

### MODULE QUIZ 44.2

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

1. Jones Brothers uses a two-factor macroeconomic factor model to evaluate stocks and has derived the following results for the stock of AmGrow (AG):
    - Expected return: 10%
    - GDP factor sensitivity: 2

- Inflation factor sensitivity: –0.5

Over the past year, GDP grew at a rate that was two percentage points lower than originally expected, and inflation rose two percentage points higher than originally expected. AG also experienced a large unexpected product recall causing a firm-unique surprise of –4% to its stock price. Based on the information provided, the rate of return for AG for the year was *closest* to:

A. 1%.
B. 2%.
C. 3%.

# MODULE 44.3: MULTIFACTOR MODEL RISK AND RETURN

Video covering this content is available online.

## LOS 44.e: Explain sources of active risk and interpret tracking risk and the information ratio.

*CFA® Program Curriculum, Volume 6, page 314*

**Active return** equals the differences in returns between a managed portfolio and its benchmark:

$$\text{Active return} = R_P - R_B$$

**Active risk** (also known as *tracking error* or *tracking risk*) is defined as the standard deviation of the active return:

$$\text{Active risk} = \text{tracking error} = \sigma_{(R_P - R_B)}$$

## The Information Ratio

Active return alone is insufficient for measuring an investment manager's performance over a series of measurement periods. For example, imagine that Manager A earned a constant 0.5% (50 bps) active return over each of the last four quarters. Furthermore, suppose Manager B earned active returns of 8%, 5%, –3%, and –8% over the same four quarters. The average active returns for managers A and B are both 0.5%, but Manager B experienced far more volatility (i.e., less consistency) than Manager A.

To demonstrate a manager's consistency in generating active return, we use the *information ratio*, which standardizes average active return by dividing it by its standard deviation. In other words, the historical or ex-post information ratio equals the portfolio's average active return divided by the portfolio's tracking risk:

$$IR = \frac{\bar{R}_P - \bar{R}_B}{\sigma_{(R_P - R_B)}}$$

**EXAMPLE: Calculating the information ratio**

Imagine that the portfolio and benchmark returns over the past 12 months have been as shown in the following table.

**Portfolio and Benchmark Returns for Twelve Months**

| Month | $R_p$ | $R_B$ | $R_p - R_B$ |
|---|---|---|---|
| 1 | 0.0101 | 0.0091 | 0.0010 |
| 2 | –0.0013 | 0.0062 | –0.0075 |

| | | | |
|---|---|---|---|
| 3 | 0.0110 | 0.0069 | 0.0041 |
| 4 | 0.0135 | 0.0071 | 0.0064 |
| 5 | 0.0103 | 0.0067 | 0.0036 |
| 6 | 0.0093 | 0.0051 | 0.0042 |
| 7 | –0.0011 | 0.0007 | –0.0018 |
| 8 | 0.0085 | 0.0105 | –0.0020 |
| 9 | 0.0091 | 0.0101 | –0.0010 |
| 10 | –0.0073 | –0.0030 | –0.0043 |
| 11 | 0.0186 | 0.0012 | 0.0174 |
| 12 | 0.0103 | 0.0097 | 0.0006 |
| **Average** | **0.0076** | **0.0059** | **0.0017** |
| | | **Sample Std. Dev.** | 0.0063 |

Given the data in the table, calculate and interpret the manager's information ratio.

**Answer:**

$$\text{IR} = \frac{(\bar{R}_P - \bar{R}_B)}{\sigma_{(R_P - R_B)}} = \frac{0.0076 - 0.0059}{0.0063} \approx 0.27$$

The higher the IR, the more active return the manager earned per unit of active risk. An information ratio of 0.27 indicates the manager earned about 27 basis points of active return per unit of active risk.

### PROFESSOR'S NOTE

The information ratio is similar to the Sharpe ratio, in that their numerators both compare average portfolio return to a benchmark. The difference is that the Sharpe ratio uses the risk-free rate as the benchmark and the IR uses a portfolio benchmark return (one that best matches the investment style of the managed portfolio). In the denominator, the Sharpe ratio uses the standard deviation of portfolio total returns while the information ratio uses the standard deviation of the active (vs. the benchmark) return.

### LOS 44.f: Describe uses of multifactor models and interpret the output of analyses based on multifactor models.

*CFA® Program Curriculum, Volume 6, page 311*

Multifactor models can be useful for return attribution, risk attribution, and portfolio construction.

## Return Attribution

Multifactor models can be used to attribute a manager's active portfolio return to different factors.

Recall that active return = $R_P - R_B$.

We can decompose active return into its two components: (1) factor return (arising from the manager's decision to take on factor exposures that differ from those of the benchmark) and (2) security selection (arising from the manager choosing a different weight for specific securities compared to the weight of those securities in the benchmark). These two differences also contribute to active risk (discussed later).

Active return = factor return + security selection return

where:

$$\text{factor return} = \sum_{i=1}^{k} (\beta_{pi} - \beta_{bi}) \times (\lambda_i)$$

where:

$\beta_{pi}$ = factor sensitivity for the ith factor in the active portfolio

$\beta_{bi}$ = factor sensitivity for the ith factor in the benchmark portfolio

$\lambda_i$ = factor risk premium for factor $i$

The security selection return is then the *residual* difference between active return and factor return:

security selection return = active return – factor return

**EXAMPLE: Return decomposition**

Glendale Pure Alpha Fund generated a return of 11.2% over the past 12 months, while the benchmark portfolio returned 11.8%. Attribute the cause of difference in returns using a fundamental factor model with two factors as given in the following and describe the manager's apparent skill in factor bets as well as in security selection.

| Factor | Factor Sensitivity (betas) | | Factor Risk Premium (λ) |
|---|---|---|---|
| | Portfolio | Benchmark | |
| P/E | 1.10 | 1.00 | –5.00% |
| Size | 0.69 | 1.02 | 2.00% |

**Answer:**

| Factor | Factor Sensitivity (betas) | | | Factor Risk Premium (λ) | Contribution to Active Return |
|---|---|---|---|---|---|
| | Portfolio | Benchmark | Difference | | |
| | (1) | (2) | (3) | (4) | (5) = (3) × (4) |
| P/E | 1.10 | 1.00 | 0.10 | –5.00% | –0.50% |
| Size | 0.69 | 1.02 | –0.33 | 2.00% | –0.66% |
| | | | | Total | –1.16% |

Difference between portfolio return and benchmark return =11.20% – 11.80% = –0.60%

Return from factor tilts (computed previously) = –1.16%

Return from security selection = –0.6% – (–1.16%) = +0.56%

The active manager's regrettable factor bets resulted in a return of –1.16% relative to the benchmark. However, the manager's superior security selection return of +0.56% resulted in a total active return of –0.60% relative to the benchmark.

## Risk Attribution

Recall that active risk = tracking error = $\sigma_{(R_P - R_B)}$.

The active risk of a portfolio can be separated into two components:

1. *Active factor risk:* Risk from active factor tilts attributable to deviations of the portfolio's factor sensitivities from the benchmark's sensitivities to the same set of factors.

2. *Active specific risk:* Risk from active asset selection attributable to deviations of the portfolio's individual asset weightings versus the benchmark's individual asset weightings, after controlling for differences in factor sensitivities of the portfolio versus the benchmark.

The sum of active factor risk and active specific risk is equal to active risk squared (which is the variance of active returns):

active risk squared = active factor risk + active specific risk

Both components contribute to deviations of the portfolio's returns from the benchmark's returns. For example, consider a fundamental factor model that includes industry risk factors. In this case, active risk can be described as follows:

- *Active factor risk example*: A portfolio manager may decide to under- or overweight particular industries relative to the portfolio's benchmark. Therefore, the portfolio's industry factor sensitivities will not coincide with those of the benchmark, and, consequently, the portfolio returns may deviate from the benchmark.
- *Active specific risk example*: The active portfolio manager may decide to overweight or underweight individual stocks within specific industries. For example, a stock's market capitalization may comprise 1% of the industry, but the portfolio manager may allocate 2% of industry allocation to the stock, causing the portfolio returns to deviate from the benchmark returns.

Active specific risk can be computed as:

$$\text{active specific risk} = \sum_{i=1}^{n} (W_{pi} - W_{bi})^2 \sigma_{\varepsilon i}{}^2$$

where:

$W_{pi}$ and $W_{bi}$ = weight of ith security in the active and benchmark portfolio, respectively

$\sigma_{\varepsilon i}{}^2$ = residual (i.e., unsystematic) risk of the ith asset

Active factor risk represents the risk explained by deviation of the portfolio's factor exposures relative to the benchmark and is computed as the residual (plug):

active factor risk = active risk squared – active specific risk

**EXAMPLE: Risk decomposition**

Steve Martingale, CFA is analyzing the performance of three actively managed mutual funds using a two-factor model. The results of his risk decomposition are shown in the following table:

| | Active Factor | | | | |
|---|---|---|---|---|---|
| Fund | Size Factor | Style Factor | Total Factor | Active Specific | Active Risk Squared |
| Alpha | 6.25 | 12.22 | 18.47 | 3.22 | 21.69 |
| Beta | 3.20 | 0.80 | 4.00 | 12.22 | 16.22 |
| Gamma | 17.85 | 0.11 | 17.96 | 19.7 | 37.66 |

1. Which fund assumes the highest level of active risk?
2. Which fund assumes the highest level of style factor risk as a proportion of active risk?

3. Which fund assumes the highest level of size factor risk as a proportion of active risk?
4. Which fund assumes the lowest level of active specific risk as a proportion of active risk?

**Answer:**

The following table shows the proportional contributions of various sources of active risk as a proportion of active risk squared. For example, the proportional contribution of style factor risk for Alpha fund can be calculated as 12.22 / 21.69 = 56%.

| | Active Factor | | | | |
|---|---|---|---|---|---|
| Fund | Size Factor | Style Factor | Total Factor | Active Specific | Active Risk |
| Alpha | 29% | 56% | 85% | 15% | 4.7% |
| Beta | 20% | 5% | 25% | 75% | 4.0% |
| Gamma | 47% | 0% | 48% | 52% | 6.1% |

1. The Gamma fund has the highest level of active risk (6.1%). Note that active risk is the square root of active risk squared (as given).
2. The Alpha fund has the highest exposure to style factor risk as seen by 56% of active risk being attributed to differences in style.
3. The Gamma fund has highest exposure to size factor as a proportion of total active risk (47%) compared to the other two funds.
4. The Alpha fund has the lowest exposure to active specific risk (15%) as a proportion of total active risk.

## Uses of Multifactor Models

Multifactor models can be useful, for example, to a passive manager who seeks to replicate the factor exposures of a benchmark, or to an active manager who seeks to make directional bets on specific factors. Specific applications of multifactor models include:

1. *Passive management.* Managers seeking to track a benchmark can construct a *tracking portfolio*. Tracking portfolios have a deliberately designed *set* of factor exposures. That is, a tracking portfolio is intentionally constructed to have the same set of factor exposures to match (track) a predetermined benchmark.
2. *Active management.* Active managers use factor models to make specific bets on desired factors while hedging (or remaining neutral) on other factors. A *factor portfolio* is a portfolio that has been constructed to have sensitivity of one to just one risk factor and sensitivities of zero to the remaining factors. Factor portfolios are particularly useful for speculation or hedging purposes. For example, suppose that a portfolio manager believes GDP growth will be stronger than expected but wishes to hedge against all other factor risks. The manager can take a long position in the GDP factor portfolio; the factor portfolio is exposed to the GDP risk factor, but has zero sensitivity to all other risk factors. This manager is speculating that GDP will rise beyond market expectations.

   Alternatively, consider a manager who wishes to hedge his portfolio against GDP factor risk. Imagine that the portfolio's GDP factor sensitivity equals 0.8, and the portfolio's sensitivities to the remaining risk factors are different from zero. Suppose the portfolio manager wishes to hedge against GDP risk but remain exposed to the remaining factors. The manager can hedge against GDP risk by taking an 80% short position in the GDP factor portfolio. The 0.8 GDP sensitivity of the managed portfolio

will be offset by the –0.8 GDP sensitivity from the short position in the GDP factor portfolio.

3. *Rules-based or algorithmic active management (alternative indices).* These strategies use rules to mechanically tilt factor exposures when constructing portfolios. These strategies introduce biases in the portfolio relative to value-weighted benchmark indices.

We will use the Carhart model to illustrate the use of factor portfolios.

## Carhart Model

The Carhart four-factor model is a multifactor model that extends the Fama and French three-factor model to include not only market risk, size, and value as relevant factors, but also momentum.

$$E(R) = R_F + \beta_1 RMRF + \beta_2 SMB + \beta_3 HML + \beta_4 WML$$

where:
E(R) = expected return
$R_F$ = risk-free rate of return
RMRF = return on value-weighted equity index – the risk-free rate
SMB = average return on small cap stocks – average return on large cap stocks
HML = average return on high book-to-market stocks – average return on low book-to-market stocks
WML = average returns on past winners – average returns on past losers

**EXAMPLE: Factor Portfolios**

Sam Porter is evaluating three portfolios based on the Carhart model. The following table provides the factor exposures of each of these portfolios to the four Carhart factors.

| Portfolio | Risk Factor | | | |
|---|---|---|---|---|
| | RMRF | SMB | HML | WML |
| Eridanus | 1.0 | 0.0 | 0.0 | 0.0 |
| Scorpius | 0.0 | 1.0 | 0.0 | 0.0 |
| Lyra | 1.2 | 0.0 | 0.2 | 0.8 |

Which strategy would be *most* appropriate if the manager expects that:

1. RMRF will be higher than expected.
2. Large cap stocks will outperform small cap stocks.

**Answer:**

1. The manager would go long in the Eridanus portfolio as it is constructed to have exposure only to the RMRF factor. The Lyra portfolio would not be ideal for Porter's purpose because it provides unneeded exposures to the HML and WML factors as well.
2. The manager would go short the Scorpius portfolio, which is constructed to be a pure bet on SMB (i.e., Scorpius is a factor portfolio). We short the portfolio because we are expecting that large cap stocks will outperform small cap stocks.

### LOS 44.g: Describe the potential benefits for investors in considering multiple risk dimensions when modeling asset returns.

Under the CAPM framework, investors choose a combination of the market portfolio and the risk-free asset depending on their risk tolerance. By including more risk factors, multifactor models enable investors to zero in on risks that the investor has a comparative advantage in bearing and avoid the risks that the investor is incapable of absorbing. For example, a pension plan invests for long-term and, hence, would not be averse to holding a security that bears liquidity risk (and that offers a liquidity risk premium).

Also, if the actual asset returns are better described by multifactor models, then using such models can help investors select more efficient portfolios.

## MODULE QUIZ 44.3

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

1. A multifactor model to evaluate style and size exposures (e.g., large cap value) of different mutual funds would be *most appropriately* called a:
   A. systematic factor model.
   B. fundamental factor model.
   C. macroeconomic factor model.
2. A portfolio that has the same factor sensitivities as the S&P 500, but does not hold all 500 stocks in the index, is *best* described as a:
   A. factor portfolio.
   B. tracking portfolio.
   C. market portfolio.
3. A portfolio with a factor sensitivity of one to the yield spread factor and a sensitivity of zero to all other macroeconomic factors is *best* described as a:
   A. factor portfolio.
   B. tracking portfolio.
   C. market portfolio.
4. Factor Investment Services, LLC manages a tracking portfolio that claims to outperform the S&P 500. The active factor risk and active specific risk for the tracking portfolio are *most likely* to be described as:
   A. high active factor risk and high active specific risk.
   B. high active factor risk and low active specific risk.
   C. low active factor risk and high active specific risk.
5. Relative to the CAPM, the *least likely* advantage of multifactor models is that multifactor models help investors to:
   A. target risks that the investor has a comparative advantage in bearing.
   B. select an appropriate proportion of the portfolio to allocate to the market portfolio.
   C. assemble more efficient and better diversified portfolios.

# KEY CONCEPTS

## LOS 44.a

The arbitrage pricing theory (APT) describes the equilibrium relationship between expected returns for well-diversified portfolios and their multiple sources of systematic risk. The APT makes only three key assumptions: (1) unsystematic risk can be diversified away in a portfolio, (2) returns are generated using a factor model, and (3) no arbitrage opportunities exist.

## LOS 44.b

An arbitrage opportunity is defined as an investment opportunity that bears no risk and has no cost, but provides a profit. Arbitrage is conducted by forming long and short portfolios; the proceeds of the short sale are used to purchase the long portfolio. Additionally, the factor sensitivities (betas) of the long and short portfolios are identical and, hence, our net exposure to systematic risk is zero. The difference in returns on the long and short portfolios is the arbitrage return.

## LOS 44.c

Expected return = risk-free rate + ∑(factor sensitivity) × (factor risk premium)

## LOS 44.d

A multifactor model is an extension of the one-factor market model; in a multifactor model, asset returns are a function of more than one factor. There are three types of multifactor models:

- Macroeconomic factor models assume that asset returns are explained by surprises (or shocks) in macroeconomic risk factors (e.g., GDP, interest rates, and inflation). Factor surprises are defined as the difference between the realized value of the factor and its consensus expected value.
- Fundamental factor models assume asset returns are explained by the returns from multiple firm-specific factors (e.g., P/E ratio, market cap, leverage ratio, and earnings growth rate).
- Statistical factor models use multivariate statistics (factor analysis or principal components) to identify statistical factors that explain the covariation among asset returns. The major weakness is that the statistical factors may not lend themselves well to economic interpretation.

## LOS 44.e

Active return is the difference between portfolio and benchmark returns ($R_P - R_B$), and active risk is the standard deviation of active return over time. Active risk is determined by the manager's active factor tilt and active asset selection decisions:

active risk squared = active factor risk + active specific risk

The information ratio is active return divided by active risk:

$$IR = \frac{\bar{R}_P - \bar{R}_B}{\sigma_{(R_P - R_B)}}$$

## LOS 44.f

Multifactor models can be useful for risk and return attribution and for portfolio composition. In return attribution, the difference between an active portfolio's return and the benchmark return is allocated between factor return and security selection return.

$$\text{factor return} = \sum_{\mathrm{i}=1}^{\mathrm{k}} (\beta_{\mathrm{pi}} - \beta_{\mathrm{bi}}) \times (\lambda_{\mathrm{i}})$$

In risk attribution, the sum of the active factor risk and active specific risk is equal to active risk squared (which is the variance of active returns):

active risk squared = active factor risk + active specific risk

$$\text{active specific risk} = \sum_{\mathrm{i}=1}^{\mathrm{n}} (\mathrm{W}_{\mathrm{pi}} - \mathrm{W}_{\mathrm{bi}})^2 {\sigma_{\varepsilon \mathrm{i}}}^2$$

active factor risk = active risk squared − active specific risk

Multifactor models can also be useful for portfolio construction. Passive managers can invest in a tracking portfolio, while active managers can go long or short factor portfolios.

A factor portfolio is a portfolio with a factor sensitivity of 1 to a particular factor and zero to all other factors. It represents a pure bet on a single factor and can be used for speculation or hedging purposes. A tracking portfolio is a portfolio with a specific set of factor sensitivities. Tracking portfolios are often designed to replicate the factor exposures of a benchmark index like the S&P 500.

## LOS 44.g

Multifactor models enable investors to take on risks that the investor has a comparative advantage in bearing and avoid the risks that the investor is unable to absorb.

Models that incorporate multiple sources of systematic risk have been found to explain asset returns more effectively than single-factor CAPM.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 44.1

1. **C** The assumptions of APT include (1) unsystematic risk can be diversified away in a portfolio, (2) returns can be explained by a factor model, and (3) no arbitrage opportunities exist. However, arbitrage does not cause the risk premium for systematic risk to be zero. (LOS 44.a)

2. **C** An arbitrage portfolio comprises long and short positions such that the net return is positive yet the net factor sensitivity is zero. In this question, the low expected return of portfolio C per unit of factor sensitivity indicates that portfolio C should be shorted. Suppose that we arbitrarily assign portfolio C a 100% short weighting and, furthermore, we assign a weighting of $w$ to portfolio A and a weighting of $(1 – w)$ to portfolio B. Because the weighted sum of long and short factor sensitivities must be equal, we develop the following equation: $w \times 1.20 + (1 – w) \times 2.00 = 1.00 \times 1.76$. Solving algebraically for $w$ gives a 30% long weight on portfolio A, a 70% long weight on portfolio B, and a 100% short weight on portfolio C. The factor sensitivity of this portfolio will be (0.3)(1.20) + (0.7)(2.0) – (1)(1.76) = 0. The expected return on this zero risk, zero investment portfolio will be (0.3)(10) + (0.7) (20) – (1)(13) = 4%. (LOS 44.b)

3. **B** Using the two-factor APT model, the expected return for stock A equals:

   $E(R_{IF}) = 0.05 + (0.88) \times (0.03) + (1.10) \times (0.01) = 0.0874 = 8.74\%$

   (LOS 44.c)

## Module Quiz 44.2

1. **A** The two-factor model for AG is $R_{AG} = 0.10 + 2(–0.02) – 0.50(0.02) – 0.04 = 0.01 = 1\%$

   The AG return was less than originally expected because AG was hurt by lower-than-expected economic growth (GDP), higher-than-expected inflation, and a negative company-specific surprise event. (LOS 44.d)

## Module Quiz 44.3

1. **B** Style (e.g., value versus growth) can be evaluated based on company-specific fundamental variables such as P/E or P/B ratio. Size is generally proxied by market capitalization. A fundamental factor model is appropriate when the underlying variables are company-specific. (LOS 44.f)

2. **B** A *tracking portfolio* is a portfolio with a specific set of factor sensitivities. Tracking portfolios are often designed to replicate the factor exposures of a benchmark index like the S&P 500—in fact, a factor portfolio is just a special case of a tracking portfolio. One use of tracking portfolios is to attempt to outperform the S&P 500 by using the same factor exposures as the S&P 500 but with a different set of securities than the S&P 500. (LOS 44.f)

3. **A** A *factor portfolio* is a portfolio with a factor sensitivity of 1 to a particular factor and zero to all other factors. It represents a *pure bet* on that factor. For example, a portfolio manager who believes GDP growth will be greater than expected, but has no view of future interest rates and wants to hedge away the interest rate risk in her portfolio, could create a *factor portfolio* that is only exposed to the GDP factor and not exposed to the interest rate factor. (LOS 44.f)

4. **C** A tracking portfolio is deliberately constructed to have the same set of factor exposures to match (track) a predetermined benchmark. The strategy involved in constructing a tracking portfolio is usually an active bet on asset selection (the manager claims to beat the S&P 500). The manager constructs the portfolio to have the same factor exposures as the benchmark, but then selects superior securities (subject to the factor sensitivities constraint), thus outperforming the benchmark without taking on more systematic risk than the benchmark. Therefore, a tracking portfolio, with active asset selection but with factor sensitivities that match those of the benchmark, will have little or no active factor risk, but will have high active specific risk. (LOS 44.f)

5. **B** Multifactor models enable investors to zero in on risks that the investor has a comparative advantage in bearing and avoid the risks that the investor is unable to take on. Multifactor models are preferred over single factor models like CAPM in cases where the underlying asset returns are better described by multifactor models. Allocation of an investor's portfolio between the market portfolio and the risk-free asset is part of CAPM, not multifactor models. (LOS 44.g)

The following is a review of the Portfolio Management (1) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #45.

# READING 45: MEASURING AND MANAGING MARKET RISK

**Study Session 16**

## EXAM FOCUS

This topic review discusses different approaches to risk measurement as well as mechanisms to manage and control risk. VaR is an important risk metric, and you should know different ways to compute it as well as pros and cons of different approaches. Also know the limitations of VaR as a risk metric and the variations of VaR. The discussion on scenario and sensitivity analysis is mostly qualitative. Finally, know the risk measures that are more relevant for different asset managers, such as banks, pension funds, et cetera.

## MODULE 45.1: VALUE AT RISK (VAR)

Video covering this content is available online.

### LOS 45.a: Explain the use of value at risk (VaR) in measuring portfolio risk.

*CFA® Program Curriculum, Volume 6, page 335*

**Value at risk (VaR)** measures downside risk of a portfolio. It has three components: the loss size, the probability (of a loss greater than or equal to the specified loss size), and a time frame. Consider the statement: "There is a 5% probability that the company will experience a loss of $25,000 or more in any given month." This is the same as stating that the monthly 5% VaR is $25,000. In the previous statement, the probability is 5%, the loss size is $25,000, and the time frame is one month.

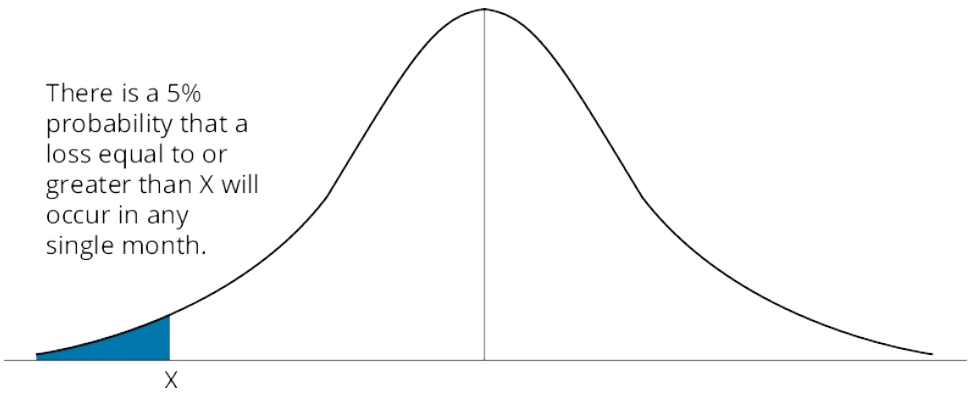
Note that $25,000 is a *minimum* loss amount, so we can state, "5% of the time the minimum monthly loss that the company will experience is $25,000."

VaR can also be expressed in percentage terms so that for a portfolio, we could state that the 5% monthly VaR is 3%, meaning that 5% of the time the monthly portfolio value will fall by *at least* 3%. We can also state VaR as a confidence level: we are 95% (i.e., 100% – 5%) confident that the portfolio will experience a loss of no more than 3%.

To estimate a VaR, we must specify the time period and the size of the loss, so there is significant judgment involved in VaR estimation. If we choose the size of the loss, we will estimate the probability of losses of that size or larger; but, if we choose the probability of the loss, we will estimate the minimum size of the losses that will occur with that probability.

Figure 45.1 shows the 5% VaR for a given probability distribution of monthly returns. *The 5% left-hand tail of the distribution of possible monthly outcomes is bounded by the 5% VaR*; VaR is the upper limit of the specified left tail.

**Figure 45.1:** Distribution of Monthly Returns




While any probability can be specified, VaR is typically expressed for 1%, 5%, or 16% (one standard deviation below the mean for a normal distribution) probability. The time frame specified also varies; we could estimate VaR for a day, a week, a month, or any other relevant period.

### LOS 45.b: Compare the parametric (variance–covariance), historical simulation, and Monte Carlo simulation methods for estimating VaR.

### LOS 45.c: Estimate and interpret VaR under the parametric, historical simulation, and Monte Carlo simulation methods.

*CFA® Program Curriculum, Volume 6, page 340*

The first step in estimating the VaR for a portfolio is to identify the risk factors that enter into the determination of portfolio returns. These risk factors might include market risk, interest rate risk, or currency risk, among others.

One method of estimating VaR is the **parametric** or **variance-covariance** method. Often we assume that the risk factors are distributed normally, but we could also assume other distributions. Assuming normality allows us to estimate the risk of the portfolio based only on the means, variances, and covariances (or correlations) of the various risk factors. An assumption that risk factor probabilities are non-normal would increase the complexity of the analysis and require that we estimate values for other parameters, such as skewness and kurtosis.

Assuming normality, we can use the portfolio variance formula to estimate the mean and variance of portfolio returns. Once we have estimated these parameters, we can identify portfolio VaR as the value bounding the left-hand tail of the distribution, as we illustrated in Figure 45.1. To simplify the explanation of the parametric method, we will consider a case of only two risk factors, both of which are normally distributed.

Consider two securities, asset A and asset B. For a portfolio with portfolio fraction $W_A$ invested in asset A and the remaining portfolio fraction $W_B$ invested in asset B, portfolio variance is given by the formula:

$$\sigma^2_{\text{Portfolio}} = W_A^2\sigma_A^2 + W_B^2\sigma_B^2 + 2W_AW_B\text{Cov}_{AB}$$

The returns period that we use to estimate the mean and standard deviation of returns for each risk factor (each fund in our example) is called the **lookback period**. For estimating the variance of daily returns, we might use the last two years; but, for estimating the variance of annual returns, we would choose a longer lookback period. The important point is that the

parameter estimates we use should be those we expect over the period for which we are estimating the VaR. Estimates based on recent periods may be adjusted towards longer-term averages.

**EXAMPLE: Estimating VaR**

Imagine that we are provided the following information about two assets, Security A and Security B:

| Security | Standard deviation of daily returns | Mean daily return | Covariance of daily returns |
|---|---|---|---|
| Security A | 0.0158 | 0.0004 | 0.000106 |
| Security B | 0.0112 | 0.0003 | |

How would we use this information to estimate the 5% annual VaR for a portfolio that is 60% invested in Security A and 40% invested in Security B?

**Answer:**

Mean daily portfolio return = 0.6(0.0004) + 0.4(0.0003) = 0.00036

Variance of portfolio return = $(0.6)^2(0.0158)^2 + (0.4)^2(0.0112)^2 + 2(0.4)(0.6)(0.000106) = 0.000161$

Standard deviation of portfolio returns = $\sqrt{0.000161} = 0.012682$

For a 5% VaR we want 5% in the left-hand tail, so we calculate the value 1.65 standard deviations below the mean:

5% daily VaR = 0.00036 – 1.65(0.012682) = –0.0206

Assuming the distribution of daily returns is constant over the year, that there are 250 trading days in one year, and that daily returns are independently distributed, we can calculate the annual mean return as 250(0.00036) = 0.09.

The annual standard deviation can be calculated as $\sqrt{250}$ (0.012682) = 0.20052.

Based on these estimates, the 5*% annual VaR* = 0.09 – 1.65(0.20052) = –0.2409.

For a portfolio with a value of $10 million, the 5% daily and annual VaR are:

10 million (0.0206) = $206,000 and
10 million (0.2409) = $2,409,000.

The parametric method is relatively simple to apply under the assumption of normally distributed returns. Of course, its estimates will only be as good as the estimates of future mean returns and standard deviations. The calculated VaR is also very sensitive to the covariance estimate. The length of the lookback period will affect the parameter estimates, and care must be taken to adjust estimates based on recent results when they may not reflect the future distribution of returns. In cases where normality cannot be reasonably assumed, such as when the portfolio contains options, the parametric method has limited usefulness.

The **historical simulation method** of estimating VaR is based on the actual periodic changes in risk factors over a lookback period. For a daily VaR, the change in the value of the current portfolio is calculated for each day of the lookback period, using the actual daily changes in portfolio value. By ordering the changes in portfolio value from most positive to most negative, we can find the largest 5% of losses. The smallest of those losses is our estimate of the 5% VaR for the current portfolio.

Under the historical simulation method, no adjustments are made for the difference between the results for the lookback period and the results over a longer prior period.

One positive aspect of the historical simulation method is that we do not need the assumption of normality, or any other distributional assumption, to estimate VaR. Because the historical results for a portfolio containing options include the changes in option values, the historical simulation method can be used to estimate the VaR for portfolios that include options.

VaR estimates will depend on the lookback period and, as with any forecasts, will vary with the characteristics of the sample data used. VaR based on an unusually volatile lookback period will yield overestimates of VaR, just as VaR based on a lookback period with low volatility will likely underestimate the true VaR over subsequent periods.

A third method of VaR estimation is **Monte Carlo simulation**. Monte Carlo simulation is based on an assumed probability distribution for each risk factor. Additionally, an assumption must be made about the correlations between risk factors. Computer software is used to generate random values for each risk factor, and pricing models are used calculate the change in portfolio value for that set of risk factor changes.

This procedure is repeated thousands of times. Then, just as with historical simulation, we can order the outcomes and identify the fifth percentile (i.e., a value for which 5% of the outcomes will be lower) to estimate the 5% VaR. As with the other methods, the data used and the assumptions about the distributions of the risk factors will have significant effects on the estimated VaR. Assuming a large sample size, the Monte Carlo method will produce identical results as the parametric method if the distribution specified and the parameters are the same.

### MODULE QUIZ 45.1

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

1. Weekly 5% VaR of £1 million indicates:
   A. a maximum allowable loss of £1 million in 5% of weeks.
   B. that the largest weekly loss is £1 million or 5% of portfolio value.
   C. a 5% probability of a loss greater than £1 million in any given week.
2. A lookback period is *least likely* to be specified when estimating VaR using:
   A. historical simulation.
   B. the parametric method.
   C. Monte Carlo simulation.
3. A portfolio manager expects to earn a return of 6.5% over the next year with a standard deviation of 9%. The portfolio is currently valued at $6.4 million. What is the 5% annual VaR of the portfolio?
   A. $83,500.
   B. $160,000.
   C. $534,400.

## MODULE 45.2: USING VAR

Video covering this content is available online.

### LOS 45.d: Describe advantages and limitations of VaR.

*CFA® Program Curriculum, Volume 6, page 349*

VaR, as a measure of portfolio risk, has many benefits but suffers from the same limitations as many other forward-looking estimates of portfolio risk.

## ADVANTAGES OF VAR

- The concept of VaR is simple and easy to explain, although the details of the methodology can be complex.
- VaR allows the risk of different portfolios, asset classes, or trading operations to be compared to gain a sense of relative riskiness.
- VaR can be used for performance evaluation (i.e., returns generated vs. risk taken). Rather than evaluating a trading group's performance based only on returns, VaR allows calculation of the ratio of trading income to VaR.
- When allocating capital to various trading units, a firm's risk managers can also look at the allocation of VaR and optimize the allocation of capital given the firm's determination of the maximum VaR that the organization should be exposed to (sometimes referred to as *risk budgeting*). In the same manner, managers can estimate risk-adjusted performance of trading units or profits per dollar of VaR. For example, the equity trading desk may be assigned a maximum daily VaR of $5 million while the more profitable currency trading desk may be assigned a daily VaR of $15 million.
- Global banking regulators accept VaR as a measure of financial risk, although they do not prescribe estimation methods or impose a maximum VaR.
- Reliability of VaR as a measure of risk can be verified by backtesting.

## LIMITATIONS OF VAR

- VaR estimation requires many choices (loss percentage, lookback period, distribution assumptions, and parameter estimates) and can be very significantly affected by these choices. An unscrupulous analyst can choose assumptions that lead to a low estimate of VaR.
- The assumption of normality leads to underestimates of downside (tail) risk because actual returns distributions frequently have "fatter tails" than a normal distribution. When this is the case, VaRs based on an assumption of normality tend to underestimate the probability of extreme outcomes. Although the assumption of normality is not a requirement of VaR, it is almost always used, especially with the parametric method.
- Liquidity often falls significantly when asset prices fall. A VaR which does not account for this will understate the actual losses incurred when liquidating positions that are under extreme price pressure.
- It is well known that correlations increase, or spike, during periods of financial stress. Increasing correlations mean that VaR measures based on normal levels of correlation will overestimate diversification benefits and underestimate the magnitude of potential losses.
- While VaR is a single number that can be used to quantify risk, as with any summary measure, many aspects of risk are not quantified or included. Users of VaR must understand the limitations of VaR as a measure of risk in order to use it appropriately.
- VaR focuses only on downside risk and extreme negative outcomes. Including consideration of right-hand tail values will give a better understanding of the risk-return trade-off.

### LOS 45.e: Describe extensions of VaR.

Another measure based on VaR is the **conditional VaR** (CVaR). The CVaR is the expected loss, given that the loss is equal to or greater than the VaR. For this reason, the CVaR is also referred to as the *expected tail loss* or *expected shortfall*. The CVaR is expected loss given that the loss is in the left-hand tail past the VaR.

When the VaR is estimated using the historical simulation method or Monte Carlo simulation, we have all the losses greater than the VaR loss, so it is straightforward to take the average of these to get the CVaR. With the parametric method, we don't know the magnitude of losses greater than the VaR, so calculating the expected loss in the left-hand tail is mathematically complex.

**Incremental VaR** (IVaR) is the change in VaR from a change in the portfolio allocation to a security. If a 2% increase in the weight of a security in the portfolio increases the portfolio's VaR from $1,345,600 to $1,562,400, the IVaR for the 2% increase in the portfolio weight of the security is 1,562,400 – 1,345,600 = $216,800.

A related measure is the **marginal VaR** (MVaR). The MVaR is estimated as the slope of a curve that plots VaR as a function of a security's weight in the portfolio. The MVaR is calculated at the point on the curve corresponding to the security's current weight, so we can interpret it as the change in VaR for a 1% increase in the security's weight. This is not precisely correct because the MVaR is the slope at a point on the curve, not the slope for a 1% change in weight. It is, however, a reasonable approximation of the sensitivity of VaR to a 1% change in weight of a security. Thus, both the MVaR and IVaR can be used to estimate the change in VaR that will result from a change in the weight of a single security.

**Ex ante tracking error**, also referred to as **relative VaR**, measures the VaR of the difference between the return on a portfolio and the return on its manager's benchmark portfolio. A 5% monthly relative VaR of 2.5% implies that 5% of time, the portfolio's relative underperformance will be at least 2.5%. The relative VaR can be calculated as the VaR of a combination of a long position in the subject portfolio and a short position in the benchmark portfolio.

### LOS 45.f: Describe sensitivity risk measures and scenario risk measures and compare these measures to VaR.



Given the limitations of VaR as a risk measure, analysts should use other risk measures that complement VaR.

Risk assessment using **sensitivity analysis** focuses on the effect on portfolio value given a small change in one risk factor. By examining the sensitivity of a portfolio's value to several risk factors, portfolio risk can be better understood and more effectively managed. Sensitivity analysis complements VaR in understanding portfolio risk, but, unlike VaR, it does not involve any prediction of the probability of losses of any specific amount.

While sensitivity analysis provides an estimate of the change in portfolio value due to a small change in a single risk factor, **scenario analysis** provides an estimate of the effect on portfolio value of a set of changes of significant magnitude in multiple risk factors. The changes in risk factors used in scenario analysis are often a set of changes that are expected to

result in a significant decline in portfolio value, although a scenario of changes in risk factors that would increase portfolio value may also be considered.

A **historical scenario** approach uses a set of changes in risk factors that have actually occurred in the past, especially changes during a period of financial disruption and stress such as the subprime mortgage crisis of 2008 or the equity market crash of 1987.

With a **hypothetical scenario** approach, any set of changes in risk factors can be used, not just one that has happened in the past. A hypothetical scenario could have more extreme changes in risk factors than those that have occurred in the past, but that have some non-zero probability of occurring in the future.

**Stress tests** examine the effect on value (or solvency) of a scenario of extreme risk-factor changes.

### LOS 45.g: Demonstrate how equity, fixed-income, and options exposure measures may be used in measuring and managing market risk and volatility risk.

*CFA® Program Curriculum, Volume 6, page 355*

The risk factors used to measure the risks of equities, fixed-income securities, and options are all different. For equities, the most often used risk factor is **beta**. Beta is a measure of how the returns of a security or a portfolio are expected to be affected by overall market returns. The capital asset pricing model (CAPM) is based on market risk as measured by beta and concludes that the expected return on an asset is equal to the risk-free rate plus beta times the market risk premium:

$$E(R_i) = R_f + \text{Beta}_i\,[E(R_{MKT}) - R_f]$$

For fixed-income securities and portfolios, **duration** provides an estimate of how market values are affected by changes in interest rates (yields to maturity). For larger changes in interest rates, including the effects of **convexity** on fixed-income security values improves estimates of the sensitivity of the values of fixed-income securities to changes in interest rates. Together, duration and convexity are used to estimate the sensitivity of the values of fixed-income securities (and portfolios) to changes in interest rates. An estimate of the percentage change in value of a fixed-income security or portfolio in response to a change in YTM ($\Delta Y$) is given by:

$$\text{Change in price} = -\text{Duration}\,(\Delta Y) + \tfrac{1}{2}\,\text{Convexity}\,(\Delta Y)^2$$

**PROFESSOR'S NOTE**

If duration in the previous equation is Macaulay duration (rather than modified duration), $\Delta Y$ is replaced by $\Delta Y/(1 + Y)$.

Several risk factors affect the values of options positions. **Delta** is an estimate of the sensitivity of options values to changes in the value of the underlying asset. Delta is the ratio of the change in an option's value to a change in the price of the underlying security. A call delta of 0.6 means that for every $1 increase in the price of the underlying asset, the call value increases by $0.60. A put delta of –0.5 means that for every $1 increase the value of the underlying asset, the put value will decrease by $0.50.

**Gamma** is an estimate of how delta changes as the price of the underlying asset changes and is calculated as the ratio of the *change in delta* to a change in the price of the underlying

asset. Just as convexity improves estimates of the impact of interest rate changes captured by delta, gamma improves estimates of the impact of a change in the price of the underlying asset on option values. Both convexity and gamma are considered *second-order effects,* while duration and delta measure first-order effects of risk factor changes.

**Vega** is a measure of the sensitivity of option values to changes in the expected volatility of the price of the underlying asset. We can incorporate all three of these option risk measures in the following equation:

Change in call price = delta ($\Delta S$) + ½ gamma $(\Delta S)^2$ + vega ($\Delta V$)

where $\Delta S$ is the change in the price of the underlying asset and $\Delta V$ is the change in future volatility.

### MODULE QUIZ 45.2

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

1. Which of the following is a limitation of VaR?
   A. VaR focuses on downside risk.
   B. Use of VaR is discouraged by banking regulators.
   C. Estimates of VaR for different asset classes are not comparable.
2. The expected amount of a loss, given that it is equal to or greater than the VaR, is the:
   A. marginal VaR.
   B. conditional VaR.
   C. incremental VaR.
3. The sensitivity of an option value to changes in volatility of the underlying asset price is measured by:
   A. beta.
   B. vega.
   C. gamma.

## MODULE 45.3: SENSITIVITY AND SCENARIO RISK MEASURES

Video covering this content is available online.

**LOS 45.h: Describe the use of sensitivity risk measures and scenario risk measures.**

*CFA® Program Curriculum, Volume 6, page 355*

Sensitivity risk measures can inform a portfolio manager about a portfolio's exposure to various risk factors to facilitate risk management. Exposure to risks the manager believes are excessive can be reduced (i.e., hedged). Of course, eliminating all risk is not the goal; portfolios not exposed to risk can be expected to earn only the risk-free rate of return.

When using scenario analysis for a portfolio that contains options or fixed-income securities with embedded options, the individual options and bonds must be valued with a pricing model using scenario values for the risk factors. Factor sensitivities can be used to estimate the effects of small changes in risk factors for these securities; for larger risk factor changes, pricing models for portfolio securities must be used. Even combining first-order and second-order effects, such as duration and convexity, only provides an approximation of the change in value that would result from a relatively large change in a risk factor.

Pricing models can be quite accurate when all of the relevant characteristics of a security are specified. With scenario analysis, each portfolio security is model-priced using the risk factor values of a particular scenario in order to estimate the scenario impact on portfolio value.

Scenario analysis is often performed as if the scenario changes were instantaneous. In some cases, scenario changes are modeled as incremental changes, and the scenario includes portfolio manager actions in response to each, perhaps daily, incremental change in the set of risk factors. The idea is to allow for the reduction or closing of some positions or adjusting hedges appropriately. Because such actions will reduce the overall impact of the scenario changes, scenario analysis based on an instantaneous change in risk factors is considered more conservative. It is also more realistic in circumstances where, for example, counterparties are unable or unwilling to provide additional collateral required or lack of liquidity makes changing portfolio positions very costly or impossible.

In **reverse stress testing**, the first step is to identify a portfolio's largest risk exposures. Then an unacceptable outcome is determined (usually one that would threaten the survival of the organization), and scenarios of changes in risk factors that would result in such an outcome are identified. The question then becomes how likely such scenarios are. Using scenario analysis in this way can be beneficial in helping risk managers identify the vulnerabilities of a portfolio and perhaps mitigate the risk exposures identified.

Scenario analysis can be seen as the final step in the risk assessment and management process, after performing sensitivity analysis. For a firm that has limited its risk through a maximum VaR, limits on position sizes, limits on specific risk exposures, and so on, scenario analysis can provide additional information on a portfolio's vulnerability to a set of events or changes in correlations that would significantly reduce the value of the portfolio.

Firms that use leverage, especially banks and hedge funds, often use stress tests involving a single risk factor to determine the size of change in that factor that could cause such losses that the firm's sustainability is compromised.

### LOS 45.i: Describe advantages and limitations of sensitivity risk measures and scenario risk measures.

*CFA® Program Curriculum, Volume 6, page 365*

VaR, sensitivity analysis, and scenario analysis complement each other, and a risk manager should not rely on only one of these measures. VaR provides a probability of loss. Sensitivity analysis provides estimates of the relative exposures to different risk factors, but no estimate of the probability of any specific changes in risk factors. Scenario analysis will provide information about exposure to simultaneous changes in several risk factors or changes in risk correlations, but, again, there is no probability associated with a specific scenario other than the empirical probability of a historical scenario over the lookback period.

As an example of the limitations of sensitivity analysis, consider two bond portfolios that both have the same duration, so that the change in value resulting from a one basis point change in yield is the same for both portfolios. The problem with using duration as the risk measure is that the yield volatility of one portfolio may be quite different from the yield volatility of the other. The yield volatilities of government bonds, investment-grade bonds, corporate bonds, and high-yield bonds may be quite different from each other so that the probabilities of a given percentage decrease in value are quite different as well. Similarly, option delta (or delta and gamma) may be an appropriate measure of the risk for small

changes in the price of the underlying, but the volatility of the prices of the underlying may be quite different for different options.

## MODULE 45.4: APPLICATIONS OF RISK MEASURES

Video covering this content is available online.

### LOS 45.j: Describe risk measures used by banks, asset managers, pension funds, and insurers.

*CFA® Program Curriculum, Volume 6, page 369*

The risk measures used by an organization will depend on the types of risks it is exposed to, the regulations that govern it, and whether the organization uses leverage. For each type of organization, differences among firms will result in differences in the risk measures used. In what follows, we focus on similarities of risk measures used among organizations of the same type and typical differences between the risk measures used by different organizations.

**Banks** typically use sensitivity measures (duration of held-to-maturity securities and foreign exchange risk exposure), scenario analysis and stress testing (for their full balance sheets), leverage risk measures, and VaR (especially for trading securities). Banks also estimate risk from asset-liability mismatches, estimate VaR for economic capital, and disaggregate risk by both geographic location and business unit type.

**PROFESSOR'S NOTE**

Economic capital is the amount of capital a firm needs to hold for it to survive severe losses due to the risks in its businesses.

**Traditional (long-only) asset managers** typically focus on relative risk measures unless their goal is an absolute return target. Typical risk measures used include the size of positions, sensitivity measures of interest rate and market risk, historical and hypothetical scenario analysis, and options risk. A risk measure more specific to asset management is **active share**: the difference between the weight of a security in the portfolio and its weight in the benchmark.

**Ex-post tracking error** (backward looking) and **ex ante tracking error** (forward looking) measures provide different information. Ex-post tracking error is a measure of a portfolio's tracking error relative to a benchmark portfolio over a lookback period. Ex-post tracking error is used for performance attribution and to assess manager skill over prior periods. Traditional asset managers mostly use ex ante tracking error for risk estimation, which focuses on the potential underperformance of the current (rather than a historical) portfolio. Managers with an absolute return target may use VaR instead.

For **hedge funds**, the risk measures used depend, to some extent, on the strategy employed. For hedge funds in general, the risk measures used include sensitivity analysis, leverage measures, scenario analysis, and stress tests. Funds with both long and short positions will estimate risk measures for long positions and short positions, as well as for the overall portfolio (gross exposure). Hedge funds that use VaR focus on VaR measures of less than 10% for short periods.

Hedge funds with significantly non-normal returns distributions use a risk measure referred to as *maximum drawdown*: the largest decrease in value over prior periods of a specific length.

As we have noted, sensitivity measures based on standard deviation or beta may be misleading for large changes in risk factors when returns are non-normal.

**Defined benefit pension funds** calculate the difference between the present value of their assets (often market values) and the present value of their estimated future liabilities (payments to retirees and heirs). A risk measure used by pension funds is **surplus-at-risk**, a VaR for plan assets minus liabilities. A negative surplus must be made up by the firm if higher-than-expected asset returns do not reduce it significantly over time. The term *glide path* refers to a multi-year plan for adjusting pension fund contributions to reverse a significant overfunded or underfunded status. To reduce surplus uncertainly, a pension fund may match its assets to its liabilities. A related risk measure is an estimate of the hedged exposure and unhedged (returns-generating) exposure of the fund.

**Insurance companies** are often subject to significant regulation of their products and their investment portfolios (reserves). **Property and casualty insurers** sell auto, home, boat, liability, and health insurance. The insurance risks of a P&C company are not highly correlated with the market risk of their investment portfolios. Insurance risks are reduced by purchasing reinsurance (from another insurance company) and by geographical diversification. **Life insurers** primarily sell life insurance policies and annuities, some of which make payments until the death of the annuity owner.

P&C insurers use sensitivities of their exposures to market risk factors in their investment portfolios for risk management. Premium income is expected to cover the cost of insurance claims in a typical year, with the investment portfolio available to cover extraordinary claim losses, such as those in a year with a natural disaster.

P&C insurers use VaR and capital at risk as measures of their risk exposure in their investment accounts. They also use scenario analysis, often combining portfolio risk factors and insurance risk factors in a scenario. Regulations may require specific amounts of reserves (based on policies issued), and regulators discount the values of riskier assets held as reserves in determining their adequacy.

The insurance risk of life insurers is more highly correlated with the market risk exposures of their investment portfolios than it is for P&C insurers. Because annuities pay over relatively long periods into the future, the present values of these liabilities are quite sensitive to the discount factors used, although they have significant mortality risk factors as well. (The longer a life annuity pays, the larger the current liability.) For this reason, life insurers estimate the sensitivities to market risk factors for both their investment portfolios and their annuity liabilities.

Because life insurers are able to somewhat match the market risk of their portfolio assets to their liabilities, they must consider the risk of the remaining mismatch between assets and liabilities. Life insurers also use scenario analysis that includes both nonmarket (insurance) risk factors and market risk factors.

## MODULE QUIZ 45.3, 45.4

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

1. Which of the following risk measures is *most likely* to be used by a traditional asset manager?
    A. Active share.
    B. Surplus at risk.
    C. Maximum drawdown.

2. The risk measure of volatility of surplus would most likely be used by a:
   A. bank.
   B. pension fund.
   C. life insurance company.

# MODULE 45.5: CONSTRAINTS AND CAPITAL ALLOCATION DECISIONS

Video covering this content is available online.

## LOS 45.k: Explain constraints used in managing market risks, including risk budgeting, position limits, scenario limits, and stop-loss limits.

*CFA® Program Curriculum, Volume 6, page 377*

Constraints imposed to limit risk can be too restrictive, impairing profitability, or not restrictive enough, leading to financial stress, corporate reorganization, or bankruptcy. Imposing restrictions at the business-unit level may be too restrictive to the extent diversification benefits or offsetting positions across business units are not taken into account. Risk limits that are often imposed include the following.

**Risk budgeting** refers to a risk management process that first determines the acceptable total risk for an organization, and then allocates that risk to different activities, strategies, or asset classes as appropriate. An example would be first determining the maximum allowable 5% VaR amount, then allocating that VaR across various business units. A portfolio manager may set a limit for total risk relative to a benchmark and then allocate that risk to deviations from the portfolio's target asset allocations, deviations from benchmark weights in specific industries, and deviations from benchmark weights for firms within a specific industry.

**Position limits** are one way to limit risk because they ensure some minimum level of diversification by limiting risk exposures. For example, position limits may be imposed on allocations to individual securities within an asset class, asset classes such as equities or high-yield bonds, investments in a single country, securities in a single currency or the differences between long and short positions for a hedge fund manager.

Position limits can be expressed as currency amounts or as percentages of a portfolio's value. Position limits can also be based on a liquidity measure, such as average daily or weekly trading volume.

**Scenario limits** are limits on expected loss for a given scenario.

**Stop-loss limits** require that a risk exposure be reduced if losses exceed a specified amount over a certain period of time. An example of a simple stop-loss limit is a requirement to reduce the portfolio allocation to a stock or asset class (by a given amount) if it declines in value by more than a specified percentage (or currency amount). A slightly more complex type of stop-loss limit is a requirement that a risk exposure be hedged as the value of a security or index falls. This is referred to as **portfolio insurance** when the value of a portfolio is hedged by index puts.

## LOS 45.l: Explain how risk measures may be used in capital allocation decisions.

*CFA® Program Curriculum, Volume 6, page 380*

**Capital allocation** decisions refer to how the capital of a firm is used to fund its various business units or activities, analogous to asset allocation for a portfolio manager. The optimal capital allocation, ignoring risk, would be the allocation that maximizes the expected return on the firm's invested capital. Risk management, however, requires that the risk exposure for each use of firm capital be considered.

One way to introduce risk exposures to various activities into the capital allocation decision is to limit the overall risk of all the activities. By calculating a VaR for each activity or business unit, the maximum acceptable VaR can be allocated across the activities or business units in a process similar to risk budgeting for a portfolio manager. This is but one method of considering risk exposures when determining the optimal allocation of firm capital to various activities.

## MODULE QUIZ 45.5

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

1. The risk committee of an investment management firm believes high-yield bonds will decrease in value if the economy goes into recession, and the committee decides to limit exposure to this asset class to 10% of assets under management. This constraint is *best* described as a:
    A. position limit.
    B. scenario limit.
    C. stop-loss limit.

# KEY CONCEPTS

## LOS 45.a

Value at risk (VaR) is an estimate of the minimum loss that will occur with a given probability over a specified period expressed as a currency amount or as percentage of portfolio value.

## LOS 45.b

Value at risk estimation methods:

- Parametric method—uses the estimated variances and covariances of portfolio securities to estimate the distribution of possible portfolio values, often assuming a normal distribution.
- Historical simulation—uses historical values for risk factors over some prior lookback period to get a distribution of possible values.
- Monte Carlo simulation—draws each risk factor change from an assumed distribution and calculates portfolio values based on a set of changes in risk factors; repeated thousands of times to get a distribution of possible portfolio values.

## LOS 45.c

The x% VaR is calculated as the minimum loss for the current portfolio, x% of the time, based on an estimated distribution of portfolio values.

## LOS 45.d

Advantages of VaR:

- Widely accepted by regulators.
- Simple to understand.
- Expresses risk as a single number.
- Useful for comparing the risk of portfolios, portfolio components, and business units.

Disadvantages of VaR:

- Subjective in that the time period and the probability are chosen by the user.
- Very sensitive to the estimation method and assumptions employed by the user.
- Focused only on left-tail outcomes.
- Vulnerable to misspecification by the user.

## LOS 45.e

Conditional VaR (CVaR) is the expected loss given that the loss exceeds the VaR.

Incremental VaR (IVaR) is the estimated change in VaR from a specific change in the size of a portfolio position.

Marginal VaR (MVaR) is the estimate of the change in VaR for a small change in a portfolio position and is used as an estimate of the position’s contribution to overall VaR.

Ex ante tracking error, also referred to as relative VaR, measures the VaR of the difference between the return on a portfolio and the return on the manager’s benchmark portfolio.

## LOS 45.f

Sensitivity analysis is used to estimate the change in a security or portfolio value to an incremental change in a risk factor.

Scenario analysis refers to estimation of the effect on portfolio value of a specific set of changes in relevant risk factors.

A scenario of changes in risk factors can be historical, based on a past set of risk factors changes that actually occurred, or hypothetical (based on a selected set of significant changes in the risk factors of interest).

## LOS 45.g

Equity risk is measured by beta (sensitivity to overall market returns).

The interest rate risk of fixed-income securities is measured by duration (sensitivity to change in yield) and convexity (second-order effect, change in duration).

Options risk is measured by delta (sensitivity to asset price changes), gamma (second-order effect, change in delta), and vega (sensitivity to asset price volatility).

Market risk can be managed by adjusting portfolio holdings to control the exposures to these various risk factors.

## LOS 45.h

A stress test based on either sensitivity or scenario analysis uses extreme changes to examine the expected effects on a portfolio or organization, often to determine the effects on a firm's equity or solvency. A reverse stress test is designed to identify scenarios that would result in business failure.

Sensitivity analysis can give a risk manager a more complete view of the vulnerability of a portfolio to a variety of risk factors. Sensitivity and scenario risk measures provide additional information about portfolio risk but do not necessarily provide probabilities or, in the case of sensitivity measures, the sizes of expected changes in risk factors and portfolio value.

Sensitivity and scenario analysis provide information that VaR does not and are not necessarily based on historical results. A historical scenario will not necessarily be repeated. Hypothetical scenarios may be misspecified, and the probability that a scenario will occur is unknown.

## LOS 45.i

VaR, sensitivity analysis, and scenario analysis complement each other, and a risk manager should not rely on only one of these measures.

- VaR provides a probability of loss.
- Sensitivity analysis provides estimates of the relative exposures to different risk factors, but does not provide estimates of the probability of any specific movement in risk factors.
- Scenario analysis provides information about exposure to simultaneous changes in several risk factors or changes in risk correlations, but there is no probability associated with a specific scenario.

## LOS 45.j

Banks are concerned with many risks including asset-liability mismatches, market risk for their investment portfolio, their leverage, the duration and convexity of their portfolio of fixed-income securities, and the overall risk to their economic capital.

Asset managers are most concerned with returns volatility and the probability distribution of either absolute losses or losses relative to a benchmark portfolio.

Pension fund managers are concerned with any mismatch between assets and liabilities as well as with the volatility of the surplus (assets minus liabilities).

P&C companies are concerned with the sensitivity of their investment portfolio to risk factors, the VaR of their economic capital, and scenarios that incorporate both market and insurance risks as stress tests of the firm.

Life insurers are concerned with market risks to their investment portfolio assets and liabilities (to make annuity payments), any mismatch between assets and liabilities, and scenarios that would lead to large decreases in their surplus.

## LOS 45.k

Risk budgeting begins with determination of an acceptable amount of risk and then allocates this risk among investment positions to generate maximum returns for the risk taken.

Position limits are maximum currency amounts or portfolio percentages allowed for individual securities, securities of a single issuer, or classes of securities, based on their risk factor exposures.

A stop-loss limit requires that an investment position be reduced (by sale or hedging) or closed out when losses exceed a given amount over a specified time period.

A scenario limit requires adjustment of the portfolio so that the expected loss from a given scenario will not exceed a specified amount.

## LOS 45.l

Firms use risk measures by adjusting expected returns for risk when making capital allocation decisions.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 45.1

1. **C** Weekly 5% VaR of £1 million indicates that there is a 5% probability that a loss during any given week will be greater than £1 million. (LOS 45.a)

2. **C** Monte Carlo simulation uses estimated statistical properties for each of its risk factors. The parametric method and historical simulation both use a lookback period. (LOS 45.b)

3. **C** % VaR = 0.065 – 1.65(0.09) = −0.0835

   $ VaR = (0.0835) × ($6,400,000) = $534,400

   (LOS 45.c)

## Module Quiz 45.2

1. **A** Because VaR focuses on negative (left-tail) outcomes, it does not provide a complete view of the trade-off between risk and return. Advantages of VaR include its acceptance by global banking regulators and its usefulness in comparing risk across different asset classes. (LOS 45.d)

2. **B** Conditional VaR is the expected amount of a loss, given that it is equal to or greater than the VaR. Marginal VaR is the slope of a curve of VaR as a function of a security's weight in a portfolio. Incremental VaR is the change in VaR resulting from changing the portfolio weight of a security. (LOS 45.e)

3. **B** Vega is a measure of the sensitivity of an option value to changes in volatility of the underlying asset price. (LOS 45.f)

## Module Quiz 45.3, 45.4

1. **A** Active share is the difference between the weight of a security in an asset manager's portfolio and its weight in a benchmark index. Maximum drawdown is a risk measure often used by hedge funds. Surplus at risk is a risk measure used by defined benefit pension plans. (Module 45.4, LOS 45.j)

2. **B** Pension fund managers are concerned with any mismatch between assets and liabilities as well as with the volatility of the surplus (assets minus liabilities). (Module 45.4, LOS 45.j)

## Module Quiz 45.5

1. **A** Limiting the allocation to an asset class is an example of a position limit. (LOS 45.k)

The following is a review of the Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #46.

# READING 46: ECONOMICS AND INVESTMENT MARKETS

**Study Session 17**

## EXAM FOCUS

This topic review links real rate of return to investors' inter-temporal rate of substitution. It further uses utility theory to derive risk premium for consumption hedging properties of assets. Be able to identify appropriate risk premiums for different asset classes.

## MODULE 46.1: VALUATION AND INTEREST RATES

Video covering this content is available online.

**LOS 46.a: Explain the notion that to affect market values, economic factors must affect one or more of the following: 1) default-free interest rates across maturities, 2) the timing and/or magnitude of expected cash flows, and 3) risk premiums.**

*CFA® Program Curriculum, Volume 6, page 402*

The value of any asset can be computed as the present value of its expected future cash flows discounted at an appropriate risk-adjusted discount rate. The more uncertain the cash flows, the higher the discount rate.

Components of the discount rate are:

1. Real risk-free discount rate (R).
2. Expected inflation (π).
3. Risk premium reflecting the uncertainty about the cash flow (RP).

The value of an asset will change if either the cash flow forecasts change or any of the components of the discount rate changes. Risk premiums not only vary across assets (and asset classes), but also vary with changes in investors' perception of risk. We will examine the decomposition of risk premiums for several asset classes in the remainder of this topic review.

**LOS 46.b: Explain the role of expectations and changes in expectations in market valuation.**

*CFA® Program Curriculum, Volume 6, page 405*

The value of an asset depends on (1) its expected future cash flows and (2) the discount rate used to value those cash flows. As market participants receive new information, the timing and amounts of expected future cash flows are revised and valuations change as a result. The impact of new information will depend on its effect on current expectations so that an

earnings report of 53% growth in earnings may have a positive or negative effect on the firm's value, depending on whether expectations were for slower or more rapid growth.

### LOS 46.c: Explain the relationship between the long-term growth rate of the economy, the volatility of the growth rate, and the average level of real short-term interest rates.

*CFA® Program Curriculum, Volume 6, page 414*

Even in a world of no inflation, a default-free bond has to compensate an investor for forgoing their current consumption. The investor evaluates the disutility of forgoing current consumption relative to the utility of obtaining future consumption.

The real risk-free rate of interest derives from the **inter-temporal rate of substitution**, which represents an investor's trade-off between real consumption now and real consumption in the future. Based on utility theory, we can represent this trade-off as:

inter-temporal rate of substitution =

$$m_t = \frac{\text{marginal utility of consuming 1 unit in the future}}{\text{marginal utility of current consumption of 1 unit}} = \frac{u_t}{u_0}$$

For a given quantity of consumption, investors always prefer current consumption over future consumption ($u_0 > u_t$) and $m_t<1$ as a result.

The current price ($P_0$) of a zero-coupon, inflation-indexed, risk-free bond that will pay $1 at time *t* can be expressed as:

$$P_0 = E(m_t)$$

in which case, the real risk-free rate of return is:

$$R = \frac{1-P_0}{P_0} = \left[\frac{1}{E(m_t)}\right] - 1$$

**PROFESSOR'S NOTE**

We have been considering an inflation-indexed bond in this example because we do not want to consider the effects of inflation in our analysis yet.

Some key points to keep in mind:

- The higher the utility investors attach for current consumption relative to future consumption, the higher the real rate.
- Diminishing marginal utility of wealth means that an investor's marginal utility of consumption declines as wealth increases. This suggests that marginal utility of consumption is higher during periods of scarcity, such as during economic contractions.
- If investors expect higher incomes in the future, their expected marginal utility of future consumption is decreased relative to current consumption. When investor expectations about the economy change to better economic times ahead, the expectation of higher incomes in the future will lead to an increase in current consumption and a reduction in savings. Investors will derive greater utility from current consumption relative to future consumption and would, therefore, save less.

Conversely, investors expecting worse times ahead would prefer to increase future consumption by reducing current consumption and saving more.

- Investors increase their savings rate when expected returns are high or when uncertainty about their future income increases.

## Risky Cash Flows and Risk Premiums

The risk aversion of investors can be explained by the covariance of an investor's inter-temporal marginal rate of substitution and expected returns on savings. Our discussion so far was limited to risk-free investments. However, if the underlying cash flows are uncertain, investors demand a risk premium for bearing the risk that comes with such uncertainty. The investor's expected marginal utility of a payoff is inversely related to the level of uncertainty of the payoff. Investors experience a larger loss of utility for a loss in wealth as compared to a gain in utility for an equivalent gain in wealth. This property is called as **risk-aversion**.

An investor's absolute risk-aversion declines with their wealth; wealthier investors are less risk-averse and more willing to take risk relative to their poorer counterparts. However, the marginal utility of holding risky assets declines as an investor holds more risky assets in her portfolio. When the markets are in equilibrium, wealthy and poorer investors would have the same willingness to hold risky assets.

Consider a risk-free, inflation-indexed, zero-coupon bond that an investor will sell prior to maturity. The uncertainty about the sale price gives rise to a risk premium. The price of the bond will be lower than the expected sale price discounted at the real risk free rate. We can model this risk premium as:

$$P_0 = \frac{E(P_1)}{(1+R)} + \operatorname{cov}\left(P_1, m_1\right)$$

where:
R = the real risk-free rate

The covariance between the expected future price of the bond and the investor's inter-temporal rate of substitution can be viewed as a risk premium. Now imagine this relationship in the context of a risky asset (e.g., stocks). For risk-averse investors, the covariance is negative; when the expected future price of the asset is high, the marginal utility of future consumption relative to current consumption is low. This is because during good economic times, both investors' labor incomes and most risky asset values are high. However, with higher future labor incomes, the marginal utility of future consumption is lower. The resulting negative covariance between the marginal utility of consumption and asset prices reduces the value of the asset for a given expected sale price, $P_1$. Everything else constant, the lower current price ($P_0$) increases expected return. This higher expected return is due to a positive risk premium.

For a single-period risk-free bond, the covariance is zero as there is no uncertainty about the terminal value; there is no risk premium.

## GDP Growth Rates

If GDP growth is forecasted to be high, the utility of consumption in the future (when incomes will be high) will be low and the inter-temporal rate of substitution will fall; investors will save less, increasing real interest rates. Therefore, real interest rates will be

positively correlated with real GDP growth rates. This is consistent with the existence of high real rates in rapidly growing developing economies such as those of India and China. Interest rates are also positively correlated with the expected volatility in GDP growth due to higher risk premium.

**LOS 46.d: Explain how the phase of the business cycle affects policy and short-term interest rates, the slope of the term structure of interest rates, and the relative performance of bonds of differing maturities.**

*CFA® Program Curriculum,Volume 6, page 424*

So far we have not considered the implications of inflation in our analysis of the correlation between interest rates and GDP growth. Nominal risk-free interest rates include a premium for expected inflation ($\pi$). However, actual inflation is uncertain. This additional risk gives rise to an additional risk premium for the uncertainty about actual inflation ($\theta$). This risk premium is higher for longer maturity bonds.

For short-term risk-free securities (e.g., T-bills), the uncertainty about inflation is negligible and, therefore, the nominal interest rate (r) would be comprised of real risk-free rate (R) and expected inflation ($\pi$):

$$r(\text{short-term}) = R + \pi$$

For longer term bonds, we add the risk premium for uncertainty about inflation, $\theta$:

$$r(\text{long-term}) = R + \pi + \theta$$

## Taylor Rule

Central banks are usually charged with setting policy rates so as to (1) maintain price stability and (2) achieve the maximum sustainable level of employment. The Taylor rule links the central bank's policy rate to economic conditions (employment level and inflation):

$$r = R_n + \pi + 0.5(\pi - \pi^*) + 0.5(y - y^*)$$

where:
r = central bank policy rate implied by the Taylor rule
$R_n$ = neutral *real* policy interest rate
$\pi$ = current inflation rate
$\pi^*$ = central bank's target inflation rate
y = log of current level of output
y* = log of central bank's target (sustainable) output

Central banks can moderate the business cycle by making appropriate changes to the policy rate or can magnify the cycle by not responding appropriately to changing economic conditions (e.g., committing policy errors such as keeping rates too low).

## Business Cycle and Slope of the Yield Curve

When the economy is in recession, policy rates tend to be low. Investors' improving expectations about future GDP growth and increasing inflation as the economy comes out of recession, leads to higher longer-term rates. This results in a positively sloped yield curve. Conversely, expectations of a decline in GDP growth results in a negatively sloped (inverted)

yield curve. For this reason, an inverted yield curve is often considered a predictor of future recessions. Later stages of an economic expansion often are characterized by high inflation and high short-term interest rates, while longer term rates tend to be low, reflecting investor's expectation of decreasing inflation and GDP growth.

A **term spread** is the difference between the yield on a longer-term bond yield and the yield on a short-term bond. Evidence suggests that normal term spread is positive so the yield curve is upward sloping. Recall that the risk premium for uncertainty in inflation ($\theta$) is higher for longer maturity bonds. Positive term spreads can be attributed to increasing $\theta$ for longer periods.

### LOS 46.e: Describe the factors that affect yield spreads between non-inflation-adjusted and inflation-indexed bonds.

*CFA® Program Curriculum, Volume 6, page 432*

The difference between the yield of a non-inflation-indexed risk-free bond and the yield of an inflation-indexed risk-free bond of the same maturity is the **break-even inflation rate (BEI)**.

BEI = yield on non-inflation-indexed bond – yield on inflation-indexed bond

Recall that for longer maturity bonds, the nominal rate is composed of the real rate, expected inflation, and a risk premium for inflation uncertainty. Therefore, BEI is composed of two elements: expected inflation ($\pi$) and a risk premium for uncertainty about actual inflation ($\theta$).

$$BEI = \pi + \theta$$

### LOS 46.f: Explain how the phase of the business cycle affects credit spreads and the performance of credit-sensitive fixed-income instruments.

*CFA® Program Curriculum, Volume 6, page 447*

The required rate of return for bonds with credit risk includes an additional risk premium. This credit risk premium (credit spread) is the difference in yield between a credit risky bond and a default-free bond of the same maturity.

$$\text{Required rate of return for credit risky bonds} = R + \pi + \theta + \gamma$$

where:
$\gamma$ = additional risk premium for credit risk = credit spread

Credit spreads tend to rise during times of economic downturns and fall during expansions. Research has shown that defaults increase, and recovery rates decrease, during periods of economic weakness. Both effects result in greater credit losses during economic downturns.

When credit spreads narrows, credit risky bonds will outperform default-free bonds. Overall, lower rated bonds tend to benefit more than higher rated bonds from a narrowing of credit spreads (their yields fall more). Conversely, when credit spreads widen, higher rated bonds will outperform lower rated bonds on a relative basis (because their yields will rise less).

## MODULE QUIZ 46.1

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

1. Carrier, Inc.'s stock price fell last week, which was contrary to the movement in the industry index. Which of the following is *most likely* a valid reason for that to occur?
   A. An increase in the real risk-free rate.

B. Inflation is expected to be higher.
C. Investors are demanding a higher risk premium on Carrier.

2. Sonic, Inc., reported 12% earnings growth year-over-year, but its stock price fell. Which of the following is *most likely* a valid reason for that to occur?
   A. The market's expectation for Sonic was to report an earnings growth of less than 12%.
   B. The market's expectation for Sonic was to report an earnings growth of more than 12%.
   C. The market expected Sonic to outperform its competitors.
3. Which of the following statements is *most accurate*? Higher expected GDP growth would:
   A. lower the utility of future consumption and reduce the inter-temporal rate of substitution.
   B. increase the utility of future consumption and reduce the inter-temporal rate of substitution.
   C. lower the utility of future consumption and increase the inter-temporal rate of substitution.
4. Break-even inflation rate is comprised of the:
   A. real rate and unexpected inflation.
   B. expected inflation and risk premium for inflation uncertainty.
   C. inter-temporal rate of substitution and expected inflation.
5. An economy just getting out of recession would *most likely* have:
   A. high short-term rates and an inverted yield curve.
   B. low short-term rates and an inverted yield curve.
   C. low short-term rates and an upward sloping yield curve.
6. Zeon Corp's 10-year bonds are currently yielding 7.50%. The real rate is 3% and expected inflation is 2%. Which of the following is *most accurate*? Credit spread on Zeon bonds is:
   A. equal to 2.50%.
   B. less than 2.50%.
   C. greater than 2.50%.

## MODULE 46.2: THE BUSINESS CYCLE

Video covering this content is available online.

### LOS 46.g: Explain how the characteristics of the markets for a company's products affect the company's credit quality.

*CFA® Program Curriculum, Volume 6, page 453*

Analysis of credit spreads by industrial sectors reveals that spreads differ among sectors and over time. Differences in credit spreads are primarily due to differences in industry products and services and the financial leverage of the firms in the industry. Spreads for issuers in the consumer cyclical sector increase significantly during economic downturns compared to spreads for issuers in the consumer non-cyclical sector.

### LOS 46.h: Explain how the phase of the business cycle affects short-term and long-term earnings growth expectations.

*CFA® Program Curriculum, Volume 6, page 461*

Corporate earnings may be related to the business cycle. Cyclical industries (e.g., durable goods manufacturers and consumer discretionary) tend to be relatively more sensitive to the phase of the business cycle. Companies in these industries have revenues and earnings that rise and fall with the rate of economic growth. Defensive or non-cyclical industries (e.g., consumer non-discretionary) tend to be relatively immune to fluctuations in economic activity; their earnings tend to be relatively stable throughout the business cycle.

### LOS 46.i: Explain the relationship between the consumption-hedging properties of equity and the equity risk premium.

*CFA® Program Curriculum, Volume 6, page 460*

The discount rate used to value equity securities includes an additional risk premium, the equity risk premium. This risk premium is in addition to the risk premium on credit risky bonds because equity is more risky than debt.

Discount rate for equity = $R + \pi + \theta + \gamma + \kappa$

where:

$\kappa$ =additional risk premium relative to risky debt for an investment in equities

$\lambda$ =equity risk premium = $\gamma + \kappa$

Assets that provide a higher payoff during economic downturns are more highly valued because of the *consumption hedging property* of the asset. This property reduces the risk premium on an asset. Equity prices are generally cyclical, with higher values during economic expansions when the marginal utility of consumption is lower. Equity investments, therefore, are not the most effective hedge against bad consumption outcomes. Because of this poor consumption hedging ability, equity risk premium is positive.

### LOS 46.j: Describe cyclical effects on valuation multiples.

*CFA® Program Curriculum, Volume 6, page 467*

Price multiples such as P/E and P/B are often used in determining the relative values of companies, of sectors, or of the overall market from a historical perspective. However, it is inappropriate to judge the multiple in a historical context only. If the P/E ratio for S&P 500 is above historical standards, it could be that the index is overvalued, but it also could be that the index level is justified by current conditions.

Price multiples are positively correlated with expected earnings growth rates and negatively correlated to required returns. Therefore, price multiples rise with increases in expected future earnings growth and with a decrease in any of the components of the required rate of return (the real rate, expected inflation, the risk premium for inflation uncertainty, or the equity risk premium). As a result, the equity risk premium declines during economic expansions and rises during recessions.

Shiller's CAPE (real cyclically adjusted P/E) ratio reduces the volatility of unadjusted P/E ratios by using real (i.e., inflation-adjusted) prices in the numerator and a 10-year moving average of real earnings in the denominator.

### LOS 46.k: Describe the implications of the business cycle for a given style strategy (value, growth, small capitalization, large capitalization).

*CFA® Program Curriculum, Volume 6, page 470*

Growth stocks are characterized by high P/Es and by low dividend yields and tend to be in immature markets with high growth prospects. Value stocks tend to have low P/Es, have high dividend yields, and are generally found in established and mature markets. Value stocks tend to have stable earnings. A growth investing strategy means investing in growth stocks, while a value strategy means investing in value stocks. Historically, there have been periods when one strategy distinctly outperforms the other. A value strategy performs well during and

immediately following recessionary conditions, while growth strategy performs well during economic expansions.

Stocks are also categorized by company size as measured by market capitalization (e.g., small-cap, mid-cap, and large-cap). Small-cap stocks tend to have higher volatility and command a higher risk premium.

### LOS 46.l: Describe how economic analysis is used in sector rotation strategies.

*CFA® Program Curriculum, Volume 6, page 472*

Ex post risk premiums on equity sectors can be computed as the difference between the average return on a sector and the short-term risk free rate. Consider two sectors: cyclical and non-cyclical industries. There are periods during which one sector outperforms the other; one sector generates a higher risk premium relative to the other. If investors could rotate out of the under-performing sector and into the better performing sector right before the change in performance, they would generate superior returns. Getting the timing right is of course very difficult. The point, however, is that understanding and forecasting the relationship between the equity market performance of different sectors and the business cycle would help analysts enhance their sector rotation strategies.

### LOS 46.m: Describe the economic factors affecting investment in commercial real estate.

*CFA® Program Curriculum, Volume 6, page 474*

Commercial real estate investments have:

- Bond-like characteristics. The steady rental income stream is similar to cash flows from a portfolio of bonds. Furthermore, just as the credit quality of issuers affects the value of a bond portfolio, the credit quality of tenants affects the value of commercial real estate.
- Equity-like characteristics. The value of commercial real estate is influenced by many factors, including the state of the economy, the demand for rental properties, and property location. Uncertainty about the value of the property at the end of the lease term gives commercial properties an equity-like character.
- Illiquidity. Real estate as an asset class is characterized by illiquidity; it could take years to exit a real estate investment at its fair value.

## Valuation

When estimating the value of real estate investment, the discount rate includes an additional risk premium for the lack of liquidity:

Discount rate for commercial real estate = $R + \pi + \theta + \gamma + \kappa + \varphi$

where:

$\kappa$ = risk premium for uncertainty about terminal value of property (similar to the equity risk premium)

$\varphi$ = risk premium for illiquidity

While rental income from commercial properties seems to be more or less steady across business cycles, commercial property values tend to be very cyclical. Because of this, the

correlation of commercial property values with those of other asset classes (e.g., equities) tends to be positive. Similar to equities, real estate provides a poor hedge against bad consumption outcomes. Therefore, the risk premium required by investors for investment in commercial properties will be relatively high and often close to the risk premium required for equity investments.

## MODULE QUIZ 46.2

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

1. Credit spreads on issuers classified as consumer cyclical are *most likely* to:
   A. widen during economic downturns.
   B. narrow during economic downturns.
   C. remain stable during the entire business cycle.
2. Earnings of companies in the consumer staples industry are *most likely* to:
   A. fluctuate with the business cycle.
   B. remain stable over the business cycle.
   C. fluctuate more than companies in consumer discretionary industries.
3. Which of the following statements is *most accurate*? Equity as an asset class provides:
   A. good consumption hedging properties and, therefore, commands a positive risk premium.
   B. poor consumption hedging properties and, therefore, commands a positive risk premium.
   C. good consumption hedging properties and, therefore, commands a negative risk premium.
4. Analysis of price multiples is *most likely* to indicate that the equity risk premium:
   A. declines during economic downturns.
   B. is stable over the business cycle.
   C. declines over economic expansions.
5. Growth stocks are *least likely* to be characterized by high:
   A. dividend yield.
   B. price multiple.
   C. expected earnings growth rate.
6. Relative to other asset classes, investors in commercial real estate are *least likely* to require a risk premium for:
   A. uncertainty in inflation.
   B. illiquidity.
   C. uncertainty in terminal value.

# KEY CONCEPTS

## LOS 46.a

The value of any asset can be computed as present value of its expected future cash flows discounted at an appropriate risk-adjusted discount rate. Risky cash flows require the discount rate to be higher due to inclusion of a risk premium.

## LOS 46.b

Market prices reflect current expectations. Only changes in expectations cause a change in market price.

## LOS 46.c

Interest rates are positively related to GDP growth rate and to the expected volatility in GDP growth due to a higher risk premium.

## LOS 46.d

When the economy is in recession, short-term policy rates tend to be low. Investor expectations about higher future GDP growth and inflation as the economy comes out of recession lead to higher longer-term rates. This leads to positive slope of the yield curve. Conversely, an inversely sloping yield curve is often considered a predictor of future recessions.

## LOS 46.e

Break-even inflation rate (BEI)

= yield on non-inflation indexed bonds − yield on inflation indexed bonds

BEI is comprised of two elements: expected inflation ($\pi$) and risk premium for uncertainty in inflation ($\theta$).

## LOS 46.f

Credit spreads tend to rise during times of economic downturns and shrink during expansions. When spreads narrow, lower-rated bonds tend to outperform higher-rated bonds.

## LOS 46.g

Spreads for issuers in consumer cyclical sector widen considerably during economic downturns compared to spreads for issuers in the consumer non-cyclical sector.

## LOS 46.h

Cyclical industries (e.g., durable goods manufacturers and consumer discretionary) tend to be extremely sensitive to the business cycle; their earnings rise during economic expansions and fall during contractions. Non-cyclical or defensive industries tend to have relatively stable earnings.

## LOS 46.i

Equities are generally cyclical; they have higher values during good times and have poor consumption hedging properties. Therefore, the risk premium on equities should be positive.

## LOS 46.j

Price multiples tend to follow the business cycle: multiples rise during economic expansions

(as analysts revise growth estimates upward) and fall during contractions (as growth estimates are revised downward).

### LOS 46.k

Empirical evidence shows that there are periods during which one style strategy (e.g., growth) will outperform others. However, timing the style strategy is the tricky part.

### LOS 46.l

Relative outperformance of sectors can be discerned ex post. Ex ante forecasting of this outperformance is the objective of active managers.

### LOS 46.m

Commercial real estate has equity-like and bond-like characteristics. The valuation depends on the rental income stream, the quality of tenants, and the terminal value at the end of the lease term. The discount rate for commercial real estate includes a risk premium for uncertainty in terminal value and also for illiquidity.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 46.1

1. **C** If the real risk-free rate had increased or expected inflation had been higher, the discount rate would have been higher and would have lowered both Carrier's stock price and industry index. Given the divergence between Carrier's stock price and the industry index, a higher risk premium for Carrier's stock is the only valid reason from the choices provided. (LOS 46.a)

2. **B** Market prices embed current expectations. If the market reaction to earnings growth of 12% was negative, it would mean that the market prices were based on a higher earnings growth rate expectation. (LOS 46.b)

3. **A** A higher GDP growth rate would mean higher incomes in the future. Due to the principle of diminishing marginal utility, the utility of future consumption would, therefore, be lower. Lower future utility relative to the utility of current consumption lowers the inter-temporal rate of substitution. (LOS 46.c)

4. **B** BEI = expected inflation + risk premium for uncertainty in inflation. (LOS 46.e)

5. **C** An economy just getting out of recession is more likely to have low short-term rates, as the central bank policy rate would be low. Higher future GDP growth prospects would mean higher real rates and higher expected inflation over the longer term, so long-term rates would be high, leading to an upward sloping yield curve. (LOS 46.d)

6. **B** Yield on risky corporate debt = real risk-free rate + expected inflation + risk premium for inflation uncertainty + credit spread. 2.50% = risk premium for inflation uncertainty + credit spread. Given that the bond is long term, the risk premium for inflation uncertainty must be positive and credit spread must be less than 2.50%. (LOS 46.f)

## Module Quiz 46.2

1. **A** Credit spreads on consumer cyclical issuers widen during economic downturns and narrow during economic expansions. (LOS 46.g)

2. **B** Earnings of consumer staples companies tend to be relatively stable over the entire business cycle. (LOS 46.h)

3. **B** Stocks in general tend to perform well during economic expansions and, therefore, pay off during good economic times. The property of performing poorly during bad economic times implies that equities are a poor consumption hedge. Because they are a poor consumption hedge, investors demand a positive risk premium for investing in equities. (LOS 46.i)

4. **C** Price multiples tend to expand during economic expansions, suggesting that the equity risk premium declines during expansions. This is because investors become less risk averse during economic expansions and demand a lower premium for taking risk. (LOS 46.j)

5. **A** Growth stocks tend to have a low dividend yields, high price multiples, and high expected earnings growth rates. (LOS 46.k)
6. **A** Two risk premia that are unique to real estate as an asset class are the risk premium for illiquidity and the risk premium for uncertainty in terminal value (similar to the equity risk premium). (LOS 46.m)

The following is a review of the Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #47.

# READING 47: ANALYSIS OF ACTIVE PORTFOLIO MANAGEMENT

**Study Session 17**

## EXAM FOCUS

The information ratio is used to evaluate active managers and can be used to make portfolio allocation decisions for an investor. There are lots of formulae and linkages to be on top of for this reading. Understand the differences between the Sharpe ratio and the information ratio. Be able to describe the full fundamental law and what influences each of the components. Understand the application of the fundamental law in the context of market timing and sector rotation strategies. Finally, be aware of the limitations of the fundamental law.

## MODULE 47.1: VALUE ADDED BY ACTIVE MANAGEMENT

Video covering this content is available online.

### LOS 47.a: Describe how value added by active management is measured.

*CFA® Program Curriculum, Volume 6, page 494*

Active management seeks to add value by outperforming a passively managed benchmark portfolio.

**PROFESSOR'S NOTE**

In this topic review, we are going to assume that the systematic risk of the active portfolio is the same as the systematic risk of the benchmark portfolio (i.e., the beta of the active portfolio relative to the benchmark is 1). If the beta of the actively managed portfolio is different than the beta of the benchmark, active return is computed as the difference in risk-adjusted returns and is known as alpha.

## Active Return

Active return ($R_A$) is the value added by active management. Active return can be measured ex-ante (i.e., based on expectations) or ex-post ("after the fact"). Ex-ante active return is the difference between the expected return of an actively managed portfolio and the expected return of its benchmark:

$$E(R_A) = E(R_P) - E(R_B)$$

**Active weights** in a portfolio determine the amount of value added. Active weight is the difference between a security's weight in an actively managed portfolio and its weight in the benchmark portfolio. Overweighted (underweighted) securities have positive (negative) active weights. Active weights must sum to zero.

For an active portfolio of N securities:

$$E(R_A) = \Sigma w_i E(R_i)$$

where:

$\Delta w_i =$ active weight of security $i = w_{Pi} - w_{Bi}$

Ex-post active return is the difference between the realized return of the actively managed portfolio and its benchmark portfolio.

**EXAMPLE: Active return**

The following information is available for an actively managed portfolio and its benchmark.

| Security (i) | Portfolio Weight ($W_{Pi}$) | Benchmark Weight ($W_{Bi}$) | Expected Return $E(R_i)$ |
|---|---|---|---|
| A | 22% | 25% | 12% |
| B | 20% | 25% | –6% |
| C | 21% | 25% | 4% |
| D | 37% | 25% | 19% |

**Calculate** the ex-ante active return.

**Answer:**

$$\text{Active return} = E(R_P) - E(R_B)$$

$$\begin{aligned} E(R_P) &= \sum w_{Pi}(R_i) \\ &= (0.22)(0.12) + (0.20)(-0.06) + (0.21)(0.04) + (0.37)(0.19) \\ &= 0.0931 \text{ or } 9.31\% \\ E(R_B) &= \sum w_{Bi}(R_i) \\ &= (0.25)(0.12) + (0.25)(-0.06) + (0.25)(0.04) + (0.25)(0.19) \\ &= 0.0725 \text{ or } 7.25\% \\ E(R_A) &= 0.0931 - 0.0725 = 0.0206 \text{ or } 2.06\% \end{aligned}$$

Alternatively:

| Security (i) | Portfolio Weight ($W_{Pi}$) | Benchmark Weight ($W_{Bi}$) | Return $R_i$ | Active Weight ($\Delta W_i$) |
|---|---|---|---|---|
| A | 22% | 25% | 12% | –3% |
| B | 20% | 25% | –6% | –5% |
| C | 21% | 25% | 4% | –4% |
| D | 37% | 25% | 19% | 12% |

$$\begin{aligned} E(R_A) &= \sum \Delta w_i E(R_i) \\ &= (-0.03)(0.12) + (-0.05)(-0.06) + (-0.04)(0.04) + (0.12)(0.19) \\ &= 2.06\% \end{aligned}$$

Given an investment strategy involving multiple asset classes, expected returns on the active and benchmark portfolios can be computed as the weighted average of securities returns:

$$E(R_P) = \sum w_{P,j} E(R_{P,j}) \text{and } E(R_B) = \sum w_{B,j} E(R_{B,j})$$

Ex-ante active return is the expected return on the active portfolio minus the expected return on the benchmark:

$$E(R_A) = \sum w_{P,j} E(R_{P,j}) - \sum w_{B,j} E(R_{B,j})$$

Alternatively, active return can be decomposed into two parts:

1. Asset allocation return (from deviations of asset class portfolio weights from benchmark weights).
2. Security selection return (from active returns within asset classes).

$$E(R_A) = \sum \Delta w_j E(R_{B,j}) + \sum w_{P,j} E(R_{A,j})$$

where:

$\sum \Delta w_j E(R_{B,j})$ = return from asset allocation

$\sum w_{P,j} E(R_{A,j})$ = return from security selection

$E(R_{A,j})$ = expected active return within asset classes = $E(R_{Pj}) - E(R_{Bj})$

Consider an active portfolio manager with a benchmark portfolio composed of 25% stocks and 75% bonds. The portfolio manager could overweight stocks (and underweight bonds), resulting in a difference in return relative to the benchmark; this is the asset allocation return. The manager can also choose to have higher weight to a specific stock within the allocation to stocks (and correspondingly underweight some other stocks). This contributes to the security selection return.

**EXAMPLE: Active return**

Optoma Fund invests in three asset classes: U.S. equities, U.S. bonds, and international equities. The asset allocation weights of Optoma and the expected performance of each asset class and the benchmark are shown in the following table.

| Asset Class (i) | Portfolio Weight ($W_{Pi}$) | Benchmark Weight ($W_{Bi}$) | Portfolio Return $E(R_{Pi})$ | Benchmark Return $E(R_{Bi})$ |
|---|---|---|---|---|
| U.S. equities | 45% | 40% | 11% | 12% |
| U.S. bonds | 30% | 30% | 6% | 5% |
| International Equities | 25% | 30% | 14% | 12% |

**Calculate** the expected active return.

**Answer:**

| Asset Class (i) | Portfolio Weight ($W_{Pi}$) | Benchmark Weight ($W_{Bi}$) | Portfolio Return $E(R_{Pi})$ | Benchmark Return $E(R_{Bi})$ | Active Weight ($\Delta W_i$) |
|---|---|---|---|---|---|
| U.S. equities | 45% | 40% | 11% | 12% | 5% |
| U.S. bonds | 30% | 30% | 6% | 5% | 0% |
| International Equities | 25% | 30% | 14% | 12% | –5% |
| Total | | | | | |

| Asset Class (i) | $(\Delta W_i) \times E(R_{Bi})$ | $E(A_i) = E(R_{Pi}) - E(R_{Bi})$ | $(W_{Pi}) \times E(A_i)$ |
|---|---|---|---|
| U.S. equities | 0.60% | –1% | –0.45% |
| U.S. bonds | 0.00% | 1% | 0.30% |
| International Equities | –0.60% | 2% | 0.50% |
| Total | 0.00% | | 0.35% |

$$E(R_A) = \sum w_{P,i} E(R_{P,i}) - \sum w_{B,i} E(R_{B,i}) = 10.25\% - 9.90\% = 0.35\%$$

Alternatively,

$$E(R_A) = \sum \Delta w_i E(R_{B,i}) + \sum w_{P,i} E(R_{A,i}) = 0.00\% + 0.35\% = 0.35\%$$

It can be seen that all of the expected active return is attributable to security selection. The active weights do not contribute to any asset allocation return.

### MODULE QUIZ 47.1

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

1. When measuring value added by active management, it is *most accurate* to state that the active weights in an actively managed portfolio:
   A. must add to 100%.
   B. are the differences between an individual asset's weight in the actively managed portfolio versus the corresponding weight in an equally-weighted portfolio.
   C. must be positively correlated with realized asset returns for value added to be positive.

## MODULE 47.2: THE INFORMATION RATIO VS. THE SHARPE RATIO

Video covering this content is available online.

**LOS 47.b: Calculate and interpret the information ratio (*ex post* and *ex ante*) and contrast it to the Sharpe ratio.**

*CFA® Program Curriculum, Volume 6, page 499*

The information ratio and the Sharpe ratio are two different methods of measuring a portfolio's risk-adjusted rate of return.

The **Sharpe ratio** (SR) is calculated as excess return per unit of risk (standard deviation):

$$SR = \frac{R_P - R_F}{\sigma_P}$$

An important attribute of the Sharpe ratio is that it is *unaffected by the addition of cash or leverage* in the portfolio. A 50% allocation to the risk-free asset would reduce both the excess return and standard deviation of returns by half.

The **information ratio** (IR) is the ratio of the active return to the standard deviation of active returns, which is known as **active risk**:

$$\mathrm{IR} = \frac{\mathrm{R_P} - \mathrm{R_B}}{\sigma_{(\mathrm{R_P} - \mathrm{R_B})}} = \frac{\mathrm{R_A}}{\sigma_{\mathrm{A}}} = \frac{\text{active return}}{\text{active risk}}$$

## Some Important Points

- In this topic review, the information ratio that we are considering is usually the ex-ante information ratio (i.e., the information ratio based on expectations). The ex-ante information ratio is generally positive (otherwise active management is not worth pursuing), while ex-post information ratios will often turn out to be negative.
- A **closet index fund** is a fund that is purported to be actively managed but in reality closely tracks the underlying benchmark index. These funds will have a Sharpe ratio similar to that of the benchmark index, a very low information ratio, and little active risk. After fees, the information ratio of a closet index fund is often negative.
- A fund with zero systematic risk (e.g., a market-neutral long-short equity fund) that uses the risk-free rate as its benchmark would have an information ratio that is equal to its Sharpe ratio. This is because active return will be equal to the portfolio's return minus the risk-free rate, and active risk will be equal to total risk.
- Unlike the Sharpe ratio, the information ratio will change with the addition of cash or the use of leverage. The numerator (active return) of the information ratio is measured relative to a noncash benchmark. Adding cash to a portfolio is likely to lower active return, while active risk (i.e., volatility of active return) should not change much, meaning that the addition of cash is most likely to decrease the information ratio.
- The information ratio of an unconstrained portfolio is unaffected by the aggressiveness of the active weights. If the active weights of a portfolio are tripled, the active return and the active risk both triple, leaving the information ratio unchanged.
- If we combine an actively managed portfolio with an allocation to the benchmark portfolio, the resulting blended portfolio will have the same information ratio as the original actively managed portfolio. As we increase the weight of the benchmark portfolio, the active return and active risk decrease proportionately, leaving the information ratio unchanged.
- Investors can select an appropriate amount of active risk by investing a portion of their assets in the active portfolio and the remaining portion in the benchmark. For example, if the active risk of a fund is 10%, an investor seeking to limit active risk to 6% can do so by investing 60% in the active portfolio and the remaining 40% in the benchmark portfolio.

For an unconstrained active portfolio, the optimal amount of active risk is the level of active risk that maximizes the portfolio's Sharpe ratio. This optimal amount of active risk can be calculated as:

$$\sigma_{\mathrm{A}}^{*} = \frac{\mathrm{IR}}{\mathrm{SR_B}} \sigma_{\mathrm{B}}$$

**PROFESSOR'S NOTE**

Unconstrained active portfolios have optimal weights for each of the securities in the portfolio based on ex ante expectations of active return and active risk. Sometimes constraints (e.g., long only positions) are imposed on active portfolios, resulting in less than optimal weights. We will discuss this in detail later in this topic review.

The Sharpe ratio of a portfolio with optimal level of active risk can be calculated as:

$$SR_P = \sqrt{SR_B + IR^2}$$

Furthermore, the total risk of the portfolio is given by:

$$\sigma_p{}^2 = \sigma_B{}^2 + \sigma_A{}^2$$

**EXAMPLE: Optimal active risk**

Omega fund has an information ratio of 0.2 and active risk of 9%. The benchmark portfolio has a Sharpe ratio of 0.4 and total risk of 12%. If a portfolio (portfolio P) with an optimal level of active risk has been constructed by combining Omega fund and the benchmark portfolio, calculate:

1. Portfolio P's Sharpe ratio.
2. Portfolio P's excess return (i.e., return above the risk-free rate).
3. The proportion of benchmark and Omega fund in portfolio P.

**Answer:**

1. Optimal active risk = $\sigma_A{}^* = \frac{IR}{SR_B}\sigma_B = \frac{0.2}{0.4}(12\%) = 6\%$

   Based on Omega's information ratio of 0.2, the Sharpe ratio of portfolio P with an optimal level of active risk will be $(0.4^2 + 0.2^2)^{½} = 0.4472$
2. The expected active return- given an active risk of 6% is:

   $E(R_A) = IR \times \sigma_A = 0.2 \times 0.06 = 1.2\% = (R_P - R_B)$

   Given the benchmark Sharpe ratio of 0.4 and a benchmark total risk of 12%,

   $$0.40 = \frac{R_B - R_F}{\sigma_P} = \frac{R_B - R_F}{0.12}$$

   Therefore,

   $(R_B - R_F) = 4.8\%$,

   portfolio P's excess return = $(R_P - R_F) = (R_P - R_B) + (R_B - R_F) = 1.2\% + 4.8\% = 6.0\%$,

   and $\sigma_P^2 = \sigma_B^2 + \sigma_A^2 = 0.12^2 + 0.06^2 = 0.018$ and $\sigma_P = 0.134$

   The Sharpe ratio of portfolio P then is: SR = 6% / 13.4% = 0.4472 (as calculated before).
3. The optimal level of active risk is 6% and Omega fund has an active risk of 9%, so we can calculate that 6% / 9% = 67% of portfolio P's allocation will be to the Omega fund and 33% to the benchmark portfolio.

## MODULE QUIZ 47.2

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

1. Which of the following statements regarding the ex-post and ex-ante information ratio and Sharpe ratio is *most accurate*?
   - A. The Sharpe ratio measures reward per unit of risk in benchmark relative returns.
   - B. The information ratio measures reward per unit of absolute risk.
   - C. The information ratio can be applied either ex ante to expected returns or ex post to realized returns.

# MODULE 47.3: THE FUNDAMENTAL LAW

Video covering this content is available online.

**LOS 47.c: State and interpret the fundamental law of active portfolio management including its component terms—transfer coefficient, information coefficient, breadth, and active risk (aggressiveness).**

*CFA® Program Curriculum, Volume 6, page 509*

There are three factors that determine the information ratio:

- The **information coefficient** (IC) is a measure of a manager's skill. IC is the *ex-ante* (i.e., expected), risk-weighted correlation between active returns and forecasted active returns. The ex-post information coefficient, $IC_R$ measures *actual* correlation between active returns and expected active returns.
- The **transfer coefficient** (TC) can be thought of as the correlation between actual active weights and optimal active weights. The optimal active weight for a security is positively related to its expected active return and negatively related to its expected active risk. For an unconstrained active portfolio, the active weights will be equal to the optimal weights and TC = 1. For a constrained portfolio (e.g., constraints on short positions or active risk), TC may be less than 1.

  More precisely, transfer coefficient is the cross-sectional correlation between the forecasted active returns and the actual weights adjusted for risk:

  $$TC = CORR(\mu_i/\sigma_i, \Delta w_i \sigma_i) = CORR(\Delta w_i^* \sigma_i, \Delta w_i \sigma_i)$$

  where:
  $\mu_i$ = the ex-ante active return for security i
- **Breadth** (BR) is the number of independent active bets taken per year. For example, if a manager takes active positions in 10 securities each month, then BR = 10 × 12 = 120.

The **Grinold rule** allows us to compute the expected active return based on the information coefficient, active risk, and a standardized score:

$$\mu_i = IC\sigma_i S_i$$

where:
$S_i$ = score of security *i* (standardized with an assumed variance of 1)

The expected value added by active management is:

$$E(R_A) = \sum \Delta w_i \mu_i$$

For an unconstrained portfolio, TC = 1 and optimal values are denoted by asterisks (*):

$$IR^* = IC\sqrt{BR}$$
$$E(R_A)^* = IC\sqrt{BR}\,\sigma_A$$

For constrained portfolios, the actual active weights ($\Delta w_i$) will differ from the optimal active weights ($\Delta w_i^*$) and the transfer coefficient will be less than 1. In this case, we have:

$$\mathrm{IR} = \left(\mathrm{TC}\right)\mathrm{IC}\sqrt{\mathrm{BR}}$$

$$\mathrm{E}(\mathrm{R_A}) = \left(\mathrm{TC}\right)\mathrm{IC}\sqrt{\mathrm{BR}}\,\sigma_{\mathrm{A}}$$

Because transfer coefficients are always less than one (TC<1), the information ratio must be less than the optimal information ratio (IR<IR*), and the expected active return must be less than the optimal expected active return $E(R_A)<E(R_A)^*$.

Recall that the optimal level of active risk (in an unconstrained portfolio) is a function of the information ratio, the Sharpe ratio of the benchmark, and the standard deviation of the benchmark return:

$$\sigma_{\mathrm{A}}{}^* = \frac{\mathrm{IR}}{\mathrm{SR_B}}\sigma_{\mathrm{B}}$$

For a constrained portfolio, the optimal level of active risk ($\sigma_{CA}{}^*$) is calculated as:

$$\sigma_{\mathrm{CA}}{}^* = \mathrm{TC}\frac{\mathrm{IR}^*}{\mathrm{SR_B}}\sigma_{\mathrm{B}}$$

where:

$IR^*$ = the information ratio of an unconstrained portfolio

This implies that the optimal active risk of a constrained portfolio will be less than the optimal active risk of an unconstrained portfolio. Similarly, the Sharpe ratio of a constrained portfolio is lower than the Sharpe ratio of an unconstrained portfolio and is given by:

$$SR_{PC} = \sqrt{SR_B{}^2 + TC^2 \times IR^{*2}}$$

## Ex-Post Performance Measurement

Realized value added from active management is the ex-post alpha that the manager achieves. Using the ex-post information coefficient $IC_R$, the fundamental law can be written as:

$$\mathrm{E}\left(\mathrm{R_A}\middle|\mathrm{IC_R}\right) = \left(\mathrm{TC}\right)\left(\mathrm{IC_R}\right)\sqrt{\mathrm{BR}}\sigma_{\mathrm{A}}$$

The actual return on the active portfolio can be expressed as its conditional expected return and a noise term:

$R_A = E(R_A \mid IC_R)$ + noise

where $E(R_A \mid IC_R)$ represents the expected value added, given the realized skill of the investor that period.

The proportion of realized variance attributed to variation in the realized information coefficient is $TC^2$.

**LOS 47.d: Explain how the information ratio may be useful in investment manager selection and choosing the level of active portfolio risk.**

*CFA® Program Curriculum, Volume 6, page 504*

Portfolio theory concludes that investors will choose some combination of the risk-free asset and an optimal risky portfolio, with the weights determined by their preferences (risk

tolerance). The optimal risky portfolio is the portfolio with the highest Sharpe ratio. The Sharpe ratio of an actively managed portfolio is higher than the Sharpe ratio of the benchmark based on the information ratio of the actively managed portfolio. **The portfolio with the highest information ratio will also be the portfolio with the highest Sharpe ratio**, so investors will choose the active manager with the highest information ratio; the actively managed portfolio with the highest information ratio is the optimal (active) portfolio for all investors regardless of their risk tolerance.

The information ratio can be used to determine the expected active return for a given target level of active risk:

$$E(R_A) = IR \times \sigma_A$$

### MODULE QUIZ 47.3

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

1. Investors that are constrained by regulation or investment policy may find that some of the important variables identified by the fundamental law of active portfolio management are out of their control. The element that is *most likely* to still be within the investor's control is the:
   A. information coefficient.
   B. transfer coefficient.
   C. benchmark tracking risk.
2. The information ratio is *least appropriate* as a criterion for:
   A. quantifying an actively managed portfolio's return in excess of the risk-free rate.
   B. constructing an actively managed portfolio.
   C. evaluating the past performance of actively managed portfolios.

## MODULE 47.4: ACTIVE MANAGEMENT

Video covering this content is available online.

**LOS 47.e: Compare active management strategies (including market timing and security selection) and evaluate strategy changes in terms of the fundamental law of active management.**

*CFA® Program Curriculum, Volume 6, page 521*

Market timing is simply a bet on the direction of the market (or a segment of the market). For example, an active manager may rotate money out of equities and into cash based on an expected decline in stock prices. For a market timer, the information coefficient is based on the proportion of correct calls:

$$IC = 2(\%\ \text{correct}) - 1$$

If the manager is correct 50% the time, the IC will equal zero.

**EXAMPLE: Market timer vs. security selector**

Darsh Bhansali is a manager with Optimus Capital. Bhansali, a market timer, makes quarterly asset allocation decisions based on his forecast of the direction of the market. Bhansali's forecasts are right 55% of the time.

Mike Neal is an equity analyst focusing on technology stocks. Neal, a security selector, typically makes 50 active stock selections annually. Neal has an information coefficient of 0.04.

Compute the information ratios of Bhansali and Neal assuming that both managers construct unconstrained portfolios.

**Answer:**

Because both portfolios are unconstrained, TC = 1.

Bhansali's IC = 2(0.55) − 1 = 0.10

Bhansali's IR = $\mathrm{IC}\sqrt{\mathrm{BR}}$ = (0.10) $\sqrt{4}$ = 0.20

Neal's IR = $\mathrm{IC}\sqrt{\mathrm{BR}}$ = (0.04) $\sqrt{50}$ = 0.28

## Sector Rotation

Market timing can also be used to make sector rotation decisions. For example, an active manager may allocate assets into sectors that are expected to outperform. Consider a two sector market made up of sectors X and Y. Assume the expected sector return and volatility of returns are $E(R_X)$ and $\sigma_X$ for Sector X, and $E(R_Y)$ and $\sigma_Y$ for Sector Y.

If the correlation between the returns of sectors X and Y is given by $r_{XY}$, the active risk of this strategy is the standard deviation of differential returns of the two sectors (i.e., $R_X - R_Y$) and is given by $\sigma_C$:

$$\sigma_C = \left[\sigma_X{}^2 - 2\sigma_X\sigma_Y r_{XY} + \sigma_Y{}^2\right]^{1/2}$$

The annualized active risk is a function of the number of bets made during the year. If, for example, the active manager makes quarterly bets, BR = 4:

annualized active risk = $\sigma_{\mathrm{A}} = \sigma_{\mathrm{C}} \times \sqrt{\mathrm{BR}}$

and the annualized active return = $\mathrm{E}\left(\mathrm{R_A}\right) = \mathrm{IC} \times \sqrt{\mathrm{BR}} \times \sigma_{\mathrm{A}}$

**EXAMPLE: Sector rotation**

Hwang Soi makes monthly allocation decisions between consumer discretionary and consumer staples based on a proprietary model. The historical correlation between the returns of the two sectors is 0.30 and Soi's bets have been correct 60% of the time. Further information is in the following table.

| Sector | E(R) | σ | Benchmark Weight |
|---|---|---|---|
| Consumer staples | 10.8% | 3.0% | 65% |
| Consumer discretionary | 13.2% | 5.0% | 35% |

1. What is the annualized active risk of Soi's sector rotation strategy?
2. What is the expected annualized active return of Soi's sector rotation strategy?
3. What will be the allocation to the consumer discretionary sector if Soi feels that consumer staples will outperform the consumer discretionary sector over the next month and if the active risk is limited to 5.20%?

**Answer:**

1. $\text{Monthly active risk} = \sigma_{\mathrm{c}}$

   $= \left[\sigma_X{}^2 - 2\sigma_X\sigma_Y r_{XY} + \sigma_Y{}^2\right]^{1/2}$

   $= \left[0.03^2 - 2\left(0.03\right)\left(0.05\right)\left(0.30\right) + 0.05^2\right]^{1/2}$

   $= 0.05 \text{ or } 5\%$

   Annualized active risk = 0.05 × $(12)^{1/2}$ = 0.1732 or 17.32%
2. IC = 2(0.60) − 1 = 0.20

   $\text{Annualized active return} = \mathrm{IC} \times \sqrt{\mathrm{BR}} \times \sigma_{\mathrm{A}}$

   $= 0.20 \times (12)^{1/2} \times 0.1732$

$= 0.12 \text{ or } 12\%$

Alternatively, active return from this strategy using a probability weighted average (given that Soi makes correct calls 60% of time) of combined risk is:

(0.60)(0.05) + (0.40)(–0.05) = 0.01 or 1% per month.

Annual active return = 1% × 12 = 12%.

3. If active risk is limited to 5.20%, the deviation from the benchmark weights of 65% and 35% is limited to (5.20% / 17.32%) = 30%. When Soi feels that consumer staples will outperform, the allocation to that sector will be 65% + 30%, or 95%, and the allocation to consumer discretionary will be 5%.

## LOS 47.f: Describe the practical strengths and limitations of the fundamental law of active management.

*CFA® Program Curriculum, Volume 6, page 534*

As we previously demonstrated, the fundamental law can be used to evaluate a range of active strategies, including security selection, market timing, and sector rotation. The practical limitations of the fundamental law of active management can be summarized as "garbage in, garbage out;" poor input estimates lead to incorrect evaluations. In the case of unconstrained optimization, the two components (inputs) that determine the information ratio are (1) the information coefficient (IC) and (2) the breadth (BR) of the manager's strategy.

The limitations are generally derived from inaccurate estimates of the two inputs:

- *Ex-ante measurement of skill*: The information coefficient is an estimate of the accuracy of an active manager's forecasts on an ex-ante basis. One problem with this is that managers tend to overestimate their ability to outperform the market and, hence, overestimate their IC. Regardless of the bias, the accuracy of the IC determines the accuracy of the ex-ante information ratio.
- *Independence:* The breadth of a strategy is meant to measure the number of truly independent decisions that an active manager makes. If two or more decisions rely on same (or similar) information, then they are not independent. If individual decisions are correlated, then the breadth can be estimated as:

  $$\text{BR} = \frac{\text{N}}{1+(\text{N}-1)\text{r}}$$

  where:

  N = number of decisions

  r = correlation between the decisions

  Decision independence may be compromised by systemic influences within a strategy, the cross-sectional dependency. For example, a value strategy applied to different stocks within an industry may not be truly independent (most stocks will have similar fundamentals, such as P/E ratio). Similarly, decision independence can be compromised by time-series dependency. Monthly rebalancing decisions may not be truly independent from period to period.

**MODULE QUIZ 47.4**

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

1. Breadth is *most likely* to be equal to the number of securities multiplied by the number of decision periods per year if active returns are correlated:

A. cross-sectionally.
B. over time.
C. with active weights.

2. Which of the following factors *least accurately* identifies one of the major limitations of the fundamental law of active management?
   A. Ex ante measurement of skill using the information coefficient.
   B. Assumption of independence in forecasts across assets and over time.
   C. Attribution of value added to a small number of inputs.

# KEY CONCEPTS

## LOS 47.a

Value-added = active return = active portfolio return − benchmark return

Portfolio active return = Σ(active weight of security *i* × return of security *i*).

Active return is composed of two parts: asset allocation return plus security selection return:

$$E(R_A) = \sum \Delta w_i E(R_{B,i}) + \sum w_{P,i} E(R_{A,i})$$

where:
$E(R_{A,j})$ = expected active return within asset classes = $E(R_{Pi}) - E(R_{Bi})$

## LOS 47.b

Sharpe ratio = $SR = \frac{R_P - R_F}{\sigma_P}$

Information ratio = $IR = \frac{R_P - R_B}{\sigma_{(R_P - R_B)}} = \frac{R_A}{\sigma_A} = \frac{\text{active return}}{\text{active risk}}$

Unconstrained portfolio optimal active risk = $\sigma_A{}^* = \frac{IR}{SR_B}\sigma_B$

The Sharpe ratio of a portfolio comprised of an optimal proportion of benchmark portfolio and active portfolio is $SR_P = \sqrt{SR_B^2 + IR^2}$

## LOS 47.c

The three components of the information ratio are the information coefficient (measure of manager's skill), the breadth (number of independent active bets), and the transfer coefficient (the degree of constraints on manager's active management).

$$IR = \left(TC\right) IC \sqrt{BR}$$

$$E\left(R_A\right) = \left(TC\right) IC \sqrt{BR} \sigma_A$$

For an unconstrained portfolio, TC = 1.

## LOS 47.d

An investor will always choose the active manager with the highest information ratio regardless of her risk aversion. The investor will combine this optimal active portfolio with the benchmark to create a portfolio with a suitable level of optimal risk based on her risk preferences.

## LOS 47.e

The information coefficient of a market timer = IC = 2(% correct) − 1

The fundamental law can also be used to evaluate active sector rotation strategies.

## LOS 47.f

While the fundamental law can be used for evaluating market timing, security selection, and sector rotation strategies, one has to be aware of its practical limitations. The limitations of

the fundamental law include bias in measurement of the ex-ante information coefficient and lack of true independence while measuring breadth of an active strategy.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 47.1

1. **C** Value added will be positive only when end-of-period realized asset returns are positively correlated with the asset weights that the manager selected at the beginning of the period. Active weights are defined as the differences between an asset's weight in a managed portfolio versus its weight in the benchmark portfolio. Active weights in a portfolio must add up to zero, not 100%. (LOS 47.a)

## Module Quiz 47.2

1. **C** The information ratio can be applied either ex ante to expected returns or ex post to realized returns. The Sharpe ratio measures reward per unit of absolute (or total) risk. The information ratio measures reward per unit of risk in benchmark relative terms. (LOS 47.b)

## Module Quiz 47.3

1. **A** The information coefficient represents an active manager's own skill and ability to forecast returns accurately. The other three of the four elements of the fundamental law of active portfolio management (transfer coefficient, breadth of the strategy, and benchmark tracking risk) may be beyond investors' control if they are constrained by investment policy or regulation. (LOS 47.c)

2. **A** The information ratio evaluates risk-adjusted return in relation to a benchmark-investment baseline, rather than in relation to a risk-free investment. Expected information ratio is the single best criterion for building an actively managed portfolio. The ex-post information ratio is the best criterion for evaluating the past performance of actively managed funds. (LOS 47.d)

## Module Quiz 47.4

1. **C** Breadth (BR) is intended to measure the number of independent decisions that an investor makes each year. Breadth is equal to the number of securities multiplied by the number of decision periods per year only if (1) active returns are cross-sectionally uncorrelated and (2) active returns are uncorrelated over time. (LOS 47.e)

2. **C** The fundamental law of active management's usefulness stems from its ability to separate the expected value added of a portfolio into the contributions of the few basic elements of the strategy. Limitations of the fundamental law of active management concern uncertainty about the ex-ante information coefficient, as well as the definition of breadth as the number of independent decisions. (LOS 47.f)

The following is a review of the Portfolio Management (2) principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #48.

# READING 48: TRADING COSTS AND ELECTRONIC MARKETS

**Study Session 17**

## EXAM FOCUS

This topic review covers issues with trade execution: trading costs, the impact of market innovations on trading costs, execution quality, and finally, regulatory oversight. Candidates should be able to calculate effective spread and volume-weighted average price transaction cost. Some of the material on electronic markets and market microstructure overlaps with the topic review on algorithmic trading (discussed later). Candidates should become familiar with a lot of terminology in electronic trading, including abusive trading practices.

## MODULE 48.1: EXPLICIT AND IMPLICIT TRADING COSTS

Video covering this content is available online.

Evaluation of trade execution should not only consider explicit costs such as brokerage fees but also implicit costs (the focus of this reading), which consist of the price impact cost of an unfavorable execution price and the opportunity costs of failed orders. While explicit costs are observable and transparent, implicit costs are not readily discernible. We will spend the first part of this topic review learning about approaches to estimate these implicit costs.

**LOS 48.a: Explain the components of execution costs, including explicit and implicit costs.**

*CFA® Program Curriculum, Volume 6, page 556*

### Trading Costs

**Explicit trading costs** include brokerage, taxes, and fees; one would expect to receive a receipt for such costs. For large buy-side traders, explicit trading costs include having a trading staff and related expenses, which tend to be fixed in nature. Smaller traders use brokers and incur variable commissions.

**Implicit costs** are harder to measure, and include the bid-ask spread, market or price impact costs, opportunity costs, and delay costs (or slippage). They must be estimated by measuring the results of a trade relative to a reference point (i.e., a **benchmark**).

- The **bid-ask spread** is the highest potential cost for a small trade. Trades at the posted bid or ask prices are quickly executed. Patient traders may choose to trade between the posted bid and ask prices (also known as offer prices), but run the risk of not filling their orders. Larger, liquidity-demanding trades tend to move down the order book and are filled at a higher cost.

- **Market impact** (or **price impact**) is the impact of demanding liquidity in the market (i.e., market-moving trades). If a trader has a large buy (sell) order to execute, the trader would have to increase (lower) prices to attract sellers (buyers). A larger order can be broken into smaller trades to go with the flow of the market and minimize the price impact cost. However, it may increase the delay and opportunity costs (discussed next).
- **Delay cost** (or **slippage**) is the cost of an adverse price movement during the lag in executing a large trade. A trader breaking up a large buy (sell) order risks the price increasing (decreasing) over time and the latter batches being executed at a significantly higher (lower) price.
- **Opportunity cost** arises from unfilled orders or failed trading opportunities. A patient value trader might see that an underpriced security rises in price (i.e., the delay cost). If the resulting higher price forces the trader to cancel the unfilled part of the order, the resulting lost profits are the opportunity cost of the trade.

While the other components of implicit costs look at the difference between actual execution price and the price observed when the order was triggered, opportunity costs look at the cost of lost opportunities on account of unfilled trades. Note that there is a tradeoff between the market impact cost on one hand and the delay plus opportunity cost on the other; while we are patiently waiting for a good price, the market may move out of our trading range.

### PROFESSOR'S NOTE

Liquidity-demanding trades are market orders that accept a posted bid or ask price. On the other hand, limit orders provide liquidity by offering to trade at a posted bid or ask price. Larger, liquidity-demanding trades often walk down the limit order book, exhausting the quantity offered in successive limit orders. For example, a buy order for 150,000 shares may hit several limit orders (with posted ask prices) such that the total quantity offered for sale across those orders adds up to 150,000.

**LOS 48.b: Calculate and interpret effective spreads and VWAP transaction cost estimates.**

*CFA® Program Curriculum, Volume 6, page 559*

## Dealer Quotes

Dealers make the market by offering to buy for, and sell from, their own inventory. Every quote will have a bid price or ask price as well as associated quantity. The **best bid** is the highest-posted bid price and is also known as the **inside bid**. Similarly, the **best ask** or **inside ask** is the lowest ask price. **Inside spread** is the difference between the best ask price and the best bid price. A **midquote** price is the average of the bid and ask price quoted by a single dealer.

A **limit order book** shows the available posted bid and ask prices (offers) with corresponding quantities that the dealer is willing to purchase or sell, respectively. Bids and offers are sorted from best to worst as shown in Figure 48.1.

**Figure 48.1:** Limit Order Book for XYZ, Inc., Stock

| Bids → purchase price | | | | Asks / Selling price | | | |
|---|---|---|---|---|---|---|---|
| Dealer | Time Entered | Price | Size | Dealer | Time Entered | Price | Size |
| P | 9:31 am | $32.25 | 3,000 | R | 9:31 am | $32.29 | 2,000 |
| Q | 9:41 am | $32.24 | 2,500 | P | 9:31 am | $32.31 | 3,000 |
| R | 9:45 am | $32.23 | 3,500 | Q | 9:41 am | $32.35 | 3,500 |

At 9:31 am, a trader executing a market purchase order for 3,000 shares would purchase 2,000 shares at $32.29 and the remaining 1,000 shares at $32.31. Note that the trader had to split the larger order because the inside ask quoted by dealer R was only for 2,000 shares. This resulted in a $0.02 per share higher cost for part of the order. Larger orders have a price impact as they move down the order book (and, therefore, execute at worse prices). This price impact depends on the size of the order and the relative liquidity in the market. It should be noted that dealer P may revise his quote higher once he sees a trade, resulting in the inside ask of $32.29 disappearing from the order book. To avoid missing out on the $32.31 price, a trader may execute the entire trade with dealer P.

A trader may also post her own quote in the form of a **standing limit order**. Standing orders provide liquidity to the market and trade at their posted prices, but at a risk of failure to complete the trade.

In a nonexchange market, absent a clearinghouse guarantee, a trader may choose a dealer other than the one offering the most favorable price. Relationships with dealers and their creditworthiness are factors (other than price) that play a role in choosing the counterparty in such markets.

## Types of Benchmarks

The implicit costs of a trade are measured relative to a benchmark; trades at prices better than the benchmark are rated favorably relative to trades that execute at inferior prices. Several benchmarks can be used to evaluate trades, including the effective spread, VWAP, and implementation shortfall.

### *1. Effective Spread*

The effective spread transaction cost uses the midquote price as the benchmark price. The difference between the transaction price and the midquote price is the transaction cost per share:

per-share effective spread transaction cost = (side) × (transaction price – midquote price)

where:
side = +1 for buy orders and –1 for sell orders

effective spread = 2 × (per-share effective spread transaction cost)

If the trade occurs at the posted bid or ask prices, the effective spread will be same as the quoted spread. If the trade occurs at a better price, there will be a **price improvement** and the effective spread will be lower than the quoted spread.

> **EXAMPLE: Spreads**
>
> Answer these questions using the information provided in Figure 48.1.

1. **Calculate**:
    a. The spread quoted by dealer Q.
    b. The inside spread.
    c. The midquote for dealer R.
2. Suppose that a purchase transaction occurred at $32.29. Using dealer P's quotes only, calculate the effective spread and the quoted spread.

**Answer:**

1.
    a. Spread quoted by dealer Q = 32.35 – 32.24 = $0.11
    b. Best ask price = $32.29 and best bid price = $32.25; inside spread = 32.29 – 32.25 = $0.04
    c. Midquote price for dealer R = (32.23 + 32.29) / 2 = $32.26
2. Midquote price for dealer P = (32.25 + 32.31) / 2 = $32.28

    Quoted spread = 32.31 – 32.25 = $0.06

    Effective spread = 2 × (+1) × ($32.29 – $32.28) = $0.02

    Since the effective spread is less than the quoted spread, there was a price improvement on that trade.

### *Limitations of Effective Spread*

- When a large order is split into smaller orders, the effective spread is a poor indicator of trade performance because it does not take into account the price impact cost.
- Effective spread also does not account for slippage or delay costs when part of the order does not get filled at desired prices. Delay costs can also occur when the trader does not route the order to the most appropriate market (i.e., one with the desired liquidity). Delay costs are measured for the portion of the order that does not get filled by the end of the trading day.
- Sometimes, the market price will move unfavorably, voiding a trading opportunity. For example, an analyst values a stock at $12.55, and the current market price of the stock is $12.15. The analyst then places a purchase order for 10,000 shares with the firm's trading desk. The trader executing the trade splits the order to obtain a favorable price (i.e., to reduce the price impact cost). If the stock price rises beyond the $12.55 target price, the unfilled part of the order will have to be abandoned. These lost opportunities represent the opportunity cost when an unfilled part of the order is canceled due to adverse price movements. Effective spread does not capture the opportunity cost of a trade.

## *2. Volume-Weighted Average Price*

**Volume-weighted average price (VWAP)**, also known as the **interval VWAP**, is the weighted average price at which all the trades were executed during the time interval between the order being placed and being executed. The weights used are based on the dollar volume of each trade. VWAP is easy to interpret—it evaluates the price at which an order was executed relative to other trades occurring during the same time period.

To evaluate a trade, the VWAP of the trade is compared to the benchmark VWAP. If the entire order was executed at one price, its VWAP would be that price.

VWAP transaction cost = trade size × (side) × (trade VWAP – benchmark VWAP)

where:

side = +1 for buy orders and –1 for sell orders

**EXAMPLE: VWAP**

The following trades are observed for BNC, Inc., stock during the relevant time interval:

- At 10:00 am, 100 shares trade at $12.11.
- At 11:00 am, 300 shares trade at $12.00.
- At 11:30 am, 600 shares trade at $11.75.

Suppose that the subject trade was for the purchase of 300 shares, which was executed as follows:

- 100 shares at $12.11.
- 200 shares at $12.00.

1. Calculate the benchmark VWAP and trade VWAP for BNC.
2. Calculate the VWAP transaction cost.

**Answer:**

The total number of shares traded during the relevant time interval is 1,000.

1. benchmark VWAP = (100 / 1,000) × $12.11 + (300 / 1,000) × $12.00 + (600 / 1,000) × $11.75 = $11.86

   trade VWAP = (100 / 300) × $12.11 + (200 / 300) × $12.00 = $12.04

2. VWAP transaction cost = 300 × (+1) × (12.04 – 11.86) = $54

### *Limitations of VWAP Transaction Cost*

- VWAP is not useful if the trade being evaluated is a significant part of the trading volume. In such cases, the benchmark VWAP and the trade VWAP will be close to each other and the measured transaction cost will be skewed toward zero.
- VWAP does not capture the price impact cost. For example, if a large buy order was the only trade that was executed during a time interval at a price above the normal trading price, the benchmark VWAP will then be identical to the trade VWAP and the calculated transaction cost will be zero. However, the trade was not executed at a good price.

This bias toward zero may explain the popularity of VWAP among investment managers seeking to highlight the low transaction cost of their trades.

An improvement over the VWAP transaction cost approach is the implementation shortfall measure as discussed in the next LOS.

**LOS 48.c: Describe the implementation shortfall approach to transaction cost measurement.**

*CFA® Program Curriculum, Volume 6, page 560*

## *3. Implementation Shortfall*

Implementation shortfall is a conceptual approach that measures transaction costs as the difference between the value of the actual portfolio and the value of a hypothetical **paper portfolio**. In the paper portfolio, the trade is fully executed at no cost, and at the prevailing

price (also called the decision price, arrival price, or strike price) when the order was placed. The prevailing price used is generally the midquote price at that time.

Implementation shortfall addresses the shortfalls of VWAP because it measures the total cost of trading by capturing all three implicit costs (i.e., price impact, slippage, and opportunity costs). However, the computation involved is more complex.

## MODULE QUIZ 48.1

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

**Use the following information to answer Questions 1 and 2.**

**Figure 1: Limit Order Book for Sima, Inc., Stock**

| Bids | | | | Offers | | | |
|---|---|---|---|---|---|---|---|
| Dealer | Time Entered | Price | Size | Dealer | Time Entered | Price | Size |
| Alpha | 9:31 am | $17.65 | 3,000 | Alpha | 9:31 am | $17.69 | 2,000 |
| Bravo | 9:41 am | $17.63 | 2,500 | Bravo | 9:31 am | $17.71 | 3,000 |
| Charlie | 9:45 am | $17.62 | 3,500 | Charlie | 9:41 am | $17.75 | 3,500 |

1. At 9:31 am, a trade to purchase 4,000 shares was executed at in two lots of 2,000 shares. Using the information in Figure 1, the price impact cost per share of the second lot is *closest* to:
   A. $0.01.
   B. $0.02.
   C. $0.04.
2. Using the information in Figure 1, the inside spread is *closest* to:
   A. $0.02.
   B. $0.03.
   C. $0.04.

**Use the following information to answer Questions 3 through 5.**

**Figure 2: Trade Data for ABC, Inc., June 15, 2019**

- At 10:00 am, 1,000 shares trade at $44.55.
- At 11:00 am, 3,000 shares trade at $44.65.
- At 11:30 am, 6,000 shares trade at $44.75.
- During that time interval, a trader purchased 1,000 shares at $44.65 and 500 shares at $44.75.

3. Using data in Figure 2, the benchmark VWAP is *closest* to:
   A. $44.58.
   B. $44.62.
   C. $44.70.
4. Using data in Figure 2, the trade VWAP is *closest* to:
   A. $44.58.
   B. $44.68.
   C. $44.70.
5. Using data in Figure 2, the VWAP transaction cost is *closest* to:
   A. ($30).
   B. $25.
   C. ($150).
6. The use of VWAP to evaluate execution quality is *most likely* to be appropriate when:
   A. the objective is to capture the price impact cost of a large trade.

B. the trade represents a small part of the overall trading volume.
C. the trade is a significant part of the overall trading volume.

7. Which transaction cost measure captures the price impact, slippage, and opportunity cost of a trade?
   A. VWAP.
   B. Bid-offer spread.
   C. Implementation shortfall.

# MODULE 48.2: ELECTRONIC TRADING SYSTEMS

Video covering this content is available online.

## LOS 48.d: Describe factors driving the development of electronic trading systems.

*CFA® Program Curriculum, Volume 6, page 562*

The use of information technology in the development of electronic markets has resulted in lower trading costs and improved execution efficiency. Automated electronic systems are used by exchanges and their trader clients to match orders quickly. High-speed order processing and communication systems are needed for traders to implement their trading algorithms, and for the exchanges to process the vast number of orders such systems produce.

**Factors driving development of electronic trading systems are:**

1. *Cost:* Electronic systems are cheaper to operate as compared to their manual counterparts.
2. *Accuracy:* Electronic systems perform exactly as they are programmed to perform. As such, they precisely enforce the exchange's order precedence and pricing rules.
3. *Audit trails:* Electronic systems generate and maintain records, allowing investigators to examine the precise chain of events that may be of interest to them.
4. *Fraud prevention:* Electronic systems keep hidden orders hidden, and do not leak information inadvertently or fraudulently.
5. *Continuous market:* Electronic systems don't need breaks, operating continuously during trading hours. Electronic trading is also unaffected by severe weather or other events that may hinder human traders from convening on the trading floor.

From the perspective of traders, electronic systems can quickly process vast amounts of data, exhibit perfect discipline (do what they are programmed to do, without any behavioral bias), and maintain perfect records.

While the efficiencies of electronic trading systems have greatly benefited stock traders, bond market trades remain largely over the counter. While many competing electronic exchanges for bond markets exist, they are used primarily by dealers. Significant cost savings would result for public investors if they were given access to these systems by their brokers.

## LOS 48.e: Describe market fragmentation.

*CFA® Program Curriculum, Volume 6, page 564*

**Market fragmentation** occurs when a security trades in multiple markets. There may be significant liquidity differences between these electronic markets. For example, a security may have several posted bids, but only a few offers on one exchange with the opposite

situation in another exchange. Fragmentation can lead to significant price and liquidity differences between markets.

Automated trading strategies for large orders seek out liquidity across all markets to minimize the price impact of their trades. Trading algorithms such as smart order routing and liquidity aggregation seek to overcome the challenges posed by market fragmentation. **Liquidity aggregation algorithms** create a "super book" displaying liquidity across all markets. **Smart order routing algorithms** send orders to the markets with the best prices and sizes.

### LOS 48.f: Distinguish among types of electronic traders.

*CFA® Program Curriculum, Volume 6, page 565*

Electronic trading systems are used by profit-seeking proprietary traders (dealers, arbitrageurs, and front runners), buy-side traders (investment and risk managers), and the brokers that serve them. Electronic proprietary traders include high-frequency traders (i.e., those who make quick round-trip trades thousands of times during the day) and low-latency traders (i.e., those who rely on speed in receiving news and trading on it). **Latency** is defined as the time lapse between the occurrence of an event and the execution of a trade based on that event.

Major types of electronic traders include:

- **Electronic news traders**. These analyze high-speed news feeds and submit market orders (as opposed to limit orders) based on the analysis. News traders often employ artificial intelligence systems to quickly process the news and generate trades based on it so that they can trade against stale orders (i.e., posted limit orders whose prices do not reflect the news). Some news traders also employ natural language processors to read qualitative data to judge the impact of the news on the market price of the stock. Due to low round-trip transaction costs in electronic markets, news traders can make a profit even if their analysis is right only a fraction of the time.
- **Electronic dealers**. These post bid and offer prices to profit from the spread. Dealer profit depends on the frequency with which they trade. Electronic dealers maintain a low inventory of actively traded securities and quickly adjust their positions based on market information. Dealers manage the risk of adverse price movements (e.g., price declines when the dealer has a long position) by quickly taking the opposite side of the trade (e.g., selling the inventory by removing all bids). Electronic dealers often monitor news feeds and suspend their quotes when news is released. This results in lost trading opportunities when the news is immaterial, but protects the dealer from providing liquidity to news traders when the news is material.
- **Electronic arbitrageurs**. These trade in multiple markets seeking to exploit price discrepancies. **Arbitrage portfolios** consist of long and short positions (called **legs**), which minimize the cost and risk to the arbitrageur.
- **Electronic front runners**. These use artificial intelligence to sniff out large trades (or many small trades) on the same side and then use low latency to trade ahead of them. For example, a buy-side trader may break up a large order, seeking to minimize the price impact cost of the trade. Once this activity is unearthed, front runners will seek to trade ahead of the buyer to purchase at the lowest-posted ask prices, pushing the market price higher. Front runners search for patterns in order submissions or relationships between orders and events.

- *Patterns*: Most jurisdictions forbid dealers and brokers from front running orders that their clients have submitted (because they would be trading on inside information). However, past client records may provide insight into client behavior and thereby enable the dealer or broker to *predict* forthcoming orders. Front runners may also seek out clear patterns in executed trades expecting those patterns to repeat in the future. For example, if a specific order size is executed every five minutes for an hour, the dealer may expect that pattern to repeat when that same pattern starts the next day. Knowing that front runners are always on the lookout for patterns, trading algorithms developed by brokers for their buy-side clients often randomize their trading patterns. However, large trades are difficult to hide—and front runners, with their sophisticated data mining tools, will seek those out.
- *Events*: Some front runners use observed relationships between events and orders to predict future orders. For example, if there is a distinct pattern of orders following an earnings announcement, front runners can use that knowledge to trade ahead of the anticipated orders.

- **Electronic quote matchers**. Standing limit orders (i.e., limit orders waiting to be filled) provide valuable information to other traders; they disclose the intent of the trader posting the order to buy or sell the specified quantity. Electronic quote matchers use their knowledge of standing orders as valuable *options to trade* while limiting their risk. For example, a quote matcher notices a standing buy order on a stock at $12.20 and purchases this stock at $12.25. If the price rises, the quote matcher profits from the upside, while the downside risk is limited to $0.05 per share due to the available standing buy order.
- **Buy-side traders**. These execute trades on behalf of their portfolio managers and use electronic order management systems (OMSs) to track the orders that portfolio managers have submitted, the orders that are sent to the broker, and the ones that have been already filled. Buy-side traders use **electronic brokers** for trade execution, and these brokers often offer advanced order-processing algorithms and tactics in addition to standard market and limit order processing to their clients.

### PROFESSOR'S NOTE

Buy-side traders should not be confused with buy orders; buy-side traders process trades (both buy and sell) generated by their portfolio managers, who manage money for individual and institutional investors.

### MODULE QUIZ 48.2

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

1. Which of the following is *least likely* to be a factor driving the development of electronic trading systems?
   A. Operating cost.
   B. Prevention of fraud.
   C. Market fragmentation.
2. Which of the following statements about electronic trading markets is *least accurate*?
   A. Electronic trading has mostly facilitated bond trading for retail traders.
   B. Efficiencies in electronic trading systems have greatly benefited stock traders.
   C. Electronic markets continue to function even during severe weather.
3. Automated trading strategies seeking out liquidity across markets is *most likely* in response to:
   A. market fragmentation.

B. a reduction in brokerage costs.
C. even liquidity across markets.

4. Traders using artificial intelligence to sniff out large trades that are being processed in small parts are *most appropriately* labeled as electronic:
   A. front runners.
   B. arbitrageurs.
   C. dealers.

# MODULE 48.3: CHARACTERISTICS AND USES OF ELECTRONIC TRADING SYSTEMS

Video covering this content is available online.

**LOS 48.h: Describe comparative advantages of low-latency traders.**

*CFA® Program Curriculum, Volume 6, page 570*

## The Need for Speed

In addition to lower trading costs, electronic trading systems allow low-latency traders a competitive advantage by jumping the order queue. Jumping the order queue may be in order taking (i.e., executing against a standing sell order when positive market news is revealed), market making (taking precedence when providing liquidity) and order canceling when they do not want to fill the order anymore (e.g., when trades at other exchanges make a trader's posted quote ill advised). In other words, electronic traders have to be faster than their competitors to capitalize on market opportunities.

**Low-latency** traders focus on minimizing the latency involved in three phases of a trade:

1. The time gap between the publication of actionable news and the receipt of that news by the trader.
2. The time gap between the receipt of actionable news and deciding on an appropriate action (i.e., order).
3. The time gap between order determination and communicating that order to the exchange.

Latency due to the first and third components relates to communication speed, while latency due to the second component relates to computing speed.

1. *Communication speed:* Minimizing the distance travelled is the key to minimizing latency associated with communication speed. Traders investing in the latest and fastest communication technology and setting up their servers as close as possible to the exchange has become the norm. One approach is to **co-locate** the trader's servers in the exchange (if offered). Fairness dictates that the exchange cannot selectively offer collocation to only a few traders.
2. *Computation speed:* Electronic traders minimize latencies by using the best hardware, including: overclocking the fastest processors (coupled with souped-up cooling systems), use of fast memory as opposed to hard disks (which are slowed by disc-seeking time), and the use of multiple processors, each specialized for the task at hand.

   In addition to hardware, traders use software that has a low overhead, including simple, no-frills operating systems. Important functions often use assembler language rather than more high-level languages such as C++ whose compilers are not specialized, and hence, are slower. If the software tends to be dynamic (i.e., code gets updated as the

market conditions change), code may be written in faster-to-write languages (e.g., Python) as the speed of software deployment is more important than the speed of processing.

Sometimes, the latency in processing may be reduced by running the decision analysis for a wide variety of scenarios ahead of time. As such, the optimal action for each scenario is predetermined, avoiding delays once a scenario is actually observed.

**LOS 48.g: Describe characteristics and uses of electronic trading systems.**

*CFA® Program Curriculum, Volume 6, page 569*

## Advanced Orders, Trading Tactics, and Trading Algorithms

**Advanced order types** are limit orders with a dynamic limit price that varies with a benchmark. For example, consider a pegged limit order to buy 1,000 shares at a price one tick lower than the lowest ask price. A broker that supports such an order type would forward the order to an exchange that also supports these types of orders. As the posted ask prices change, the original order is automatically canceled and replaced by a new order with a revised bid price.

**Trading tactics** are plans calling for the submission of multiple orders. One tactic is to send multiple orders at a given price through multiple exchanges so as to uncover any hidden trading opportunities. For example, a stock has a posted best bid and ask of $18.00 and $18.02, respectively. A limit purchase order at $18.01 may uncover any hidden asks at that price. Alternatively, these tactics can uncover **discretionary orders**, which are orders that have a limit +/– discretion amount specified to the exchange. For example, a limit ask of $18.03 with a discretion of $0.02 may get uncovered by a limit buy order at $18.01. Usually, these orders are structured to be **immediate or cancel (IOC) orders** (i.e., orders that are canceled unless executed immediately). Trading tactics may also be employed while trading at **dark pools**, which are trading venues that hide their liquidity and restrict trading to a select clientele.

Another trading tactic involves an IOC order at a specified price. If the order does not fill after a specified amount of time (which can be determined randomly), it is canceled and automatically replaced by another order with a better price. Trading tactics are often designed to reduce their footprint by introducing randomness into order size and the time to cancellation. In summary, trading tactics are often employed to execute **midspread orders** (i.e., limit orders pegged to the midpoint of the quoted bid-ask prices).

**Algorithms (or algos)** are programmed execution strategies using multiple orders, sequencing of orders, and trading tactics to achieve specific goals. For example, a VWAP algorithm may break up an order into orders proportional to expected trading volume, thereby reducing the price impact of a trade. Good algorithms seek to minimize the total transaction costs by judiciously using limit orders and offering liquidity when appropriate, as well as using market orders to minimize delay and opportunity costs.

## Impact of Electronic Trading

Electronic markets and trading have changed how proprietary traders, brokers, and other traders devise their trading strategies. A few examples follow.

1. **Hidden orders.** These are limit orders that are hidden from the market except for the exchange receiving them. Hidden orders seek to remove the valuable option that exposed standing orders provide to the rest of the market. As compared to human traders, electronic markets are better suited for hidden orders because the probability of inadvertently exposing hidden orders is much lower for electronic markets. Some traders seek to expose hidden orders by repeatedly pinging the market (via submission of small IOC orders). If executed, these pings would reveal the existence of a hidden order (but not the size of the hidden order). Traders who subscribe to a trade feed for odd-lot trades would also see the results of successful pings. However, they would not know the side of the trade represented by the hidden order.
2. **Leapfrog.** This is the practice of beating the best bid or ask price. In the presence of large quoted bid-ask spreads, there are dealers who may be willing to post a better price (i.e., a lower ask or higher bid), thereby leapfrogging the best price. A leapfrogging limit order therefore narrows the inside spread. This frustrates other traders who have to quote a better price to maintain their order precedence, and this game of leapfrogging may continue!
3. **Flickering quotes.** These are exposed limit orders that are submitted and canceled almost immediately. This technique is used by traders not wanting to have standing orders that provide a valuable option to trade to other traders. Traders wanting to trade at the flickering quote can submit a hidden limit order to execute in anticipation of the return of the flickering order.
4. **Electronic arbitrage.** There are three types of electronic arbitrage strategies:
   A. **Take liquidity on both sides.** This is an arbitrage trade to buy and sell the same security in different markets to take advantage of mispricing across markets. Arbitrageurs submit market buy and sell orders on a security simultaneously in different markets for execution at the posted ask and bid prices. Given the competition among arbitrageurs, these opportunities are few and far between, and low latency is critical to ensure that both sides of the trade get executed at target prices.
   B. **Offer liquidity on one side.** Suppose a particular security is quoted at $100 bid, $105 offered in both markets X and Y. An arbitrageur may place a bid at $95 in market X. If the order fills (probably due to a large transaction by some market participant), the arbitrageur will immediately try to sell the security to the $100 bid in market Y, realizing a profit of $5.
   C. **Offer liquidity on both sides.** This is another arbitrage trade that seeks to further lower transaction costs by posting limit orders that are inferior to the best bid and offer prices in different markets. This strategy is fraught with risks; after one leg of the order is filled, if the other leg does not fill, the trader is exposed to risk of adverse price movement.
5. **Machine learning.** Also known as data mining, machine learning involves using statistical modeling techniques that allow the model to evolve based on new data. These techniques rely on empirical data to fine-tune trading algorithms but are ineffective during extraordinary times when volatility spikes and past information is not a useful guide to future outcomes. Many traders shut down trading during these high-risk periods.

**EXAMPLE: Electronic arbitrage**

Ben Khuslow, a trader for Greater Wealth Bank, is looking at his terminal for opportunities to trade. The default view on the terminal provides the best bid and offer prices for a security in different electronic markets. Khuslow observes the following quotes for stock ZZ:

| Market | Best Bid | Bid Size | Best Ask | Ask Size |
|---|---|---|---|---|
| Alpha | $10.06 | 20,000 | $10.12 | 18,000 |
| Bravo | $10.02 | 15,000 | $10.05 | 11,000 |

1. Assuming that Khuslow takes liquidity on both sides of the market, calculate the profit per share that Khuslow can expect to earn (if the quotes hold up for both sides of the trade).
2. Explain how Khuslow can increase the expected return per share by using either (a) offering liquidity on one side of the market or (b) offering liquidity on both sides of the market.
3. What are the risks of each of these strategies?

**Answer:**

1. The best bid across the two markets is $10.06, and the best ask is $10.05 (resulting in an arbitrage profit of $0.01 per share). Khuslow can submit a market purchase order at the best ask of $10.05 (for 11,000 shares) and simultaneously submit a market sell order at $10.06 (again for 11,000 shares). Assuming that the prices don't move between the time Khuslow gets the quotes, submits the order, and the orders are received by the exchange, both segments would be filled, resulting in the $0.01 per share arbitrage profit (or $110 on 11,000 shares).
2. Regarding (a), instead of submitting a market order in both markets, Khuslow can submit a limit purchase order with a bid of $10.04 in market Bravo. If Khuslow's trade gets filled at $10.04, an immediate sell order in market Alpha (i.e., at posted bid of $10.06) would now result in a profit per share of $10.06 – $10.04 = $0.02.

   Regarding (b), instead of using market orders, Khuslow can submit a limit purchase order with a bid of $10.04 in market Bravo and a limit sell order in market Alpha (at an ask of $10.07). If both legs get filled, the profit per share would now be $10.07 – $10.04 = $0.03 per share.
3. With any of the strategies, the risk is that the prices may change before execution of one or both legs of the order. The time lag between quotes being refreshed at an exchange, its receipt by a trader, the trader's action on that quote, and communication of an action from the trader's computer to the exchange may make the original quote stale. Hence, all or part of the order may not get filled. This failure-to-fill risk is lower for market orders, and hence, is highest when the trader offers liquidity on both sides of the market. The trader may find that only one side of the trade is filled, leaving him exposed to the risk of having a long (or short) position in a security.

## MODULE QUIZ 48.3

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

1. Which of the following is an example of achieving lower latency via computation speed?
   A. Collocation.
   B. Use of simple, no-frills operating systems.
   C. Use of high-speed fiber optic networks.
2. Limit orders with dynamic prices are *most appropriately* labeled as:
   A. discretionary orders.
   B. immediate or cancel (IOC) orders.
   C. advanced orders.
3. A leapfrog strategy is *most likely* to be employed during times of:
   A. market fragmentation.
   B. a large inside spread in a security.
   C. flickering quotes.

4. A highly risk-averse trader seeking to profit from mispricing across markets would *most likely*:
   A. take liquidity on both sides.
   B. offer liquidity on one side.
   C. offer liquidity on both sides.
5. A trader observes the following quotes for a stock in two different markets:

| Market | Best Bid | Bid Size | Best Ask | Ask Size |
|---|---|---|---|---|
| Philly-1 | $16.13 | 50,000 | $16.14 | 48,000 |
| LA-9 | $16.09 | 90,000 | $16.11 | 100,000 |

Assuming that the trader takes liquidity in both markets, the arbitrage profit would be *closest* to:

   A. $1,000.
   B. $2,000.
   C. $4,000.

## MODULE 48.4: RISKS AND SURVEILLANCE OF ELECTRONIC TRADING SYSTEMS

Video covering this content is available online.

### LOS 48.i: Describe the risks associated with electronic trading and how regulators mitigate them.

*CFA® Program Curriculum, Volume 6, page 577*

Risks associated with electronic trading include:

- **High-frequency traders (HFT) arms race.** Due to the competitive advantage offered to the fastest market participants, high-frequency traders (HFT) need to deploy the latest and most expensive state-of-the-art technologies. This arms race offsets some of the lower cost benefits of electronic trading, effectively serving as an entry barrier to some traders and making the playing field not level for smaller traders. This unfairness has led to calls to mitigate the advantage of HFT by introducing delays in trading at random intervals (which cannot be forecast by HFT algos).
- **Systemic risk.** This is the cost of bad trades being borne by parties other than the party responsible for the trade. Traders who don't face the full consequences of their actions have less incentive to take action to mitigate a bad trading decision. Programming errors in one trader's platform may lead to market chaos with many casualties before the error is spotted and corrected. Some of the common trading errors include:
  - **Runaway algorithms.** These produce a series of unintended orders. For example, the flash crash of May 2010 was caused by a trading algorithm executing a large market sell order on mini S&P 500 futures contracts. The algorithm was programmed to release orders proportionate to the trading volume in the contract, increasing the volume of trade in the contract, resulting in even more trading by the algorithm. Since the order was not a limit order, the algorithm caused a huge increase in volatility.

- **Fat finger errors.** These are input errors, and if sufficiently large, can lead to dramatic volatility in an electronic market (where human checks and balances are missing).
- **Overcharge orders.** These demand liquidity significantly higher than what is available in the market. These are market orders that are too large for the market to which they are sent. The flash crash resulting from a large market order to sell S&P 500 mini contracts led to ripple effects across markets.
- **Malevolent orders.** These are created to specifically manipulate the market. Examples include aggrieved employees programming rogue trades and traders seeking to conduct denial-of-service attacks on their competitors with excessive submission of quotes.

Systemic risks can be mitigated by having proper checks and balances. Traders need to ensure that only authorized orders are inputted, and that the software they use is adequately backtested. Furthermore, updates to the trading software should be strictly controlled, and supervisory personnel should sign off on changes to the software before it is deployed.

Brokers must scrutinize orders received from their clients to ensure the appropriateness of the orders before submission to electronic markets. Finally, markets should have limits on price changes and automated trade halts, which kick in when volatility spikes.

### LOS 48.j: Describe abusive trading practices that real-time surveillance of markets may detect.

*CFA® Program Curriculum, Volume 6, page 582*

Real-time surveillance and monitoring of electronic markets seek to detect market abuses and potential crises as they unfold, allowing for a faster response. Abusive market practices include:

- **Front running.** This is low-latency trading ahead of known large trades. For example, a front runner who acquires information that a large buy order is being processed in pieces may take the best ask prices, and then resell to the unsuspecting buyer at higher prices. In most jurisdictions, front running is illegal if the information that serves as the impetus for front running is obtained improperly. In many cases, though, the information may be simply obtained from market data. Algorithms processing large orders often break them down into smaller pieces. Front runners, with the aid of machine learning, may sniff out these large orders allowing them to front run.
- **Market manipulation.** This includes activities that produce false market data, including price and volume data. Manipulative traders deceive other traders, causing them to act based on this misleading information to the advantage of the manipulators. While market manipulation is illegal in most jurisdictions, enforcement is lax due to the difficulty of separating manipulative trades from genuine ones. Market manipulation activities include:
    - **Trading for market impact.** These are trades designed to change the price (up or down), sometimes at a large cost. The objective is to influence other traders' perception of value.
    - **Rumormongering.** This involves dissemination of fake information to affect the target trader's value assessments. Analysts need to be able to parse large amounts of information (true and fake) to determine what information is valid and its

implication for value. While rumormongering is generally illegal, biased reporting (highlighting one side of the story) is not.

- **Wash trading.** This is trading between commonly controlled accounts to create an impression of false liquidity. Wash trading gives other market participants a false sense of security about liquidity in a particular stock.
- **Spoofing** or **layering**. These are fake limit orders posted to create fake optimism or pessimism about the security. For example, a buyer wanting to buy a security cheaply may post a hidden limit order to buy at a price lower than the current market price, and one or more exposed sell orders also at a low price. The exposed sell orders may convince other traders that prices are falling and motivate them to sell at lower price, filling the hidden buy order. Layering is risky, as the exposed sell orders that the spoofer intended on canceling may actually get filled.
- **Bluffing**. This involves preying on momentum traders. Momentum traders follow the market—buying in a rising market and selling when prices are falling. Bluffing involves posting orders to influence the perceived value of a security. For example, a *pump and dump* strategy involves buying a stock to raise its price only to sell it back at a higher price to the momentum traders. Pump and dump traders may also resort to rumormongering or wash trading to facilitate their pump and dump strategy. A similar, less common strategy on the sell side is the *short and distorts* strategy. Analysts should have a sound basis for their valuation (Standard V(A): Diligence and Reasonable Basis) so that they do not fall for bluffing.
- **Gunning the market**. This forces other traders into bad trades. For example, rapid short selling may collapse the market for a security, triggering stop-loss orders which are then filled by the manipulator, repurchasing those shares at a lower price.
- **Squeezing** and **cornering**. This involves obtaining control over resources needed to settle contracts and then withdrawing those resources, triggering defaults. Resources are then extended at a higher price. In a short squeeze, manipulators may take control of significant chunk of lendable shares, lending them to unsuspecting shorts. The manipulator can then recall the loans abruptly, forcing the shorts to cover at a higher price. Short traders should therefore use caution and ensure that there is a good diversity of lenders in the market before borrowing shares. Cornering, in a commodity market, involves long futures positions combined with buying much of the supply in the spot market. Corners then demand physical delivery for settling their futures positions, which the counterparty is unable to supply due to the spot market being cornered. This practice is illegal, and is prohibited by most futures exchanges. In general, long futures parties cannot force delivery unless they have a valid business reason. Enforcement is difficult, however, and is often gamed by the cornering traders.

## MODULE QUIZ 48.4

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

**Use the following information to answer Questions 1 through 3.**

Ben Storm, CFA, is discussing the implementation of new trading algorithms that the firm has developed with the firm's head trader, Mihir Kotak. Storm states that he wants to ensure that there are appropriate checks and balances in place before these new strategies are deployed in

the market.

Storm makes the following statements:

I. We need to ensure that only authorized personnel can input orders.

II. Updates to the algorithms need to be signed off by appropriate supervisory personnel.

Kotak makes the following statements:

I. I am more concerned about traders seeking to conduct denial-of-service attacks on their competitors with excessive submission of quotes.

II. In some markets, rapid short selling may collapse the market for a security, triggering stop-loss orders.

1. Regarding Storm's statements about appropriate checks and balances:
   A. both statements are correct.
   B. neither of the statements is correct.
   C. only one of the statements is correct.
2. Kotak's statement I *most accurately* describes the trading tactic of:
   A. Bluffing.
   B. Gunning the market.
   C. Malevolent orders.
3. Kotak's statement II *most accurately* describes the trading tactic of:
   A. Bluffing.
   B. Gunning the market.
   C. Malevolent orders.

# KEY CONCEPTS

## LOS 48.a

Explicit trading costs include brokerage, taxes, and fees; implicit costs include the bid-ask spread, price impact, slippage, and opportunity cost.

## LOS 48.b

Effective spread = 2 × (per-share effective spread transaction cost)

VWAP transaction cost = trade size × (side) × (trade VWAP – benchmark VWAP)

where:
side = +1 for buy orders and –1 for sell orders

## LOS 48.c

Implementation shortfall is the difference in value between a hypothetical (or paper) portfolio in which the trade is fully executed with no cost, and the value of the actual portfolio.

## LOS 48.d

The factors driving the development of electronic trading systems include lower cost, higher accuracy, provision for audit trails, fraud prevention, and a continuous market during trading hours.

## LOS 48.e

Market fragmentation results when a security trades in multiple markets. Trading algorithms such as liquidity aggregation (i.e., creation of a super book) and smart order routing seek to overcome the challenges posed by market fragmentation.

## LOS 48.f

Electronic traders include news traders, dealers, arbitrageurs, front runners, quote matchers, and buy-side traders.

## LOS 48.g

Latency is defined as the time lapse between the occurrence of an event and execution of a trade based on that event. Electronic trading systems allow low-latency traders a competitive advantage by jumping the order queue.

## LOS 48.h

Electronic market traders employ advanced orders, trading tactics, and trading algorithms. Electronic markets enable hidden orders, leapfrogging algorithms, flickering quotes, electronic arbitrage, and machine learning.

## LOS 48.i

Risks of electronic trading include HFT arms races at a disadvantage to small traders, as well as increases in systemic risk due to runaway algorithms, fat finger errors, overcharge orders, and malevolent orders.

## LOS 48.j

Real-time surveillance and monitoring of electronic markets seek to detect market abuses and potential crises as they unfold, allowing for a faster response. Abusive trading practices include front running and market manipulation. Market manipulation activities include trading for price impact, rumormongering, wash trading, spoofing, bluffing, gunning the market, and squeezing and cornering.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 48.1

1. **B** The first trade would occur at the best ask price of $17.69, exhausting the quantity offered. The second trade would occur at the next-best ask price of $17.71, resulting in a price impact cost of $0.02 per share. (LOS 48.a)

2. **C** Inside spread = best offer – best bid = $17.69 – $17.65 = $0.04 per share. (LOS 48.b)

3. **C** Benchmark VWAP = (1,000 × $44.55) + (3,000 × $44.65) + (6,000 × $44.75) / 10,000 = $44.70. (LOS 48.b)

4. **B** Trade VWAP = (1,000 × $44.65) + (500 × $44.75) / 1,500 = $44.68. (LOS 48.b)

5. **A** Trade VWAP – benchmark VWAP = $44.70 – $44.68 = ($0.02), an improvement of $0.02 per share. Total VWAP transaction cost = 1,500 × (+1) × –$0.02 = –$30. (LOS 48.b)

6. **B** The VWAP transaction cost approach is suitable when the trade being evaluated is a small part of the overall trading in that security. When the trade is a significant part of the overall trading volume, the benchmark VWAP and trade VWAP would be very close, and the VWAP transaction cost will be close to zero. (LOS 48.b)

7. **C** Implementation shortfall captures the price impact, delay (or slippage), and opportunity cost of a trade. (LOS 48.c)

## Module Quiz 48.2

1. **C** The factors driving the development of electronic trading systems include lower cost, higher accuracy, provision for audit trails, fraud prevention, and continuous market during trading hours. Market fragmentation is the result of electronic trading and not a reason for developing systems. (LOS 48.d)

2. **A** While electronic trading has lowered costs and improved efficiencies for stock traders, electronic trading in the bond markets is primarily between dealers, and hence, has not benefited retail investors. Electronic markets do not need human intervention, and hence, can function even when humans cannot reach a trading floor due to severe weather. (LOS 48.d)

3. **A** Trading algorithms such as smart order routing and liquidity aggregation seek to overcome the challenges posed by market fragmentation. Liquidity aggregation algorithms create a super book displaying liquidity across all markets. Smart order routing algorithms send orders to the markets with the best prices and sizes. (LOS 48.e)

4. **A** Electronic front runners use artificial intelligence to sniff out large trades (or many small trades) on the same side and then use low latency to trade ahead of them. (LOS 48.f)

## Module Quiz 48.3

1. **B** Collocation and use of high-speed fiber optic networks seek to reduce the latency by using faster communication between the trader's computer and the electronic market. The use of simple, no-frill operating systems reduces the overhead burden on a computer's resources, and hence, reduces the latency due to computation speed. (LOS 48.h)

2. **C** Advanced orders are limit orders with dynamic prices. IOC orders would get canceled if not immediately filled at the price specified. Discretionary orders provide a specified discretion amount with the limit price to an electronic exchange that supports discretionary orders. (LOS 48.g)

3. **B** Leapfrog is the practice of beating the best bid or ask price. In the presence of large quoted bid-ask spreads, there are dealers who may be willing to post a better price (i.e., a lower ask or higher bid), leapfrogging the best price. (LOS 48.g)

4. **A** A highly risk-averse trader would submit market orders in both markets if an arbitrage is feasible. Submission of a limit order in either (or both) markets increases the risk for the trader of not completing part of the round-trip transaction. (LOS 48.g)

5. **A** A trader would purchase 50,000 shares from LA-9 at $16.11 and sell them in Philly-1 at a price of $16.13, resulting in a profit of $0.02 per share or 50,000 × 0.02 = $1,000. (LOS 48.g)

### Module Quiz 48.4

1. **A** Both statements by Storm are correct as being part of appropriate checks on algorithmic trading. (LOS 48.i)

2. **C** Malevolent orders are more nefarious orders created to specifically manipulate the market. Examples include aggrieved employees programming rogue trades and traders seeking to conduct denial-of-service attacks on their competitors with excessive submission of quotes. (LOS 48.i)

3. **B** Gunning the market is a manipulative trade forcing other traders into a bad trade. Excessive sell orders to trigger stop-loss trades is an example of gunning the market. (LOS 48.j)

# TOPIC ASSESSMENT: PORTFOLIO MANAGEMENT

*You have now finished the Portfolio Management topic section. The following topic assessment will provide immediate feedback on how effective your study of this material has been. The test is best taken timed; allow 3 minutes per subquestion (18 minutes per item set). This topic assessment is more exam-like than typical module quizzes or QBank questions. A score less than 70% suggests that additional review of this topic is needed.*

**Use the following information for Questions 1 through 6.**

Faster Analytics Capital Management makes portfolio recommendations using various factor models. Bill Adams, chief economist at Faster Analytics, is responsible for providing macroeconomic and capital market forecasts. Mauricio Rodriguez, a Faster Analytics research analyst, is examining the prospects of several portfolios: the FACM Century Fund (CF), the FACM Esquire Fund (EF), the FACM Zeta Fund (ZF), and the FACM Delta Benchmark (DB).

**Figure 1: Selected Data for CF, ZF and Their Benchmark**

| | |
|---|---|
| Information ratio (CF) | 0.12 |
| Information ratio (ZF) | 0.25 |
| Benchmark Sharpe ratio | 0.30 |
| Benchmark total risk(s) | 20% |

Rodriguez's supervisor, Barbara Woodson, asks Rodriguez to use the capital asset pricing model (CAPM) and a multifactor model (APT) to make a decision about whether to continue or terminate the Esquire Fund. The two factors in the multifactor model are not identified. To help with the decision, Adams provides Rodriguez with the capital market forecasts shown in Figure 2.

**Figure 2: Capital Market Forecasts**

| | |
|---|---|
| Risk-free rate | 4% |
| Market portfolio risk premium | 8% |
| APT factor 1 risk premium | 5% |
| APT factor 2 risk premium | 2% |
| Inflation rate | 3% |

After examining the prospects for the EF portfolio, Rodriguez derives the forecasts in Figure 3.

**Figure 3: EF Data**

| | |
|---|---|
| Expected Return | 12% |
| CAPM beta | 0.80 |
| APT factor 1 risk sensitivity | 1.50 |
| APT factor 2 risk sensitivity | 2.00 |

Rodriguez also develops a 2-factor macroeconomic factor model for the EF portfolio. The two factors used in the model are the surprise in GDP growth and the surprise in investor

sentiment. The equation for the macro factor model is:

$$R_{EF} = a_{EF} + b_{EF,1}F_{GDP} + b_{EF,2}F_{IS} + \varepsilon_{EF}$$

During an investment committee meeting, Woodson makes the following statements related to the 2-factor macroeconomic factor model:

| | |
|---|---|
| *Statement 1:* | An investment allocated between CF and EF that provides a GDP growth factor beta equal to one and an investor sentiment factor beta equal to zero will have lower active factor risk than a tracking portfolio consisting of CF and EF. |
| *Statement 2:* | When markets are in equilibrium, no combination of CF and EF will produce an arbitrage opportunity. |

Rodriguez says to Woodson that for a long-term, default-risk-free bond, if the covariance between the bond's price and investors' inter-temporal rate of substitution is positive, the bond will trade at a lower price than it otherwise would, and that covariance will capture the risk premium on the bond.

In their final meeting, Rodriguez informs Woodson that the DB portfolio consistently outperformed its benchmark over the past five years. "The consistency with which DB outperformed its benchmark is amazing. The difference between the DB monthly return and its benchmark's return was nearly always positive and varied little over time," says Rodriguez.

1. The highest possible Sharpe ratio for a portfolio consisting of a combination of the CF fund and the benchmark is *closest* to:
   A. 0.32.
   B. 0.35.
   C. 0.38.

2. For an investor in the ZF, the optimal level of active risk, and the corresponding total excess return (over risk-free rate), are respectively *closest* to:

| | Optimal active risk | Total excess return |
|---|---|---|
| A. | 12.0% | 9.2%. |
| B. | 16.7% | 10.2%. |
| C. | 18.6% | 11.9%. |

3. Considering the data provided in Figure 2 and Figure 3, should Rodriguez recommend that Faster Analytics continue to invest in the EF fund using an analysis based on the CAPM or 2-factor APT?

| | CAPM? | 2-factor APT? |
|---|---|---|
| A. | Yes | Yes |
| B. | Yes | No |

C. No Yes

4. Rodriguez's statement regarding default risk-free bonds is *most likely*:
   A. correct.
   B. incorrect about the existence of a risk premium on a default-risk-free bond.
   C. incorrect about the covariance being positive.

5. Are Woodson's statements 1 and 2 regarding the macro factor model correct?
   A. Both statements are correct.
   B. Only statement 1 is correct.
   C. Only statement 2 is correct.

6. The historical performance of the DB portfolio is *best* summarized as:
   A. high active risk.
   B. high tracking risk.
   C. high information ratio.

# TOPIC ASSESSMENT ANSWERS: PORTFOLIO MANAGEMENT

1. **A** The optimal combination of the CF and the benchmark portfolio will result in highest possible Sharpe ratio.

   The Sharpe ratio for the optimal portfolio consisting of the benchmark and the CF can be calculated using the following equality: $SR_P^2 = SR_B^2 + IR^2$.

   $$SR_P = \sqrt{SR_B^2 + IR_{CD}^2}$$
   $$= \sqrt{0.30^2 + 0.12^2}$$
   $$= 0.3231$$

   (Study Session 17, Module 47.2, LOS 47.b)

2. **B** Optimal active risk

   $$= \sigma_{ZF}^* = \left(\frac{IR_{ZF}}{SR_B}\right)\sigma_B = \left(\frac{0.25}{0.30}\right)0.20$$
   $$= 0.1667 = 16.67\%$$

   Expected excess return for ZF (active return):

   $E(R_A) = IR \times \sigma_A = (0.25) \times (0.1667) = 4.17\%$

   Benchmark excess return = (0.30) × (0.20) = 6%

   Total excess return = 4.17% + 6% = 10.17%

   (Study Session 17, Module 47.2, LOS 47.b)

3. **B** The equations for required rate of return using the CAPM and a 2-factor APT are respectively:

   CAPM: $R_{EF} = RF + \beta_{EF}[E(R_M) - RF]$

   2-factor APT: $R_{EF} = RF + \beta_{EF,1}(\lambda_1) + \beta_{EF,2}(\lambda_2)$

   Using the data provided in Figures 2 and 3:

   CAPM required rate of return = 0.04 + 0.80(0.08) = 0.104 = 10.4%

   2-factor APT required rate of return = 0.04 + 1.5(0.05) + 2(0.02) = 0.155 = 15.5%

   The expected return for the EF is 12%, which exceeds the CAPM required return. Therefore, Rodriguez predicts that the EF portfolio return will exceed its CAPM required return; a signal to continue investing in EF. However, the forecasted EF return of 12% is less than the 2-factor APT model required return of 15.5%; this is a signal to not invest in EF. (Study Session 16, Module 44.1, LOS 44.c)

4. **C** The covariance between the uncertain future price of a default-risk-free bond and the investor's intertemporal rate of substitution is negative, resulting in a positive risk premium for a longer-term, default-risk-free bond. (Study Session 17, Module 46.1, LOS 46.c)

5. **C** A portfolio that has a factor beta equal to one for one factor and factor betas equal to zero for all other factors is called a factor portfolio. In contrast, a portfolio that has factor betas equal to the benchmark factor betas is called a tracking portfolio. Unlike the tracking portfolio, the factor portfolio betas are not identical to the benchmark betas. As a result, factor portfolios have higher active factor risk (which refers to the deviations of a portfolio's factor betas from those of the benchmark). Therefore, Woodson's first statement is not correct.

   Her second statement is correct. When markets are in equilibrium, all expected (i.e., forecast) asset returns are equal to their required returns. An arbitrage opportunity refers to an investment that requires no cost and no risk yet still provides a profit. If markets are in equilibrium, no profits can be earned from a costless, riskless investment. (Study Session 16, Module 44.3, LOS 44.f)

6. **C** The information ratio equals active return divided by active risk. Active return equals the average difference between the CF portfolio return and the benchmark return. Active risk equals the standard deviation of the CF return minus benchmark return. From the comments made by Rodriquez about the historical performance of the CF portfolio, we know that the numerator of the information ratio is positive and that the denominator is very close to zero. Therefore, the information ratio will be high.

   The fund standard deviation is very close to that of its benchmark (since its returns were nearly always a constant percentage above the benchmark). The CF rose and fell with the benchmark (same risk as the benchmark) but always beat the benchmark (outperformed the benchmark). Therefore, tracking risk (which is also referred to as active risk) is low. (Study Session 16, Module 44.3, LOS 44.e)

# FORMULAS

## *Study Session 15: Alternative Investments*

net operating income:

rental income if fully occupied
<u>+ other income</u>
= potential gross income
<u>– vacancy and collection loss</u>
= effective gross income
<u>– operating expense</u>
= net operating income

capitalization rate:

cap rate = discount rate – growth rate

$$\text{cap rate} = \frac{\text{NOI}_1}{\text{value}} \text{ or } \text{cap rate} = \frac{\text{NOI}_1}{\text{comparable sales price}}$$

value of a property using direct capitalization:

$$\text{value} = \text{V}_0 = \frac{\text{NOI}_1}{\text{cap rate}} \text{ or } \text{value} = \text{V}_0 = \frac{\text{stabilized NOI}}{\text{cap rate}}$$

value of a property based on net rent and "all risks yield": $\text{value} = \text{V}_0 = \frac{\text{rent}_1}{\text{ARY}}$

value of a property using gross income multiplier:

$$\text{gross income multiplier} = \frac{\text{sales price}}{\text{gross income}}$$

value = gross income × gross income multiplier

term and reversion property valuation approach:

total value = PV of term rent + PV reversion to ERV

layer approach:

total value = PV of term rent + PV of incremental rent

NCREIF Property Index (NPI) calculation:

$$\text{return} = \frac{\text{NOI} - \text{capital expenditures} + (\text{end market value} - \text{beg market value})}{\text{beginning market value}}$$

debt service coverage ratio (DSCR): $\text{DSCR} = \frac{\text{first-year NOI}}{\text{debt service}}$

loan-to-value (LTV) ratio: $\text{LTV} = \frac{\text{loan amount}}{\text{appraisal value}}$

capitalization rate based on comparable recent transactions:

$$\text{capitalization rate} = \frac{\text{net operating income}}{\text{property value}}$$

capitalization of a property's rental stream: $\text{property value} = \frac{\text{net operating income}}{\text{capitalization rate}}$

Net Asset Value approach to REIT share valuation:

estimated cash NOI
÷ assumed cap rate
= estimated value of operating real estate
+ cash and accounts receivable
– debt and other liabilities
= net asset value
÷ shares outstanding
= NAV/share

price-to-FFO approach to REIT share valuation:

funds from operations (FFO)
÷ shares outstanding
= FFO/share
× sector average P/FFO multiple
= NAV/share

price-to-AFFO approach to REIT share valuation:

funds from operations (FFO)
– non-cash rents:
– recurring maintenance-type capital expenditures
= AFFO
÷ shares outstanding
= AFFO/share
× property subsector average P/AFFO multiple
= NAV/share

discounted cash flow approach to REIT share valuation:

value of a REIT share

= PV(dividends for years 1 through n) + PV(terminal value at the end of year n)

exit value:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| investment cost | + | earnings growth | + | increase in price multiple | + | reduction in debt | = | exit value |

NAV before distributions:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| = | NAV after distributions in prior year | + | capital called down | – | management fees | + | operating results | |

NAV after distributions:

= NAV before distributions – carried interest – distributions

venture capital method:

the post-money portion of a firm purchased by an investment is:

$$f_1 = \frac{\text{investment}_1}{\text{PV}_1(\text{exit value})}$$

the number of new shares issued is:

$$\text{shares}_{\text{VC}} = \text{shares}_{\text{EQUITY}} \left(\frac{f_1}{1-f_1}\right)$$

where $\text{shares}_{\text{EQUITY}}$ is the pre-investment number of shares, and share price is:

$$\text{price}_1 = \frac{\text{investment}_1}{\text{shares}_{\text{VC}}}$$

Theory of Storage:

commodity futures price = spot price + storage costs – convenience yield

## *Study Sessions 16 & 17: Portfolio Management*

ETF premium (discount) % = (ETF price − NAV per share) / NAV per share

APT equation:

$$\text{E}(\text{R}_\text{P}) = \text{R}_\text{F} + \beta_{\text{P},1}(\lambda_1) + \beta_{\text{P},2}(\lambda_2) + \ldots + \beta_{\text{P},\text{k}}(\lambda_\text{k})$$

expected return = risk free rate + Σ(factor sensitivity) × (factor risk premium)

active return = factor return + security selection return

multifactor model return attribution:

$$\text{factor return} = \sum(\beta_{\text{pi}} - \beta_{\text{bi}}) \times (\lambda_\text{i})$$

active risk squared = active factor risk + active specific risk

active factor risk = active risk squared – active specific risk

active specific risk = $\sum_{i=1}^{n} (W_{pi} - W_{bi})^2 \sigma_{\varepsilon i}{}^2$

portfolio variance for $W_A$% in fund A and $W_B$% in fund B:

$$\sigma^2_{\text{Portfolio}} = \text{W}_\text{A}^2\sigma_\text{A}^2 + \text{W}_\text{B}^2\sigma_\text{B}^2 + 2\text{W}_\text{A}\text{W}_\text{B}\text{Cov}_\text{AB}$$

annualized standard deviation $= \sqrt{250} \times (\text{daily standard deviation})$

percentage change in value due to a change in yield to maturity (ΔY):

% change in price = –duration (ΔY) + ½ convexity $(\Delta Y)^2$

*Note: For Macaulay duration rather than modified duration, ΔY is replaced by ΔY / (1 + Y).*

option value versus future volatility:

change in call price = delta (ΔS) + ½ gamma $(\Delta S)^2$ + vega (ΔV)

*where ΔV is the change in future volatility*

inter-temporal rate of substitution:

$$= m_t = \frac{\text{marginal utility of consuming 1 unit in the future}}{\text{marginal utility of current consumption of 1 unit}}$$
$$= \frac{u_t}{u_0}$$

real risk-free rate of return = $R = \frac{1-P_0}{P_0} = \left[\frac{1}{E(m_t)}\right] - 1$

price of a default-free, inflation-indexed, zero-coupon bond:

$$P_0 = \frac{E(P_1)}{(1+R)} + \text{cov}\left(P_1, m_1\right)$$

nominal short term interest rate (r) = real risk-free rate (R) + expected inflation (π)

r(long-term) = R + π + θ

*where θ = risk premium for uncertainty about inflation*

Taylor rule:

$r = R_n + \pi + 0.5(\pi - \pi^*) + 0.5(y - y^*)$

break-even inflation rate (BEI):

BEI = yield on non-inflation indexed bond – yield on inflation indexed bond

BEI for longer maturity bonds = expected inflation (π) + risk premium for uncertainty about actual inflation (θ)

required rate of return for credit risky bonds = R + π + θ + γ

*where:*
γ = *additional risk premium for credit risk = credit spread*

discount rate for equity = R + π + θ + γ + κ

*where:*
κ = *additional risk premium relative to risky debt for an investment in equities*
λ = *equity risk premium* = γ+κ

discount rate for commercial real estate = R + π + θ + γ + κ + φ

*where:*
κ = *risk premium for uncertainty about terminal value of property (similar to equity risk premium)*
φ = *risk premium for illiquidity*

active return = portfolio return – benchmark return $R_A = R_P - R_B$

portfolio return = $R_P = \sum_{i=1}^{n} w_{P,i} R_i$

benchmark return = $R_B = \sum_{i=1}^{n} w_{B,i} R_i$

information ratio $= \frac{R_P - R_B}{\sigma_{(R_P - R_B)}} = \frac{R_A}{\sigma_A} = \frac{\text{active return}}{\text{active risk}}$

portfolio Sharpe ratio:

$$\mathrm{SR} = \frac{\mathrm{R_P} - \mathrm{R_F}}{\sigma_\mathrm{P}}$$

information ratio = $\mathrm{IR} = \mathrm{TC} \times \mathrm{IC} \times \sqrt{\mathrm{BR}}$

expected active return = $\mathrm{E}(\mathrm{R_A}) = \mathrm{IR} \times \sigma_\mathrm{A}$

“full” fundamental law of active management:

$$E\left(R_A\right) = (TC)\,(IC)\sqrt{BR}\sigma_A$$

Sharpe-ratio-maximizing level of aggressiveness:

$$\sigma_\mathrm{A}{}^* = \frac{\mathrm{IR}}{\mathrm{SR_B}}\sigma_\mathrm{B}$$

portfolio total risk versus benchmark risk and active risk:

$$\mathrm{STD}(\mathrm{R_P})^2 = \mathrm{STD}(\mathrm{R_B})^2 + \mathrm{STD}(\mathrm{R_A})^2$$

per share effective spread transaction cost = (side) × (transaction price – midquote price)

where:
side = +1 for buy orders and –1 for sell orders

effective spread = 2 × (per share effective spread transaction cost)

VWAP transaction cost = trade size × (side) × (trade VWAP − benchmark VWAP)

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