# 2020 CFA®

## PROGRAM EXAM PREP

SchweserNotes™ Level I

# Derivatives, Alternative Investments, and Portfolio Management

eBook 5

KAPLAN SCHWESER

CFA-FRM最新课程，全网更新最快，微信：a13845702825

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## 48. Derivative Markets and Instruments

The candidate should be able to:

a. define a derivative and distinguish between exchange-traded and over-the-counter derivatives. (page 1)
b. contrast forward commitments with contingent claims. (page 2)
c. define forward contracts, futures contracts, options (calls and puts), swaps, and credit derivatives and compare their basic characteristics. (page 2)
d. determine the value at expiration and profit from a long or short position in a call or put option. (page 7)
e. describe purposes of, and controversies related to, derivative markets. (page 10)
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*The topical coverage corresponds with the following CFA Institute assigned reading:*

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c. describe potential benefits of alternative investments in the context of portfolio management. (page 63)
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*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 51. Portfolio Management: An Overview

The candidate should be able to:

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b. describe the steps in the portfolio management process. (page 78)
c. describe types of investors and distinctive characteristics and needs of each. (page 79)
d. describe defined contribution and defined benefit pension plans. (page 80)
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*The topical coverage corresponds with the following CFA Institute assigned reading:*

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The candidate should be able to:

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

## 53. Portfolio Risk and Return: Part II

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a. describe the implications of combining a risk-free asset with a portfolio of risky assets. (page 117)
b. explain the capital allocation line (CAL) and the capital market line (CML). (page 118)
c. explain systematic and nonsystematic risk, including why an investor should not expect to receive additional return for bearing nonsystematic risk. (page 121)
d. explain return generating models (including the market model) and their uses. (page 123)
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f. explain the capital asset pricing model (CAPM), including its assumptions, and the security market line (SML). (page 127)
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i. calculate and interpret the Sharpe ratio, Treynor ratio, *M2*, and Jensen's alpha. (page 133)

# STUDY SESSION 19

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

## 54. Basics of Portfolio Planning and Construction

The candidate should be able to:

a. describe the reasons for a written investment policy statement (IPS). (page 143)
b. describe the major components of an IPS. (page 144)
c. describe risk and return objectives and how they may be developed for a client. (page 144)
d. distinguish between the willingness and the ability (capacity) to take risk in analyzing an investor's financial risk tolerance. (page 145)
e. describe the investment constraints of liquidity, time horizon, tax concerns, legal and regulatory factors, and unique circumstances and their implications for the choice of portfolio assets. (page 146)
f. explain the specification of asset classes in relation to asset allocation. (page 147)
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*The topical coverage corresponds with the following CFA Institute assigned reading:*

## 55. Introduction to Risk Management

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

## 56. Technical Analysis

The candidate should be able to:

a. explain principles of technical analysis, its applications, and its underlying assumptions. (page 169)
b. describe the construction of different types of technical analysis charts and interpret them. (page 170)
c. explain uses of trend, support, resistance lines, and change in polarity. (page 173)
d. describe common chart patterns. (page 174)
e. describe common technical analysis indicators (price-based, momentum oscillators, sentiment, and flow of funds). (page 176)
f. explain how technical analysts use cycles. (page 180)
g. describe the key tenets of Elliott Wave Theory and the importance of Fibonacci numbers. (page 180)
h. describe intermarket analysis as it relates to technical analysis and asset allocation. (page 181)

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

## 57. Fintech in Investment Management

The candidate should be able to:

a. describe “fintech.” (page 187)
b. describe Big Data, artificial intelligence, and machine learning. (page 188)
c. describe fintech applications to investment management. (page 189)
d. describe financial applications of distributed ledger technology. (page 191)

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The following is a review of the Derivatives principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #48.

# READING 48: DERIVATIVE MARKETS AND INSTRUMENTS

**Study Session 16**

## EXAM FOCUS



This topic review contains introductory material that describes specific types of derivatives. Definitions and terminology are presented along with information about derivatives markets. Upon completion of this review, candidates should be familiar with the basic concepts that underlie derivatives and the general arbitrage framework. The next topic review will build on these concepts to explain how prices of derivatives are determined.

## MODULE 48.1: FORWARDS AND FUTURES

Video covering this content is available online.

### LOS 48.a: Define a derivative and distinguish between exchange-traded and over-the-counter derivatives.

*CFA® Program Curriculum, Volume 5, page 386*

A **derivative** is a security that *derives* its value from the value or return of another asset or security.

A physical exchange exists for many options contracts and futures contracts. **Exchange-traded derivatives** are standardized and backed by a clearinghouse.

*Forwards* and *swaps* are custom instruments and are traded/created by dealers in a market with no central location. A dealer market with no central location is referred to as an **over-the-counter** market. They are largely unregulated markets and each contract is with a counterparty, which may expose the owner of a derivative to default risk (when the counterparty does not honor their commitment).

Some *options* trade in the over-the-counter market, notably bond options.

### LOS 48.b: Contrast forward commitments with contingent claims.

*CFA® Program Curriculum, Volume 5, page 387*

A **forward commitment** is a legally binding promise to perform some action in the future. Forward commitments include forward contracts, futures contracts, and swaps. Forward contracts and futures contracts can be written on equities, indexes, bonds, foreign currencies, physical assets, or interest rates.

A **contingent claim** is a claim (to a payoff) that depends on a particular event. **Options** are contingent claims that depend on a stock price at some future date. While forwards, futures, and swaps have payments that are based on a price or rate outcome whether the movement is up or down, contingent claims only require a payment if a certain threshold price is broken

(e.g., if the price is above *X* or the rate is below *Y*). It takes two options to replicate the payoffs on a futures or forward contract.

Credit derivatives are contingent claims that depend on a credit event such as a default or ratings downgrade.

**LOS 48.c: Define forward contracts, futures contracts, options (calls and puts), swaps, and credit derivatives and compare their basic characteristics.**

*CFA® Program Curriculum, Volume 5, page 394*

## Forward Contracts

In a **forward contract**, one party agrees to buy and the counterparty to sell a physical or financial asset at a specific price on a specific date in the future. A party may enter into the contract to speculate on the future price of an asset, but more often a party seeks to enter into a forward contract to hedge an existing exposure to the risk of asset price or interest rate changes. A forward contract can be used to reduce or eliminate uncertainty about the future price of an asset it plans to buy or sell at a later date.

Typically, neither party to the contract makes a payment at the initiation of a forward contract. If the expected future price of the asset increases over the life of the contract, the right to buy at the **forward price** (i.e., the price specified in the forward contract) will have positive value, and the obligation to sell will have an equal negative value. If the expected future price of the asset falls below the forward price, the result is opposite and the right to sell (at an above-market price) will have a positive value.

The party to the forward contract who agrees to buy the financial or physical asset has a **long forward position** and is called the *long*. The party to the forward contract who agrees to sell or deliver the asset has a **short forward position** and is called the *short*.

A *deliverable* forward contract is settled by the short delivering the underlying asset to the long. Other forward contracts are settled in cash. In a **cash-settled forward contract**, one party pays cash to the other when the contract expires based on the difference between the forward price and the market price of the underlying asset (i.e., the **spot price**) at the settlement date. Apart from transactions costs, deliverable and cash-settled forward contracts are economically equivalent. Cash-settled forward contracts are also known as *contracts for differences* or *non-deliverable forwards* (NDFs).

## Futures Contracts

A **futures contract** is a forward contract that is standardized and exchange-traded. The primary ways in which forwards and futures differ are that futures are traded in an active secondary market, subject to greater regulation, backed by a clearinghouse, and require a daily cash settlement of gains and losses.

**Futures contracts** are similar to forward contracts in that both:

- Can be either deliverable or cash-settled contracts.
- Have contract prices set so each side of the contract has a value of zero value at the initiation of the contract.

Futures contracts *differ* from forward contracts in the following ways:

- Futures contracts trade on organized exchanges. Forwards are private contracts and typically do not trade.
- Futures contracts are standardized. Forwards are customized contracts satisfying the specific needs of the parties involved.
- A clearinghouse is the counterparty to all futures contracts. Forwards are contracts with the originating counterparty and therefore have counterparty (credit) risk.
- The government regulates futures markets. Forward contracts are usually not regulated and do not trade in organized markets.

A major difference between forwards and futures is futures contracts have standardized contract terms. For each commodity or financial asset, listed futures contracts specify the quality and quantity of assets required under the contract and the delivery procedure (for deliverable contracts). The exchange sets the minimum price fluctuation (called the tick size), daily price move limit, the settlement date, and the trading times for each contract.

The **settlement price** is analogous to the closing price for a stock but is not simply the price of the final trade of the day. It is an average of the prices of the trades during the last period of trading, called the closing period, which is set by the exchange. This specification of the settlement price reduces the opportunity of traders to manipulate the settlement price. The settlement price is used to calculate the daily gain or loss at the end of each trading day. On its final day of trading the settlement price is equal to the spot price of the underlying asset (i.e., futures prices converge to spot prices as futures contracts approach expiration).

The buyer of a futures contract is said to have gone long or taken a *long position*, while the seller of a futures contract is said to have gone short or taken a *short position*. For each contract traded, there is a buyer (long) and a seller (short). The long has agreed to buy the asset at the contract price at the settlement date, and the short has an agreed to sell at that price. The number of futures contracts of a specific kind (e.g., soybeans for November delivery) that are outstanding at any given time is known as the **open interest**. Open interest increases when traders enter new long and short positions and decreases when traders exit existing positions.

*Speculators* use futures contracts to gain exposure to changes in the price of the asset underlying a futures contract. In contrast, hedgers use futures contracts to reduce an existing exposure to price changes in the asset (i.e., hedge their asset price risk). An example is a wheat farmer who sells wheat futures to reduce the uncertainty about the price he will receive for his wheat at harvest time.

Each futures exchange has a **clearinghouse**. The clearinghouse guarantees traders in the futures market will honor their obligations. The clearinghouse does this by splitting each trade once it is made and acting as the opposite side of each position. The clearinghouse acts as the buyer to every seller and the seller to every buyer. By doing this, the clearinghouse allows either side of the trade to reverse positions at a future date without having to contact the other side of the initial trade. This allows traders to enter the market knowing that they will be able to reverse or reduce their position. The guarantee of the clearinghouse removes counterparty risk (i.e., the risk that the counterparty to a trade will not fulfill their obligation at settlement) from futures contracts. In the history of U.S. futures trading, the clearinghouse has never defaulted on a contract.

**PROFESSOR'S NOTE**

> The terminology is that you “bought” bond futures if you entered into the contract with the long position. In my experience, this terminology has caused confusion for many candidates. You don’t purchase the contract, you enter into it. You are contracting to buy an asset on the long side. “Buy” means take the long side, and “sell” means take the short side in futures.

In the futures markets, **margin** is money that must be deposited by both the long and the short as a performance guarantee prior to entering into a futures contract. Unlike margin in bond or stock accounts, there is no loan involved and, consequently, no interest charges. This provides protection for the clearinghouse. Each day, the margin balance in a futures account is adjusted for any gains and losses in the value of the futures position based on the new settlement price, a process called the mark to market or marking to market. **Initial margin** is the amount that must be deposited in a futures account before a trade may be made. Initial margin per contract is relatively low and equals about one day’s maximum price fluctuation on the total value of the assets covered by the contract.

**Maintenance margin** is the minimum amount of margin that must be maintained in a futures account. If the margin balance in the account falls below the maintenance margin through daily settlement of gains and losses (from changes in the futures price), additional funds must be deposited to bring the margin balance back up to the *initial* margin amount. This is different from maintenance margin in an equity account, which requires investors only to bring the margin backup to the maintenance margin amount. Margin requirements are set by the clearinghouse.

Many futures contracts have **price limits**, which are exchange-imposed limits on how each day’s settlement price can change from the previous day’s settlement price. Exchange members are prohibited from executing trades at prices outside these limits. If the equilibrium price at which traders would willingly trade is above the upper limit or below the lower limit, trades cannot take place.

Consider a futures contract that has a daily price limit of $0.02 and settled the previous day at $1.04. If, on the following trading day, traders wish to trade at $1.07 because of changes in market conditions or expectations, no trades will take place. The settlement price will be reported as $1.06 (for the purposes of marking-to-market). The contract will be said to have made a **limit move**, and the price is said to be **limit up** (from the previous day). If market conditions had changed such that the price at which traders are willing to trade is below $1.02, $1.02 will be the settlement price, and the price is said to be **limit down**. If trades cannot take place because of a limit move, either up or down, the price is said to be **locked limit** since no trades can take place and traders are locked into their existing positions.

## MODULE QUIZ 48.1

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

1. Which of the following statements *most accurately* describes a derivative security? A derivative:
   A. always increases risk.
   B. has no expiration date.
   C. has a payoff based on an asset value or interest rate.
2. Which of the following statements about exchange-traded derivatives is *least accurate*? Exchange-traded derivatives:
   A. are liquid.
   B. are standardized contracts.
   C. carry significant default risk.
3. Which of the following derivatives is a forward commitment?

A. Stock option.
B. Interest rate swap.
C. Credit default swap.

4. A custom agreement to purchase a specific *T*-bond next Thursday for $1,000 is:
   A. an option.
   B. a futures contract.
   C. a forward commitment.

# MODULE 48.2: SWAPS AND OPTIONS

Video covering this content is available online.

**Swaps** are agreements to exchange a series of payments on periodic *settlement dates* over a certain time period (e.g., quarterly payments over two years). At each settlement date, the two payments are *netted* so that only one (net) payment is made. The party with the greater liability makes a payment to the other party. The length of the swap is termed the *tenor* of the swap and the contract ends on the termination date.

Swaps are similar to forwards in several ways:

- Swaps typically require no payment by either party at initiation.
- Swaps are custom instruments.
- Swaps are not traded in any organized secondary market.
- Swaps are largely unregulated.
- Default risk is an important aspect of the contracts.
- Most participants in the swaps market are large institutions.
- Individuals are rarely swaps market participants.

There are swaps facilitators who bring together parties with needs for the opposite sides of swaps. There are also dealers, large banks, and brokerage firms who act as principals in trades just as they do in forward contracts.

In the simplest type of swap, a **plain vanilla interest rate swap**, one party makes *fixed-rate* interest payments on a notional principal amount specified in the swap in return for *floating-rate* payments from the other party. A **basis swap** involves trading one set of floating rate payments for another. In a plain vanilla interest rate swap, the party who wants floating-rate interest payments agrees to pay fixed-rate interest and has the *pay-fixed* side of the swap. The counterparty, who receives the fixed payments and agrees to pay variable-rate interest, has the *pay-floating* side of the swap and is called the *floating-rate payer*. The payments owed by one party to the other are based on a **notional principal** that is stated in the swap contract.

### PROFESSOR'S NOTE

The Level I derivatives material focuses on interest rate swaps. Other types of swaps, such as currency swaps and equity swaps, are introduced at Level II.

## Options

An **option contract** gives its owner the right, but not the obligation, to either buy or sell an underlying asset at a given price (the **exercise price** or **strike price**). While an option buyer can choose whether to exercise an option, the seller is obligated to perform if the buyer exercises the option.

- The owner of a **call option** has the right to purchase the underlying asset at a specific price for a specified time period.
- The owner of a **put option** has the right to sell the underlying asset at a specific price for a specified time period.

**PROFESSOR'S NOTE**

To remember these terms, note that the owner of a call can "call the asset in" (i.e., buy it); the owner of a put has the right to "put the asset to" the writer of the put.

The seller of an option is also called the **option writer**. There are four possible options positions:

1. Long call: the buyer of a call option—has the right to buy an underlying asset.
2. Short call: the writer (seller) of a call option—has the obligation to sell the underlying asset.
3. Long put: the buyer of a put option—has the right to sell the underlying asset.
4. Short put: the writer (seller) of a put option—has the obligation to buy the underlying asset.

The price of an option is also referred to as the **option premium**.

**American options** may be exercised at any time up to and including the contract's expiration date.

**European options** can be exercised only on the contract's expiration date.

**PROFESSOR'S NOTE**

The name of the option does not imply where the option trades—they are just names.

At expiration, an American option and a European option on the same asset with the same strike price are identical. They may either be exercised or allowed to expire. Before expiration, however, they are different and may have different values. In those cases, we must distinguish between the two.

## Credit Derivatives

A **credit derivative** is a contract that provides a bondholder (lender) with protection against a downgrade or a default by the borrower. The most common type of credit derivative is a **credit default swap** (CDS), which is essentially an insurance contract against default. A bondholder pays a series of cash flows to a credit protection seller and receives a payment if the bond issuer defaults.

Another type of credit derivative is a **credit spread option**, typically a call option that is based on a bond's yield spread relative to a benchmark. If the bond's credit quality decreases, its yield spread will increase and the bondholder will collect a payoff on the option.

**LOS 48.d: Determine the value at expiration and profit from a long or short position in a call or put option.**

*CFA® Program Curriculum, Volume 5, page 406*

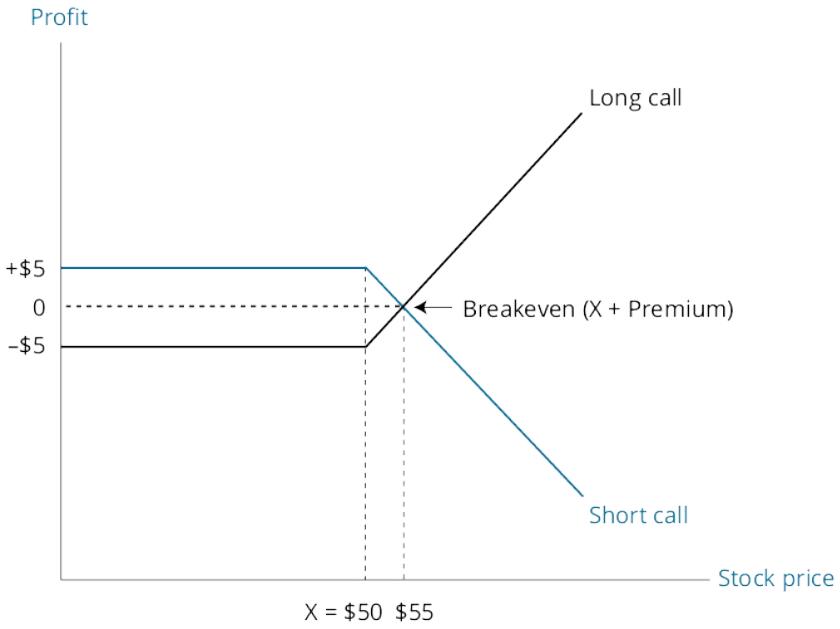
## Call Option Profits and Losses

Consider a call option with a premium of $5 and a strike price of $50. This means the buyer pays $5 to the writer. At expiration, if the price of the stock is less than or equal to the $50 strike price (the option has zero value), the buyer of the option is out $5, and the writer of the option is ahead $5. As the stock's price exceeds $50, the buyer of the option starts to gain (breakeven will come at $55, when the value of the stock equals the strike price and the option premium). However, as the price of the stock moves upward, the seller of the option starts to lose (negative figures will start at $55, when the value of the stock equals the strike price and the option premium).

The profit/loss diagram for the buyer (long) and writer (short) of the call option we have been discussing at expiration is presented in Figure 48.1. This profit/loss diagram illustrates the following:

- The maximum loss for the buyer of a call is the loss of the $5 premium (at any S ≤ $50).
- The breakeven point for the buyer and seller is the strike price plus the premium (at S = $55).
- The profit potential to the buyer of the option is unlimited, and, conversely, the potential loss to the writer of the call option is unlimited.
- The call holder will exercise the option whenever the stock's price exceeds the strike price at the expiration date.
- The greatest profit the writer can make is the $5 premium (at any S ≤ $50).
- The sum of the profits between the buyer and seller of the call option is always zero; thus, options trading is a *zero-sum game*. There are no net profits or losses in the market. The long profits equal the short losses.

**Figure 48.1:** Profit/Loss Diagram for a Call Option



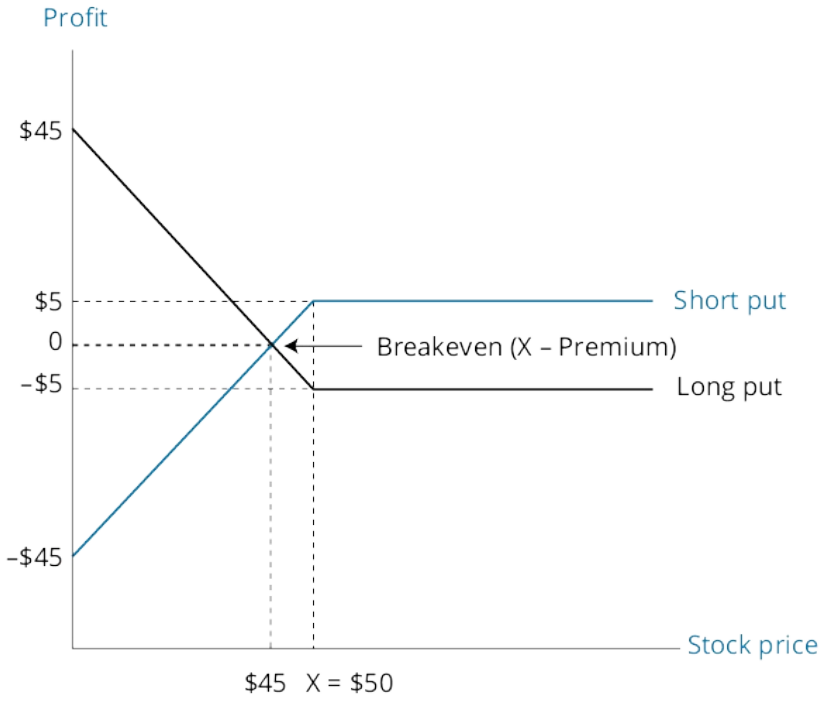

## Put Option Profits and Losses

To examine the profits/losses associated with trading put options, consider a put option with a $5 premium. The buyer pays $5 to the writer. When the price of the stock at expiration is greater than or equal to the $50 strike price, the put has zero value. The buyer of the option has a loss of $5, and the writer of the option has a gain of $5. As the stock's price falls below $50, the buyer of the put option starts to gain (breakeven will come at $45, when the value of the stock equals the strike price less the option premium). However, as the price of the stock moves downward, the seller of the option starts to lose (negative profits will start at $45, when the value of the stock equals the strike price less the option premium).

Figure 48.2 shows the profit/loss diagram for the buyer (long) and seller (short) of the put option that we have been discussing. This profit/loss diagram illustrates that:

- The maximum loss for the buyer of a put is the loss of the $5 premium (at any S ≥ $50).
- The maximum gain to the buyer of a put is limited to the strike price less the premium ($50 – $5 = $45). The potential loss to the writer of the put is the same amount.
- The breakeven price of a put buyer (seller) is at the strike price minus the option premium ($50 – $5 = $45).
- The greatest profit the writer of a put can make is the $5 premium (S ≥ $50).
- The sum of the profits between the buyer and seller of the put option is always zero. Trading put options is a *zero-sum game*. In other words, the buyer's profits equal the writer's losses.

**Figure 48.2:** Profit/Loss Diagram for a Put Option




**EXAMPLE: Option profit calculations**

Suppose that both a call option and a put option have been written on a stock with an exercise price of $40. The current stock price is $42, and the call and put premiums are $3 and $0.75, respectively.

Calculate the profit to the long and short positions for both the put and the call with an expiration day stock price of $35 and with a price at expiration of $43.

**Answer:**

*Profit* will be computed as ending option valuation – initial option cost.

*Stock at $35:*

- Long call: $0 – $3 = –$3. The option finished out-of-the-money, so the premium is lost.
- Short call: $3 – $0 = $3. Because the option finished out-of-the-money, the call writer's gain equals the premium.
- Long put: $5 – $0.75 = $4.25. You paid $0.75 for an option that is now worth $5.
- Short put: $0.75 – $5 = –$4.25. You received $0.75 for writing the option, but you face a $5 loss because the option is in-the-money.

*Stock at $43:*

- Long call: –$3 + $3 = $0. You paid $3 for the option, and it is now worth $3. Hence, your net profit is zero.
- Short call: $3 – $3 = $0. You received $3 for writing the option and now face a –$3 valuation for a net profit of zero.
- Long put: –$0.75 – $0 = –$0.75. You paid $0.75 for the put option and the option is now worthless. Your net profit is –$0.75.
- Short put: $0.75 – $0 = $0.75. You received $0.75 for writing the option and keep the premium because the option finished out-of-the-money.

A buyer of puts or a seller of calls will profit when the price of the underlying asset decreases. A buyer of calls or a seller of puts will profit when the price of the underlying asset increases. In general, a put buyer believes the underlying asset is overvalued and will decline in price, while a call buyer anticipates an increase in the underlying asset's price.

## LOS 48.e: Describe purposes of, and controversies related to, derivative markets.

*CFA® Program Curriculum, Volume 5, page 422*

The *criticism of derivatives* is that they are "too risky," especially to investors with limited knowledge of sometimes complex instruments. Because of the high leverage involved in derivatives payoffs, they are sometimes likened to gambling.

The *benefits of derivatives* markets are that they:

- Provide price information.
- Allow risk to be managed and shifted among market participants.
- Reduce transactions costs.

## LOS 48.f: Explain arbitrage and the role it plays in determining prices and promoting market efficiency.

*CFA® Program Curriculum, Volume 5, page 430*

**Arbitrage** is an important concept in valuing (pricing) derivative securities. In its purest sense, arbitrage is riskless. If a return greater than the risk-free rate can be earned by holding a portfolio of assets that produces a certain (riskless) return, then an arbitrage opportunity exists.

Arbitrage opportunities arise when assets are mispriced. Trading by arbitrageurs will continue until they affect supply and demand enough to bring asset prices to efficient (no-arbitrage) levels.

There are two arbitrage arguments that are particularly useful in the study and use of derivatives.

The first is based on the **law of one price**. Two securities or portfolios that have identical cash flows in the future, regardless of future events, should have the same price. If A and B have the identical future payoffs and A is priced lower than B, buy A and sell B. You have an immediate profit, and the payoff on A will satisfy the (future) liability of being short on B.

The second type of arbitrage requires an investment. If a portfolio of securities or assets will have a certain payoff in the future, there is no risk in investing in that portfolio. In order to prevent profitable arbitrage, it must be the case that the return on the portfolio is the risk free rate. If the certain return on the portfolio is greater than the risk free rate, the arbitrage would be to borrow at Rf, invest in the portfolio, and keep the excess of the portfolio return above the risk free rate that must be paid on the loan. If the portfolio's certain return is less than Rf, we could sell the portfolio, invest the proceeds at Rf, and earn more than it will cost to buy back the portfolio at a future date.

## PROFESSOR'S NOTE

We discuss derivatives pricing based on arbitrage in more detail in our review of Basics of Derivative Pricing and Valuation.

## MODULE QUIZ 48.2

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

1. Interest rate swaps are:
   A. highly regulated.
   B. equivalent to a series of forward contracts.
   C. contracts to exchange one asset for another.
2. A call option is:
   A. the right to sell at a specific price.
   B. the right to buy at a specific price.
   C. an obligation to buy at a certain price.
3. At expiration, the exercise value of a put option is:
   A. positive if the underlying asset price is less than the exercise price.
   B. zero only if the underlying asset price is equal to the exercise price.
   C. negative if the underlying asset price is greater than the exercise price.
4. At expiration, the exercise value of a call option is:
   A. the underlying asset price minus the exercise price.
   B. the greater of zero or the exercise price minus the underlying asset price.
   C. the greater of zero or the underlying asset price minus the exercise price.
5. An investor writes a put option with an exercise price of $40 when the stock price is $42. The option premium is $1. At expiration the stock price is $37. The investor will realize:
   A. a loss of $2.
   B. a loss of $3.
   C. a profit of $1.
6. Derivatives are *least likely* to:
   A. improve liquidity.
   B. provide price information.
   C. prevent arbitrage.
7. Arbitrage prevents:

A. market efficiency.
B. earning returns higher than the risk-free rate of return.
C. two assets with identical payoffs from selling at different prices.

# KEY CONCEPTS

## LOS 48.a

A derivative's value is derived from the value of another asset or an interest rate.

Exchange-traded derivatives, notably futures and some options, are traded in centralized locations (exchanges) and are standardized, regulated, and are free of default.

Forwards and swaps are custom contracts (over-the-counter derivatives) created by dealers or financial institutions. There is limited trading of these contracts in secondary markets and default (counterparty) risk must be considered.

## LOS 48.b

A forward commitment is an obligation to buy or sell an asset or make a payment in the future. Forward contracts, futures contracts, and swaps are all forward commitments.

A contingent claim is an asset that has a future payoff only if some future event takes place (e.g., asset price is greater than a specified price). Options and credit derivatives are contingent claims.

## LOS 48.c

Forward contracts obligate one party to buy, and another to sell, a specific asset at a specific price at a specific time in the future.

Interest rate swaps contracts are equivalent to a series of forward contracts on interest rates.

Futures contracts are much like forward contracts, but are exchange-traded, liquid, and require daily settlement of any gains or losses.

A call option gives the holder the right, but not the obligation, to buy an asset at a specific price at some time in the future.

A put option gives the holder the right, but not the obligation, to sell an asset at a specific price at some time in the future.

A credit derivative is a contract that provides a payment if a specified credit event occurs.

## LOS 48.d

Call option value at expiration is Max(0, underlying price minus exercise price) and profit (loss) is Max(0, underlying price minus exercise price) minus option cost.

Put value at expiration is Max(0, exercise price minus underlying price) and profit (loss) is Max(0, exercise price minus underlying price) minus option cost.

A call buyer (call seller) anticipates an increase (decrease) in the value of the underlying asset.

A put buyer (put seller) anticipates a decrease (increase) in the value of the underlying asset.

## LOS 48.e

Derivative markets are criticized for their risky nature. However, many market participants use derivatives to manage and reduce existing risk exposures.

Derivative securities play an important role in promoting efficient market prices and reducing transaction costs.

## LOS 48.f

Riskless arbitrage refers to earning more than the risk-free rate of return with no risk, or receiving an immediate gain with no possible future liability.

Arbitrage can be expected to force the prices of two securities or portfolios of securities to be equal if they have the same future cash flows regardless of future events.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 48.1

1. **C** A derivative's value is derived from another asset or an interest rate. (LOS 48.a)
2. **C** Exchange-traded derivatives have relatively low default risk because the clearinghouse stands between the counterparties involved in most contracts. (LOS 48.a)
3. **B** An interest rate swap is a forward commitment because both counterparties have obligations to make payments in the future. Options and credit derivatives are contingent claims because one of the counterparties only has an obligation if certain conditions are met. (LOS 48.b)
4. **C** This type of custom contract is a forward commitment. (LOS 48.b)

## Module Quiz 48.2

1. **B** A swap is an agreement to buy or sell an underlying asset periodically over the life of the swap contract. It is equivalent to a series of forward contracts. (LOS 48.c)
2. **B** A call gives the owner the right to call an asset away (buy it) from the seller. (LOS 48.c)
3. **A** The exercise value of a put option is positive at expiration if the underlying asset price is less than the exercise price. Its exercise value is zero if the underlying asset price is greater than or equal to the exercise price. The exercise value of an option cannot be negative because the holder can allow it to expire unexercised. (LOS 48.d)
4. **C** If the underlying asset price is greater than the exercise price of a call option, the value of the option is equal to the difference. If the underlying asset price is less than the exercise price, a call option expires with a value of zero. (LOS 48.d)
5. **A** Because the stock price at expiration is less than the exercise price, the buyer of the put option will exercise it against the writer. The writer will have to pay $40 for the stock and can only sell it for $37 in the market. However, the put writer collected the $1 premium for writing the option, which reduces the net loss to $2. (LOS 48.d)
6. **C** While derivatives prices are the result of potential arbitrage, they do not prevent arbitrage. Derivatives improve liquidity and provide price information. (LOS 48.e)
7. **C** Arbitrage forces two assets with the same expected future value to sell for the same current price. If this were not the case, you could simultaneously buy the cheaper asset and sell the more expensive one for a guaranteed riskless profit. (LOS 48.f)

The following is a review of the Derivatives principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #49.

# READING 49: BASICS OF DERIVATIVE PRICING AND VALUATION

**Study Session 16**

## EXAM FOCUS

Here the focus is on the pricing and valuation of derivatives based on a no-arbitrage condition. The derivation of the price in a forward contract and calculating the value of a forward contract over its life are important applications of no-arbitrage pricing. Candidates should also understand the equivalence of interest rates swaps to a series of forward rate agreements and how each factor that affects option values affects puts and calls.

## MODULE 49.1: FORWARDS AND FUTURES VALUATION

Video covering this content is available online.

### LOS 49.a: Explain how the concepts of arbitrage, replication, and risk neutrality are used in pricing derivatives.

*CFA® Program Curriculum, Volume 5, page 456*

For most risky assets, we estimate current value as the discounted present value of the expected price of the asset at some future time. Because the future price is subject to risk (uncertainty), the discount rate includes a risk premium along with the risk-free rate. We assume that investors are **risk-averse** so they require a positive premium (higher return) on risky assets. An investor who is **risk-neutral** would require no risk premium and, as a result, would discount the expected future value of an asset or future cash flows at the risk-free rate.

In contrast to valuing risky assets as the (risk-adjusted) present value of expected future cash flows, the valuation of derivative securities is based on a **no-arbitrage condition**. *Arbitrage* refers to a transaction in which an investor purchases one asset or portfolio of assets at one price and simultaneously sells an asset or portfolio of assets that has the same future payoffs, regardless of future events, at a higher price, realizing a risk-free gain on the transaction. While arbitrage opportunities may be rare, the reasoning is that when they do exist, they will be exploited rapidly. Therefore, we can use a no-arbitrage condition to determine the current value of a derivative, based on the known value of a portfolio of assets that has the same future payoffs as the derivative, regardless of future events. Because there are transactions costs of exploiting an arbitrage opportunity, small differences in price may persist because the arbitrage gain is less than the transactions costs of exploiting it.

In markets for traditional securities, we don't often encounter two assets that have the same future payoffs. With derivative securities, however, the risk of the derivative is entirely based on the risk of the underlying asset, so we can construct a portfolio consisting of the underlying asset and a derivative based on it that has no uncertainty about its value at some future date (i.e., a hedged portfolio). Because the future payoff is certain, we can calculate the

present value of the portfolio as the future payoff discounted at the risk-free rate. This will be the current value of the portfolio under the no-arbitrage condition, which will force the return on a risk-free (hedged) portfolio to the risk-free rate.

The value of an asset combined with a short forward position is simply the price of the forward contract, $F_0(T)$. The asset will be delivered at the settlement date for the forward contract price, $F_0(T)$.

Thus, with a time 0 value of an asset of $S_0$, and a forward price of $F_0(T)$, it must be the case that $F_0(T) / S_0 = (1 + Rf)^T$.

A riskless transaction should return the riskless rate of interest. Because the payoff at time *T* (settlement date of the forward contract) is from a fully hedged position, its time *T* value is certain. The asset will be sold at time *T* at the price specified in the forward contract. To prevent arbitrage, the above equality must hold.

Another way to understand this relationship is to consider buying an asset at $S_0$ and holding it until time *T*, or going long a forward contract on the asset at $F_0(T)$ and buying a pure discount bond that pays $F_0(T)$ at time *T*. Both have the same payoff at settlement. They both result in owning the asset at time *T*. The proceeds of the bond, $F_0(T)$, are just enough to buy the asset at time *T*. Because both strategies must, therefore, have the same value at time 0, we can write $F_0(T) = S_0 \times (1 + Rf)^T$, a rearrangement of our previous relationship.

$F_0(T)$ is the no-arbitrage price of the forward contract. If the forward price is greater than $S_0 \times (1 + Rf)^T$, we could buy the asset and take a short position in the forward contract to receive an arbitrage profit of $F_0(T) – S_0 \times (1 + Rf)^T$ at time *T*, the settlement date of the forward contract. If the forward price is less than $S_0 \times (1 + Rf)^T$, we could sell the asset short, invest the proceeds in a pure discount bond at Rf, and take a long position in the forward contract. At settlement of the forward contract we could use the proceeds of the bond to buy the asset at $F_0(T)$ (to cover the short position) and retain the bond proceeds in excess of the forward price, $S_0 \times (1 + Rf)^T – F_0(T)$, as an arbitrage profit.

When the equality $F_0(T) = S_0 \times (1 + Rf)^T$ holds, we say the derivative is at its no-arbitrage price. Because we know the risk-free rate, the spot price of the asset, and the certain payoff at time *T*, we can solve for the no-arbitrage price of the forward contract. Note the investor's risk aversion has not entered into our valuation of the derivative as it did when we described the valuation of a risky asset. For this reason, the determination of the no-arbitrage derivative price is sometimes called **risk-neutral pricing**, which is the same as no-arbitrage pricing or the price under a no-arbitrage condition.

This process is called **replication** because we are replicating the payoffs on one asset or portfolio with those of a different asset or portfolio.

Another example of risk-neutral pricing is to combine a risky bond with a credit protection derivative to replicate a risk-free bond. We can write:

risky bond + credit protection = bond valued at the risk-free rate

and see that the no-arbitrage price of credit protection is the value of the bond if it were risk-free minus the actual value of the risky bond.

As a final example of risk-neutral pricing and replication, consider an investor who buys a share of stock, sells a call on the stock at 40, and buys a put on the stock at 40 with the same expiration date as the call. The investor will receive 40 at option expiration regardless of the stock price because:

- If the stock price is 40 at expiration, the put and the call are both worthless at expiration.
- If the stock price > 40 at expiration, the call will be exercised, the stock will be delivered for 40, and the put will expire worthless.
- If the stock price is < 40 at expiration, the put will be exercised, the stock will be delivered for 40, and the call will expire worthless.

Thus, for a six-month call and put we can write:

$$\text{stock} + \text{put} - \text{call} = 40 / (1+Rf)^{0.5} \text{ and equivalently}$$

$$\text{call} = \text{stock} + \text{put} - 40 / (1+Rf)^{0.5} \text{ and}$$

$$\text{put} = \text{call} + 40 / (1+Rf)^{0.5} - \text{stock}$$

These replications will be introduced later in this topic review as the *put-call parity* relationship.

## LOS 49.b: Distinguish between value and price of forward and futures contracts.

*CFA® Program Curriculum, Volume 5, page 468*

Recall that the *value* of futures and forward contracts is zero at initiation, when the forward *price* is its no-arbitrage value. As the price of the underlying asset changes during the life of the contract, the *value* of a futures or forward contract position may increase or decrease.

As an example of the difference between the price and value of a forward or futures contract, consider a long position in a forward contract to buy the underlying asset in the future at $50, which is the forward contract price. At initiation of the contract, the value is zero but the contract price is $50. If the spot price of the underlying asset increases (other things equal), the value of the long contract position will increase and the value of a short position will decrease. The contract *price* at which the long forward will purchase the asset in the future does not change over the life of the contract, but the *value* of the forward contract almost surely will.

### PROFESSOR'S NOTE

We will address LOS 49.c after addressing LOS 49.d and 49.e.

## LOS 49.d: Explain how the value and price of a forward contract are determined at expiration, during the life of the contract, and at initiation.

*CFA® Program Curriculum, Volume 5, page 469*

Because neither party to a forward transaction pays at initiation to enter the contract, the forward contract price must be set so the contract has zero value at initiation. As we have discussed, for an asset that has no costs or benefits from holding it, setting the forward price $F_0(T)$ equal to $S_0 (1 + Rf)^T$ ensures that the value of either a long or short forward contract is zero at contract initiation.

During its life, at time t < T, the value of the forward contract is the spot price of the asset minus the present value of the forward price:

$$V_t(T) = S_t - F_0(T) / (1 + Rf)^{T-t}$$

At settlement, t = T so that T – t = 0 (there is no time left on the contract). The discounting term is $(1 + Rf)^0 = 1$ and the payoff to a long forward is $S_T - F_0(T)$, the difference between the spot price of the asset at expiration and the price of the forward contract.

**EXAMPLE: Value of a forward contract during its life**

An investor took a long position in a 1-year forward contract at a price of 35. If the risk-free rate is 3%, what is the value of the forward contract after 9 months have passed when the spot price of the asset is 36?

**Answer:**

The value of the forward contract at t = 0.75 years is $36 - 35 / (1.03)^{(1-0.75)} = 1.26$.

## LOS 49.e: Describe monetary and nonmonetary benefits and costs associated with holding the underlying asset and explain how they affect the value and price of a forward contract.

*CFA® Program Curriculum, Volume 5, page 471*

We previously derived the no-arbitrage forward price for an asset as $F_0(T) = S_0 \times (1 + Rf)^T$. In doing this we assumed that there were no benefits of holding the asset and no costs of holding the asset, other than opportunity cost of the funds to purchase the asset (the risk-free rate of interest). There may be additional costs of owning an asset, such as storage and insurance costs. For financial assets, these costs are very low and not significant. There may also be benefits to holding the asset, both monetary and nonmonetary.

Dividend payments on a stock or interest payments on a bond are examples of monetary benefits of holding an asset. Nonmonetary benefits of holding an asset are sometimes referred to as its **convenience yield**. The convenience yield is difficult to measure and is only significant for some assets, primarily commodities. If an asset is difficult to sell short in the market, owning it may convey benefits in circumstances where selling the asset is advantageous. For example, a shortage of the asset may drive prices up, making sale of the asset in the short term profitable. While the ability to look at a painting or sculpture provides nonmonetary benefits to its owner, this is unlikely with corn or other commodities.

We can denote the present value of any costs of holding the asset from time 0 to settlement at time *T* as $PV_0(\text{cost})$ and the present value of any cash flows from the asset and any convenience yield over the holding period as $PV_0(\text{benefit})$.

Consider first a case where there are costs of holding the asset but no benefits. The asset can be purchased now and held to time *T* at a total cost of $[S_0 + PV_0(\text{cost})](1 + Rf)^T$, so the no-arbitrage forward price at contract initiation is $F_0(T) = [S_0 + PV_0(\text{cost})](1 + Rf)^T$. Any other forward price will create an arbitrage opportunity at the initiation of the forward contract.

The intuition here is that the cost of buying the asset and holding it until the forward settlement date is higher by the present value of the costs of storing the asset, so that the no-arbitrage forward price must be higher.

In a case where there are only benefits of holding the asset over the life of the forward contract, the cost of buying the asset and holding it until the settlement of the forward contract at time *T* is $[S_0 - PV_0(\text{benefit})](1 + Rf)^T$. Again, any forward price that is not equal to the no-arbitrage forward price will create an arbitrage opportunity. Here the intuition is that if an asset makes a cash interest payment during the life of the forward contract, the asset's cost could be reduced by selling the interest payment for its present value at the time of purchase.

The no-arbitrage forward price is lower to the extent the present value of any benefits is greater, and higher to the extent the present value of any costs incurred over the life of the forward contract is greater. If an asset has both storage costs and benefits from holding the asset over the life of the forward contract, we can combine these into a more general formula and express the no-arbitrage forward price (that will produce a value of zero for the forward at initiation) as:

$$F_0(T) = [S_0 + PV_0(\text{cost}) - PV_0(\text{benefit})](1 + Rf)^T$$

Both the present values of the costs of holding the asset and the benefits of holding the asset decrease as time passes and the time to settlement, $(T - t)$, decreases, so the value of the forward at any point in time *t* is:

$$V_t(T) = S_t + PV_t(\text{cost}) - PV_t(\text{benefit}) - F_0(T) / (1 + Rf)^{T - t}$$

At settlement, when t = T, the costs and benefits of holding the asset until settlement are zero, so that the payoff on a long forward position at time *T* is, again, simply $S_T - F_0(T)$, the difference between the spot price of the asset at contract settlement date and the forward price of the contract.

## LOS 49.c: Calculate a forward price of an asset with zero, positive, or negative net cost of carry.

*CFA® Program Curriculum, Volume 5, page 471*

The **net cost of carry** (or simply **carry**) = PV(benefits of holding the asset) – PV(costs of holding the asset). When the benefits (cash flow yield and convenience yield) exceed the costs (storage and insurance) of holding the asset, we say the net cost of carry is positive.

### PROFESSOR'S NOTE

Be careful about the signs here. The net cost of carry (or "the carry") is positive when the PV of the benefits is greater than the PV of the costs.

Noting that the no-arbitrage futures price = $[S_0 + PV_0(\text{costs}) - PV_0(\text{benefits})] \times (1 + Rf)^T$, we can see that a positive net cost of carry will reduce the futures price. Rearranging the formula, we have:

$$F_0(T) = \{S_0 - [PV_0(\text{benefits}) - PV_0(\text{costs})]\} \times (1 + Rf)^T$$

$$= [S_0 - \text{net cost of carry}] \times (1 + Rf)^T$$

> **EXAMPLE: Net cost of carry**
>
> Using a risk-free rate of 2%, calculate the no-arbitrage futures price for a 1-year contract at initiation for an

asset with a spot price of $125 and a net cost of carry of $2.

**Answer:**

($125 – $2)(1.02) = $125.46

## MODULE QUIZ 49.1

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

1. Derivatives pricing models use the risk-free rate to discount future cash flows because these models:
   A. are based on portfolios with certain payoffs.
   B. assume that derivatives investors are risk-neutral.
   C. assume that risk can be eliminated by diversification.
2. The price of a forward or futures contract:
   A. is typically zero at initiation.
   B. is equal to the spot price at settlement.
   C. remains the same over the term of the contract.
3. For a forward contract on an asset that has no costs or benefits from holding it to have zero value at initiation, the arbitrage-free forward price must equal:
   A. the expected future spot price.
   B. the future value of the current spot price.
   C. the present value of the expected future spot price.
4. The underlying asset of a derivative is *most likely* to have a convenience yield when the asset:
   A. is difficult to sell short.
   B. pays interest or dividends.
   C. must be stored and insured.

# MODULE 49.2: FORWARD RATE AGREEMENTS AND SWAP VALUATION

Video covering this content is available online.

### LOS 49.f: Define a forward rate agreement and describe its uses.

*CFA® Program Curriculum, Volume 5, page 473*

A **forward rate agreement** (FRA) is a derivative contract that has a future interest rate, rather than an asset, as its underlying. The point of entering into an FRA is to lock in a certain interest rate for borrowing or lending at some future date. One party will pay the other party the difference (based on an agreed-upon notional contract value) between the fixed interest rate specified in the FRA and the market interest rate at contract settlement.

LIBOR is most often used as the underlying rate. U.S. dollar LIBOR refers to the rates on Eurodollar time deposits, interbank U.S. dollar loans in London.

Consider an FRA that will, in 30 days, pay the difference between 90-day LIBOR and the 90-day rate specified in the FRA (the contract rate). A company that expects to borrow 90-day funds in 30 days will have higher interest costs if 90-day LIBOR 30 days from now increases. A long position in the FRA (pay fixed, receive floating) will receive a payment that will offset the increase in borrowing costs from the increase in 90-day LIBOR. Conversely, if 90-day LIBOR 30 days from now decreases over the next 30 days, the long position in the FRA will make a payment to the short in the amount that the company's borrowing costs have decreased relative to the FRA contract rate.

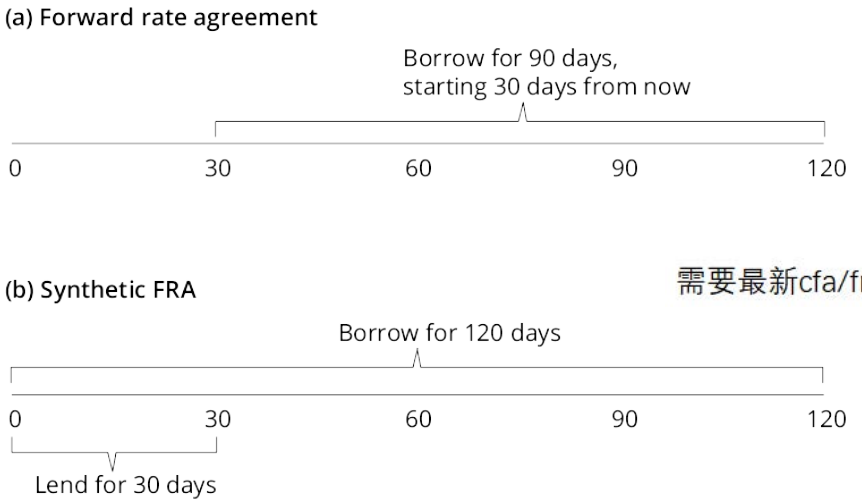
FRAs are used by firms to hedge the risk of (remove uncertainty about) borrowing and lending they intend to do in the future. A company that intends to borrow funds in 30 days could take a long position in an FRA, receiving a payment if future 90-day LIBOR (and its borrowing cost) increases, and making a payment if future 90-day LIBOR (and its borrowing cost) decreases, over the 30-day life of the FRA. Note a perfect hedge means not only that the firm's borrowing costs will not be higher if rates increase, but also that the firm's borrowing costs will not be lower if interest rates decrease.

For a firm that intends to have funds to lend (invest) in the future, a short position in an FRA can hedge its interest rate risk. In this case, a decline in rates would decrease the return on funds loaned at the future date, but a positive payoff on the FRA would augment these returns so that the return from both the short FRA and loaning the funds is the no-arbitrage rate that is the *price* of the FRA at initiation.

Rather than enter into an FRA, a bank can create the same payment structure with two LIBOR loans, a **synthetic FRA**. A bank can borrow money for 120 days and lend that amount for 30 days. At the end of 30 days, the bank receives funds from the repayment of the 30-day loan it made, and has use of these funds for the next 90 days at an effective rate determined by the original transactions. The effective rate of interest on this 90-day loan depends on both 30-day LIBOR and 120-day LIBOR at the time the money is borrowed and loaned to the third party. This rate is the contract rate on a 30-day FRA on 90-day LIBOR. The resulting cash flows will be the same with either the FRA or the synthetic FRA.

Figure 49.1 illustrates these two methods of "locking in" a future lending or borrowing rate (i.e., hedging the risk from uncertainty about future interest rates).

**Figure 49.1:** 30-Day FRA on 90-Day LIBOR






Note that the no-arbitrage price of an FRA is determined by the two transactions in the synthetic FRA, borrowing for 120 days and lending for 30 days.

## LOS 49.g: Explain why forward and futures prices differ.

*CFA® Program Curriculum, Volume 5, page 476*

Forwards and futures serve the same function in gaining exposure to or hedging specific risks, but differ in their degree of standardization, liquidity, and, in many instances, counterparty risk. From a pricing and valuation perspective, the most important distinction is

that futures gains and losses are settled each day and the margin balance is adjusted accordingly. If gains put the margin balance above the initial margin level, any funds in excess of that level can be withdrawn. If losses put the margin value below the minimum margin level, funds must be deposited to restore the account margin to its initial (required) level. Forwards, typically, do not require or provide funds in response to fluctuations in value during their lives.

While this difference is theoretically important in some contexts, in practice it does not lead to any difference between the prices of forwards and futures that have the same terms otherwise. If interest rates are constant, or even simply uncorrelated with futures prices, the prices of futures and forwards are the same. A positive correlation between interest rates and the futures price means that (for a long position) daily settlement provides funds (excess margin) when rates are high and they can earn more interest, and requires funds (margin deposits) when rates are low and opportunity cost of deposited funds is less. Because of this, futures prices will be higher than forward prices when interest rates and futures prices are positively correlated, and they will be lower than forward prices when interest rates and futures prices are negatively correlated.

### LOS 49.h: Explain how swap contracts are similar to but different from a series of forward contracts.

### LOS 49.i: Distinguish between the value and price of swaps.

*CFA® Program Curriculum, Volume 5, page 478*

In a simple interest-rate swap, one party pays a floating rate and the other pays a fixed rate on a notional principal amount. Consider a one-year swap with quarterly payments, one party paying a fixed rate and the other a floating rate of 90-day LIBOR. At each payment date the difference between the swap fixed rate and LIBOR (for the prior 90 days) is paid to the party that owes the least, that is, a net payment is made from one party to the other.

We can separate these payments into a known payment and three unknown payments which are equivalent to the payments on three forward rate agreements. Let $S_n$ represent the floating rate payment (based on 90-day LIBOR) owed at the end of quarter $n$ and $F_n$ be the fixed payment owed at the end of quarter $n$. We can represent the swap payment to be received by the fixed rate payer at the end of period $n$ as $S_n - F_n$. We can replicate each of these payments to (or from) the fixed rate payer in the swap with a forward contract, specifically a long position in a forward rate agreement with a contract rate equal to the swap fixed rate and a settlement value based on 90-day LIBOR.

We illustrate this separation below for a one-year fixed for floating swap with a fixed rate of $F$, fixed payments at time $n$ of $F_n$, and floating rate payments at time $n$ of $S_n$.

First payment (90 days from now) = $S_1 - F_1$ which is known at time zero because the payment 90 days from now is based on 90-day LIBOR at time 0 and the swap fixed rate, $F$, both of which are known at the initiation of the swap.

Second payment (180 days from now) is equivalent to a long position in an FRA with contract rate $F$ that settles in 180 days and pays $S_2 - F_2$.

Third payment (270 days from now) is equivalent to a long position in an FRA with contract rate *F* that settles in 270 days and pays $S_3 - F_3$.

Fourth payment (360 days from now) is equivalent to a long position in an FRA with contract rate *F* that settles in 360 days and pays $S_4 - F_4$.

Note that a forward on 90-day LIBOR that settles 90 days from now, based on 90-day LIBOR at that time, actually pays the present value of the difference between the fixed rate *F* and 90-day LIBOR 90 days from now (times the notional principal amount). Thus, the forwards in our example actually pay on days 90, 180, and 270. However, the amounts paid are equivalent to the differences between the fixed rate payment and floating rate payment that are due when interest is actually paid on days 180, 270, and 360, which are the amounts we used in the example.

Therefore, we can describe an interest rate swap as equivalent to a series of forward contracts, specifically forward rate agreements, each with a forward contract rate equal to the swap fixed rate. However, there is one important difference. Because the forward contract rates are all equal in the FRAs that are equivalent to the swap, these would not be zero value forward contracts at the initiation of the swap. Recall that forward contracts are based on a contract rate for which the value of the forward contract at initiation is zero. There is no reason to suspect that the swap fixed rate results in a zero value forward contract for each of the future dates.

When a forward contract is created with a contract rate that gives it a non-zero value at initiation, it is called an *off-market forward*. The forward contracts we found to be equivalent to the series of swap payments are almost certainly all off-market forwards with non-zero values at the initiation of the swap. Because the swap itself has zero value to both parties at initiation, it must consist of some off-market forwards with positive present values and some off-market forwards with negative present values, so that the sum of their present values equals zero.

Finding the swap fixed rate (which is the contract rate for our off-market forwards) that gives the swap a zero value at initiation is not difficult if we follow our principle of no-arbitrage pricing. The fixed rate payer in a swap can replicate that derivative position by borrowing at a fixed rate and lending the proceeds at a variable (floating) rate. For the swap in our example, borrowing at the fixed rate *F* and lending the proceeds at 90-day LIBOR will produce the same cash flows as the swap. At each date the payment due on the fixed-rate loan is $F_n$ and the interest received on lending at the floating rate is $S_n$.

As with forward rate agreements, the price of a swap is the fixed rate of interest specified in the swap contract (the contract rate) and the value depends on how expected future floating rates change over time. At initiation, a swap has zero value because the present value of the fixed-rate payments equals the present value of the expected floating-rate payments. An increase in expected short-term future rates will produce a positive value for the fixed-rate payer in an interest rate swap, and a decrease in expected future rates will produce a negative value because the promised fixed rate payments have more value than the expected floating rate payments over the life of the swap.

## MODULE QUIZ 49.2

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

1. How can a bank create a synthetic 60-day forward rate agreement on a 180-day interest rate?
   A. Borrow for 180 days and lend the proceeds for 60 days.
   B. Borrow for 180 days and lend the proceeds for 120 days.
   C. Borrow for 240 days and lend the proceeds for 60 days.
2. For the price of a futures contract to be greater than the price of an otherwise equivalent forward contract, interest rates must be:
   A. uncorrelated with futures prices.
   B. positively correlated with futures prices.
   C. negatively correlated with futures prices.
3. The price of a fixed-for-floating interest rate swap:
   A. is specified in the swap contract.
   B. is paid at initiation by the floating-rate receiver.
   C. may increase or decrease during the life of the swap contract.

# MODULE 49.3: OPTION VALUATION AND PUT-CALL PARITY

Video covering this content is available online.

## LOS 49.j: Explain the exercise value, time value, and moneyness of an option.

*CFA® Program Curriculum, Volume 5, page 481*

**Moneyness** refers to whether an option is *in the money or out of the money*. If immediate exercise of the option would generate a positive payoff, it is in the money. If immediate exercise would result in a loss (negative payoff), it is out of the money. When the current asset price equals the exercise price, exercise will generate neither a gain nor loss, and the option is *at the money*.

The following describes the conditions for a **call option** to be in, out of, or at the money. S is the price of the underlying asset and *X* is the exercise price of the option.

- *In-the-money call options.* If S − X > 0, a call option is in the money. S − X is the amount of the payoff a call holder would receive from immediate exercise, buying a share for *X* and selling it in the market for a greater price *S*.
- *Out-of-the-money call options.* If S − X < 0, a call option is out of the money.
- *At-the-money call options.* If S = X, a call option is said to be at the money.

The following describes the conditions for a **put option** to be in, out of, or at the money.

- *In-the-money put options.* If X − S > 0, a put option is in the money. X − S is the amount of the payoff from immediate exercise, buying a share for *S* and exercising the put to receive *X* for the share.
- *Out-of-the-money put options.* When the stock's price is greater than the strike price, a put option is said to be out of the money. If X − S < 0, a put option is out of the money.
- *At-the-money put options.* If S = X, a put option is said to be at the money.

**EXAMPLE: Moneyness**

Consider a July 40 call and a July 40 put, both on a stock that is currently selling for $37/share. Calculate how much these options are in or out of the money.

**PROFESSOR'S NOTE**

A July 40 call is a call option with an exercise price of $40 and an expiration date in July.

**Answer:**

The call is $3 out of the money because S − X = –$3.00. The put is $3 in the money because X − S = $3.00.

We define the **intrinsic value** (or **exercise value**) of an option the maximum of zero and the amount that the option is in the money. That is, the intrinsic value is the amount an option is in the money, if it is in the money, or zero if the option is at or out of the money. The intrinsic value is also the exercise value, the value of the option if exercised immediately.

Prior to expiration, an option has time value in addition to any intrinsic value. The **time value** of an option is the amount by which the **option premium** (price) exceeds the intrinsic value and is sometimes called the *speculative value* of the option. This relationship can be written as:

option premium = intrinsic value + time value

At any point during the life of an option, its value will typically be greater than its intrinsic value. This is because there is some probability that the underlying asset price will change in an amount that gives the option a positive payoff at expiration greater than the (current) intrinsic value. Recall that an option's intrinsic value (to a buyer) is the amount of the payoff at expiration and is bounded by zero.

When an option reaches expiration, there is no time remaining and the time value is zero. This means the value at expiration is either zero, if the option is at or out of the money, or its intrinsic value, if it is in the money.

## LOS 49.k: Identify the factors that determine the value of an option and explain how each factor affects the value of an option.

*CFA® Program Curriculum, Volume 5, page 482*

There are six factors that determine option prices.

1. **Price of the underlying asset.** For call options, the higher the price of the underlying, the greater its intrinsic value and the higher the value of the option. Conversely, the lower the price of the underlying, the less its intrinsic value and the lower the value of the call option. In general, call option values increase when the value of the underlying asset increases.

   For put options this relationship is reversed. An increase in the price of the underlying reduces the value of a put option.

2. **The exercise price.** A higher exercise price decreases the values of call options and a lower exercise price increases the values of call options.

   A higher exercise price increases the values of put options and a lower exercise price decreases the values of put options.

3. **The risk-free rate of interest.** An increase in the risk-free rate will increase call option values, and a decrease in the risk-free rate will decrease call option values.

   An increase in the risk-free rate will decrease put option values, and a decrease in the risk-free rate will increase put option values.

**PROFESSOR'S NOTE**

One way to remember the effects of changes in the risk-free rate is to think about present values of the payments for calls and puts. These statements are strictly true only for in-the-money options, but it's a way to remember the relationships. The holder of a call option will pay in the future to exercise a call option and the present value of that payment is lower when the risk-free rate is higher, so a higher risk-free rate increases a call option's value. The holder of a put option will receive a payment in the future when the put is exercised and an increase in the risk-free rate decreases the present value of this payment, so a higher risk-free rate decreases a put option's value.

4. **Volatility of the underlying.** Volatility is what makes options valuable. If there were no volatility in the price of the underlying asset (its price remained constant), options would always be equal to their intrinsic values and time or speculative value would be zero. An increase in the volatility of the price of the underlying asset increases the values of both put and call options and a decrease in volatility of the price of the underlying decreases both put values and call values.
5. **Time to expiration.** Because volatility is expressed per unit of time, longer time to expiration effectively increases expected volatility and increases the value of a call option. Less time to expiration decreases the time value of a call option so that at expiration it value is simply its intrinsic value.

   For most put options, longer time to expiration will increase option values for the same reasons. For some European put options, however, extending the time to expiration can decrease the value of the put. In general, the deeper a put option is in the money, the higher the risk-free rate, and the longer the current time to expiration, the more likely that extending the option's time to expiration will decrease its value.

   To understand this possibility consider a put option at $20 on a stock with a value that has decreased to $1. The intrinsic value of the put is $19 so the upside is very limited, the downside (if the price of the underlying subsequently increases) is significant, and because no payment will be received until the expiration date, the current option value reflects the present value of any expected payment. Extending the time to expiration would decrease that present value. While overall we expect a longer time to expiration to increase the value of a European put option, in the case of a deep in-the-money put, a longer time to expiration could decrease its value.
6. **Costs and benefits of holding the asset.** If there are benefits of holding the underlying asset (dividend or interest payments on securities or a convenience yield on commodities), call values are decreased and put values are increased. The reason for this is most easily understood by considering cash benefits. When a stock pays a dividend, or a bond pays interest, this reduces the value of the asset. Decreases in the value of the underlying asset decrease call values and increase put values.

   Positive storage costs make it more costly to hold an asset. We can think of this as making a call option more valuable because call holders can have long exposure to the asset without paying the costs of actually owning the asset. Puts, on the other hand, are less valuable when storage costs are higher.

## LOS 49.l: Explain put–call parity for European options.

*CFA® Program Curriculum, Volume 5, page 491*

Our derivation of **put-call parity** for European options is based on the payoffs of two portfolio combinations: a fiduciary call and a protective put.

A *fiduciary call* is a combination of a call with exercise price *X* and a pure-discount, riskless bond that pays *X* at maturity (option expiration). The payoff for a fiduciary call at expiration is *X* when the call is out of the money, and X + (S − X) = S when the call is in the money.

A *protective put* is a share of stock together with a put option on the stock. The expiration date payoff for a protective put is (X – S) + S = X when the put is in the money, and *S* when the put is out of the money.

**PROFESSOR'S NOTE**

When working with put-call parity, it is important to note that the exercise prices on the put and the call and the face value of the riskless bond are all equal to *X*.

If at expiration *S* is greater than or equal to *X*:

- The protective put pays *S* on the stock while the put expires worthless, so the payoff is *S*.
- The fiduciary call pays *X* on the bond portion while the call pays (S − X), so the payoff is X + (S − X) = S.

If at expiration *X* is greater than *S*:

- The protective put pays *S* on the stock while the put pays (X − S), so the payoff is S + (X − S) = X.
- The fiduciary call pays *X* on the bond portion while the call expires worthless, so the payoff is *X*.

In either case, the payoff on a protective put is the same as the payoff on a fiduciary call. Our no-arbitrage condition holds that portfolios with identical payoffs regardless of future conditions must sell for the same price to prevent arbitrage. We can express the put-call parity relationship as:

$$c + X / (1 + Rf)^T = S + p$$

Equivalencies for each of the individual securities in the put-call parity relationship can be expressed as:

$$S = c - p + X / (1 + Rf)^T$$

$$p = c - S + X / (1 + Rf)^T$$

$$c = S + p - X / (1 + Rf)^T$$

$$X / (1 + Rf)^T = S + p - c$$

Note that the options must be European-style and the puts and calls must have the same exercise price and time to expiration for these relations to hold.

The single securities on the left-hand side of the equations all have exactly the same payoffs as the portfolios on the right-hand side. The portfolios on the right-hand side are the **synthetic** equivalents of the securities on the left. For example, to synthetically produce the payoff for a long position in a share of stock, use the following relationship:

$$S = c - p + X / (1 + Rf)^T$$

This means that the payoff on a long stock can be synthetically created with a long call, a short put, and a long position in a risk-free discount bond.

The other securities in the put-call parity relationship can be constructed in a similar manner.

**PROFESSOR'S NOTE**

After expressing the put-call parity relationship in terms of the security you want to synthetically create, the sign on the individual securities will indicate whether you need a long position (+ sign) or a short position (– sign) in the respective securities.

**EXAMPLE: Call option valuation using put-call parity**

Suppose that the current stock price is $52 and the risk-free rate is 5%. You have found a quote for a 3-month put option with an exercise price of $50. The put price is $1.50, but due to light trading in the call options, there was not a listed quote for the 3-month, $50 call. Estimate the price of the 3-month call option.

**Answer:**

Rearranging put-call parity, we find that the call price is:

$$\text{call} = \text{put} + \text{stock} - \text{present value(X)}$$

$$\text{call} = \$1.50 + \$52 - \frac{\$50}{1.05^{0.25}} = \$4.11$$

This means that if a 3-month, $50 call is available, it should be priced at (within transactions costs of) $4.11 per share.

## LOS 49.m: Explain put–call–forward parity for European options.

*CFA® Program Curriculum, Volume 5, page 494*

**Put-call-forward parity** is derived with a forward contract rather than the underlying asset itself. Consider a forward contract on an asset at time *T* with a contract price of $F_0(T)$. At contract initiation the forward contract has zero value. At time *T*, when the forward contract settles, the long must purchase the asset for $F_0(T)$. The purchase (at time=0) of a pure discount bond that will pay $F_0(T)$ at maturity (time = T) will cost $F_0(T) / (1 + Rf)^T$.

By purchasing such a pure discount bond and simultaneously taking a long position in the forward contract, an investor has created a synthetic asset. At time = T the proceeds of the bond are just sufficient to purchase the asset as required by the long forward position. Because there is no cost to enter into the forward contract, the total cost of the synthetic asset is the present value of the forward price, $F_0(T) / (1 + Rf)^T$.

The put-call forward parity relationship is derived by substituting the synthetic asset for the underlying asset in the put-call parity relationship. Substituting $F_0(T) / (1 + Rf)^T$ for the asset price $S_0$ in $S + p = c + X / (1 + Rf)^T$ gives us:

$$F_0(T) / (1 + Rf)^T + p_0 = c_0 + X / (1 + Rf)^T$$

which is put-call forward parity at time 0, the initiation of the forward contract, based on the principle of no arbitrage. By rearranging the terms, put-call forward parity can also be expressed as:

$$p_0 - c_0 = [X - F_0(T)] / (1 + Rf)^T$$

# MODULE 49.4: BINOMIAL MODEL FOR OPTION VALUES

Video covering this content is available online.

**LOS 49.n: Explain how the value of an option is determined using a one-period binomial model.**

*CFA® Program Curriculum, Volume 5, page 496*

Recall from Quantitative Methods that a **binomial model** is based on the idea that, over the next period, some value will change to one of two possible values (binomial). To construct a binomial model, we need to know the beginning asset value, the size of the two possible changes, and the probabilities of each of these changes occurring.

## One-Period Binomial Model

Consider a share of stock currently priced at $30. The size of the possible price changes, and the probabilities of these changes occurring, are as follows:

$U$ = size of up-move = 1.15

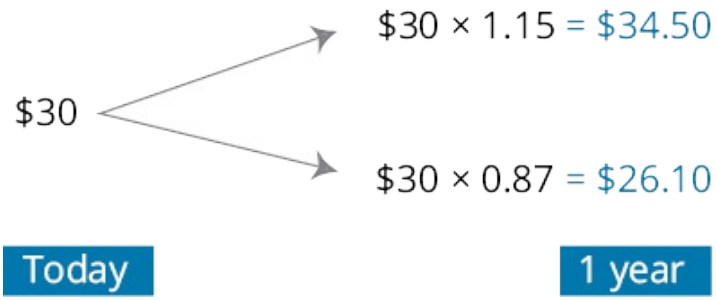
$D$ = size of down-move = $\frac{1}{U} = \frac{1}{1.15} = 0.87$

$\pi_U$ = probability of an up-move = 0.715

$\pi_D$ = probability of a down-move = $1 - \pi_U = 1 - 0.715 = 0.285$

Note that the down-move factor is the reciprocal of the up-move factor, and the probability of an up-move is one minus the probability of a down-move. The one-period binomial tree for the stock is shown in Figure 49.2. The beginning stock value of $30 is to the left, and to the right are the two possible end-of-period stock values, $34.50 and $26.10.

**Figure 49.2:** One-Period Binomial Tree




The probabilities of an up-move and a down-move are calculated based on the size of the moves and the risk-free rate:

$\pi_U$ = risk-neutral probability of an up-move = $\frac{1+R_f-D}{U-D}$

$\pi_D$ = risk-neutral probability of a down-move = $1 - \pi_U$

where:

$R_f$ = risk-free rate

U = size of an up-move

D = size of a down-move

**PROFESSOR'S NOTE**

These two probabilities are not the actual probability of an up- or down-move. They are risk-neutral pseudo probabilities. The calculation of risk-neutral probabilities is not required for the Level I exam, so you don't need to worry about it.

We can calculate the value of an option on the stock by:

- Calculating the payoff of the option at maturity in both the up-move and down-move states.
- Calculating the expected value of the option in one year as the probability-weighted average of the payoffs in each state.
- Discounting this expected value back to today at the risk-free rate.

**EXAMPLE: Calculating call option value with a one-period binomial tree**

Use the binomial tree in Figure 49.2 to calculate the value today of a one-year call option on the stock with an exercise price of $30. Assume the risk-free rate is 7%, the current value of the stock is $30, and the size of an up-move is 1.15.

**Answer:**

First, we have to calculate the parameters—the size of a down-move and the probabilities:

$$D = \text{size of down move} = \frac{1}{U} = \frac{1}{1.15} = 0.87$$

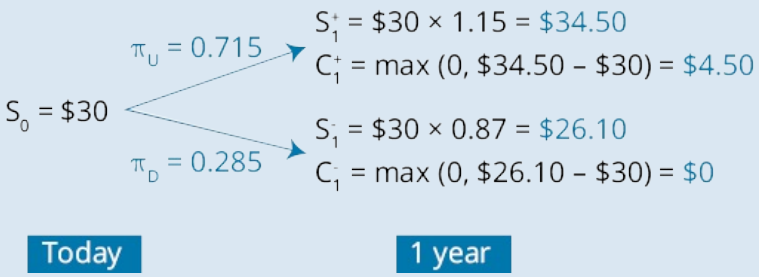
$$\pi_U = \text{risk-neutral probability of an up-move} = \frac{1+0.07-0.87}{1.15-0.87} = 0.715$$

$$\pi_D = \text{risk-neutral probability of a down-move} = 1 - 0.715 = 0.285$$

Next, determine the payoffs to the option in each state. If the stock moves up to $34.50, a call option with an exercise price of $30 will pay $4.50. If the stock moves down to $26.10, the call option will expire worthless. The option payoffs are illustrated in the following figure.

Let the stock values for the up-move and down-move be $S_1^+$ and $S_1^-$ and for the call values, $C_1^+$ and $C_1^-$.

**One-Period Call Option With X = $30**




The expected value of the option in one period is:

E(call option value in 1 year) = ($4.50 × 0.715) + ($0 × 0.285) = $3.22

The value of the option today, discounted at the risk-free rate of 7%, is:

$$C_0 = \frac{\$3.22}{1.07} = \$3.01$$

We can use the same basic framework to **value a one-period put option**. The only difference is that the payoff to the put option will be different from the call payoffs.

**EXAMPLE: Valuing a one-period put option on a stock**

Use the information in the previous example to calculate the value of a put option on the stock with an exercise price of $30.

**Answer:**

If the stock moves up to $34.50, a put option with an exercise price of $30 will expire worthless. If the stock moves down to $26.10, the put option will be worth $3.90.

The risk-neutral probabilities are 0.715 and 0.285 for an up- and down-move, respectively. The expected value of the put option in one period is:

E(put option value in 1 year) = ($0 × 0.715) + ($3.90 × 0.285) = $1.11

The value of the option today, discounted at the risk-free rate of 7%, is:

$$P_0 = \frac{\$1.11}{1.07} = \$1.04$$



In practice, we would construct a binomial model with many short periods and have many possible outcomes at expiration. However, the one-period model is sufficient to understand the concept and method. Note that the actual probabilities of an up move and a down move do not enter directly into our calculation of option value. The size of the up-move and down-move, along with the risk-free rate, determine the risk-neutral probabilities we use to calculate the expected payoff at option expiration. Remember, the risk-neutral probabilities come from constructing a hedge that creates a certain payoff. Because their calculation is based on an arbitrage relationship, we can discount the expected payoff based on risk-neutral probabilities, at the risk-free rate.

## LOS 49.o: Explain under which circumstances the values of European and American options differ.

*CFA® Program Curriculum, Volume 5, page 500*

The only difference between European and American options is that a holder of an American option has the right to exercise prior to expiration, while European options can only be exercised at expiration. The prices of European and American options will be equal unless the right to exercise prior to expiration has positive value. At expiration, both types of options are, of course, equivalent and they will have the same value, the exercise value. Their exercise value at expiration will either be zero if they are at or out of the money, or the amount that they are in the money.

For a call option on an asset that has no cash flows during the life of the option, there is no advantage to early exercise. During its life, the market value of a call option will be greater than its exercise value (by its time value), so early exercise is not valuable and we sometimes say that such call options are “worth more alive than dead.” Because there is no value to early exercise, otherwise identical American and European call options on assets with no cash flows will have the same value.

If the asset pays cash flows during the life of a call option, early exercise can be valuable because options are not adjusted for cash flows on the underlying asset. Consider a call option on a stock that will pay a $3 dividend. The stock price is expected to decrease by $3

on the ex-dividend day which will decrease the value of the call option, so exercising the call option prior to the ex-dividend date may be advantageous because the stock can be sold at its predividend price or held to receive the dividend. Because early exercise may be valuable for call options on assets with cash flows, the price of American call options on assets with cash flows will be greater than the price of otherwise identical European call options.

For put options, cash flows on the underlying do not make early exercise valuable. Actually, a decrease in the price of the underlying asset after cash distributions makes put options more valuable. In the case of a put option that is deep in the money, however, early exercise may be advantageous. Consider the (somewhat extreme) case of a put option at $20 on a stock that has fallen in value to zero. Exercising the put will result in an immediate payment of $20, the exercise value of the put. With a European put option, the $20 cannot be realized until option expiration, so its value now is only the present value of $20. Given the potential positive value of early exercise for put options, American put options can be priced higher than otherwise identical European put options.

## MODULE QUIZ 49.3, 49.4

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

1. The price of an out-of-the-money option is:
   A. less than its time value.
   B. equal to its time value.
   C. greater than its time value.
2. A decrease in the risk-free rate of interest will:
   A. increase put and call option prices.
   B. decrease put option prices and increase call option prices.
   C. increase put option prices and decrease call option prices.
3. The put-call parity relationship for European options must hold because a protective put will have the same payoff as:
   A. a covered call.
   B. a fiduciary call.
   C. an uncovered call.
4. The put-call-forward parity relationship *least likely* includes:
   A. a risk-free bond.
   B. call and put options.
   C. the underlying asset.
5. In a one-period binomial model, the value of an option is *best* described as the present value of:
   A. a probability-weighted average of two possible outcomes.
   B. a probability-weighted average of a chosen number of possible outcomes.
   C. one of two possible outcomes based on a chosen size of increase or decrease.
6. An American call option is *most likely* to be exercised early when:
   A. the option is deep in the money.
   B. the underlying asset pays dividends.
   C. the risk-free interest rate has increased.

# KEY CONCEPTS

## LOS 49.a



Valuation of derivatives is based on a no-arbitrage condition with risk-neutral pricing. Because the risk of a derivative is entirely based on the risk of the underlying asset, we can construct a fully hedged portfolio and discount its future cash flows at the risk-free rate.

We can describe three replications among a derivative, its underlying asset, and a risk-free asset:

risky asset + derivative = risk-free asset

risky asset − risk-free asset = − derivative position

derivative position − risk-free asset = − risky asset

## LOS 49.b

The price of a forward or futures contract is the forward price that is specified in the contract.

The value of a forward or futures contract is zero at initiation. Its value may increase or decrease during its life, with gains or losses in the value of a long position just opposite to gains or losses in the value of a short position.

## LOS 49.c

Net cost of carry = PV(benefits of holding the asset) – PV(costs of holding the asset). When the benefits (cash flow yield and convenience yield) exceed the costs (storage and insurance) of holding the asset, we say the net cost of carry is positive. A positive net cost of carry will decrease the no-arbitrage futures price, and a negative net cost of carry will increase the no-arbitrage futures price.

## LOS 49.d

If there are no costs or benefits from holding the underlying asset, the forward price of an asset to be delivered at time *T* is:

$$F_0(T) = S_0 (1 + Rf)^T$$

The value of a forward contract is zero at initiation. During its life, at time t, the value of the forward contract is:

$$V_t(T) = S_t - F_0(T) / (1 + Rf)^{T-t}$$

At expiration, the payoff to a long forward is $S_T - F_0(T)$, the difference between the spot price of the asset at expiration and the price of the forward contract.

## LOS 49.e

If holding an asset has costs and benefits, the no-arbitrage forward price is:

$$F_0(T) = [S_0 + PV_0 \text{ (cost)} - PV_0 \text{ (benefit)}] (1 + Rf)^T$$

The present values of the costs and benefits decrease as time passes. The value of the forward at time t is:

$$V_t\left(T\right) = S_t + PV_t\left(\text{cost}\right) - PV_t\left(\text{benefit}\right) - \frac{F_0(T)}{\left(1 + Rf\right)^{T-t}}$$

At expiration the costs and benefits of holding the asset are zero and do not affect the value a long forward position, which is $S_T - F_0(T)$.

## LOS 49.f

A forward rate agreement (FRA) is a derivative contract that has a future interest rate, rather than an asset, as its underlying. FRAs are used by firms to hedge the risk of borrowing and lending they intend to do in the future. A firm that intends to borrow in the future can lock in an interest rate with a long position in an FRA. A firm that intends to lend in the future can lock in an interest rate with a short position in an FRA.

## LOS 49.g

Because gains and losses on futures contracts are settled daily, prices of forwards and futures that have the same terms may be different if interest rates are correlated with futures prices. Futures are more valuable than forwards when interest rates and futures prices are positively correlated and less valuable when they are negatively correlated. If interest rates are constant or uncorrelated with futures prices, the prices of futures and forwards are the same.

## LOS 49.h

In a simple interest-rate swap, one party pays a floating rate and the other pays a fixed rate on a notional principal amount. The first payment is known at initiation and the rest of the payments are unknown. The unknown payments are equivalent to the payments on off-market FRAs. To replicate a swap with a value of zero at initiation, the sum of the present values of these FRAs must equal zero.

## LOS 49.i

The price of a swap is the fixed rate of interest specified in the swap contract. The value depends on how expected future floating rates change over time. An increase in expected short-term future rates will produce a positive value for the fixed-rate payer, and a decrease in expected future rates will produce a negative value for the fixed-rate payer.

## LOS 49.j

If immediate exercise of an option would generate a positive payoff, the option is in the money. If immediate exercise would result in a negative payoff, the option is out of the money. An option's exercise value is the greater of zero or the amount it is in the money. Time value is the amount by which an option's price is greater than its exercise value. Time value is zero at expiration.

## LOS 49.k

Factors that determine the value of an option:

| Increase in: | Effect on call option values | Effect on put option values |
|---|---|---|
| Price of underlying asset | Increase | Decrease |
| Exercise price | Decrease | Increase |
| Risk-free rate | Increase | Decrease |
| Volatility of underlying asset | Increase | Increase |
| Time to expiration | Increase | Increase, except some European puts |
| Costs of holding underlying asset | Increase | Decrease |

| | | |
|---|---|---|
| Benefits of holding underlying asset | Decrease | Increase |

## LOS 49.l

A fiduciary call (a call option and a risk-free zero-coupon bond that pays the strike price *X* at expiration) and a protective put (a share of stock and a put at *X*) have the same payoffs at expiration, so arbitrage will force these positions to have equal prices: $c + X / (1 + Rf)^T = S + p$. This establishes put-call parity for European options.

Based on the put-call parity relation, a synthetic security (stock, bond, call, or put) can be created by combining long and short positions in the other three securities.

- $c = S + p - X / (1 + Rf)^T$
- $p = c - S + X / (1 + Rf)^T$
- $S = c - p + X / (1 + Rf)^T$
- $X / (1 + Rf)^T = S + p - c$

## LOS 49.m

Based on the fact that the present value of an asset's forward price is equal to its spot price we can su
the initiation of a forward contract to establish put-call-forward parity as:

$$c_0 + X / (1 + Rf)^T = F_0(T) / (1 + Rf)^T + p_0$$

## LOS 49.n

To determine the value of an option using a one-period binomial model, we calculate its payoff following an up-move and following a down-move, estimate risk-neutral probabilities of an up-move and a down-move, calculate the probability-weighted average of its up-move and down-move payoffs, and discount this value by one period.

## LOS 49.o

The prices of European and American options will be equal unless the right to exercise prior to expiration has positive value.

For a call option on an asset that has no cash flows during the life of the option, there is no advantage to early exercise so identical American and European call options will have the same value. If the asset pays cash flows during the life of a call option, early exercise can be valuable and an American call option will be priced higher than an otherwise identical European call option.

For put options, early exercise can be valuable when the options are deep in the money and an American put option will be priced higher than an otherwise identical European put option.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 49.1

1. **A** Derivatives pricing models use the risk-free rate to discount future cash flows (risk-neutral pricing) because they are based on constructing arbitrage relationships that are theoretically riskless. (LOS 49.a)

2. **C** The price of a forward or futures contract is defined as the price specified in the contract at which the two parties agree to trade the underlying asset on a future date. The value of a forward or futures contract is typically zero at initiation, and at expiration is the difference between the spot price and the contract price. (LOS 49.b)

3. **B** For an asset with no holding costs or benefits, the forward price must equal the future value of the current spot price, compounded at the risk-free rate over the term of the forward contract, for the contract to have a value of zero at initiation. Otherwise an arbitrage opportunity would exist. (LOS 49.d)

4. **A** Convenience yield refers to nonmonetary benefits from holding an asset. One example of convenience yield is the advantage of owning an asset that is difficult to sell short when it is perceived to be overvalued. Interest and dividends are monetary benefits. Storage and insurance are carrying costs. (LOS 49.e)

## Module Quiz 49.2

1. **C** To create a synthetic 60-day FRA on a 180-day interest rate, a bank would borrow for 240 days and lend the proceeds for 60 days, creating a 180-day loan 60 days from now. (LOS 49.f)

2. **B** If interest rates are positively correlated with futures prices, interest earned on cash from daily settlement gains on futures contracts will be greater than the opportunity cost of interest on daily settlement losses, and a futures contract will be have a higher price than an otherwise equivalent forward contract that does not feature daily settlement. (LOS 49.g)

3. **A** The price of a fixed-for-floating interest rate swap is defined as the fixed rate specified in the swap contract. Typically a swap will be priced such that it has a value of zero at initiation and neither party pays the other to enter the swap. (LOS 49.h)

## Module Quiz 49.3, 49.4

1. **B** Because an out-of-the-money option has an exercise value of zero, its price is its time value. (Module 49.3, LOS 49.j)

2. **C** Interest rates are inversely related to put option prices and directly related to call option prices. (Module 49.3, LOS 49.k)

3. **B** Given call and put options on the same underlying asset with the same exercise price and expiration date, a protective put (underlying asset plus a put option) will have the same payoff as a fiduciary call (call option plus a risk-free bond that will pay the

exercise price on the expiration date) regardless of the underlying asset price on the expiration date. (Module 49.3, LOS 49.l)

4. **C** The put-call-forward parity relationship is $F_0(T) / (1 + RFR)^T + p_0 = c_0 + X / (1 + RFR)^T$, where $X / (1 + RFR)^T$ is a risk-free bond that pays the exercise price on the expiration date, and $F_0(T)$ is the forward price of the underlying asset. (Module 49.3, LOS 49.m)

5. **A** In a one-period binomial model, the value of an option is the present value of a probability-weighted average of two possible values after one period, during which its value is assumed to move either up or down by a chosen size. (Module 49.4, LOS 49.n)

6. **B** An American call option might be exercised early to receive a dividend paid by the underlying asset. Otherwise, there is no benefit to the holder from exercising an American call early because the call can be sold instead for its higher market value. (Module 49.4, LOS 49.o)

# TOPIC ASSESSMENT: DERIVATIVES

*You have now finished the Derivatives topic section. The following Topic Assessment provides immediate feedback on how effective your study has been for this material. The number of questions on this test is equal to the number of questions for the topic on one-half of the actual Level I CFA exam. Questions are more exam-like than typical Module Quiz or QBank questions; a score of less than 70% indicates that your study likely needs improvement. These tests are best taken timed; allow 1.5 minutes per question.*

*After you've completed this Topic Assessment, you may additionally log in to your Schweser.com online account and enter your answers in the Topic Assessments product. Select "Performance Tracker" to view a breakdown of your score. Select "Compare with Others" to display how your score on the Topic Assessment compares to the scores of others who entered their answers.*

1. Which of the following derivatives positions replicates investing at the risk-free rate?
   A. Holding an asset and a short position in a forward contract on the asset.
   B. Holding an asset and a long position in a forward contract on the asset.
   C. Selling an asset short and holding a short position in a forward contract on the asset.

2. Compared to an asset with no net cost of carry, holding costs that are greater than benefits:
   A. increase the no-arbitrage price of the forward contract.
   B. decrease the no-arbitrage price of the forward contract.
   C. have no effect on the no-arbitrage price of the forward contract.

3. The value of a call option on a stock is *most likely* to decrease as a result of:
   A. an increase in asset price volatility.
   B. a decrease in the risk-free rate of interest.
   C. a decrease in the exercise price of the option.

4. In which of the following ways is an interest rate swap different from a series of forward rate agreements (FRAs)?
   A. The FRAs that replicate an interest rate swap may be off-market contracts.
   B. The fixed rate is known at initiation for an interest rate swap but not for a series of FRAs.
   C. An interest rate swap may have a nonzero value at initiation, while FRAs must have a value of zero at initiation.

5. It is *least likely* that a forward contract:
   A. has counterparty risk.
   B. can be settled in cash.
   C. requires a margin deposit.

6. With respect to European and American options, cash flows from the underlying asset may make:
   A. a European put more valuable than an otherwise identical American put.
   B. an American put more valuable than an otherwise identical European put.
   C. an American call more valuable than an otherwise identical European call.

7. Cash flows related to futures margin *least likely* include:
   A. interest on the margin loan.
   B. deposits to meet margin calls.
   C. interest received on collateral.

# TOPIC ASSESSMENT ANSWERS: DERIVATIVES

1. **A** Holding an asset and a short position in a forward contract on the asset replicates investing at the risk- free rate because the future payoff is certain. (Study Session 16, Module 49.1, LOS 49.a)

2. **A** Costs of holding the underlying asset that are greater than the benefits increase the no-arbitrage price of a forward contract. (Study Session 16, Module 49.1, LOS 49.e)

3. **B** A decrease in the risk-free rate of interest will decrease call values. The other changes will tend to increase the value of a call option. (Study Session 16, Module 49.3, LOS 49.k)

4. **A** An interest rate swap may be replicated by a series of off-market FRAs (i.e., FRAs with nonzero values at initiation), if their present values sum to zero at initiation. The fixed rate is known at initiation for either an interest rate swap or a series of FRAs. Parties to both FRAs and interest rate swaps may agree to off-market prices at initiation. (Study Session 16, Module 49.2, LOS 49.h)

5. **C** Forward contracts typically do not require a margin deposit. They are custom instruments that may require settlement in cash or delivery of the underlying asset, and they have counterparty risk. (Study Session 16, Module 48.1, LOS 48.c)

6. **C** For call options, early exercise is valuable only if the underlying asset pays a cash flow during the life of the option. If early exercise is valuable, an American call can be more valuable than an otherwise identical European call. Cash flows on the underlying asset do not make early exercise of a put option valuable. A European option cannot be more valuable than an otherwise identical American option. (Study Session 16, Module 49.4, LOS 49.o)

7. **A** Futures margin is satisfied by posting collateral and does not involve a loan. A futures investor may post interest-bearing securities as collateral and earn interest (collateral yield) on these securities. Faced with a margin call, a futures investor must either post additional margin to restore the account to the initial margin requirement or close the position. (Study Session 16, Module 48.1, LOS 48.c)

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 #50.

# READING 50: INTRODUCTION TO ALTERNATIVE INVESTMENTS

**Study Session 17**

## EXAM FOCUS

"Alternative investments" collectively refers to the many asset classes that fall outside the traditional definitions of stocks and bonds. This category includes hedge funds, private equity, real estate, commodities, infrastructure, and other alternative investments, primarily collectibles. Each of these alternative investments has unique characteristics that require a different approach by the analyst. You should be aware of the different strategies, fee structures, due diligence, and issues in valuing and calculating returns with each of the alternative investments discussed in this topic review.

## MODULE 50.1: PRIVATE EQUITY AND REAL ESTATE

Video covering this content is available online.

### LOS 50.a: Compare alternative investments with traditional investments.

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

**Alternative investments** differ from traditional investments (publicly traded stocks, bonds, cash) both in the types of assets and securities included in this asset class and in the structure of the investment vehicles in which these assets are held. Managers of alternative investment portfolios may use derivatives and leverage and short securities. Many types of real estate investment are considered alternatives to traditional investment as well. Types of alternative investment structures include hedge funds, private equity funds, various types of real estate investments, and some ETFs. Fee structures for alternative investments are different from those of traditional investments, with higher management fees on average and often with additional incentive fees based on performance. Alternative investments as a group have had relatively low returns correlations with traditional investments. Compared to traditional investments, alternative investments typically exhibit several of the following characteristics:

- Less liquidity of assets held.
- More specialization by investment managers.
- Less regulation and transparency.
- More problematic and less available historical return and volatility data.
- Different legal issues and tax treatments.
- Relatively low correlations with returns of traditional investments.
- High fees.
- Restrictions on redemptions.

- Relatively more concentrated portfolios.

## Categories of Alternative Investments

We will examine six categories of alternative investments in detail in this topic review. Here we introduce each of those categories.

1. **Hedge funds.** These funds may use leverage, hold long and short positions, use derivatives, and invest in illiquid assets. Managers of hedge funds use a great many different strategies in attempting to generate investment gains. They do not necessarily hedge risk as the name might imply.
2. **Private equity funds.** As the name suggests, private equity funds invest in the equity of companies that are not publicly traded or in the equity of publicly traded firms that the fund intends to take private. Leveraged buyout (LBO) funds use borrowed money to purchase equity in established companies and comprise the majority of private equity investment funds. A much smaller portion of these funds, venture capital funds, invest in or finance young unproven companies at various stages early in their existence. For our purposes here we will also consider investing in the securities of financially distressed companies to be private equity, although hedge funds may hold these also.
3. **Real estate.** Real estate investments include residential or commercial properties as well as real estate backed debt. These investments are held in a variety of structures including full or leveraged ownership of individual properties, individual real estate backed loans, private and publicly traded securities backed by pools of properties or mortgages, and limited partnerships.
4. **Commodities.** To gain exposure to changes in commodities prices, investors can own physical commodities, commodities derivatives, or the equity of commodity producing firms. Some funds seek exposure to the returns on various commodity indices, often by holding derivatives contracts that are expected to track a specific commodity index.
5. **Infrastructure.** Infrastructure refers to long-lived assets that provide public services. These include economic infrastructure assets such as roads, airports, and utility grids, and social infrastructure assets such as schools and hospitals. While often financed and constructed by governmental entities, infrastructure investments have more recently been undertaken by private-public partnerships, with each holding a significant stake in the infrastructure assets constructed.
6. **Other.** This category includes investment in tangible collectible assets such as fine wines, stamps, automobiles, antique furniture, and art, as well as patents, an intangible asset.

**LOS 50.b: Describe hedge funds, private equity, real estate, commodities, infrastructure, and other alternative investments, including, as applicable, strategies, sub-categories, potential benefits and risks, fee structures, and due diligence.**

**LOS 50.e: Describe issues in valuing and calculating returns on hedge funds, private equity, real estate, commodities, and infrastructure.**

*CFA® Program Curriculum, Volume 6, page 10*

**PROFESSOR'S NOTE**

We cover these LOS together and slightly out of curriculum order so that we can present the complete analysis of each category of alternative investments to help candidates better understand each category.

# Private Equity

The majority of private equity funds invest either in private companies or public companies they intend to take private (leveraged buyout funds), or in early stage companies (venture capital funds). Two additional, but smaller, categories of private equity funds are distressed investment funds and developmental capital funds.

A private equity fund may also charge fees for arranging buyouts, fees for a deal that does not happen, or fees for handling asset divestitures after a buyout.

## *Private Equity Strategies*

**Leveraged buyouts** (LBOs) are the most common type of private equity fund investment. "Leveraged" refers to the fact that the fund's purchase of the portfolio company is funded primarily by debt. This may be bank debt (leveraged debt), high-yield bonds, or **mezzanine financing**. Mezzanine financing refers to debt or preferred shares that are subordinate to the high-yield bonds issued and carry warrants or conversion features that give investors participation in equity value increases.

### PROFESSOR'S NOTE

We will use a similar term, "mezzanine-stage financing," when referring to a late-stage investment in a venture capital company that is preparing to go public via an IPO. Here we are referring to a type of security rather than a type of investment.

Two types of LBOs are **management buyouts** (MBOs), in which the existing management team is involved in the purchase, and **management buy-ins** (MBIs), in which an external management team will replace the existing management team.

In an LBO, the private equity firm seeks to increase the value of the firm through some combination of new management, management incentives, restructuring, cost reduction, or revenue enhancement. Firms with high cash flow are attractive LBO candidates because their cash flow can be used to service and eventually pay down the debt taken on for acquisition.

**Developmental capital** or **minority equity investing** refers to the provision of capital for business growth or restructuring. The firms financed may be public or private. In the case of public companies, such financing is referred to as **private investment in public equities** (PIPEs).

**Venture capital** (VC) funds invest in companies in the early stages of their development. The investment often is in the form of equity but can be in convertible preferred shares or convertible debt. While the risk of start-up companies is often great, returns on successful companies can be very high. This is often the case when a company has grown to the point where it is sold (at least in part) to the public via an IPO.

The companies in which a venture capital fund is invested are referred to as its **portfolio companies**. Venture capital fund managers are closely involved in the development of portfolio companies, often sitting on their boards or filling key management roles.

Categorization of venture capital investments is based on the company's stage of development. Terminology used to identify venture firm investment at different stages of the

company's life includes the following:

1. The formative stage refers to investments made during a firm's earliest period and comprises three distinct phases.
    - **Angel investing** refers to investments made very early in a firm's life, often the "idea" stage, and the investment funds are used for business plans and assessing market potential. The funding source is usually individuals ("angels") rather than venture capital funds.
    - The **seed stage** refers to investments made for product development, marketing, and market research. This is typically the stage during which venture capital funds make initial investments, through ordinary or convertible preferred shares.
    - **Early stage** refers to investments made to fund initial commercial production and sales.
2. **Later stage** investment refers to the stage of development where a company already has production and sales and is operating as a commercial entity. Investment funds provided at this stage are typically used for expansion of production and/or increasing sales though an expanded marketing campaign.
3. **Mezzanine-stage financing** refers to capital provided to prepare the firm for an IPO. The term refers to the timing of the financing (between private company and public company) rather than the type of financing.

## *Private Equity Structure and Fees*

Similar to hedge funds, private equity funds are typically structured as limited partnerships. **Committed capital** is the amount of capital provided to the fund by investors. The committed capital amount is typically not all invested immediately but is "drawn down" (invested) as securities are identified and added to the portfolio. Committed capital is usually drawn down over three to five years, but the *drawdown period* is at the discretion of the fund manager. Management fees are typically 1% to 3% of committed capital, rather than invested capital.

Incentive fees for private equity funds are typically 20% of profits, but these fees are not earned until after the fund has returned investors' initial capital. It is possible that incentive fees paid over time may exceed 20% of the profits realized when all portfolio companies have been liquidated. This situation arises when returns on portfolio companies are high early and decline later. A **clawback** provision requires the manager to return any periodic incentive fees to investors that would result in investors receiving less than 80% of the profits generated by portfolio investments as a whole.

## *Private Equity Exit Strategies*

The average holding period for companies in private equity portfolios is five years. There are several primary methods of exiting an investment in a portfolio company:

1. **Trade sale:** Sell a portfolio company to a competitor or another strategic buyer.
2. **IPO:** Sell all or some shares of a portfolio company to the public.
3. **Recapitalization:** The company issues debt to fund a dividend distribution to equity holders (the fund). This is not an exit, in that the fund still controls the company, but is often a step toward an exit.

4. **Secondary sale:** Sell a portfolio company to another private equity firm or a group of investors.
5. **Write-off/liquidation:** Reassess and adjust to take losses from an unsuccessful outcome.

## *Private Equity Potential Benefits and Risks*

There is evidence that over the last 20 years returns on private equity funds have been higher on average than overall stock returns. Less-than-perfect correlation of private equity returns with traditional investment returns suggests that there may be portfolio diversification benefits from including private equity in portfolios. The standard deviation of private equity returns has been higher than the standard deviation of equity index returns, suggesting greater risk. As with hedge fund returns data, private equity returns data may suffer from survivorship bias and backfill bias (both lead to overstated returns). Because portfolio companies are revalued infrequently, reported standard deviations of returns and correlations of returns with equity returns may both be biased downward.

Evidence suggests that choosing skilled fund managers is important. Differences between the returns to top quartile funds and bottom quartile funds are significant and performance rank shows persistence over time.

## *Private Equity Due Diligence*

Because of the high leverage typically used for private equity funds, investors should consider how interest rates and the availability of capital may affect any required refinancing of portfolio company debt. The choice of manager (general partner) is quite important and many of the factors we listed for hedge fund due diligence also apply to private equity fund investments. Specifically, the operating and financial experience of the manager, the valuation methods used, the incentive fee structures, and drawdown procedures are all important areas to investigate prior to investing.

## *Private Equity Company Valuation*

Valuation for private equity portfolio companies is essentially the same as valuing a publicly traded company, although the discount rate or multiples used may be different for private companies.

**Market/comparables approach:** Market or private transaction values of similar companies may be used to estimate multiples of EBITDA, net income, or revenue to use in estimating the portfolio company's value.

**Discounted cash flow approach:** A dividend discount model falls into this category, as does calculating the present value of free cash flow to the firm or free cash flow to equity.

**Asset-based approach:** Either the liquidation values or fair market values of assets can be used. Liquidation values will be lower as they are values that could be realized quickly in a situation of financial distress or termination of company operations. Liabilities are subtracted so only the equity portion of the firm's value is being estimated.

> **EXAMPLE: Portfolio company comparables approach**

A private equity fund is valuing a French private manufacturing company. EBITDA and market values for four publicly traded European companies in the same industry are shown in the following table (in millions of euros):

| | EBITDA | Market Value |
|---|---|---|
| Company 1: | €100 | €1,000 |
| Company 2: | €250 | €2,000 |
| Company 3: | €250 | €1,500 |
| Company 4: | €275 | €2,200 |

The estimated EBITDA for the French company is €175 million. Using an average of the four companies as the industry multiple, estimate the market value for the French company.

**Answer:**

| | EBITDA Multiple |
|---|---|
| Company 1: | €1,000 / €100 = 10× |
| Company 2: | €2,000 / €250 = 8× |
| Company 3: | €1,500 / €250 = 6× |
| Company 4: | €2,200 / €275 = 8× |

The average multiple for these four companies is 8×. Based on the French company's expected EBITDA of €175 million, its estimated value is €175 million × 8 = €1,400 million or €1.4 billion.

## Real Estate

Investment in real estate can provide income in the form of rents as well as the potential for capital gains. Real estate as an asset class can provide diversification benefits to an investor's portfolio and a potential inflation hedge because rents and real estate values tend to increase with inflation. Real estate investments can be differentiated according to their underlying assets. Assets included under the heading of real estate investments include:

- Residential property—single-family homes.
- Commercial property—produces income.
- Loans with residential or commercial property as collateral—mortgages ("whole loans"), construction loans.

**Residential property** is considered a direct investment in real estate. Some buyers pay cash but most take on a mortgage (borrow) to purchase. The issuer (lender) of the mortgage has a direct investment in a whole loan and is said to "hold the mortgage." Issuers often sell the mortgages they originate and the mortgages are then pooled (securitized) as publicly traded mortgage-backed securities (MBS), which represent an indirect investment in the mortgage loan pool. Property purchased with a mortgage is referred to as a *leveraged investment* and the owner's equity is the property value minus the outstanding loan amount. Changes in property value over time, therefore, affect the property owner's equity in the property.

**Commercial real estate** properties generate income from rents. Homes purchased for rental income are considered investment in commercial property. Large properties (e.g., an office building) are a form of direct investment for institutions or wealthy individuals, either purchased for cash or leveraged (a mortgage loan is taken for a portion of the purchase price). Long time horizons, illiquidity, the large size of investment needed, and the complexity of the investments make commercial real estate inappropriate for many investors. Commercial real estate properties can also be held by a limited partnership in which the partners have limited

liability and the general partner manages the investment and the properties, or by a real estate investment trust (REIT).

As with residential mortgages, whole loans (commercial property mortgages) are considered a direct investment, but loans can be pooled into commercial mortgage-backed securities (CMBS) that represent an indirect investment.

**Real estate investment trusts** (REITs) issue shares that trade publicly like shares of stock. REITs are often identified by the type of real estate assets they hold: mortgages, hotel properties, malls, office buildings, or other commercial property. Income is used to pay dividends. Typically, 90% of income must be distributed to shareholders to avoid taxes on this income that would have to be paid by the REIT before distribution to shareholders.

Two additional assets considered as real estate are timberland and farmland, for which one component of returns comes from sales of timber or agricultural products. Timberland returns also include price changes on timberland, which depend on expectations of lumber prices in the future and how much timber has been harvested. Farmland returns are based on land price changes, changes in farm commodity prices, and the quality and quantity of the crops produced.

## *Potential Benefits and Risks of Real Estate*

Real estate performance is measured by three different types of indices. An **appraisal index**, such as those prepared by the National Council of Real Estate Investment Fiduciaries (NCREIF), is based on periodic estimates of property values. Appraisal index returns are smoother than those based on actual sales and have the lowest standard deviation of returns of the various index methods. A **repeat sales index** is based on price changes for properties that have sold multiple times. The sample of properties sold and thus included in the index is not necessarily random and may not be representative of the broad spectrum of properties available (an example of sample selection bias). **REIT indices** are based on the actual trading prices of REIT shares, similar to equity indices.

Historically, REIT index returns and global equity returns have had a relatively strong correlation (on the order of 0.6) because business cycles affect REITs and global equities similarly. The correlation between global bond returns and REIT returns has been very low historically. In either case diversification benefits can result from including real estate in an investor’s portfolio. However, the methods of index construction (e.g., appraisal or repeat sales indices) may be a factor in the low reported correlations, in which case actual diversification benefits may be less than expected.

## *Real Estate Investment Due Diligence*

Property values fluctuate because of global and national economic factors, local market conditions, and interest rate levels. Other specific risks include variation in the abilities of managers to select and manage properties, and changes in regulations. Decisions regarding selecting, financing, and managing real estate projects directly affect performance. The degree of leverage used in a real estate investment is important because leverage amplifies losses as well as gains.

*Distressed properties* investing has additional risk factors compared to investing in properties with sound financials and stable operating histories. *Real estate development* has additional risk factors including regulatory issues such as zoning, permitting, and environmental

considerations or remediation, and economic changes and financing decisions over the development period. The possible inability to get long-term financing at the appropriate time for properties initially developed with temporary (short-term) financing presents an additional risk.

## *Real Estate Valuation*

Three methods are commonly used to value real estate:

- The **comparable sales approach** bases valuation on recent sales of similar properties. Values for individual properties include adjustments for differences between the characteristics of the specific property and those of the properties for which recent sales prices are available, such as age, location, condition, and size.
- The **income approach** estimates property values by calculating the present value of expected future cash flows from property ownership or by dividing the net operating income (NOI) for a property by a capitalization (cap) rate. The cap rate is a discount rate minus a growth rate and is estimated based on factors such as general business conditions, property qualities, management effectiveness, and sales of comparable properties. Note that dividing by a cap rate of 12.5% is the same as using a multiple of 8 times NOI (1 / 0.125 = 8).
- The **cost approach** estimates the replacement cost of a property. The cost of land and the cost of rebuilding at current construction costs are added to estimate replacement cost.

Value estimates for real estate investment trusts can be income based or asset based. The income-based approach is similar to the income approach for a specific property and uses some measure of cash flow and a cap rate based on the factors we noted previously for the income approach. One measure of cash flow for a REIT is funds from operations (FFO). FFO is calculated from net income with depreciation added back (because depreciation is a non-cash charge) and with gains from property sales subtracted and losses on property sales added (because these gains and losses are assumed to be nonrecurring). A second measure of cash flow is adjusted funds from operations (AFFO), which is FFO with recurring capital expenditures subtracted. AFFO is similar to free cash flow. The asset-based approach provides an estimate of the net asset value of the REIT by subtracting total liabilities from the total value of the real estate assets and dividing by the number of shares outstanding.

### MODULE QUIZ 50.1

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

1. Compared to managers of traditional investments, managers of alternative investments are likely to have fewer restrictions on:
   A. holding cash.
   B. buying stocks.
   C. using derivatives.
2. Compared to alternative investments, traditional investments tend to:
   A. be less liquid.
   B. be less regulated.
   C. require lower fees.
3. A private equity valuation approach that uses estimated multiples of cash flows to value a portfolio company is:
   A. the asset-based approach.
   B. the discount cash flow approach.

C. the market/comparables approach.

4. In a leveraged buyout, covenants in leveraged loans can:
   A. restrict additional borrowing.
   B. require lenders to provide transparency.
   C. provide protection for the general partners.
5. Direct commercial real estate ownership *least likely* requires investing in:
   A. large amounts.
   B. illiquid assets.
   C. a short time horizon.
6. A real estate property valuation would *least likely* use:
   A. an income approach.
   B. an asset-based approach.
   C. a comparable sales approach.

# MODULE 50.2: HEDGE FUNDS, COMMODITIES, AND INFRASTRUCTURE

Video covering this content is available online.

## Hedge Funds

Hedge funds employ a large number of different strategies. Hedge fund managers have more flexibility than managers of traditional investments. Hedge funds can use leverage, take short equity positions, and take long or short positions in derivatives. The complex nature of hedge fund transactions leads managers to trade through **prime brokers**, who provide many services including custodial services, administrative services, money lending, securities lending for short sales, and trading. Hedge fund managers can negotiate various service parameters with the prime brokers, such as margin requirements.

Hedge fund return objectives can be stated on an **absolute basis** (e.g., 10%) or on a **relative basis** (e.g., returns 5% above a specific benchmark return) depending on the fund strategy. Hedge funds are *less regulated* than traditional investments. Like private equity funds, hedge funds are typically set up as limited partnerships, with the investors as the limited (liability) partners. A hedge fund limited partnership may not include more than a proscribed number of investors, who must possess adequate wealth, sufficient liquidity, and an acceptable degree of investment sophistication. The management firm is the general partner and typically receives both a management fee based on the value of assets managed and an incentive fee based on fund returns.

Hedge fund investments are less liquid than traditional, publicly traded investments. Restrictions on redemptions may include a **lockup period** and/or a **notice period**. A lockup period is a time after initial investment during which withdrawals are not allowed. A notice period, typically 30 to 90 days, is the amount of time a fund has after receiving a redemption request to fulfill the request. Additional fees may be charged at redemption. All of these, of course, discourage redemptions. Hedge fund managers often incur significant transactions costs when they redeem shares. Redemption fees can offset these costs. Notice periods allow time for managers to reduce positions in an orderly manner. Redemptions often increase when hedge fund performance is poor over a period, and the costs of honoring redemptions may further decrease the value of partnership interests. This is an additional source of risk for hedge fund investors.

A **fund-of-funds** is an investment company that invests in hedge funds, giving investors diversification among hedge fund strategies and allowing smaller investors to access hedge

funds in which they may not be able to invest directly. Fund-of-funds managers charge an additional layer of fees beyond the fees charged by the individual hedge funds in the portfolio.

## *Hedge Fund Strategies*

Similar to categorizing alternative investments, classifying hedge funds can also be challenging. According to Hedge Fund Research, Inc., there are four main classifications of hedge fund strategies:

1. **Event-driven strategies** are typically based on a corporate restructuring or acquisition that creates profit opportunities for long or short positions in common equity, preferred equity, or debt of a specific corporation. Subcategories are:
    - **Merger arbitrage:** Buy the shares of a firm being acquired and sell short the firm making the acquisition.
    - **Distressed/restructuring:** Buy the (undervalued) securities of firms in financial distress when analysis indicates value will be increased by a successful restructuring; possibly short overvalued security types at the same time.
    - **Activist shareholder:** Buy sufficient equity shares to influence a company's policies with the goal of increasing company value.
    - **Special situations:** Invest in the securities of firms that are issuing or repurchasing securities, spinning off divisions, selling assets, or distributing capital.
2. **Relative value strategies** involve buying a security and selling short a related security with the goal of profiting when a perceived pricing discrepancy between the two is resolved.
    - **Convertible arbitrage fixed income:** Exploit pricing discrepancies between convertible bonds and the common stock of the issuing companies.
    - **Asset-backed fixed income:** Exploit pricing discrepancies among various mortgage-backed securities (MBS) or asset-backed securities (ABS).
    - **General fixed income:** Exploit pricing discrepancies between fixed income securities of various types.
    - **Volatility:** Exploit pricing discrepancies arising from differences between returns volatility implied by options prices and manager expectations of future volatility.
    - **Multi-strategy:** Exploit pricing discrepancies among securities in asset classes different from those previously listed and across asset classes and markets.
3. **Macro strategies** are based on global economic trends and events and may involve long or short positions in equities, fixed income, currencies, or commodities.
4. **Equity hedge fund strategies** seek to profit from long or short positions in publicly traded equities and derivatives with equities as their underlying assets.
    - **Market neutral:** Use technical or fundamental analysis to select undervalued equities to be held long, and to select overvalued equities to be sold short, in approximately equal amounts to profit from their relative price movements without exposure to market risk.
    - **Fundamental growth:** Use fundamental analysis to find high-growth companies. Identify and buy equities of companies that are expected to sustain

relatively high rates of capital appreciation.

- **Fundamental value:** Buy equity shares that are believed to be undervalued based on fundamental analysis. Here it is the hedge fund structure, rather than the type of assets purchased, that results in classification as an alternative investment.
- **Quantitative directional:** Buy equity securities believed to be undervalued and short securities believed to be overvalued based on technical analysis. Market exposure may vary depending on relative size of long and short portfolio positions.
- **Short bias:** Employ predominantly short positions in overvalued equities, possibly with smaller long positions, but with negative market exposure overall.

Many hedge funds tend to specialize in a specific strategy at first and over time may develop or add additional areas of expertise, becoming multi-strategy funds.

## *Hedge Fund Potential Benefits and Risks*

Hedge fund returns have tended to be better than those of global equities in down equity markets and to lag the returns of global equities in up markets. Different hedge fund strategies have the best returns during different time periods. Statements about the performance and diversification benefits of hedge funds are problematic because of the great variety of strategies used. Less-than-perfect correlation with global equity returns may offer some diversification benefits, but correlations tend to increase during periods of financial crisis.

## *Hedge Fund Due Diligence*

Selecting hedge funds (or funds of funds) requires significant investigation of the available funds. This may be somewhat hampered by a lack of transparency by funds that consider their strategies and systems to be proprietary information. The fact that the regulatory requirements for hedge fund disclosures are minimal presents additional challenges. A partial list of factors to consider when selecting a hedge fund or a fund-of-funds includes an examination of the fund's:



- Investment strategy.
- Investment process.
- Source of competitive advantages.
- Historical returns.
- Valuation and returns calculation methods.
- Longevity.
- Amount of assets under management.
- Management style.
- Key person risk.
- Reputation.
- Growth plans.
- Systems for risk management.
- Appropriateness of benchmarks.

The analysis of these factors is challenging because a lack of persistence in returns may mean that funds with better historical returns will not provide better-than-average returns in the future. Many of the items for due diligence, such as reputation, risk management systems, and management style, are difficult to quantify in a way that provides clear choices for potential investors. Further, previously profitable strategies to exploit pricing inefficiencies are likely to become less profitable as more funds pursue the same strategy.

An additional factor to consider is the percentage of a fund's total assets under management that represents the interests of any single investor. The withdrawal of an investment that is a significant percentage of a fund's total assets may cause the fund to fail, especially if fund assets are illiquid.

### *Hedge Fund Valuation*

Hedge fund values are based on market values for traded securities in their portfolios but must use model (estimated) values for non-traded securities. For traded securities it is most conservative to use the prices at which a position could be closed: bid prices for long positions and ask prices for short positions. Some funds use the average of the bid and ask prices instead. In the case of illiquid securities, quoted market prices may be reduced for the degree of illiquidity, based on position size compared to the total value of such securities outstanding and their average trading volume. Some funds calculate a "trading NAV" using such adjustments for illiquidity. Trading NAV is different from the calculated net asset value required by accounting standards, which is based on either market or model prices.

## Commodities

While it is possible to invest directly in commodities such as grain and gold, the most commonly used instruments to gain exposure to commodity prices are derivatives. Commodities themselves are physical goods and thus incur costs for storage and transportation. Returns are based on price changes and not on income streams.

Futures, forwards, options, and swaps are all available forms of commodity derivatives. Futures trade on exchanges; some options trade on exchanges while others trade over the counter; and forwards and swaps are over-the-counter instruments originated by dealers. Futures and forwards are contractual obligations to buy or sell a commodity at a specified price and time. Options convey the right, but not the obligation, to buy or sell a commodity at a specified price and time. Other methods of exposures to commodities include the following:

- **Exchange-traded funds** (commodity ETFs) are suitable for investors who are limited to buying equity shares. ETFs can invest in commodities or commodity futures and can track prices or indices.
- **Equities that are directly linked to a commodity** include shares of a commodity producer, such as an oil producer or a gold mining firm, and give investors exposure to price changes of the produced commodity. One potential drawback to commodity-linked equities is that the price movements of the stock and the price movements of the commodity may not be perfectly correlated.
- **Managed futures funds** are actively managed. Some managers concentrate on specific sectors (e.g., agricultural commodities) while others are more diversified. Managed future funds can be structured as limited partnerships with fees like those of hedge funds (e.g., 2 and 20) and restrictions on the number, net worth, and liquidity of the

investors. They can also be structured like mutual funds with shares that are publicly traded so that retail investors can also benefit from professional management. Additionally, such a structure allows a lower minimum investment and greater liquidity compared to a limited partnership structure.

- **Individual managed accounts** provide an alternative to pooled funds for high net worth individuals and institutions. Accounts are tailored to the needs of the specific investor.
- **Specialized funds in specific commodity sectors** can be organized under any of the structures we have discussed and focus on certain commodities, such as oil and gas, grains, precious metals, or industrial metals.

## *Potential Benefits and Risks of Commodities*

Returns on commodities over time have been lower than returns on global stocks or bonds. Sharpe ratios for commodities as an asset class have been low due to these lower returns and the high volatility of commodities prices. As with other investments, speculators can earn high returns over short periods when their expectations about short-term commodity price movements are correct and they act on them.

Historically, correlations of commodity returns with those of global equities and global bonds have been low, typically less than 0.2, so that adding commodities to a traditional portfolio can provide diversification benefits. Because commodity prices tend to move with inflation rates, holding commodities can act as a hedge of inflation risk. To the extent that commodities prices move with inflation the real return over time would be zero, although futures contracts may offer positive real returns.

## *Commodity Prices and Investments*

Spot prices for commodities are a function of supply and demand. Demand is affected by the value of the commodity to end-users and by global economic conditions and cycles. Supply is affected by production and storage costs and existing inventories. Both supply and demand are affected by the purchases and sales of nonhedging investors (speculators).

For many commodities, supply is inelastic in the short run because of long lead times to alter production levels (e.g., drill oil wells, plant crops, or decide to plant less of them). As a result, commodity prices can be volatile when demand changes significantly over the economic cycle. Production of some commodities, especially agricultural commodities, can be significantly affected by the weather, leading to high prices when production is low and low prices when production is high. Costs of extracting oil and minerals increase as more expensive methods or more remote areas are used. To estimate future needs, commodities producers analyze economic events, government policy, and forecasts of future supply. Investors analyze inventory levels, forecasts of production, changes in government policy, and expectations of economic growth in order to forecast commodity prices.

## *Commodity Valuation*

Wheat today and wheat six months from today are different products. Purchasing the commodity today will give the buyer the use of it if needed, while contracting for wheat to be delivered six months from today avoids storage costs and having cash tied up. An equation that considers these aspects is:

futures price ≈ spot price (1 + risk-free rate) + storage costs − convenience yield

**Convenience yield** is the value of having the physical commodity for use over the period of the futures contract. If this equation does not hold, an arbitrage transaction is possible.

If there is little or no convenience yield, futures prices will be higher than spot prices, a situation termed **contango**. When the convenience yield is high, futures prices will be less than spot prices, a situation referred to as **backwardation**.

Three sources of commodities futures returns are:

1. **Roll yield**—The yield due to a difference between the spot price and futures price, or a difference between two futures prices with different expiration dates. Futures prices converge toward spot prices as contracts get closer to expiration. Roll yield is positive for a market in backwardation and negative for a market in contango.
2. **Collateral yield**—The interest earned on collateral required to enter into a futures contract.
3. **Change in spot prices**—The total price return is a combination of the change in spot prices and the convergence of futures prices to spot prices over the term of the futures contract.

## Infrastructure

**Infrastructure investments** include transportation assets such as roads, airports, ports, and railways, as well as utility assets, such as gas distribution facilities, electric generation and distribution facilities, and waste disposal and treatment facilities. Other categories of infrastructure investments are communications (e.g., broadcast assets and cable systems) and social (e.g., prisons, schools, and health care facilities).

Investments in infrastructure assets that are already constructed are referred to as **brownfield investments** and investments in infrastructure assets that are to be constructed are referred to as **greenfield investments**. In general, investing in brownfield investments provides stable cash flows and relatively high yields, but offers little potential for growth. Investing in greenfield investments is subject to more uncertainty and may provide relatively lower yields, but offers greater growth potential.

In addition to categorizing infrastructure investments by type or whether or not construction of the assets is complete, they may be categorized by their geographic location.

Investment in infrastructure can be made by constructing the assets and either selling or leasing them to the government or by directly operating the assets. Alternatively, investment in infrastructure can be made by purchasing existing assets from the government to lease back to the government or operate directly. Infrastructure investments can also be made by a public-private partnership.

Infrastructure assets typically have a long life and are quite large in cost and scale so direct investment in them has low liquidity. However, more liquid investments backed by infrastructure assets are available through ETFs, mutual funds, private equity funds, or master limited partnerships (MLPs). Publicly traded vehicles for investing in infrastructure are a small part of the overall universe of infrastructure investments and are relatively concentrated in a few categories of assets.

Investing in infrastructure assets can provide diversification benefits, but investors should be aware that they are often subject to regulatory risk, risk from financial leverage, and the possibility that cash flows will be less than expected. Investors who construct infrastructure assets have construction risk. When the assets are owned and operated by a private owner, operational risk must also be considered.

## Other Alternative Investments

Various types of tangible collectibles are considered investments, including rare wines, art, rare coins and stamps, valuable jewelry and watches, and sports memorabilia. There is no income generation but owners do get enjoyment from use, as with a collectible automobile. Storage costs may be significant, especially with art and wine. Specialized knowledge is required, the markets for many collectibles are illiquid, and gains result only from increases in the prices of these assets.

**LOS 50.c: Describe potential benefits of alternative investments in the context of portfolio management.**

*CFA® Program Curriculum, Volume 6, page 13*

In a portfolio context, investors consider the portfolio risk, the portfolio return, and the relationship between the two. Because returns on alternative investments are less than perfectly correlated with returns on traditional investments, they have the potential to provide diversification benefits, decreasing portfolio risk. This has been a primary reason for investors to include alternative investments in their portfolios. Correlations have been quite variable, however, across time periods examined and across the various categories of alternative investments. As a result, the anticipated diversification benefits are not always realized. Additionally, returns correlations can increase to near-perfect correlation during periods of market disruption and decline.

The ability of alternative investments to increase portfolio returns has been called into question for two reasons. One is that returns measures for alternative investments may be less reliable than returns measures for traditional investments. Another is that risks specific to alternative investments may increase their returns. Some of the returns may be explained by lack of liquidity, lack of transparency, and the risk incurred by the need to evaluate and select specific categories of alternative investments and select specific managers. Higher returns may also be explained by inefficiencies in valuations of alternative investments that can be exploited by a skilled manager.

Overall, alternative investments have the potential to improve the risk-return characteristics of a portfolio. A commonly used measure of portfolio performance based on the relationship between risk and returns is the Sharpe ratio, the portfolio excess return per unit of returns standard deviation. Standard deviation, however, may not be the appropriate risk measure for alternative investments, as their returns often exhibit both skewness and positive excess kurtosis (fat tails). In any case, the decision about what proportion of a portfolio's assets to allocate to alternative investments is complicated and somewhat sensitive to the risk measure selected by the manager.

**LOS 50.d: Describe, calculate, and interpret management and incentive fees and net-of-fees returns to hedge funds.**

The total fee paid by investors in a hedge fund consists of a **management fee** and an **incentive fee**. The management fee is earned regardless of investment performance and incentive fees are a portion of profits. The most common fee structure for a hedge fund is "2 and 20" or "2 plus," 2% of the value of the assets under management plus an incentive fee of 20% of profits.

Profits can be (1) any gains in value, (2) any gains in value in excess of the management fee, or (3) gains in excess of a **hurdle rate**. A hurdle rate can be set either as a percentage (e.g., 4%) or a rate plus a premium (e.g., LIBOR + 2%). A *hard hurdle rate* means that incentive fees are earned only on returns in excess of the benchmark. A *soft hurdle rate* means that incentive fees are paid on all profits, but only if the hurdle rate is met.

Another feature that is often included is called a **high water mark**. This means that the incentive fee is not paid on gains that just offset prior losses. Thus incentive fees are only paid to the extent that the current value of an investor's account is above the highest value after fees previously recorded. This feature ensures that investors will not be charged incentive fees twice on the same gains in their portfolio values. Because investors invest in a fund at different times, they each may have a different high water mark value.

Investors in funds of funds incur additional fees from the managers of the funds of funds. A common fee structure from funds of funds is "1 and 10." A 1% management fee and a 10% incentive fee are charged in addition to any fees charged by the individual hedge funds within the fund-of-funds structure.

Fee calculations for both management fees and incentive fees can differ not only by the schedule of rates but also method of fee determination. Management fees may be calculated on either the beginning-of-period or end-of-period values of assets under management. Incentive fees may be calculated net of management fees (value increase less management fees) or independent of management fees. Although the most common hedge fund fee rates tend to be the "2 and 20" and "1 and 10" for funds of funds, fee structures can vary. Price breaks to investors, competitive conditions, and historical performance can influence negotiated rates.

Fee structures and their impact on investors' results are illustrated in the following example.

**EXAMPLE: Hedge fund fees**

BJI Funds is a hedge fund with a value of $110 million at initiation. BJI Funds charges a 2% management fee based on assets under management at the beginning of the year and a 20% incentive fee with a 5% soft hurdle rate, and it uses a high water mark. Incentive fees are calculated on gains net of management fees. The ending values before fees are as follows:

- Year 1: $102.2 million
- Year 2: $118.0 million

Calculate the total fees and the investor's net return for both years.

**Answer:**

Year 1:

Management fee: $110.0 million × 2% = $2.2 million

Gross value end of year (given): $102.2 million

Return net of management fee = $\frac{\$102.2 \text{ million} - \$2.2 \text{ million}}{\$110.0 \text{ million}} - 1 = -9.1\%$

There is no incentive fee because the return is less than the hurdle rate.

Total fees = $2.2 million

Ending value net of fees = $102.2 million – $2.2 million = $100.00 million

Year 2:

Management fee: $100.0 million × 2% = $2.0 million

Gross value end of year (given): $118.0 million

Return net of management fee = $\frac{\$118.0 \text{ million} - \$2.0 \text{ million}}{\$100.0 \text{ million}} - 1 = +16.0\%$

Incentive fee = ($118.0 million – $2.0 million – $110.0 million) × 20% = $1.2 million

Note that the incentive fee is calculated based on gains in value above $110 million because that is the high water mark.

Total fees = $2.0 million + $1.2 million = $3.2 million

Net return = $\frac{\$118.0 \text{ million} - \$3.2 \text{ million}}{\$100.0 \text{ million}} - 1 = +14.8\%$

## LOS 50.f: Describe risk management of alternative investments.

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

Risk management of alternative investments requires additional understanding of the unique set of circumstances for each category. We can summarize some of the more important risk considerations as follows:

- Standard deviation of returns may be a misleading measure of risk for two reasons. First, returns distributions are not approximately normal; they tend to be leptokurtic (fat tails) and negatively skewed (possibility of extreme negative outcomes). Second, for alternative assets that use appraisal or models to estimate values, returns are smoothed so that standard deviation of returns (and correlations with returns of traditional investments) will be understated. Even market-based returns can have these same limitations when transactions are infrequent. These problems can bias Sharpe measures upward and make estimates of beta misleading as well. Investors should consider downside risk measures such as **value at risk (VaR)**, which is an estimate of the size of a potential decline over a period that will occur, for example, less than 5% of the time; or the **Sortino ratio**, which measures risk as downside deviation rather than standard deviation. For publicly traded securities, such as REITs and ETFs, market returns are used and standard definitions of risk are more applicable.
- Use of derivatives introduces operational, financial, counterparty, and liquidity risk.
- Performance for some alternative investment categories is primarily determined by management expertise and execution, so risk is not just that of holding an asset class but also risk of management underperformance.
- Hedge funds and private equity funds are much less transparent than traditional investments as they release less information and may consider their strategies to be proprietary information.
- Many alternative investments are illiquid. Returns should reflect a premium for lack of liquidity to compensate investors for liquidity risk or the inability to redeem securities at all during lockup periods.
- When calculating optimal allocations, indices of historical returns and standard deviations may not be good indicators of future returns and volatility.
- Correlations vary across periods and are affected by events.

## Due Diligence

A listing of key items for due diligence for alternative investments includes six major categories: organization, portfolio management, operations and controls, risk management, legal review, and fund terms.

1. **Organization:** Experience, quality, and compensation of management and staff; analysis of all their prior and current fund results; alignment of manager and investor interests; and reputation and quality of third-party service providers used.
2. **Portfolio management:** Management of the investment process; target markets, asset types, and strategies; investment sources; operating partners' roles; underwriting; environmental and engineering review; integration of asset management, acquisitions, and dispositions; and the process for dispositions.
3. **Operations and controls:** Reporting and accounting methods; audited financial statements; internal controls; frequency of valuations; valuation approaches; insurance; and contingency plans.
4. **Risk management:** Fund policies and limits; portfolio risk and key factors; and constraints on leverage and currencies and hedging of related risks.
5. **Legal review:** Fund legal structure; registrations; and current and past litigation.
6. **Fund terms:** Fees, both management and incentive, and expenses; contractual terms; investment period; fund term and extensions; carried interest; distributions; conflicts; rights of limited partners; and termination procedures for key personnel.

### MODULE QUIZ 50.2

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

1. An investor who chooses a fund-of-funds as an alternative to a single hedge fund is *most likely* to benefit from:
   A. lower fees.
   B. higher returns.
   C. more due diligence.
2. A high water mark of £150 million was established two years ago for a British hedge fund. The end-of-year value before fees for last year was £140 million. This year's end-of-year value before fees is £155 million. The fund charges "2 and 20." Management fees are paid independently of incentive fees and are calculated on end-of-year values. What is the total fee paid this year?
   A. £3.1 million.
   B. £4.1 million.
   C. £6.1 million.
3. Diversification benefits from adding hedge funds to an equity portfolio may be limited because:
   A. correlations tend to increase during periods of financial crisis.
   B. hedge fund returns are less than perfectly correlated with global equities.
   C. hedge funds tend to perform better when global equity prices are declining.
4. Standard deviation is *least likely* an appropriate measure of risk for:
   A. hedge funds.
   B. publicly traded REITs.
   C. exchange-traded funds.
5. A hedge fund that operates as an activist shareholder is *most likely* engaging in:
   A. a macro strategy.
   B. a relative value strategy.
   C. an event-driven strategy.

6. Which component of the return on a long futures position is related to differences between spot prices and futures prices?
    A. Roll yield.
    B. Price return.
    C. Collateral yield.
7. Greenfield investments in infrastructure are *most accurately* described as investments in assets:
    A. that are operating profitably.
    B. that have not yet been constructed.
    C. related to environmental technology.

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# KEY CONCEPTS

## LOS 50.a

"Traditional investments" refers to long-only positions in stocks, bonds, and cash. "Alternative investments" refers to some types of assets such as real estate, commodities, and various collectables, as well as some specific structures of investment vehicles. Hedge funds and private equity funds (including venture capital funds) are often structured as limited partnerships; real estate investment trusts (REITs) are similar to mutual funds; and ETFs can contain alternative investments as well.

Compared to traditional investments, alternative investments typically have lower liquidity; less regulation and disclosure; higher management fees and more specialized management; potential diversification benefits; more use of leverage, use of derivatives; potentially higher returns; limited and possibly biased historical returns data; problematic historical risk measures; and unique legal and tax considerations.

## LOS 50.b

**Hedge funds** are investment companies that use a variety of strategies and may be highly leveraged, use long and short positions, and use derivatives.

- *Event-driven* strategies include merger arbitrage, distressed/restructuring, activist shareholder, and special situations.
- *Relative value* strategies seek profits from unusual pricing issues.
- *Macro hedge* strategies are "top down" strategies based on global economic trends.
- *Equity hedge* strategies are "bottom up" strategies that take long and short positions in equities and equity derivatives. Strategies include market neutral, fundamental growth, fundamental value, quantitative directional, short bias, and sector specific.

In periods of financial crisis, the correlation of returns between global equities and hedge funds tends to increase, which limits hedge funds' effectiveness as a diversifying asset class.

Due diligence factors for hedge funds are investment strategy, investment process, competitive advantages, track record, longevity of fund, and size (assets under management). Other qualitative factors include management style, key person risk, reputation, investor relations, growth plans, and management of systematic risk.

**Private equity** funds usually invest in the equity of private companies or companies wanting to become private, financing their assets with high levels of debt. This category also includes venture capital funds, which provide capital to companies early in their development.

Leveraged buyouts (LBOs) include management buyouts, in which the existing management team is involved in the purchase, and management buy-ins, in which an external management team replaces the existing management.

Stages of venture capital investing include the formative stage (composed of the angel investing, seed, and early stages); the later stage (expansion); and the mezzanine stage (prepare for IPO).

Methods for exiting investments in portfolio companies include trade sale (sell to a competitor or another strategic buyer); IPO (sell some or all shares to investors);

recapitalization (issue portfolio company debt); secondary sale (sell to another private equity firm or other investors); or write-off/liquidation.

Private equity has some historical record of potential diversification benefits. An investor must identify top performing private equity managers to benefit from private equity.

Due diligence factors for private equity include the manager's experience, valuation methods used, fee structure, and drawdown procedures for committed capital.

**Real estate** as an asset class includes residential and commercial real estate, individual mortgages, and pools of mortgages or properties. It includes direct investment in single properties or loans as well as indirect investment in limited partnerships, which are private securities, and mortgage-backed securities and real estate investment trusts, which are publicly traded.

Reasons to invest in real estate include potential long-term total returns, income from rent payments, diversification benefits, and hedging against inflation.

Forms of real estate investing:

| | **Public (Indirect)** | **Private (Direct)** |
|---|---|---|
| *Debt* | ■ Mortgage-backed securities<br>■ Collateralized mortgage obligations | ■ Mortgages<br>■ Construction loans |
| *Equity* | ■ Real estate corporation shares<br>■ Real estate investment trust shares | ■ Sole ownership<br>■ Joint ventures<br>■ Limited partnerships<br>■ Commingled funds |

Real estate investment categories include residential properties, commercial real estate, REITs, mortgage-backed securities, and timberland and farmland.

Historically, real estate returns are highly correlated with global equity returns but less correlated with global bond returns. The construction method of real estate indexes may contribute to the low correlation with bond returns.

Due diligence factors for real estate include global and national economic factors, local market conditions, interest rates, and property-specific risks including regulations and abilities of managers. Distressed properties investing and real estate development have additional risk factors to consider.

**Commodities** refers to physical assets such as agricultural products, metals, oil and gas, and other raw materials used in production. Commodities market exposure can provide an inflation hedge and diversification benefits.

The most common way to invest in commodities is with derivatives. Other methods include exchange-traded funds, equities that are directly linked to a commodity, managed futures funds, individual managed accounts, and specialized funds in specific commodity sectors.

Beyond the potential for higher returns and lower volatility benefits to a portfolio, commodity as an asset class may offer inflation protection. Commodities can offset inflation, especially if commodity prices are used to determine inflation indices.

Spot prices for commodities are a function of supply and demand. Global economics, production costs, and storage costs, along with value to user, all factor into prices.

**Infrastructure** refers to long-lived assets that provide public services and are often built or operated by governments.

Infrastructure investments may be classified as greenfield (assets to be built) or brownfield (existing assets).

Liquidity is low for direct investments in infrastructure because the assets are long-lived and tend to be large-scale. However, some liquid investment vehicles exist that are backed by infrastructure assets.

**Other alternative investments** include various types of collectibles, such as cars, wines, and art.

### LOS 50.c

The primary motivation for adding alternative investments to a portfolio is to reduce portfolio risk based on the less-than-perfect correlation between alternative asset returns and traditional asset returns. However, because correlations have been variable across time periods and categories of alternative investments, the diversification benefits are not always realized. Additionally, returns correlations can increase during periods of market disruption and decline.

### LOS 50.d

The total fee for a hedge fund consists of a management fee and an incentive fee. Other fee structure specifications include hurdle rates and high water marks. Funds of funds incur an additional level of management fees. Fee calculations for both management fees and incentive fees can differ by the schedule and method of fee determination.

### LOS 50.e

Hedge funds often invest in securities that are not actively traded and must estimate their values, and invest in securities that are illiquid relative to the size of a hedge fund's position. Hedge funds may calculate a trading NAV that adjusts for the illiquidity of these securities.

A private equity portfolio company may be valued using a market/comparables approach (multiple-based) approach, a discounted cash flow approach, or an asset-based approach.

Real estate property valuation approaches include the comparable sales approach, the income approach (multiples or discounted cash flows), and the cost approach. REITs can be valued using an income-based approach or an asset-based approach.

A commodity futures price is approximately equal to the spot price compounded at the risk-free rate, plus storage costs, minus the convenience yield.

### LOS 50.f

Risk management of alternative investments requires understanding of the unique circumstances for each category.

- Standard deviation of returns may be misleading as a measure of risk.
- Use of derivatives introduces operational, financial, counterparty, and liquidity risks.
- Performance for some alternative investment categories depends primarily on management expertise.
- Hedge funds and private equity funds are less transparent than traditional investments.
- Many alternative investments are illiquid.

- Indices of historical returns and standard deviations may not be good indicators of future returns and volatility.
- Correlations vary across periods and are affected by events.

Key items for due diligence include organization, portfolio management, operations and controls, risk management, legal review, and fund terms.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 50.1

1. **C** Traditional managers can hold cash and buy stocks but may be restricted from using derivatives. (LOS 50.a)

2. **C** Traditional investments typically require lower fees, are more regulated, and are more liquid than alternative investments. (LOS 50.a)

3. **C** The market/comparables approach uses market or private transaction values of similar companies to estimate multiples of EBITDA, net income, or revenue to use in estimating the portfolio company's value. (LOS 50.e)

4. **A** Debt covenants in leveraged buyout loans may restrict additional borrowing by the acquired firm. Covenants restrict and require borrowers' actions, not lenders' actions. Covenants in leveraged loans provide protection for the lenders, not the general partners. (LOS 50.b)

5. **C** Commercial real estate ownership requires long time horizons and purchasing illiquid assets that require large investment amounts. (LOS 50.b)

6. **B** The three approaches to valuing a property are income, comparable sales, and cost. An asset-based approach can be used for real estate investment trusts, but not for valuing individual real estate properties. (LOS 50.e)

## Module Quiz 50.2

1. **C** A fund-of-funds manager is expected to provide more due diligence and better redemption terms. Funds of funds charge an additional layer of fees. Investing in fund-of-funds may provide more diversification but may not necessarily provide higher returns. (LOS 50.b)

2. **B** Management fee is £155 million × 0.02 = £3.1 million.

   Incentive fee is (£155 million – £150 million) × 0.20 = £1.0 million.

   Total fee is £3.1 million + £1.0 million = £4.1 million. (LOS 50.d)

3. **A** Adding hedge funds to traditional portfolios may not provide the expected diversification to an equity portfolio because return correlations tend to increase during periods of financial crisis. (LOS 50.c)

4. **A** Hedge funds may hold illiquid assets that may use estimated values to calculate returns. Risk as measured by standard deviation could be understated. For publicly traded securities, such as REITs and ETFs, standard definitions of risk are more applicable. (LOS 50.f)

5. **C** Activist shareholder strategies are a subcategory of event-driven strategies. (LOS 50.b)

6. **A** Roll yield results from a difference between the spot and futures prices. (LOS 50.e)

7. **B** Greenfield investments refer to infrastructure assets that are yet to be constructed.

(LOS 50.b)

# TOPIC ASSESSMENT: ALTERNATIVE INVESTMENTS

*You have now finished the Alternative Investments topic section. The following Topic Assessment provides immediate feedback on how effective your study has been for this material. The number of questions on this test is equal to the number of questions for the topic on one-half of the actual Level I CFA exam. Questions are more exam-like than typical Module Quiz or QBank questions; a score of less than 70% indicates that your study likely needs improvement. These tests are best taken timed; allow 1.5 minutes per question.*

*After you've completed this Topic Assessment, you may additionally log in to your Schweser.com online account and enter your answers in the Topic Assessments product. Select "Performance Tracker" to view a breakdown of your score. Select "Compare with Others" to display how your score on the Topic Assessment compares to the scores of others who entered their answers.*

1. Survivorship bias in reported hedge fund index returns will *most likely* result in index:
   A. returns and risk that are biased upward.
   B. returns and risk that are biased downward.
   C. risk that is biased downward and returns that are biased upward.

2. A hedge fund with a 2 and 20 fee structure has a hard hurdle rate of 5%. If the incentive fee and management fee are calculated independently and the management fee is based on beginning-of-period asset values, an investor's net return over a period during which the gross value of the fund has increased 22% is *closest* to:
   A. 16.4%.
   B. 16.6%.
   C. 17.0%.

3. The *least appropriate* measure of risk for alternative investments is:
   A. value at risk (VaR).
   B. the Sortino ratio.
   C. variance of returns.

4. The type of real estate index that *most likely* exhibits sample selection bias is:
   A. REIT index.
   B. appraisal index.
   C. repeat sales index.

5. With respect to mezzanine-stage financing in venture capital investing and mezzanine financing of a leveraged buyout:
   A. mezzanine-stage financing refers to a type of security but mezzanine financing does not.
   B. mezzanine financing refers to a type of security but mezzanine-stage financing does not.
   C. both terms refer to financing by issuance of securities that have both debt and equity characteristics.

6. A hedge fund that engages primarily in distressed debt investing and merger arbitrage is *best* described as using:
   A. a macro strategy.
   B. an event-driven strategy.

C. a relative value strategy.

7. The type of investment *most* often used to gain exposure to commodity prices is a portfolio of:
   A. derivative securities.
   B. physical commodities.
   C. commodity producing companies.

# TOPIC ASSESSMENT ANSWERS: ALTERNATIVE INVESTMENTS

1. **C** Surviving firms are more likely to have had good past returns and have taken on less risk than the average fund, leading to upward bias in index returns and downward bias in index risk measures. (Study Session 17, Module 50.2, LOS 50.e)

2. **B** The management fee is 2% of the beginning asset value, which reduces an investor's gross return by 2% to 22 – 2 = 20%. The incentive fee is 20% of the excess gross return over the hurdle rate, or 0.20(0.22 – 0.05) = 3.4%. The investor return net of fees is 22% – 2% – 3.4% = 16.6%. (Study Session 17, Module 50.2, LOS 50.d)

3. **C** Because returns distributions of alternative investments are often leptokurtic and negatively skewed, variance is not an appropriate risk measure. Value at risk (VaR) and the Sortino ratio based on downside deviations from the mean are measures of downside risk that are more appropriate for alternative investments. (Study Session 17, Module 50.2, LOS 50.f)

4. **C** A repeat sales index includes prices of properties that have recently sold. Because these properties may not be representative of overall property values (may be biased toward properties that have declined or increased the most in value of the period), there is the risk of sample selection bias. An appraisal index or a REIT index is generally constructed for a sample of representative properties or REIT property pools. (Study Session 17, Module 50.1, LOS 50.e)

5. **B** Mezzanine financing in an LBO refers to the issue of securities that have both debt and equity features so that they are on the balance sheet between debt and equity. Mezzanine-stage financing refers to financing of different types that is employed during the period just prior to an IPO of a firm funded by venture capital. (Study Session 17, Module 50.1, LOS 50.b)

6. **B** Event-driven strategies attempt to capitalize on unique events or opportunities such as distressed debt or mergers and acquisitions. Relative value strategies involve taking long and short positions in related securities to exploit pricing inefficiencies. Macro strategy funds make directional trades on markets, currencies, interest rates, or other factors. (Study Session 17, Module 50.2, LOS 50.b)

7. **A** The most commonly used instruments to get exposure to commodity prices are commodity derivative securities, such as futures contracts. (Study Session 17, Module 50.2, LOS 50.b)

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 #51.

# READING 51: PORTFOLIO MANAGEMENT: AN OVERVIEW

**Study Session 18**

## EXAM FOCUS

Here, we introduce the portfolio management process and the investment policy statement. In this topic review, you will learn the investment needs of different types of investors, as well as the different kinds of pooled investments. Later, our topic review of "Basics of Portfolio Planning and Construction" will provide more detail on investment policy statements and investor objectives and constraints.

## MODULE 51.1: PORTFOLIO MANAGEMENT PROCESS

Video covering this content is available online.

### LOS 51.a: Describe the portfolio approach to investing.

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

The **portfolio perspective** refers to evaluating individual investments by their contribution to the risk and return of an investor's portfolio. The alternative to taking a portfolio perspective is to examine the risk and return of individual investments in isolation. An investor who holds all his wealth in a single stock because he believes it to be the best stock available is not taking the portfolio perspective—his portfolio is very risky compared to holding a diversified portfolio of stocks. Modern portfolio theory concludes that the extra risk from holding only a single security is not rewarded with higher expected investment returns. Conversely, diversification allows an investor to reduce portfolio risk without necessarily reducing the portfolio's expected return.

In the early 1950s, the research of Professor Harry Markowitz provided a framework for measuring the risk-reduction benefits of diversification. Using the standard deviation of returns as the measure of investment risk, he investigated how combining risky securities into a portfolio affected the portfolio's risk and expected return. One important conclusion of his model is that unless the returns of the risky assets are perfectly positively correlated, risk is reduced by diversifying across assets.

In the 1960s, professors Treynor, Sharpe, Mossin, and Lintner independently extended this work into what has become known as modern portfolio theory (MPT). MPT results in equilibrium expected returns for securities and portfolios that are a linear function of each security's or portfolio's market risk (the risk that cannot be reduced by diversification).

One measure of the benefits of diversification is the **diversification ratio**. It is calculated as the ratio of the risk of an equally weighted portfolio of $n$ securities (measured by its standard deviation of returns) to the risk of a single security selected at random from the $n$ securities. If

the average standard deviation of returns for the *n* stocks is 25%, and the standard deviation of returns for an equally weighted portfolio of the *n* stocks is 18%, the diversification ratio is 18 / 25 = 0.72. If the standard deviation of returns for an equally weighted portfolio is 25%, there are no diversification benefits and the diversification ratio equals one. A *lower* diversification ratio indicates a *greater* risk-reduction benefit from diversification.

While the diversification ratio provides a quick measure of the potential benefits of diversification, an equal-weighted portfolio is not necessarily the portfolio that provides the greatest reduction in risk. Computer optimization can calculate the portfolio weights that will produce the lowest portfolio risk (standard deviation of returns) for a given group of securities.

Portfolio diversification works best when financial markets are operating normally; diversification provides less reduction of risk during market turmoil, such as the credit contagion of 2008. During periods of financial crisis, correlations tend to increase, which reduces the benefits of diversification.

## LOS 51.b: Describe the steps in the portfolio management process.

*CFA® Program Curriculum, Volume 6, page 89*

There are three major steps in the portfolio management process:

*Step 1:* The **planning step** begins with an analysis of the investor's risk tolerance, return objectives, time horizon, tax exposure, liquidity needs, income needs, and any unique circumstances or investor preferences.

This analysis results in an **investment policy statement** (IPS) that details the investor's investment objectives and constraints. It should also specify an objective benchmark (such as an index return) against which the success of the portfolio management process will be measured. The IPS should be updated at least every few years and any time the investor's objectives or constraints change significantly.

*Step 2:* The **execution step** involves an analysis of the risk and return characteristics of various asset classes to determine how funds will be allocated to the various asset types. Often, in what is referred to as a *top-down* analysis, a portfolio manager will examine current economic conditions and forecasts of such macroeconomic variables as GDP growth, inflation, and interest rates, in order to identify the asset classes that are most attractive. The resulting portfolio is typically diversified across such asset classes as cash, fixed-income securities, publicly traded equities, hedge funds, private equity, and real estate, as well as commodities and other real assets.

Once the asset class allocations are determined, portfolio managers may attempt to identify the most attractive securities within the asset class. Security analysts use model valuations for securities to identify those that appear undervalued in what is termed *bottom-up* security analysis.

*Step 3:* The **feedback step** is the final step. Over time, investor circumstances will change, risk and return characteristics of asset classes will change, and the actual weights of the assets in the portfolio will change with asset prices. The portfolio manager must monitor these changes and **rebalance** the portfolio periodically in response, adjusting the allocations to the various asset classes back to their desired percentages. The manager must also measure

portfolio performance and evaluate it relative to the return on the benchmark portfolio identified in the IPS.

## LOS 51.c: Describe types of investors and distinctive characteristics and needs of each.

*CFA® Program Curriculum, Volume 6, page 93*

**Individual investors** save and invest for a variety of reasons, including purchasing a house or educating their children. In many countries, special accounts allow citizens to invest for retirement and to defer any taxes on investment income and gains until the funds are withdrawn. Defined contribution pension plans are popular vehicles for these investments. Pension plans are described later in this topic review.

Many types of **institutions** have large investment portfolios. An **endowment** is a fund that is dedicated to providing financial support on an ongoing basis for a specific purpose. For example, in the United States, many universities have large endowment funds to support their programs. A **foundation** is a fund established for charitable purposes to support specific types of activities or to fund research related to a particular disease. A typical foundation's investment objective is to fund the activity or research on a continuing basis without decreasing the real (inflation adjusted) value of the portfolio assets. Foundations and endowments typically have long investment horizons, high risk tolerance, and, aside from their planned spending needs, little need for additional liquidity.

The investment objective of a **bank**, simply put, is to earn more on the bank's loans and investments than the bank pays for deposits of various types. Banks seek to keep risk low and need adequate liquidity to meet investor withdrawals as they occur.

**Insurance companies** invest customer premiums with the objective of funding customer claims as they occur. Life insurance companies have a relatively long-term investment horizon, while property and casualty (P&C) insurers have a shorter investment horizon because claims are expected to arise sooner than for life insurers.

**Investment companies** manage the pooled funds of many investors. **Mutual funds** manage these pooled funds in particular styles (e.g., index investing, growth investing, bond investing) and restrict their investments to particular subcategories of investments (e.g., large-firm stocks, energy stocks, speculative bonds) or particular regions (emerging market stocks, international bonds, Asian-firm stocks).

**Sovereign wealth funds** refer to pools of assets owned by a government. For example, the Abu Dhabi Investment Authority, a sovereign wealth fund in the United Arab Emirates funded by Abu Dhabi government surpluses, has approximately USD 700 billion in assets.[1]

Figure 51.1 provides a summary of the risk tolerance, investment horizon, liquidity needs, and income objectives for different types of investors.

Figure 51.1: Characteristics of Different Types of Investors

| Investor | Risk Tolerance | Investment Horizon | Liquidity Needs | Income Needs |
|---|---|---|---|---|
| Individuals | Depends on individual | Depends on individual | Depends on individual | Depends on individual |
| Banks | Low | Short | High | Pay interest |
| Endowments | High | Long | Low | Spending level |

| | | | | |
|---|---|---|---|---|
| Insurance | Low | Long—life Short—P&C | High | Low |
| Mutual funds | Depends on fund | Depends on fund | High | Depends on fund |
| Defined benefit pensions | High | Long | Low | Depends on age |

## LOS 51.d: Describe defined contribution and defined benefit pension plans.

*CFA® Program Curriculum, Volume 6, page 94*

A **defined contribution pension plan** is a retirement plan in which the firm contributes a sum each period to the employee's retirement account. The firm's contribution can be based on any number of factors, including years of service, the employee's age, compensation, profitability, or even a percentage of the employee's contribution. In any event, the firm makes no promise to the employee regarding the future value of the plan assets. The investment decisions are left to the employee, who assumes all of the investment risk.

In a **defined benefit pension plan**, the firm promises to make periodic payments to employees after retirement. The benefit is usually based on the employee's years of service and the employee's compensation at, or near, retirement. For example, an employee might earn a retirement benefit of 2% of her final salary for each year of service. Consequently, an employee with 20 years of service and a final salary of $100,000, would receive $40,000 ($100,000 final salary × 2% × 20 years of service) each year upon retirement until death. Because the employee's future benefit is defined, the employer assumes the investment risk. The employer makes contributions to a fund established to provide the promised future benefits. Poor investment performance will increase the amount of required employer contributions to the fund.

## MODULE QUIZ 51.1

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

1. Compared to investing in a single security, diversification provides investors a way to:
   A. increase the expected rate of return.
   B. decrease the volatility of returns.
   C. increase the probability of high returns.
2. Which of the following is *least likely* to be considered an appropriate schedule for reviewing and updating an investment policy statement?
   A. At regular intervals (e.g., every year).
   B. When there is a major change in the client's constraints.
   C. Frequently, based on the recent performance of the portfolio.
3. A top-down security analysis begins by:
   A. analyzing a firm's business prospects and quality of management.
   B. identifying the most attractive companies within each industry.
   C. examining economic conditions.
4. Portfolio diversification is *least likely* to protect against losses:
   A. during severe market turmoil.
   B. when markets are operating normally.
   C. when the portfolio securities have low return correlation.
5. Low risk tolerance and high liquidity requirements *best* describe the typical investment needs of:
   A. a defined-benefit pension plan.
   B. a foundation.
   C. an insurance company.
6. A long time horizon and low liquidity requirements *best* describe the investment needs of:

A. an endowment.
B. an insurance company.
C. a bank.

7. In a defined contribution pension plan:
   A. the employee accepts the investment risk.
   B. the plan sponsor promises a predetermined retirement income to participants.
   C. the plan manager attempts to match the fund's assets to its liabilities.
8. In a defined benefit pension plan:
   A. the employee assumes the investment risk.
   B. the employer contributes to the employee's retirement account each period.
   C. the plan sponsor promises a predetermined retirement income to participants.

# MODULE 51.2: ASSET MANAGEMENT AND POOLED INVESTMENTS

Video covering this content is available online.

## LOS 51.e: Describe aspects of the asset management industry.

*CFA® Program Curriculum, Volume 6, page 99*

The asset management industry comprises firms that manage investments for clients. Asset management firms include both independent managers and divisions of larger financial services companies. They are referred to as **buy-side firms**, in contrast with **sell-side firms** such as broker-dealers and investment banks.

**Full-service asset managers** are those that offer a variety of investment styles and asset classes. **Specialist asset managers** may focus on a particular investment style or a particular asset class. A **multi-boutique firm** is a holding company that includes a number of different specialist asset managers.

A key distinction is between firms that use active management and those that use passive management. **Active management** attempts to outperform a chosen benchmark through manager skill, for example by using fundamental or technical analysis. **Passive management** attempts to replicate the performance of a chosen benchmark index. This may include traditional broad market index tracking or a **smart beta** approach that focuses on exposure to a particular market risk factor.

Passive management represents about one-fifth of assets under management. Its share of industry revenue is even smaller because fees for passive management are lower than fees for active management.

Asset management firms may also be classified as traditional or alternative, based on the asset classes they manage. Traditional asset managers focus on equities and fixed-income securities. Alternative asset managers focus on asset classes such as private equity, hedge funds, real estate, or commodities. Profit margins tend to be higher for the alternative asset classes. As a result, many traditional asset managers have been moving into this area, somewhat blurring the distinction between these types of firms.

Some trends in the asset management industry are worth noting:

- The market share for passive management has been growing over time. This is due in part to the lower fees passive managers charge investors, and in part to questions about whether active managers are actually able to add value over time on a risk-adjusted basis, especially in developed markets that are believed to be relatively efficient.

- The amount of data available to asset managers has grown exponentially in recent years. This has encouraged them to invest in information technology and third-party services to process these data, attempting to capitalize on information quickly to make investment decisions.
- **Robo-advisors** are a technology that can offer investors advice and recommendations based on their investment requirements and constraints, using a computer algorithm. These advisors increasingly appeal to younger investors and those with smaller portfolios than have typically been served by asset management firms. They have also lowered the barriers to entry into the asset management industry for firms such as insurance companies.

**PROFESSOR'S NOTE**

Robo-advisors and issues related to Big Data are discussed further in our topic review of Fintech in Investment Management.

### LOS 51.f: Describe mutual funds and compare them with other pooled investment products.

*CFA® Program Curriculum, Volume 6, page 104*

**Mutual funds** are one form of **pooled investments** (i.e., a single portfolio that contains investment funds from multiple investors). Each investor owns shares representing ownership of a portion of the overall portfolio. The total net value of the assets in the fund (pool) divided by the number of such shares issued is referred to as the **net asset value** (NAV) of each share.

With an **open-end fund**, investors can buy newly issued shares at the NAV. Newly invested cash is invested by the mutual fund managers in additional portfolio securities. Investors can **redeem** their shares (sell them back to the fund) at NAV as well. All mutual funds charge a fee for the ongoing management of the portfolio assets, which is expressed as a percentage of the net asset value of the fund. **No-load funds** do not charge additional fees for purchasing shares (up-front fees) or for redeeming shares (redemption fees). **Load funds** charge either up-front fees, redemption fees, or both.

**Closed-end funds** are professionally managed pools of investor money that do not take new investments into the fund or redeem investor shares. The shares of a closed-end fund trade like equity shares (on exchanges or over-the-counter). As with open-end funds, the portfolio management firm charges ongoing management fees.

## Types of Mutual Funds

**Money market funds** invest in short-term debt securities and provide interest income with very low risk of changes in share value. Fund NAVs are typically set to one currency unit, but there have been instances over recent years in which the NAV of some funds declined when the securities they held dropped dramatically in value. Funds are differentiated by the types of money market securities they purchase and their average maturities.

**Bond mutual funds** invest in fixed-income securities. They are differentiated by bond maturities, credit ratings, issuers, and types. Examples include government bond funds, tax-exempt bond funds, high-yield (lower rated corporate) bond funds, and global bond funds.

A great variety of **stock mutual funds** are available to investors. **Index funds** are **passively managed**; that is, the portfolio is constructed to match the performance of a particular index,

such as the Standard & Poor's 500 Index. **Actively managed** funds refer to funds where the management selects individual securities with the goal of producing returns greater than those of their benchmark indexes. Annual management fees are higher for actively managed funds, and actively managed funds have higher turnover of portfolio securities (the percentage of investments that are changed during the year). This leads to greater tax liabilities compared to passively managed index funds.

## Other Forms of Pooled Investments

**Exchange-traded funds** (ETFs) are similar to closed-end funds in that purchases and sales are made in the market rather than with the fund itself. There are important differences, however. While closed-end funds are often actively managed, ETFs are most often invested to match a particular index (passively managed). With closed-end funds, the market price of shares can differ significantly from their NAV due to imbalances between investor supply and demand for shares at any point in time. Special redemption provisions for ETFs are designed to keep their market prices very close to their NAVs.

ETFs can be sold short, purchased on margin, and traded at intraday prices, whereas open-end funds are typically sold and redeemed only daily, based on the share NAV calculated with closing asset prices. Investors in ETFs must pay brokerage commissions when they trade, and there is a spread between the bid price at which market makers will buy shares and the ask price at which market makers will sell shares. With most ETFs, investors receive any dividend income on portfolio stocks in cash, while open-end funds offer the alternative of reinvesting dividends in additional fund shares. One final difference is that ETFs may produce less capital gains liability compared to open-end index funds. This is because investor sales of ETF shares do not require the fund to sell any securities. If an open-end fund has significant redemptions that cause it to sell appreciated portfolio shares, shareholders incur a capital gains tax liability.

A **separately managed account** is a portfolio that is owned by a single investor and managed according to that investor's needs and preferences. No shares are issued, as the single investor owns the entire account.

**Hedge funds** are pools of investor funds that are not regulated to the extent that mutual funds are. Hedge funds are limited in the number of investors who can invest in the fund and are often sold only to qualified investors who have a minimum amount of overall portfolio wealth. Minimum investments can be quite high, often between $250,000 and $1 million.

**Private equity** and **venture capital** funds invest in portfolios of companies, often with the intention to sell them later in public offerings. Managers of funds may take active roles in managing the companies in which they invest.

### PROFESSOR'S NOTE

Hedge funds, private equity, and venture capital are addressed in the study session on Alternative Investments.

### MODULE QUIZ 51.2

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

1. Compared to exchange-traded funds (ETFs), open-end mutual funds are typically associated with lower:
   A. brokerage costs.
   B. minimum investment amounts.

C. management fees.

2. Private equity and venture capital funds:
   A. expect that only a small percentage of investments will pay off.
   B. play an active role in the management of companies.
   C. restructure companies to increase cash flow.
3. Hedge funds *most likely*:
   A. have stricter reporting requirements than a typical investment firm because of their use of leverage and derivatives.
   B. hold equal values of long and short securities.
   C. are not offered for sale to the general public.

# KEY CONCEPTS

## LOS 51.a

A diversified portfolio produces reduced risk for a given level of expected return, compared to investing in an individual security. Modern portfolio theory concludes that investors that do not take a portfolio perspective bear risk that is not rewarded with greater expected return.

## LOS 51.b

The three steps in the portfolio management process are:

1. **Planning:** Determine client needs and circumstances, including the client's return objectives, risk tolerance, constraints, and preferences. Create, and then periodically review and update, an investment policy statement (IPS) that spells out these needs and circumstances.
2. **Execution:** Construct the client portfolio by determining suitable allocations to various asset classes based on the IPS and on expectations about macroeconomic variables such as inflation, interest rates, and GDP growth (top-down analysis). Identify attractively priced securities within an asset class for client portfolios based on valuation estimates from security analysts (bottom-up analysis).
3. **Feedback:** Monitor and rebalance the portfolio to adjust asset class allocations and securities holdings in response to market performance. Measure and report performance relative to the performance benchmark specified in the IPS.

## LOS 51.c

Types of investment management clients and their characteristics:

| Investor Type | Risk Tolerance | Investment Horizon | Liquidity Needs | Income Needs |
|---|---|---|---|---|
| Individuals | Depends on individual | Depends on individual | Depends on individual | Depends on individual |
| Banks | Low | Short | High | Pay interest |
| Endowments | High | Long | Low | Spending level |
| Insurance | Low | Long—life<br>Short—P&C | High | Low |
| Mutual funds | Depends on fund | Depends on fund | High | Depends on fund |
| Defined benefit pension | High | Long | Low | Depends on age |

## LOS 51.d

In a defined contribution plan, the employer contributes a certain sum each period to the employee's retirement account. The employer makes no promise regarding the future value of the plan assets; thus, the employee assumes all of the investment risk.

In a defined benefit plan, the employer promises to make periodic payments to the employee after retirement. Because the employee's future benefit is defined, the employer assumes the investment risk.

## LOS 51.e

The asset management industry comprises buy-side firms that manage investments for clients. Asset management firms include both independent managers and divisions of larger financial services companies and may be full-service or specialist firms offering investments in traditional or alternative asset classes.

Active management attempts to outperform a chosen benchmark through manager skill. Passive management attempts to replicate the performance of a chosen benchmark index. Most assets under management are actively managed, but the market share for passive management has been increasing.

## LOS 51.f

**Mutual funds** combine funds from many investors into a single portfolio that is invested in a specified class of securities or to match a specific index. Many varieties exist, including money market funds, bond funds, stock funds, and balanced (hybrid) funds. Open-ended shares can be bought or sold at the net asset value. Closed-ended funds have a fixed number of shares that trade at a price determined by the market.

**Exchange-traded funds** are similar to mutual funds, but investors can buy and sell ETF shares in the same way as shares of stock. Management fees are generally low, though trading ETFs results in brokerage costs.

**Separately managed accounts** are portfolios managed for individual investors who have substantial assets. In return for an annual fee based on assets, the investor receives personalized investment advice.

**Hedge funds** are available only to accredited investors and are exempt from most reporting requirements. Many different hedge fund strategies exist. A typical annual fee structure is 20% of excess performance plus 2% of assets under management.

**Buyout funds** involve taking a company private by buying all available shares, usually funded by issuing debt. The company is then restructured to increase cash flow. Investors typically exit the investment within three to five years.

**Venture capital funds** are similar to buyout funds, except that the companies purchased are in the start-up phase. Venture capital funds, like buyout funds, also provide advice and expertise to the start-ups.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 51.1

1. **B** Diversification provides an investor reduced risk. However, the expected return is generally similar or less than that expected from investing in a single risky security. Very high or very low returns become less likely. (LOS 51.a)

2. **C** An IPS should be updated at regular intervals and whenever there is a major change in the client's objectives or constraints. Updating an IPS based on portfolio performance is not recommended. (LOS 51.b)

3. **C** A top-down analysis begins with an analysis of broad economic trends. After an industry that is expected to perform well is chosen, the most attractive companies within that industry are identified. A bottom-up analysis begins with criteria such as firms' business prospects and quality of management. (LOS 51.b)

4. **A** Portfolio diversification has been shown to be relatively ineffective during severe market turmoil. Portfolio diversification is most effective when the securities have low correlation and the markets are operating normally. (LOS 51.a)

5. **C** Insurance companies need to be able to pay claims as they arise, which leads to insurance firms having low risk tolerance and high liquidity needs. Defined benefit pension plans and foundations both typically have high risk tolerance and low liquidity needs. (LOS 51.c)

6. **A** An endowment has a long time horizon and low liquidity needs, as an endowment generally intends to fund its causes perpetually. Both insurance companies and banks require high liquidity. (LOS 51.c)

7. **A** In a defined contribution pension plan, the employee accepts the investment risk. The plan sponsor and manager neither promise a specific level of retirement income to participants nor make investment decisions. These are features of a defined benefit plan. (LOS 51.d)

8. **C** In a defined benefit plan, the employer promises a specific level of benefits to employees when they retire. Thus, the employer bears the investment risk. (LOS 51.d)

## Module Quiz 51.2

1. **A** Open-end mutual funds do not have brokerage costs, as the shares are purchased from and redeemed with the fund company. Minimum investment amounts and management fees are typically higher for mutual funds. (LOS 51.f)

2. **B** Private equity and venture capital funds play an active role in the management of companies. Private equity funds other than venture capital expect that the majority of investments will pay off. Venture capital funds do not typically restructure companies. (LOS 51.f)

3. **C** Hedge funds may not be offered for sale to the general public; they can be sold only to qualified investors who meet certain criteria. Hedge funds that hold equal

values of long and short securities today make up only a small percentage of funds; many other kinds of hedge funds exist that make no attempt to be market neutral. Hedge funds have reporting requirements that are less strict than those of a typical investment firm. (LOS 51.f)

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1. Source: SWF Institute (https://www.swfinstitute.org/)

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 #52.

# READING 52: PORTFOLIO RISK AND RETURN: PART I

**Study Session 18**

## EXAM FOCUS

This topic review makes use of many of the statistical and returns measures we covered in Quantitative Methods. You should understand the historical return and risk rankings of the major asset classes and how the correlation (covariance) of returns between assets and between various asset classes affects the risk of portfolios. Risk aversion describes an investor's preferences related to the tradeoff between risk and return. These preferences, along with the risk and return characteristics of available portfolios, can be used to illustrate the selection of an optimal portfolio for a given investor, that is, the portfolio that maximizes the investor's expected utility.

## MODULE 52.1: RETURNS MEASURES

Video covering this content is available online.

**LOS 52.a: Calculate and interpret major return measures and describe their appropriate uses.**

*CFA® Program Curriculum, Volume 6, page 116*

**Holding period return** (HPR) is simply the percentage increase in the value of an investment over a given time period:

$$\text{holding period return} = \frac{\text{end-of-period value}}{\text{beginning-of-period value}} - 1 = \frac{P_t + Div_t}{P_0} - 1 = \frac{P_t - P_0 + Div_t}{P_0}$$

If a stock is valued at €20 at the beginning of the period, pays €1 in dividends over the period, and at the end of the period is valued at €22, the HPR is:

HPR = (22 + 1) / 20 − 1 = 0.15 = 15%

### Average Returns

The **arithmetic mean return** is the simple average of a series of periodic returns. It has the statistical property of being an unbiased estimator of the true mean of the underlying distribution of returns:

$$\text{arithmetic mean return} = \frac{(R_1 + R_2 + R_3 + ... + R_n)}{n}$$

The **geometric mean return** is a compound annual rate. When periodic rates of return vary from period to period, the geometric mean return will have a value less than the arithmetic mean return:

$$\text{geometric mean return} = \sqrt[n]{(1 + R_1) \times (1 + R_2) \times (1 + R_3) \times ... \times (1 + R_n)} - 1$$

For example, for returns $R_t$ over three annual periods, the geometric mean return is calculated as follows:

**EXAMPLE: Return measures**

An investor purchased $1,000 of a mutual fund's shares. The fund had the following total returns over a 3-year period: +5%, –8%, +12%. Calculate the value at the end of the 3-year period, the holding period return, the mean annual return, and the geometric mean annual return.

**Answer:**

ending value = (1,000)(1.05)(0.92)(1.12) = $1,081.92

holding period return = (1.05)(0.92)(1.12) − 1 = 0.08192 = 8.192%, which can also be calculated as 1,081.92 / 1,000 − 1 = 8.192%

arithmetic mean return = (5% – 8% + 12%) / 3 = 3%

geometric mean return = $\sqrt[3]{(1.05)(0.92)(1.12)} - 1 = 0.02659 = 2.66\%$, which can also be calculated as geometric mean return = $\sqrt[3]{1 + \text{HPR}} - 1 = \sqrt[3]{1.08192} - 1 = 2.66\%$.

## Other Return Measures

**Gross return** refers to the total return on a security portfolio before deducting fees for the management and administration of the investment account. **Net return** refers to the return after these fees have been deducted. Note that commissions on trades and other costs that are necessary to generate the investment returns are deducted in both gross and net return measures.

**Pretax nominal return** refers to the return prior to paying taxes. Dividend income, interest income, short-term capital gains, and long-term capital gains may all be taxed at different rates.

**After-tax nominal return** refers to the return after the tax liability is deducted.

**Real return** is nominal return adjusted for inflation. Consider an investor who earns a nominal return of 7% over a year when inflation is 2%. The investor's approximate real return is simply 7 − 2 = 5%. The investor's exact real return is slightly lower, 1.07 / 1.02 − 1 = 0.049 = 4.9%.

Real return measures the increase in an investor's purchasing power: how much more goods she can purchase at the end of one year due to the increase in the value of her investments. If she invests $1,000 and earns a nominal return of 7%, she will have $1,070 at the end of the year. If the price of the goods she consumes has gone up 2%, from $1.00 to $1.02, she will be able to consume 1,070 / 1.02 = 1,049 units. She has given up consuming 1,000 units today but instead is able to purchase 1,049 units at the end of one year. Her purchasing power has gone up 4.9%; this is her real return.

A **leveraged return** refers to a return to an investor that is a multiple of the return on the underlying asset. The leveraged return is calculated as the gain or loss on the investment as a percentage of an investor's cash investment. An investment in a derivative security, such as a futures contract, produces a leveraged return because the cash deposited is only a fraction of the value of the assets underlying the futures contract. Leveraged investments in real estate are very common: investors pay for only part of the cost of the property with their own cash, and the rest of the amount is paid for with borrowed money.

**PROFESSOR'S NOTE**

An example of calculating the leveraged return from buying a stock using margin appears in Equity Investments.

## LOS 52.b: Compare the money-weighted and time-weighted rates of return and evaluate the performance of portfolios based on these measures.

*CFA® Program Curriculum, Volume 6, page 118*

The **money-weighted return** applies the concept of IRR to investment portfolios. The money-weighted rate of return is defined as the internal rate of return on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow, as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

**EXAMPLE: Money-weighted rate of return**

Assume an investor buys a share of stock for $100 at t = 0 and at the end of the year (t = 1), she buys an additional share for $120. At the end of Year 2, the investor sells both shares for $130 each. At the end of each year in the holding period, the stock paid a $2.00 per share dividend. What is the money-weighted rate of return?

*Step 1:* Determine the timing of each cash flow and whether the cash flow is an inflow (+), into the account, or an outflow (–), available from the account.

| | | | | |
|---|---|---|---|---|
| t = 0: | purchase of first share | = | +$100.00 | inflow to account |
| t = 1: | purchase of second share | = | +$120.00 | |
| | dividend from first share | = | –$2.00 | |
| | Subtotal, t = 1 | | +$118.00 | inflow to account |
| t = 2: | dividend from two shares | = | –$4.00 | |
| | proceeds from selling shares | = | –$260.00 | |
| | Subtotal, t = 2 | | –$264.00 | outflow from account |

*Step 2:* Net the cash flows for each time period and set the PV of cash inflows equal to the present value of cash outflows.

$$PV_{inflows} = PV_{outflows}$$

$$\$100 + \frac{\$118}{(1+r)} = \frac{\$264}{(1+r)^2}$$

*Step 3:* Solve for *r* to find the money-weighted rate of return. This can be done using trial and error or by using the IRR function on a financial calculator or spreadsheet.

The intuition here is that we deposited $100 into the account at t = 0, then added $118 to the account at t = 1 (which, with the $2 dividend, funded the purchase of one more share at $120), and ended with a total value of $264.

To compute this value with a financial calculator, use these net cash flows and follow the procedure(s) described to calculate the IRR.

Net cash flows: $CF_0 = +100$; $CF_1 = +120 - 2 = +118$; $CF_2 = -260 + -4 = -264$

**Calculating money-weighted return with the TI Business Analyst II Plus®**

Note that the values for F01, F02, etc., are all equal to one.

| Key Strokes | Explanation | Display |
|---|---|---|
| [CF] [2nd][CLR WORK] | Clear Cash Flow Registers | CF0 = 0.00000 |
| 100 [ENTER] | Initial Cash Outlay | CF0 = +100.00000 |
| [↓] 118 [ENTER] | Period 1 Cash Flow | C01 = +118.00000 |

| | | |
|---|---|---|
| [↓] [↓] 264 [+/–] [ENTER] | Period 2 Cash Flow | C02 = –264.00000 |
| [IRR] [CPT] | Calculate IRR | IRR = 13.86122 |

The money-weighted rate of return for this problem is 13.86%.

## PROFESSOR'S NOTE

In the preceding example, we entered the flows into the account as positive and the ending value as a negative (the investor could withdraw this amount from the account). Note that there is no difference in the solution if we enter the cash flows into the account as negative values (out of the investor's pocket) and the ending value as a positive value (into the investor's pocket). As long as payments into the account and payments out of the account (including the ending value) are entered with opposite signs, the computed IRR will be correct.

**Time-weighted rate of return** measures compound growth. It is the rate at which $1 compounds over a specified performance horizon. Time-weighting is the process of averaging a set of values over time. The *annual* time-weighted return for an investment may be computed by performing the following steps:

*Step 1:* Value the portfolio immediately preceding significant additions or withdrawals. Form subperiods over the evaluation period that correspond to the dates of deposits and withdrawals.

*Step 2:* Compute the holding period return (HPR) of the portfolio for each subperiod.

*Step 3:* Compute the product of (1 + HPR) for each subperiod to obtain a total return for the entire measurement period [i.e., $(1 + HPR_1) \times (1 + HPR_2) \ldots (1 + HPR_n)] - 1$. If the total investment period is greater than one year, you must take the geometric mean of the measurement period return to find the annual time-weighted rate of return.

**EXAMPLE: Time-weighted rate of return**

An investor purchases a share of stock at t = 0 for $100. At the end of the year, t = 1, the investor buys another share of the same stock for $120. At the end of Year 2, the investor sells both shares for $130 each. At the end of both years 1 and 2, the stock paid a $2 per share dividend. What is the annual time-weighted rate of return for this investment? (This is the same investment as the preceding example.)

**Answer:**

*Step 1:* Break the evaluation period into two subperiods based on timing of cash flows.

| | | |
|---|---|---|
| Holding period 1: | Beginning value | = $100 |
| | Dividends paid | = $2 |
| | Ending value | = $120 |
| Holding period 2: | Beginning value | = $240 (2 shares) |
| | Dividends paid | = $4 ($2 per share) |
| | Ending value | = $260 (2 shares) |

*Step 2:* Calculate the HPR for each holding period.

$$HPR_1 = [(\$120 + 2) / \$100] - 1 = 22\%$$

$$HPR_2 = [(\$260 + 4) / \$240] - 1 = 10\%$$

*Step 3:* Find the compound annual rate that would have produced a total return equal to the return on the account over the 2-year period.

$$(1 + \text{time-weighted rate of return})^2 = (1.22)(1.10)$$

$$\text{time-weighted rate of return} = [(1.22)(1.10)]^{0.5} - 1 = 15.84\%$$

In the investment management industry, *the time-weighted rate of return is the preferred method of performance measurement, because it is not affected by the timing of cash inflows and outflows*.

In the preceding examples, the time-weighted rate of return for the portfolio was 15.84%, while the money-weighted rate of return for the same portfolio was 13.86%. The results are different because the money-weighted rate of return gave a larger weight to the Year 2 HPR, which was 10%, versus the 22% HPR for Year 1. This is because there was more money in the account at the beginning of the second period.

If funds are contributed to an investment portfolio just before a period of relatively poor portfolio performance, the money-weighted rate of return will tend to be lower than the time-weighted rate of return. On the other hand, if funds are contributed to a portfolio at a favorable time (just prior to a period of relatively high returns), the money-weighted rate of return will be higher than the time-weighted rate of return. The use of the time-weighted return removes these distortions and thus provides a better measure of a manager's ability to select investments over the period. If the manager has complete control over money flows into and out of an account, the money-weighted rate of return would be the more appropriate performance measure.

## LOS 52.c: Describe characteristics of the major asset classes that investors consider in forming portfolios.

*CFA® Program Curriculum, Volume 6, page 133*

An examination of the returns and standard deviation of returns for the major investable asset classes supports the idea of a tradeoff between risk and return. Using U.S. data over the period 1926–2017 as an example, shown in Figure 52.1, small-capitalization stocks have had the greatest average returns and greatest risk over the period. T-bills had the lowest average returns and the lowest standard deviation of returns.

**Figure 52.1: Risk and Return of Major Asset Classes in the United States (1926–2017)[1]**

| Assets Class | Average Annual Return (Geometric Mean) | Standard Deviation (Annualized Monthly) |
|---|---|---|
| Small-cap stocks | 12.1% | 31.7% |
| Large-cap stocks | 10.2% | 19.8% |
| Long-term corporate bonds | 6.1% | 8.3% |
| Long-term government bonds | 5.5% | 9.9% |
| Treasury bills | 3.4% | 3.1% |
| Inflation | 2.9% | 4.0% |

Results for other markets around the world are similar: asset classes with the greatest average returns also have the highest standard deviations of returns.

The annual nominal return on U.S. equities has varied greatly from year to year, ranging from losses greater than 40% to gains of more than 50%. We can approximate the real returns over the period by subtracting inflation. The asset class with the least risk, T-bills, had a real return of only approximately 0.5% over the period, while the approximate real return on U.S. large-

cap stocks was 7.3%. Because annual inflation fluctuated greatly over the period, real returns have been much more stable than nominal returns.

Evaluating investments using expected return and variance of returns is a simplification because returns do not follow a normal distribution; distributions are negatively skewed, with greater kurtosis (fatter tails) than a normal distribution. The negative skew reflects a tendency towards large downside deviations, while the positive excess kurtosis reflects frequent extreme deviations on both the upside and downside. These non-normal characteristics of skewness ($\neq 0$) and kurtosis ($\neq 3$) should be taken into account when analyzing investments.

Liquidity is an additional characteristic to consider when choosing investments because liquidity can affect the price and, therefore, the expected return of a security. Liquidity can be a major concern in emerging markets and for securities that trade infrequently, such as low-quality corporate bonds.

# MODULE 52.2: COVARIANCE AND CORRELATION

Video covering this content is available online.

**LOS 52.d: Calculate and interpret the mean, variance, and covariance (or correlation) of asset returns based on historical data.**

*CFA® Program Curriculum, Volume 6, page 133*

## Variance (Standard Deviation) of Returns for an Individual Security

In finance, the variance and standard deviation of returns are common measures of investment risk. Both of these are measures of the variability of a distribution of returns about its mean or expected value.

We can calculate the population variance, $\sigma^2$, when we know the return $R_t$ for each period, the total number periods ($T$), and the mean or expected value of the population's distribution ($\mu$), as follows:

$$\sigma^2 = \frac{\sum_{t=1}^{T} (R_t - \mu)^2}{T}$$

In the world of finance, we are typically analyzing only a sample of returns data, rather than the entire population. To calculate sample variance, $s^2$, using a sample of $T$ historical returns and the mean, $\overline{R}$, of the observations, we use the following formula:

$$s^2 = \frac{\sum_{t=1}^{T} (R_t - \overline{R})^2}{T-1}$$

## Covariance and Correlation of Returns for Two Securities

**Covariance** measures the extent to which two variables move together over time. A positive covariance means that the variables (e.g., rates of return on two stocks) tend to move together. Negative covariance means that the two variables tend to move in opposite directions. A covariance of zero means there is no linear relationship between the two variables. To put it another way, if the covariance of returns between two assets is zero,

knowing the return for the next period on one of the assets tells you nothing about the return of the other asset for the period.

Here we will focus on the calculation of the covariance between two assets' returns using **historical data**. The calculation of the sample covariance is based on the following formula:

$$\text{Cov}_{1,2} = \frac{\sum_{t=1}^{n}\{[R_{t,1} - \overline{R}_1][R_{t,2} - \overline{R}_2]\}}{n-1}$$

where:

$R_{t,1}$ = return on Asset 1 in period *t*

$R_{t,2}$ = return on Asset 2 in period *t*

$\overline{R}_1$ = mean return on Asset 1

$\overline{R}_2$ = mean return on Asset 2

n = number of periods

The magnitude of the covariance depends on the magnitude of the individual stocks' standard deviations and the relationship between their co-movements. Covariance is an absolute measure and is measured in return units squared.

The covariance of the returns of two securities can be standardized by dividing by the product of the standard deviations of the two securities. This standardized measure of co-movement is called **correlation** and is computed as:

$$\rho_{1,2} = \frac{\text{Cov}_{1,2}}{\sigma_1 \sigma_2}$$

The relation can also be written as:

$$\text{Cov}_{1,2} = \rho_{1,2}\sigma_1\sigma_2$$

The term $\rho_{1,2}$ is called the *correlation coefficient* between the returns of securities 1 and 2. The correlation coefficient has no units. It is a pure measure of the co-movement of the two stocks' returns and is bounded by –1 and +1.

How should you interpret the correlation coefficient?

- A correlation coefficient of +1 means that deviations from the mean or expected return are always proportional in the same direction. That is, they are perfectly positively correlated.
- A correlation coefficient of –1 means that deviations from the mean or expected return are always proportional in opposite directions. That is, they are perfectly negatively correlated.
- A correlation coefficient of zero means that there is no linear relationship between the two stocks' returns. They are uncorrelated. One way to interpret a correlation (or covariance) of zero is that, in any period, knowing the actual value of one variable tells you nothing about the value of the other.

**EXAMPLE: Calculating mean return, returns variance, returns covariance, and correlation**

Given three years of percentage returns for assets A and B in the following table, calculate the mean return and sample standard deviation for each asset, the sample covariance, and the correlation of returns.

| Year | Asset A | Asset B |
|---|---|---|

| | | |
|---|---|---|
| 1 | 5% | 7% |
| 2 | –2% | –4% |
| 3 | 12% | 18% |

**Answer:**

mean return for asset A = (5% – 2% + 12%) / 3 = 5%

mean return for asset B = (7% – 4% + 18%) / 3 = 7%

sample variance of returns for asset A = $\frac{(5–5)^2+(–2–5)^2+(12–5)^2}{3–1}$ =

= 49

sample standard deviation for asset A = $\sqrt{49}$ = 7%

sample variance of returns for asset B = $\frac{(7–7)^2+(–4–7)^2+(18–7)^2}{3–1} = 121$

sample standard deviation for asset B = $\sqrt{121} = 11\%$

sample covariance of returns for assets A and B = $\frac{(5–5)(7–7)+(–2–5)(–4–7)+(12–5)(18–7)}{3–1} = 77$

correlation of returns for assets A and B = $\frac{77}{7\times11} = 1$

In this example, the returns on assets A and B are perfectly positively correlated.

## LOS 52.e: Explain risk aversion and its implications for portfolio selection.

*CFA® Program Curriculum, Volume 6, page 140*

A **risk-averse** investor is simply one that dislikes risk (i.e., prefers less risk to more risk). Given two investments that have equal expected returns, a risk-averse investor will choose the one with less risk (standard deviation, σ).

A **risk-seeking** (risk-loving) investor actually prefers more risk to less and, given equal expected returns, will choose the more risky investment. A **risk-neutral** investor has no preference regarding risk and would be indifferent between two such investments.

Consider this gamble: A coin will be flipped; if it comes up heads, you receive $100; if it comes up tails, you receive nothing. The expected payoff is 0.5($100) + 0.5($0) = $50. A risk-averse investor would choose a payment of $50 (a certain outcome) over the gamble. A risk-seeking investor would prefer the gamble to a certain payment of $50. A risk-neutral investor would be indifferent between the gamble and a certain payment of $50.

If expected returns are identical, a risk-averse investor will always choose the investment with the least risk. However, an investor may select a very risky portfolio despite being risk averse; a risk-averse investor will hold very risky assets if he feels that the extra return he expects to earn is adequate compensation for the additional risk.

### MODULE QUIZ 52.1, 52.2

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

1. An investor buys a share of stock for $40 at time t = 0, buys another share of the same stock for $50 at t = 1, and sells both shares for $60 each at t = 2. The stock paid a dividend of $1 per share at t = 1 and at t = 2. The periodic money-weighted rate of return on the investment is *closest* to:
   A. 22.2%.

B. 23.0%.
C. 23.8%.

2. Which of the following asset classes has historically had the highest returns and standard deviation?
   A. Small-cap stocks.
   B. Large-cap stocks.
   C. Long-term corporate bonds.
3. In a five-year period, the annual returns on an investment are 5%, –3%, –4%, 2%, and 6%. The standard deviation of annual returns on this investment is *closest* to:
   A. 4.0%.
   B. 4.5%.
   C. 20.7%.
4. A measure of how the returns of two risky assets move in relation to each other is:
   A. the range.
   B. the covariance.
   C. the standard deviation.
5. Which of the following statements about correlation is *least accurate*?
   A. Diversification reduces risk when correlation is less than +1.
   B. If the correlation coefficient is 0, a zero variance portfolio can be constructed.
   C. The lower the correlation coefficient, the greater the potential benefits from diversification.
6. The variance of returns is 0.09 for Stock A and 0.04 for Stock B. The covariance between the returns of A and B is 0.006. The correlation of returns between A and B is:
   A. 0.10.
   B. 0.20.
   C. 0.30.
7. Which of the following statements about risk-averse investors is *most accurate*? A risk-averse investor:
   A. seeks out the investment with minimum risk, while return is not a major consideration.
   B. will take additional investment risk if sufficiently compensated for this risk.
   C. avoids participating in global equity markets.

# MODULE 52.3: THE EFFICIENT FRONTIER

Video covering this content is available online.

## LOS 52.f: Calculate and interpret portfolio standard deviation.

*CFA® Program Curriculum, Volume 6, page 150*

The variance of returns for a portfolio of two risky assets is calculated as follows:

$$\text{Var}_{\text{portfolio}} = \text{w}_1^2\sigma_1^2 + \text{w}_2^2\sigma_2^2 + 2\text{w}_1\text{w}_2\text{Cov}_{12}$$

where $w_1$ is the proportion of the portfolio invested in Asset 1, and $w_2$ is the proportion of the portfolio invested in Asset 2. $w_2$ must equal $(1 - w_1)$.

Previously, we established that the correlation of returns for two assets is calculated as:

$$\rho_{12} = \frac{\text{Cov}_{12}}{\sigma_1\sigma_2}, \text{ so that we can also write } \text{Cov}_{12} = \rho_{12}\sigma_1\sigma_2.$$

Substituting this term for $\text{Cov}_{12}$ in the formula for the variance of returns for a portfolio of two risky assets, we have the following:

$$\text{Var}_{\text{portfolio}} = \text{w}_1^2\sigma_1^2 + \text{w}_2^2\sigma_2^2 + 2\text{w}_1\text{w}_2\rho_{12}\sigma_1\sigma_2$$

Because $\text{Var}_{\text{portfolio}} = \sigma^2_{\text{portfolio}}$, this can also be written as:

$$\sigma_{\text{portfolio}} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2}$$

Writing the formula in this form allows us to easily see the effect of the correlation of returns between the two assets on portfolio risk.

**EXAMPLE: Calculating portfolio standard deviation**

A portfolio is 30% invested in stocks that have a standard deviation of returns of 20% and is 70% invested in bonds that have a standard deviation of returns of 12%. The correlation of bond returns with stock returns is 0.60. What is the standard deviation of portfolio returns? What would it be if stock and bond returns were perfectly positively correlated?

**Answer:**

portfolio standard deviation

$$= \sqrt{(0.3^2)(0.2^2) + (0.7^2)(0.12^2) + 2(0.3)(0.7)(0.6)(0.2)(0.12)}$$

= 12.9%

If stock and bond returns were perfectly positively correlated, portfolio standard deviation would simply be the weighted average of the assets' standard deviations: 0.3(20%) + 0.7(12%) = 14.4%.

## LOS 52.g: Describe the effect on a portfolio's risk of investing in assets that are less than perfectly correlated.

*CFA® Program Curriculum, Volume 6, page 152*

If two risky asset returns are perfectly positively correlated, $\rho_{12} = +1$, then the square root of portfolio variance (the portfolio standard deviation of returns) is equal to:

$$\sigma_{\text{portfolio}} = \sqrt{\text{Var}_{\text{portfolio}}} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2(1)} = w_1\sigma_1 + w_2\sigma_2$$

**PROFESSOR'S NOTE**

This might be easier to see by examining the algebra in reverse. If $w_1\sigma_1 + w_2\sigma_2$ equals the square root of the term under the radical in this special case, then $(w_1\sigma_1 + w_2\sigma_2)^2$ should equal the term under the radical. If we expand $(w_1\sigma_1 + w_2\sigma_2)^2$, we get:

$$(w_1\sigma_1 + w_2\sigma_2)^2 = (w_1\sigma_1)^2 + (w_1\sigma_1)(w_2\sigma_2) + (w_2\sigma_2)(w_1\sigma_1) + (w_2\sigma_2)^2$$

$$= (w_1\sigma_1)^2 + (w_2\sigma_2)^2 + 2(w_1\sigma_1)(w_2\sigma_2)$$

$$= w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1\sigma_1w_2\sigma_2$$

In this unique case, with $\rho_{12} = 1$, the portfolio standard deviation is simply a weighted average of the standard deviations of the individual asset returns. A portfolio 25% invested in Asset 1 and 75% invested in Asset 2 will have a standard deviation of returns equal to 25% of the standard deviation ($\sigma_1$) of Asset 1's return, plus 75% of the standard deviation ($\sigma_2$) of Asset 2's return.

Focusing on returns correlation, we can see that the greatest portfolio risk results when the correlation between asset returns is +1. For any value of correlation less than +1, portfolio

variance is reduced. Note that for a correlation of zero, the entire third term in the portfolio variance equation is zero. For negative values of correlation $\rho_{12}$, the third term becomes negative and further reduces portfolio variance and standard deviation.

We will illustrate this property with an example.

**EXAMPLE: Portfolio risk as correlation varies**

Consider two risky assets that have returns variances of 0.0625 and 0.0324, respectively. The assets' standard deviations of returns are then 25% and 18%, respectively. Calculate the variances and standard deviations of portfolio returns for an equal-weighted portfolio of the two assets when their correlation of returns is 1, 0.5, 0, and –0.5.

The calculations are as follows:

$$\text{variance}_{\text{portfolio}} = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_1\sigma_1\sigma_2$$

$$\sigma_{\text{portfolio}} = \sqrt{\text{variance}_{\text{portfolio}}}$$

$$\sigma_{\text{portfolio}} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2}$$

ρ **= correlation = +1:**

σ = portfolio standard deviation = 0.5(25%) + 0.5(18%) = **21.5%**

$\sigma^2$ = portfolio variance = $0.215^2$ = 0.046225

ρ **= correlation = 0.5:**

$\sigma^2 = (0.5^2)0.0625 + (0.5^2)0.0324 + 2(0.5)(0.5)(\mathbf{0.5})(0.25)(0.18) = 0.034975$

σ = **18.70%**

ρ **= correlation = 0:**

$\sigma^2 = (0.5^2)0.0625 + (0.5^2)0.0324 = 0.023725$

σ = **15.40%**

ρ **= correlation = –0.5:**

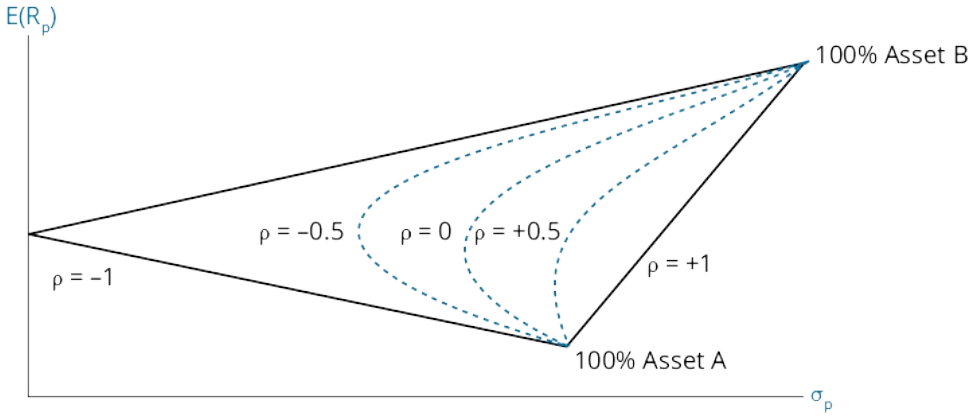
$\sigma^2 = (0.5^2)0.0625 + (0.5^2)0.0324 + 2(0.5)(0.5)(\mathbf{-0.5})(0.25)(0.18) = 0.012475$

σ = **11.17%**

Note that portfolio risk falls as the correlation between the assets' returns decreases. This is an important result of the analysis of portfolio risk: The lower the correlation of asset returns, the greater the risk reduction (diversification) benefit of combining assets in a portfolio. If asset returns were perfectly negatively correlated, portfolio risk could be eliminated altogether for a specific set of asset weights.

We show these relations graphically in Figure 52.2 by plotting the portfolio risk and return for all portfolios of two risky assets, for assumed values of the assets' returns correlation.

**Figure 52.2: Risk and Return for Different Values of ρ**




From these analyses, the risk-reduction benefits of investing in assets with low return correlations should be clear. The desire to reduce risk is what drives investors to invest in not just domestic stocks, but also bonds, foreign stocks, real estate, and other assets.

## LOS 52.h: Describe and interpret the minimum-variance and efficient frontiers of risky assets and the global minimum-variance portfolio.

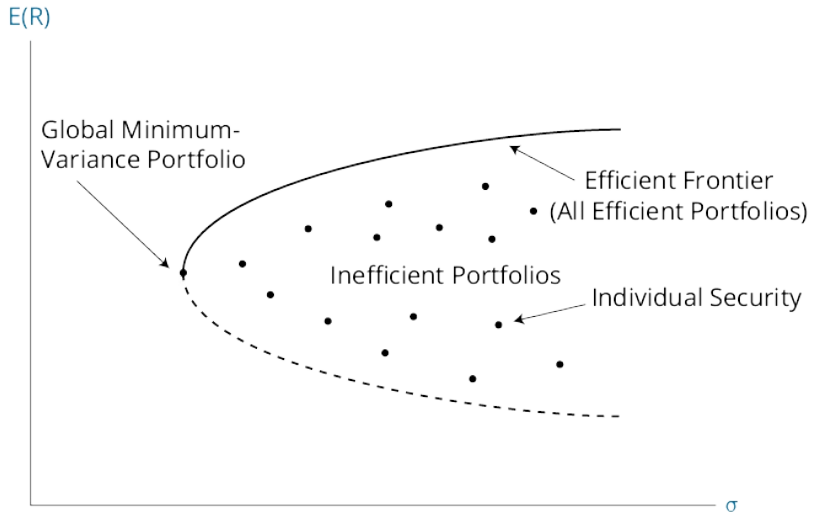
*CFA® Program Curriculum, Volume 6, page 163*

For each level of expected portfolio return, we can vary the portfolio weights on the individual assets to determine the portfolio that has the least risk. These portfolios that have the lowest standard deviation of all portfolios with a given expected return are known as **minimum-variance portfolios**. Together they make up the **minimum-variance frontier**.

Assuming that investors are risk averse, investors prefer the portfolio that has the greatest expected return when choosing among portfolios that have the same standard deviation of returns. Those portfolios that have the greatest expected return for each level of risk (standard deviation) make up the **efficient frontier**. The efficient frontier coincides with the top portion of the minimum-variance frontier. A risk-averse investor would only choose portfolios that are on the efficient frontier because all available portfolios that are not on the efficient frontier have lower expected returns than an efficient portfolio with the same risk. The portfolio on the efficient frontier that has the least risk is the **global minimum-variance portfolio**.

These concepts are illustrated in Figure 52.3.

**Figure 52.3: Minimum-Variance and Efficient Frontiers**

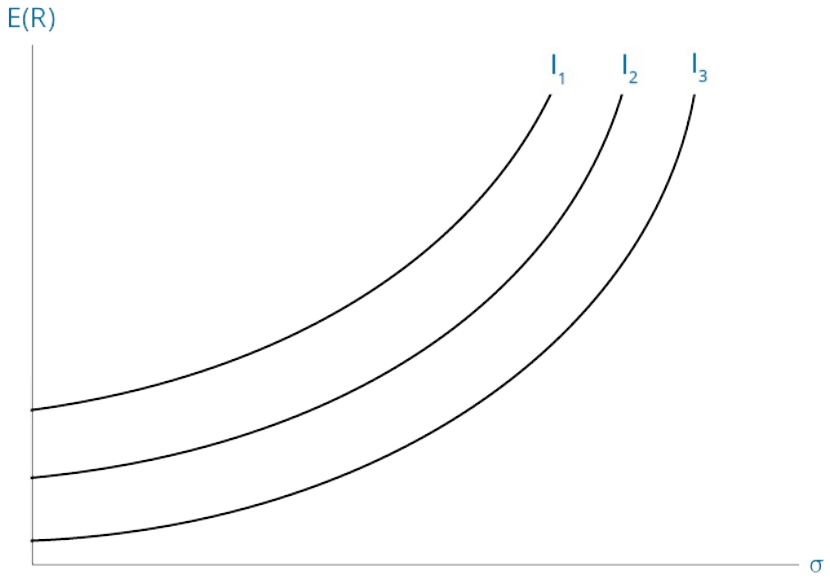



## LOS 52.i: Explain the selection of an optimal portfolio, given an investor's utility (or risk aversion) and the capital allocation line.

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

An investor's **utility function** represents the investor's preferences in terms of risk and return (i.e., his degree of risk aversion). An **indifference curve** is a tool from economics that, in this application, plots combinations of risk (standard deviation) and expected return among which an investor is indifferent. In constructing indifference curves for portfolios based on only their expected return and standard deviation of returns, we are assuming that these are the only portfolio characteristics that investors care about. In Figure 52.4, we show three indifference curves for an investor. The investor's expected utility is the same for all points along a single indifference curve. Indifference curve $I_1$ represents the most preferred portfolios in Figure 52.4; our investor will prefer any portfolio along $I_1$ to any portfolio on either $I_2$ or $I_3$.

**Figure 52.4: Risk-Averse Investor's Indifference Curves**



Indifference curves slope upward for risk-averse investors because they will only take on more risk (standard deviation of returns) if they are compensated with greater expected returns. An investor who is relatively more risk averse requires a relatively greater increase in expected return to compensate for a given increase in risk. In other words, a more risk-averse investor will have steeper indifference curves, reflecting a higher **risk aversion coefficient**.

In our previous illustration of efficient portfolios available in the market, we included only risky assets. Now we will introduce a risk-free asset into our universe of available assets, and we will consider the risk and return characteristics of a portfolio that combines a portfolio of risky assets and the risk-free asset. Recall from Quantitative Methods that we can calculate the expected return and standard deviation of a portfolio with weight $W_A$ allocated to risky Asset A and weight $W_B$ allocated to risky Asset B using the following formulas:

$$E(R_{portfolio}) = W_A E(R_A) + W_B E(R_B)$$

$$\sigma_{portfolio} = \sqrt{W_A^2\sigma_A^2 + W_B^2\sigma_B^2 + 2W_A W_B \rho_{AB}\sigma_A\sigma_B}$$

Allow Asset B to be the risk-free asset and Asset A to be the risky asset portfolio. Because a risk-free asset has zero standard deviation and zero correlation of returns with those of a risky portfolio, this results in the reduced equation:

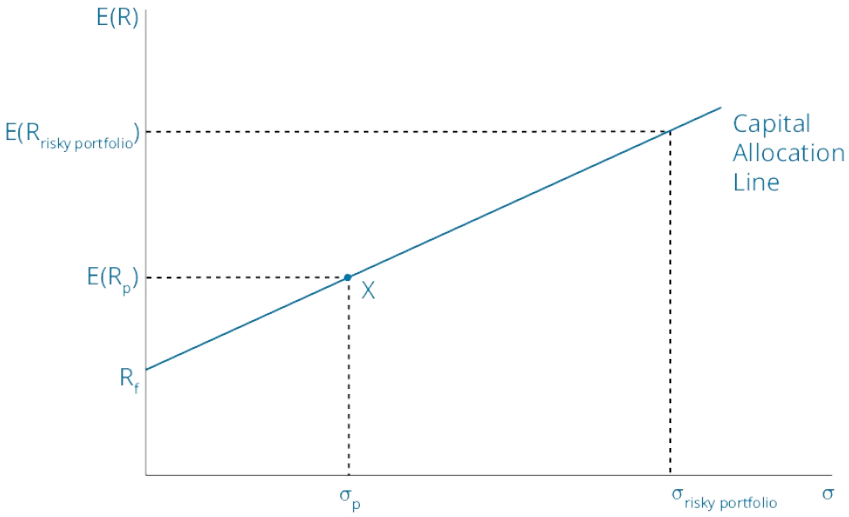
$$\sigma_{portfolio} = \sqrt{W_A^2\sigma_A^2} = W_A\sigma_A$$

The intuition of this result is quite simple: If we put X% of our portfolio into the risky asset portfolio, the resulting portfolio will have standard deviation of returns equal to X% of the standard deviation of the risky asset portfolio. The relationship between portfolio risk and return for various portfolio allocations is linear, as illustrated in Figure 52.5.

Combining a risky portfolio with a risk-free asset is the process that supports the **two-fund separation theorem**, which states that all investors' optimum portfolios will be made up of some combination of an optimal portfolio of risky assets and the risk-free asset. The line representing these possible combinations of risk-free assets and the optimal risky asset portfolio is referred to as the **capital allocation line**.

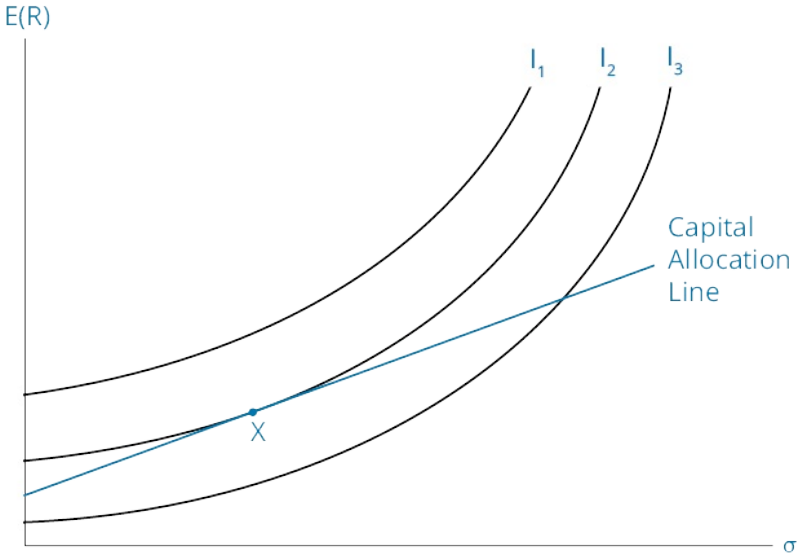
Point X on the capital allocation line in Figure 52.5 represents a portfolio that is 40% invested in the risky asset portfolio and 60% invested in the risk-free asset. Its expected return will be $0.40[E(R_{risky\ asset\ portfolio})] + 0.60(R_f)$, and its standard deviation will be $0.40(\sigma_{risky\ asset\ portfolio})$.

**Figure 52.5: Capital Allocation Line and Risky Asset Weights**




Now that we have constructed a set of the possible efficient portfolios (the capital allocation line), we can combine this with indifference curves representing an individual's preferences for risk and return to illustrate the logic of selecting an optimal portfolio (i.e., one that maximizes the investor's expected utility). In Figure 52.6, we can see that Investor A, with preferences represented by indifference curves $I_1$, $I_2$, and $I_3$, can reach the level of expected utility on $I_2$ by selecting portfolio X. This is the optimal portfolio for this investor, as any portfolio that lies on $I_2$ is preferred to all portfolios that lie on $I_3$ (and in fact to any portfolios that lie between $I_2$ and $I_3$). Portfolios on $I_1$ are preferred to those on $I_2$, but none of the portfolios that lie on $I_1$ are available in the market.

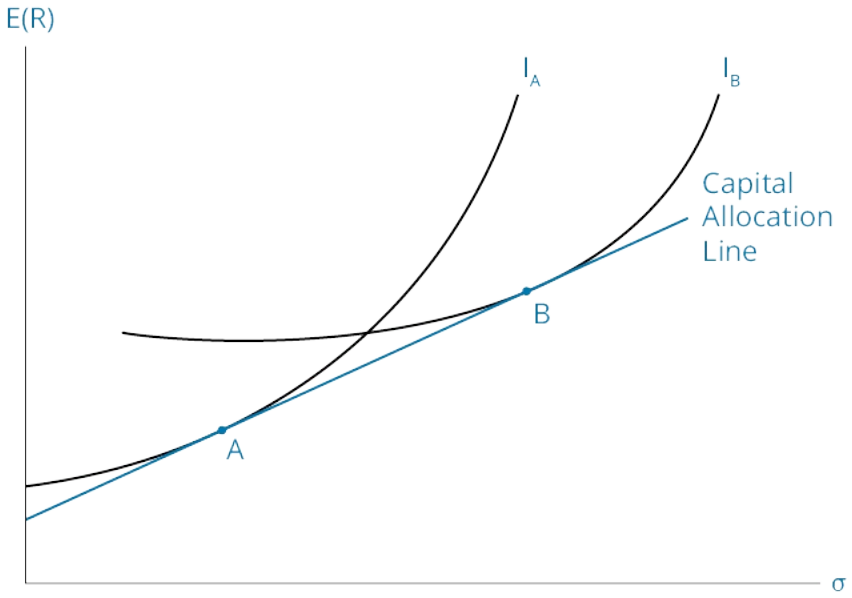
**Figure 52.6: Risk-Averse Investor's Indifference Curves**




The final result of our analysis here is not surprising; investors who are less risk averse will select portfolios that are more risky. Recall that the less an investor's risk aversion, the flatter his indifference curves. As illustrated in Figure 52.7, the flatter indifference curve for Investor B ($I_B$) results in an optimal (tangency) portfolio that lies to the right of the one that results from a steeper indifference curve, such as that for Investor A (*IA*). An investor who is

less risk averse should optimally choose a portfolio with more invested in the risky asset portfolio and less invested in the risk-free asset.

**Figure 52.7: Portfolio Choices Based on Investor's Indifference Curves**




## MODULE QUIZ 52.3

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

**Use the following data to answer Questions 1 and 2.**

A portfolio was created by investing 25% of the funds in Asset A (standard deviation = 15%) and the balance of the funds in Asset B (standard deviation = 10%).

1. If the correlation coefficient is 0.75, what is the portfolio's standard deviation?
   A. 10.6%.
   B. 12.4%.
   C. 15.0%.
2. If the correlation coefficient is –0.75, what is the portfolio's standard deviation?
   A. 2.8%.
   B. 4.2%.
   C. 5.3%.
3. Which of the following statements about covariance and correlation is *least accurate*?
   A. A zero covariance implies there is no linear relationship between the returns on two assets.
   B. If two assets have perfect negative correlation, the variance of returns for a portfolio that consists of these two assets will equal zero.
   C. The covariance of a 2-stock portfolio is equal to the correlation coefficient times the standard deviation of one stock's returns times the standard deviation of the other stock's returns.
4. Which of the following available portfolios *most likely* falls below the efficient frontier?

| | Portfolio | Expected return | Expected standard deviation |
|---|---|---|---|
| A. | A | 7% | 14% |
| B. | B | 9% | 26% |
| C. | C | 12% | 22% |

5. The capital allocation line is a straight line from the risk-free asset through:
   A. the global maximum-return portfolio.

B. the optimal risky portfolio.
C. the global minimum-variance portfolio.

# KEY CONCEPTS

## LOS 52.a

Holding period return is used to measure an investment's return over a specific period. Arithmetic mean return is the simple average of a series of periodic returns. Geometric mean return is a compound annual rate.

Gross return is total return after deducting commissions on trades and other costs necessary to generate the returns, but before deducting fees for the management and administration of the investment account. Net return is the return after management and administration fees have been deducted.

Pretax nominal return is the numerical percentage return of an investment, without considering the effects of taxes and inflation. After-tax nominal return is the numerical return after the tax liability is deducted, without adjusting for inflation. Real return is the increase in an investor's purchasing power, roughly equal to nominal return minus inflation. Leveraged return is the gain or loss on an investment as a percentage of an investor's cash investment.

## LOS 52.b

The money-weighted rate of return is the IRR calculated using periodic cash flows into and out of an account and is the discount rate that makes the PV of cash inflows equal to the PV of cash outflows.

The time-weighted rate of return measures compound growth. It is the rate at which $1 compounds over a specified performance horizon.

If funds are added to a portfolio just before a period of poor performance, the money-weighted return will be lower than the time-weighted return. If funds are added just prior to a period of high returns, the money-weighted return will be higher than the time-weighted return.

The time-weighted return is the preferred measure of a manager's ability to select investments. If the manager controls the money flows into and out of an account, the money-weighted return is the more appropriate performance measure.

## LOS 52.c

As predicted by theory, asset classes with the greatest average returns have also had the highest risk.

Some of the major asset classes that investors consider when building a diversified portfolio include small-capitalization stocks, large-capitalization stocks, long-term corporate bonds, long-term Treasury bonds, and Treasury bills.

In addition to risk and return, when analyzing investments, investors also take into consideration an investment's liquidity, as well as non-normal characteristics such as skewness and kurtosis.

## LOS 52.d

We can calculate the population variance, $\sigma^2$, when we know the return $R_t$ for period $t$, the total number $T$ of periods, and the mean $\mu$ of the population's distribution:

$$\text{population variance} = \sigma^2 = \frac{\sum_{t=1}^{T}(R_t - \mu)^2}{T}$$

In finance, we typically analyze only a sample of returns, so the sample variance applies instead:

$$\text{sample variance} = S^2 = \frac{\sum_{t=1}^{T}(R_t - \overline{R})^2}{T-1}$$

Covariance measures the extent to which two variables move together over time. Positive covariance means the variables (e.g., rates of return on two stocks) tend to move together. Negative covariance means that the two variables tend to move in opposite directions. Covariance of zero means there is no linear relationship between the two variables.

Correlation is a standardized measure of co-movement that is bounded by –1 and +1:

$$\rho_{1,2} = \frac{Cov_{1,2}}{\sigma_1 \sigma_2}$$

## LOS 52.e

A risk-averse investor is one that dislikes risk. Given two investments that have equal expected returns, a risk-averse investor will choose the one with less risk. However, a risk-averse investor will hold risky assets if he feels that the extra return he expects to earn is adequate compensation for the additional risk. Assets in the financial markets are priced according to the preferences of risk-averse investors.

A risk-seeking (risk-loving) investor actually prefers more risk to less and, given investments with equal expected returns, will choose the more risky investment.

A risk-neutral investor has no preference regarding risk and would be indifferent between two investments with the same expected return but different standard deviation of returns.

## LOS 52.f

The standard deviation of returns for a portfolio of two risky assets is calculated as follows:

$$\sigma_{\text{portfolio}} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2}$$

## LOS 52.g

The greatest portfolio risk will result when the asset returns are perfectly positively correlated. As the correlation decreases from +1 to –1, portfolio risk decreases. The lower the correlation of asset returns, the greater the risk reduction (diversification) benefit of combining assets in a portfolio.

## LOS 52.h

For each level of expected portfolio return, the portfolio that has the least risk is known as a minimum-variance portfolio. Taken together, these portfolios form a line called the minimum-variance frontier.

On a risk versus return graph, the one risky portfolio that is farthest to the left (has the least risk) is known as the global minimum-variance portfolio.

Those portfolios that have the greatest expected return for each level of risk make up the efficient frontier. The efficient frontier coincides with the top portion of the minimum variance frontier. Risk-averse investors would only choose a portfolio that lies on the efficient frontier.

## LOS 52.i

An indifference curve plots combinations of risk and expected return that an investor finds equally acceptable. Indifference curves generally slope upward because risk-averse investors will only take on more risk if they are compensated with greater expected returns. A more risk-averse investor will have steeper indifference curves.

Flatter indifference curves (less risk aversion) result in an optimal portfolio with higher risk and higher expected return. An investor who is less risk averse will optimally choose a portfolio with more invested in the risky asset portfolio and less invested in the risk-free asset.

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 52.1, 52.2

1. **C** Using the cash flow functions on your financial calculator, enter $CF_0 = –40$; $CF_1 = –50 + 1 = –49$; $CF_2 = 60 \times 2 + 2 = 122$; CPT IRR = 23.82%. (Module 52.1, LOS 52.a)

2. **A** Small-cap stocks have had the highest annual return and standard deviation of return over time. Large-cap stocks and bonds have historically had lower risk and return than small-cap stocks. (Module 52.1, LOS 52.c)

3. **B** mean annual return = (5% – 3% – 4% + 2% + 6%) / 5 = 1.2%

   Squared deviations from the mean:

   5% – 1.2% = 3.8% $3.8^2 = 14.44$

   –3% –1.2% = –4.2% $–4.2^2 = 17.64$

   –4% –1.2% = –5.2% $–5.2^2 = 27.04$

   2% –1.2% = 0.8% $0.8^2 = 0.64$

   6% –1.2% = 4.8% $4.8^2 = 23.04$

   sum of squared deviations = 14.44 + 17.64 + 27.04 + 0.64 + 23.04 = 82.8

   sample variance = 82.8 / (5 – 1) = 20.7

   sample standard deviation = $20.7^{1/2} = 4.55\%$

   (Module 52.2, LOS 52.d)

4. **B** The covariance is defined as the co-movement of the returns of two assets or how well the returns of two risky assets move together. Range and standard deviation are measures of dispersion and measure risk, not how assets move together. (Module 52.2, LOS 52.d)

5. **B** A zero-variance portfolio can only be constructed if the correlation coefficient between assets is –1. Diversification benefits can be had when correlation is less than +1, and the lower the correlation, the greater the potential benefit. (Module 52.2, LOS 52.d)

6. **A** $\sqrt{A} = \sqrt{0.09} = 0.30$

   $\sqrt{B} = \sqrt{0.04} = 0.20$

   correlation = 0.006 / [(0.30)(0.20)] = 0.10 (Module 52.2, LOS 52.d)

7. **B** Risk-averse investors are generally willing to invest in risky investments, if the return of the investment is sufficient to reward the investor for taking on this risk. Participants in securities markets are generally assumed to be risk-averse investors. (Module 52.2, LOS 52.e)

## Module Quiz 52.3

1. **A** $\sqrt{(0.25)^2(0.15)^2 + (0.75)^2(0.10)^2 + 2(0.25)(0.75)(0.15)(0.10)(0.75)} =$

$\sqrt{0.001406 + 0.005625 + 0.004219} = \sqrt{0.01125} = 0.106 = 10.6\%$
(LOS 52.f)

2. **C** $\sqrt{(0.25)^2(0.15)^2 + (0.75)^2(0.10)^2 + 2(0.25)(0.75)(0.15)(0.10)(-0.75)} =$
$\sqrt{0.001406 + 0.005625 - 0.004219} = \sqrt{0.002812} = 0.053 = 5.3\%$
(LOS 52.f)

3. **B** If the correlation of returns between the two assets is –1, the set of possible portfolio risk/return combinations becomes two straight lines (see Figure 52.2). A portfolio of these two assets will have a positive returns variance unless the portfolio weights are those that minimize the portfolio variance. Covariance is equal to the correlation coefficient multiplied by the product of the standard deviations of the returns of the two stocks in a 2-stock portfolio. If covariance is zero, then correlation is also zero, which implies that there is no linear relationship between the two stocks' returns. (LOS 52.g)

4. **B** Portfolio B must be the portfolio that falls below the Markowitz efficient frontier because there is a portfolio (Portfolio C) that offers a higher return and lower risk. (LOS 52.h)

5. **B** An investor's optimal portfolio will lie somewhere on the capital allocation line, which begins at the risk-free asset and runs through the optimal risky portfolio. (LOS 52.i)

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1. 2018 SBBI Yearbook.

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 #53.

# READING 53: PORTFOLIO RISK AND RETURN: PART II

**Study Session 18**

## EXAM FOCUS

The concepts developed here are very important to finance theory and are also used extensively in practice. You must know this material completely—not only the formulas and definitions, but the ideas that underlie their use. A model assumption that diversification is costless leads to the conclusion that only systematic risk (which cannot be reduced by further diversification) is priced in equilibrium, so that bearing nonsystematic risk does not increase expected returns.

## MODULE 53.1: SYSTEMATIC RISK AND BETA

Video covering this content is available online.

### LOS 53.a: Describe the implications of combining a risk-free asset with a portfolio of risky assets.

*CFA® Program Curriculum, Volume 6, page 192*

In the previous topic review, we covered the mathematics of calculating the risk and return of a portfolio with a percentage weight of $W_A$ invested in a risky portfolio (P) and a weight of $W_B = 1 - W_A$ invested in a risk-free asset.

$$E(R_P) = W_A\,E(R_A) + W_B\,E(R_B)$$

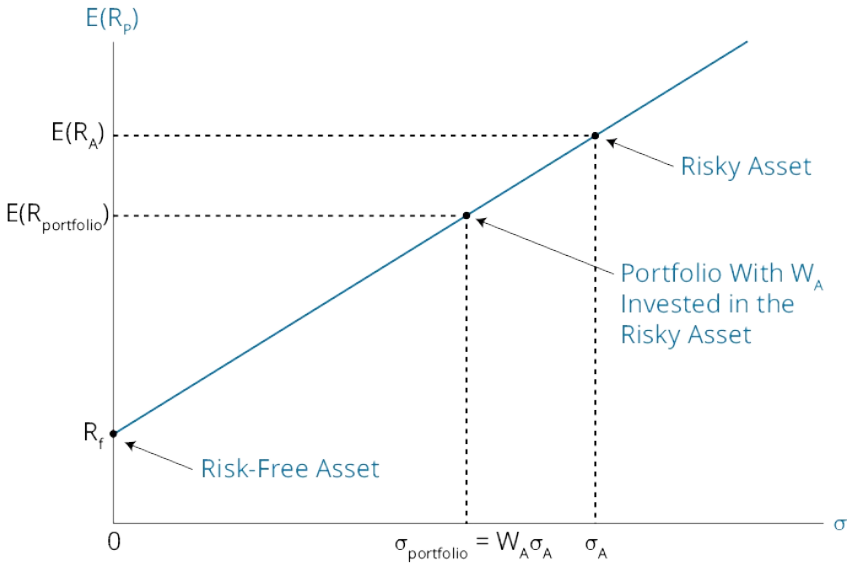
$$\sigma_P = \sqrt{W_A^2\sigma_A^2 + W_B^2\sigma_B^2 + 2W_A W_B \rho_{AB}\sigma_A\sigma_B}$$

Because a risk-free asset has zero standard deviation and zero correlation of returns with a risky portfolio, allowing Asset B to be the risk-free asset and Asset A to be the risky asset portfolio results in the following reduced equation:

$$\sigma_P = \sqrt{W_A^2\sigma_A^2} = W_A\sigma_A$$

Our result is that the risk (standard deviation of returns) and expected return of portfolios with varying weights in the risk-free asset and a risky portfolio can be plotted as a line that begins at the risk-free rate of return and extends through the risky portfolio. This result is illustrated in Figure 53.1.

**Figure 53.1: Combining a Risk-Free Asset With a Risky Asset**

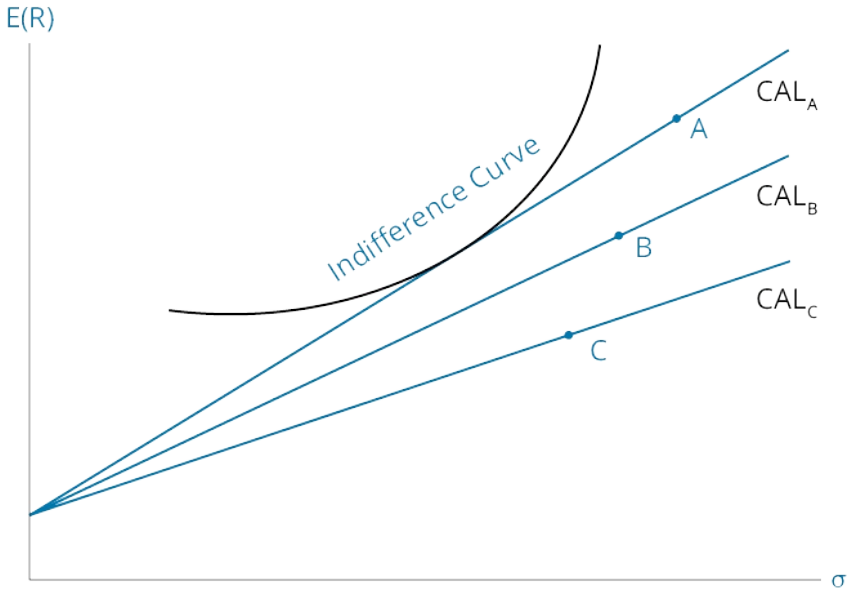



## LOS 53.b: Explain the capital allocation line (CAL) and the capital market line (CML).

*CFA® Program Curriculum, Volume 6, page 192*

The line of possible portfolio risk and return combinations given the risk-free rate and the risk and return of a portfolio of risky assets is referred to as the **capital allocation line** (CAL). For an individual investor, the best CAL is the one that offers the most-preferred set of possible portfolios in terms of their risk and return. Figure 53.2 illustrates three possible investor CALs for three different risky portfolios A, B, and C. The optimal risky portfolio for this investor is Portfolio A because it results in the most preferred set of possible portfolios constructed by combining the risk-free asset with the risky portfolio. Of all the portfolios available to the investor, a combination of the risk-free asset with risky Portfolio A offers the investor the greatest expected utility.

**Figure 53.2: Risky Portfolios and Their Associated Capital Allocation Lines**



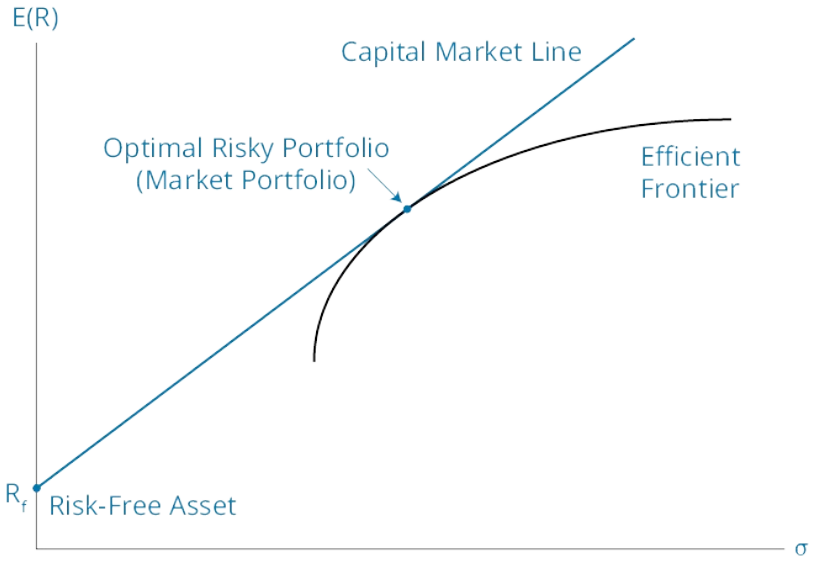

If each investor has different expectations about the expected returns of, standard deviations of, or correlations between risky asset returns, each investor will have a different optimal

risky asset portfolio and a different CAL.

A simplifying assumption underlying modern portfolio theory (and the capital asset pricing model, which is introduced later in this topic review) is that investors have homogeneous expectations (i.e., they all have the same estimates of risk, return, and correlations with other risky assets for all risky assets). Under this assumption, all investors face the same efficient frontier of risky portfolios and will all have the same optimal risky portfolio and CAL.

Figure 53.3 illustrates the determination of the optimal risky portfolio and optimal CAL for all investors under the assumption of homogeneous expectations. Note that, under this assumption, the optimal CAL for any investor is the one that is just tangent to the efficient frontier. Depending on their preferences for risk and return (their indifference curves), investors may choose different portfolio weights for the risk-free asset and the risky (tangency) portfolio. Every investor, however, will use the same risky portfolio. When this is the case, that portfolio must be the **market portfolio** of all risky assets because all investors that hold any risky assets hold the same portfolio of risky assets.

**Figure 53.3: Determining the Optimal Risky Portfolio and Optimal CAL Assuming Homogeneous Expectations**




Under the assumption of homogeneous expectations, this optimal CAL for all investors is termed the **capital market line** (CML). Along this line, expected portfolio return, $E(R_P)$, is a linear function of portfolio risk, $\sigma_P$ . The equation of this line is as follows:

$$E(R_P) = R_f + \left(\frac{E(R_M) - R_f}{\sigma_M}\right)\sigma_P$$

The *y*-intercept of this line is $R_f$ and the slope (rise over run) of this line is as follows:

$$\left(\frac{E(R_M) - R_f}{\sigma_M}\right)$$

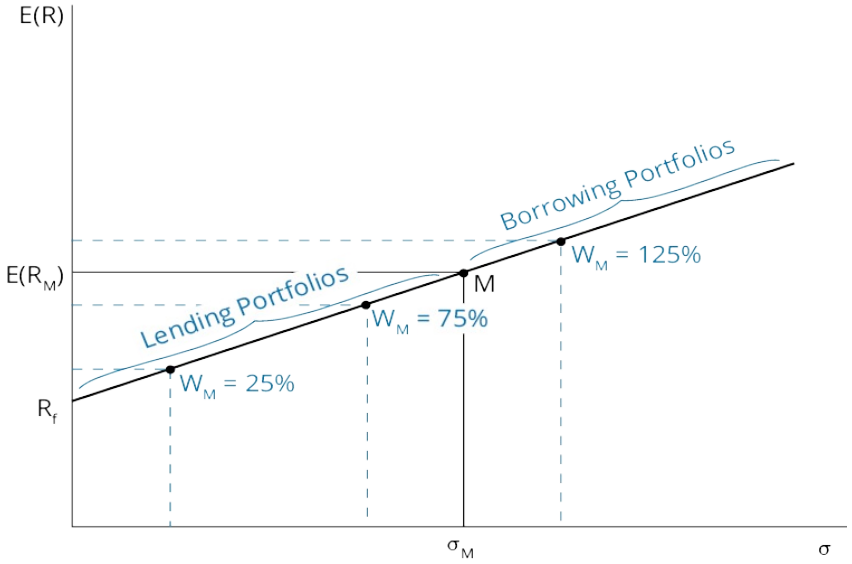
The intuition of this relation is straightforward. An investor who chooses to take on no risk ($\sigma_P = 0$) will earn the risk-free rate, $R_f$. The difference between the expected return on the market and the risk-free rate is termed the **market risk premium**. If we rewrite the CML equation as

$$E(R_P) = R_f + (E(R_M) - R_f)\left(\frac{\sigma_P}{\sigma_M}\right)$$

we can see that an investor can expect to get one unit of market risk premium in additional return (above the risk-free rate) for every unit of market risk, $\sigma_M$, that the investor is willing to accept.

If we assume that investors can both lend (invest in the risk-free asset) at the risk-free rate and borrow (as with a margin account) at the risk-free rate, they can select portfolios to the right of the market portfolio, as illustrated in Figure 53.4.

**Figure 53.4: Borrowing and Lending Portfolios**




Investors who believe market prices are informationally efficient often follow a **passive investment strategy** (i.e., invest in an index of risky assets that serves as a proxy for the market portfolio and allocate a portion of their investable assets to a risk-free asset, such as short-term government securities). In practice, many investors and portfolio managers believe their estimates of security values are correct and market prices are incorrect. Such investors will not use the weights of the market portfolio but will invest more than the market weights in securities that they believe are undervalued and less than the market weights in securities which they believe are overvalued. This is referred to as **active portfolio management** to differentiate it from a passive investment strategy that utilizes a market index for the optimal risky asset portfolio.

## LOS 53.c: Explain systematic and nonsystematic risk, including why an investor should not expect to receive additional return for bearing nonsystematic risk.

*CFA® Program Curriculum, Volume 6, page 204*

When an investor diversifies across assets that are not perfectly correlated, the portfolio's risk is less than the weighted average of the risks of the individual securities in the portfolio. The risk that is eliminated by diversification is called **unsystematic risk** (also called *unique, diversifiable,* or *firm-specific risk*). Because the market portfolio contains *all* risky assets, it must be a well-diversified portfolio. All the risk that can be diversified away has been. The

risk that remains cannot be diversified away and is called the **systematic risk** (also called *nondiversifiable risk* or *market risk*).

The concept of systematic risk applies to individual securities as well as to portfolios. Some securities' returns are highly correlated with overall market returns. Examples of firms that are highly correlated with market returns are luxury goods manufacturers such as Ferrari automobiles and Harley Davidson motorcycles. These firms have high systematic risk (i.e., they are very responsive to market, or systematic, changes). Other firms, such as utility companies, respond very little to changes in the systematic risk factors. These firms have very little systematic risk. Hence, total risk (as measured by standard deviation) can be broken down into its component parts: unsystematic risk and systematic risk. Mathematically:

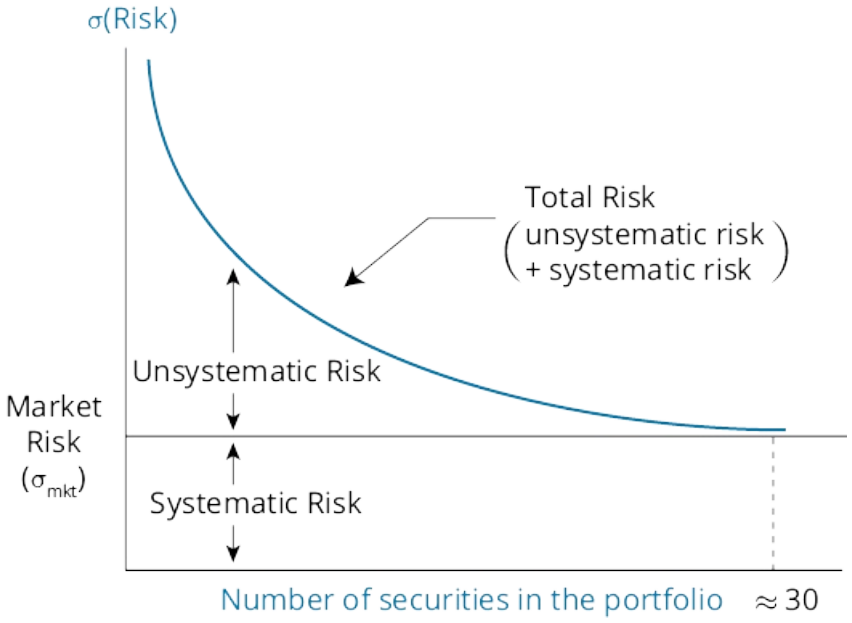
total risk = systematic risk + unsystematic risk

**PROFESSOR'S NOTE**

Know this concept!

Do you actually have to buy all the securities in the market to diversify away unsystematic risk? No. Academic studies have shown that as you increase the number of stocks in a portfolio, the portfolio's risk falls toward the level of market risk. One study showed that it only took about 12 to 18 stocks in a portfolio to achieve 90% of the maximum diversification possible. Another study indicated it took 30 securities. Whatever the number, it is significantly less than *all* the securities. Figure 53.5 provides a general representation of this concept. Note, in the figure, that once you get to 30 or so securities in a portfolio, the standard deviation remains constant. The remaining risk is systematic, or nondiversifiable, risk. We will develop this concept later when we discuss beta, a measure of systematic risk.

**Figure 53.5: Risk vs. Number of Portfolio Assets**




## Systematic Risk Is Relevant in Portfolios

One important conclusion of capital market theory is that equilibrium security returns depend on a stock's or a portfolio's systematic risk, not its total risk as measured by standard deviation. One of the assumptions of the model is that diversification is free. The reasoning is

that investors will not be compensated for bearing risk that can be eliminated at no cost. If you think about the costs of a no-load index fund compared to buying individual stocks, diversification is actually very low cost if not actually free.

The implications of this conclusion are very important to asset pricing (expected returns). The riskiest stock, with risk measured as standard deviation of returns, does not necessarily have the greatest expected return. Consider a biotech stock with one new drug product that is in clinical trials to determine its effectiveness. If it turns out that the drug is effective and safe, stock returns will be quite high. If, on the other hand, the subjects in the clinical trials are killed or otherwise harmed by the drug, the stock will fall to approximately zero and returns will be quite poor. This describes a stock with high standard deviation of returns (i.e., high total risk).

The high risk of our biotech stock, however, is primarily from firm-specific factors, so its unsystematic risk is high. Because market factors such as economic growth rates have little to do with the eventual outcome for this stock, systematic risk is a small proportion of the total risk of the stock. Capital market theory says that the equilibrium return on this stock may be less than that of a stock with much less firm-specific risk but more sensitivity to the factors that drive the return of the overall market. An established manufacturer of machine tools may not be a very risky investment in terms of total risk, but may have a greater sensitivity to market (systematic) risk factors (e.g., GDP growth rates) than our biotech stock. Given this scenario, the stock with more total risk (the biotech stock) has less systematic risk and will therefore have a lower equilibrium rate of return according to capital market theory.

Note that holding many biotech firms in a portfolio will diversify away the firm-specific risk. Some will have blockbuster products and some will fail, but you can imagine that when 50 or 100 such stocks are combined into a portfolio, the uncertainty about the portfolio return is much less than the uncertainty about the return of a single biotech firm stock.

To sum up, unsystematic risk is not compensated in equilibrium because it can be eliminated for free through diversification. Systematic risk is measured by the contribution of a security to the risk of a well-diversified portfolio, and the expected equilibrium return (required return) on an individual security will depend only on its systematic risk.

## LOS 53.d: Explain return generating models (including the market model) and their uses.

*CFA® Program Curriculum, Volume 6, page 206*

**Return generating models** are used to estimate the expected returns on risky securities based on specific factors. For each security, we must estimate the sensitivity of its returns to each specific factor. Factors that explain security returns can be classified as macroeconomic, fundamental, and statistical factors. **Multifactor models** most commonly use macroeconomic factors such as GDP growth, inflation, or consumer confidence, along with fundamental factors such as earnings, earnings growth, firm size, and research expenditures. Statistical factors often have no basis in finance theory and are suspect in that they may represent only relations for a specific time period which have been identified by data mining (repeated tests on a single dataset).

The general form of a multifactor model with *k* factors is as follows:

$$E(R_i) - R_f = \beta_{i1} \times E(\text{Factor 1}) + \beta_{i2} \times E(\text{Factor 2}) + ....+ \beta_{ik} \times E(\text{Factor k})$$

This model states that the expected excess return (above the risk-free rate) for Asset *i* is the sum of each **factor sensitivity** or **factor loading** (the βs) for Asset *i* multiplied by the expected value of that factor for the period. The first factor is often the expected excess return on the market, $E(R_m - R_f)$.

One multifactor model that is often used is that of Fama and French. They estimated the sensitivity of security returns to three factors: firm size, firm book value to market value ratio, and the return on the market portfolio minus the risk-free rate (excess return on the market portfolio). Carhart suggests a fourth factor that measures price momentum using prior period returns. Together, these four factors do a relatively good job of explaining returns differences for U.S. equity securities over the period for which the model has been estimated.

The simplest factor model is a single-factor model. A single-factor model with the return on the market, $R_m$, as its only risk factor can be written (in excess returns form) as:

$$E(R_i) - R_f = \beta_i \times [E(R_m) - R_f]$$

Here, the expected excess return (return above the risk-free rate) is the product of the factor weight or factor sensitivity, Beta i, and the risk factor, which in this model is the excess return on the market portfolio or market index, so that this is also sometimes called a **single-index model**.

A simplified form of a single-index model is the **market model**, which is used to estimate a security's (or portfolio's) beta and to estimate a security's abnormal return (return above its expected return) based on the actual market return.

The form of the market model is as follows:

$$R_i = \alpha_i + \beta_i R_m + e_i$$

where:
$R_i$ = return on Asset *i*
$R_m$ = market return
$\beta_i$ = slope coefficient
$\alpha_i$ = intercept
$e_i$ = abnormal return on Asset *i*

The intercept $\alpha_i$ and slope coefficient $\beta_i$ are estimated from historical return data. We can require that $\alpha_i$ is the risk-free rate times $(1 - \beta_i)$ to be consistent with the general form of a single-index model in excess returns form.

The expected return on Asset *i* is $\alpha_i + \beta_i E(R_m)$. A deviation from the expected return in a given period is the abnormal return on Asset i, $e_i$, or $R_i - (\alpha_i + \beta_i R_m)$.

In the market model, the factor sensitivity or beta for Asset *i* is a measure of how sensitive the return on Asset *i* is to the return on the overall market portfolio (market index).

### LOS 53.e: Calculate and interpret beta.

*CFA® Program Curriculum, Volume 6, page 206*

The sensitivity of an asset's return to the return on the market index in the context of the market model is referred to as its **beta**. Beta is a standardized measure of the covariance of the asset's return with the market return. Beta can be calculated as follows:

$$\beta_i = \frac{\text{covariance of Asset } i\text{'s return with the market return}}{\text{variance of the market return}} = \frac{\text{Cov}_{im}}{\sigma_m^2}$$

We can use the definition of the correlation between the returns on Asset *i* with the returns on the market index:

$$\rho_{im} = \frac{\text{Cov}_{im}}{\sigma_i \sigma_m}$$

$$\text{to get } \text{Cov}_{im} = \rho_{im}\sigma_i\sigma_m$$

Substituting for $\text{Cov}_{im}$ in the equation for $B_i$, we can also calculate beta as:

$$\beta_i = \frac{\rho_{im}\sigma_i\sigma_m}{\sigma_m^2} = \rho_{im}\left(\frac{\sigma_i}{\sigma_m}\right)$$

**EXAMPLE: Calculating an asset's beta**

The standard deviation of the return on the market index is estimated as 20%.

1. If Asset A's standard deviation is 30% and its correlation of returns with the market index is 0.8, what is Asset A's beta?

   Using the formula $\beta_i = \rho_{im}\left(\frac{\sigma_i}{\sigma_m}\right)$, we have: $\beta_i = 0.80\left(\frac{0.30}{0.20}\right) = 1.2.$

2. If the covariance of Asset A's returns with the returns on the market index is 0.048, what is the beta of Asset A?

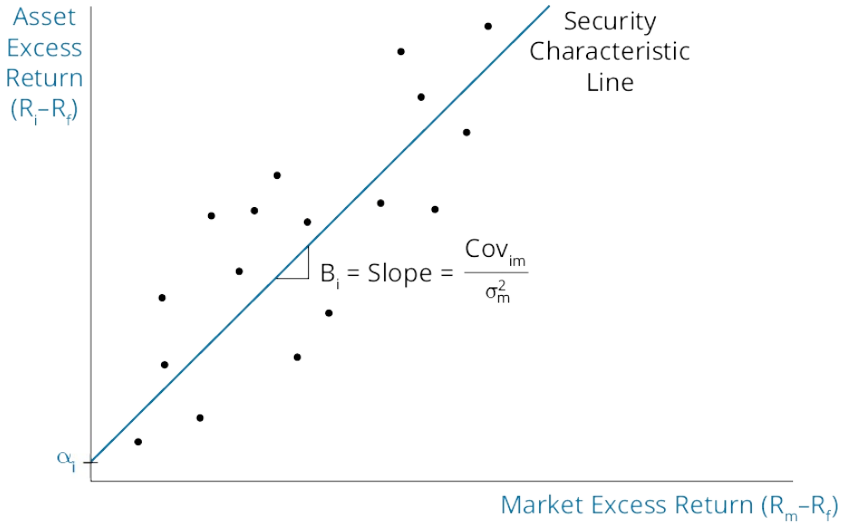
   Using the formula $\beta_i = \frac{\text{Cov}_{im}}{\sigma_m^2}$, we have $\beta_i = \frac{0.048}{0.2^2} = 1.2.$

**PROFESSOR'S NOTE**

Candidates should be prepared to calculate beta in either of the two ways in the example.

In practice, we estimate asset betas by regressing returns on the asset on those of the market index. While regression is a Level II concept, for our purposes, you can think of it as a mathematical estimation procedure that fits a line to a data plot. In Figure 53.5, we represent the excess returns on Asset *i* as the dependent variable and the excess returns on the market index as the independent variable. The *least squares regression line* is the line that minimizes the sum of the squared distances of the points plotted from the line (this is what is meant by the line of *best fit*). The slope of this line is our estimate of beta. In Figure 53.6, the line is steeper than 45 degrees, the slope is greater than one, and the asset's estimated beta is greater than one. Our interpretation is that the returns on Asset *i* are more variable in response to systematic risk factors than is the overall market, which has a beta of one.

**Figure 53.6: Regression of Asset Excess Returns Against Market Asset Returns**




This regression line is referred to as the asset's **security characteristic line**.

Mathematically, the slope of the security characteristic line is $\frac{\text{Cov}_{\text{im}}}{\sigma_{\text{m}}^2}$, which is the same formula we used earlier to calculate beta.

## MODULE QUIZ 53.1

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

1. An investor put 60% of his portfolio into a risky asset offering a 10% return with a standard deviation of returns of 8% and put the balance of his portfolio in a risk-free asset offering 5%. What is the expected return and standard deviation of his portfolio?

| | Expected return | Standard deviation |
|---|---|---|
| A. | 6.0% | 6.8% |
| B. | 8.0% | 4.8% |
| C. | 10.0% | 6.6% |

2. What is the risk measure associated with the capital market line (CML)?
   A. Beta risk.
   B. Unsystematic risk.
   C. Total risk.
3. A portfolio to the right of the market portfolio on the CML is:
   A. a lending portfolio.
   B. a borrowing portfolio.
   C. an inefficient portfolio.
4. As the number of stocks in a portfolio increases, the portfolio's systematic risk:
   A. can increase or decrease.
   B. decreases at a decreasing rate.
   C. decreases at an increasing rate.
5. Total risk equals:
   A. unique plus diversifiable risk.
   B. market plus nondiversifiable risk.
   C. systematic plus unsystematic risk.
6. A return generating model is *least likely* to be based on a security's exposure to:
   A. statistical factors.
   B. macroeconomic factors.
   C. fundamental factors.
7. The covariance of the market's returns with a stock's returns is 0.005 and the standard deviation of the market's returns is 0.05. What is the stock's beta?

A. 1.0.
B. 1.5.
C. 2.0.

# MODULE 53.2: THE CAPM AND THE SML

Video covering this content is available online.

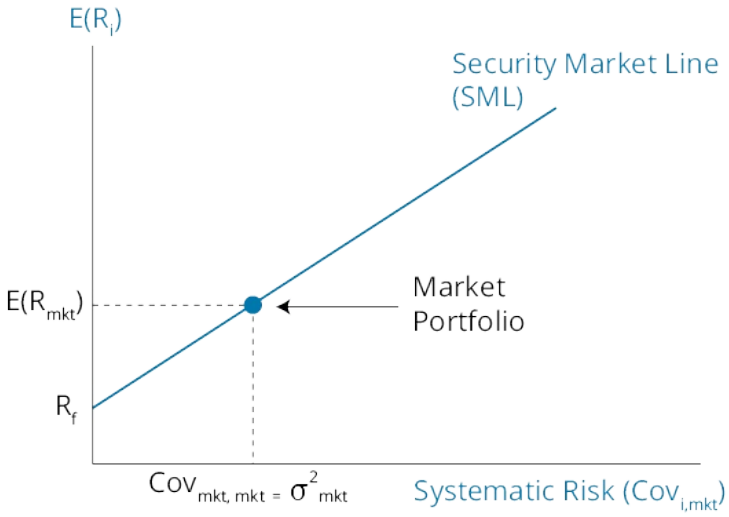
**LOS 53.f: Explain the capital asset pricing model (CAPM), including its assumptions, and the security market line (SML).**

**LOS 53.g: Calculate and interpret the expected return of an asset using the CAPM.**

*CFA® Program Curriculum, Volume 6, page 213*

Given that the only relevant (priced) risk for an individual Asset *i* is measured by the covariance between the asset's returns and the returns on the market, $Cov_{i,mkt}$, we can plot the relationship between risk and return for individual assets using $Cov_{i,mkt}$ as our measure of systematic risk. The resulting line, plotted in Figure 53.7, is one version of what is referred to as the **security market line** (SML).

**Figure 53.7: Security Market Line**




The equation of the SML is:

$$E(R_i) = R_f + \frac{E(R_{mkt}) - R_f}{\sigma^2_{mkt}}(Cov_{i,mkt})$$

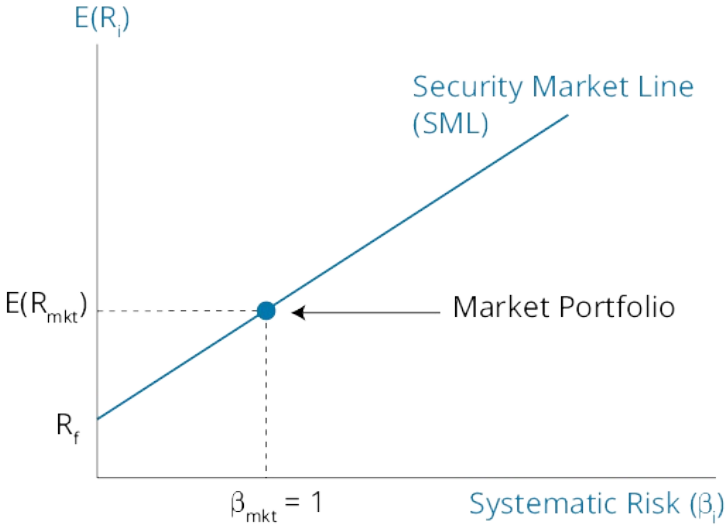
which can be rearranged and stated as:

$$E(R_i) = R_f + \frac{Cov_{i,mkt}}{\sigma^2_{mkt}}[E(R_{mkt}) - R_f]$$

The line described by this last equation is presented in Figure 53.8, where we let the standardized covariance term, $\frac{Cov_{i,mkt}}{\sigma^2_{mkt}}$, be defined as beta, $\beta_i$.

This is the most common means of describing the SML, and this relation between beta (systematic risk) and expected return is known as the **capital asset pricing model** (CAPM).

**Figure 53.8: The Capital Asset Pricing Model**




So, we can define beta, $\beta = \frac{\text{Cov}_{\text{i,mkt}}}{\sigma^2_{\text{mkt}}}$ , as a standardized measure of systematic risk.

Beta measures the relation between a security's excess returns and the excess returns to the market portfolio.

Formally, the CAPM is stated as:

$$E(R_i) = R_f + \beta_i[E(R_{mkt}) - R_f]$$

The CAPM holds that, in equilibrium, the expected return on risky asset $E(R_i)$ is the risk-free rate ($R_f$) plus a beta-adjusted market risk premium, $\beta_i[E(R_{mkt}) - R_f]$. Beta measures systematic (market or covariance) risk.

> **EXAMPLE: Capital asset pricing model**
>
> The expected return on the market is 8%, the risk-free rate is 2%, and the beta for Stock A is 1.2. Compute the rate of return that would be expected (required) on this stock.
>
> **Answer:**
>
> $E(R_A) = 2\% + 1.2(8\% - 2\%) = 9.2\%$
>
> Note: $\beta_A > 1$, so $E(R_A) > E(R_{mkt})$

The **assumptions of the CAPM** are:

- *Risk aversion*. To accept a greater degree of risk, investors require a higher expected return.
- *Utility maximizing investors*. Investors choose the portfolio, based on their individual preferences, with the risk and return combination that maximizes their (expected) utility.
- *Frictionless markets*. There are no taxes, transaction costs, or other impediments to trading.
- *One-period horizon*. All investors have the same one-period time horizon.

- *Homogeneous expectations*. All investors have the same expectations for assets' expected returns, standard deviation of returns, and returns correlations between assets.
- *Divisible assets*. All investments are infinitely divisible.
- *Competitive markets*. Investors take the market price as given and no investor can influence prices with their trades.

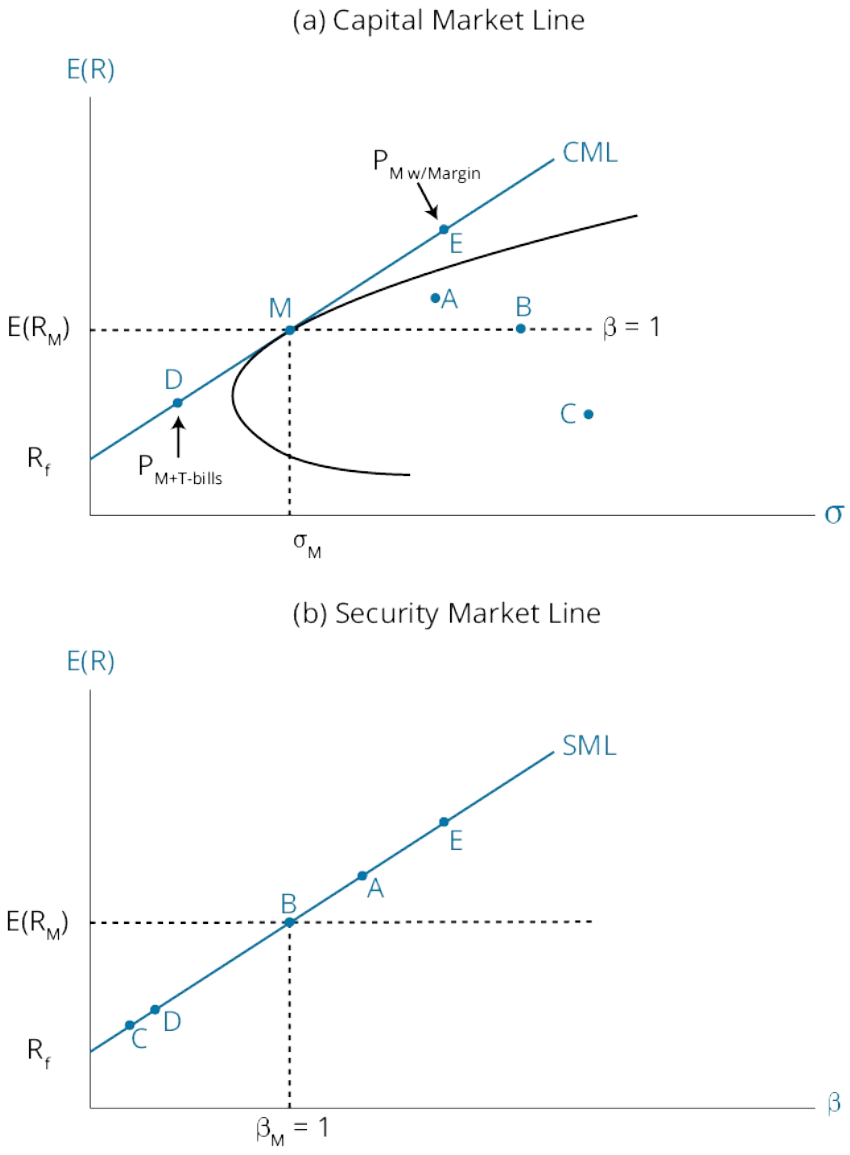
## Comparing the CML and the SML

It is important to recognize that the CML and SML are very different. Recall the equation of the CML:

$$\mathrm{E}\left(\mathrm{R_P}\right) = \mathrm{R_f} + \sigma_{\mathrm{P}} \left\{ \frac{[\mathrm{E}(\mathrm{R_M}) - \mathrm{R_f}]}{\sigma_{\mathrm{M}}} \right\}$$

The CML uses total risk = $\sigma_p$ on the x-axis. Hence, only efficient portfolios will plot on the CML. On the other hand, the SML uses beta (systematic risk) on the x-axis. So in a CAPM world, *all properly priced securities and portfolios of securities will plot on the SML*, as shown in Figure 53.9.

**Figure 53.9: Comparing the CML and the SML**




Portfolios that are not well diversified (efficient) plot inside the efficient frontier and are represented by risk-return combinations such as points A, B, and C in panel (a) of Figure 53.9. Individual securities are one example of such inefficient portfolios. According to the CAPM, the expected returns on all portfolios, well diversified or not, are determined by their systematic risk. Thus, according to the CAPM, Point A represents a high-beta stock or portfolio, Point B a stock or portfolio with a beta of one, and Point C a low-beta stock or portfolio. We know this because the expected return at Point B is equal to the expected return on the market, and the expected returns at Point A and C are greater and less than the expected return on the market (tangency) portfolio, respectively.

Note that a low-beta stock, such as represented by Point C, is not necessarily low-risk when total risk is considered. While its contribution to the risk of a well-diversified portfolio may be low, its risk when held by itself can be considered quite high. A firm whose only activity is developing a new, but as yet unproven, drug may be quite speculative with highly uncertain returns. It may also have quite low systematic risk if the uncertainty about its future returns depends primarily on firm-specific factors.

All stocks and portfolios that plot along the line labeled β = 1 in Figure 53.9 have the same expected return as the market portfolio and, thus, according to the CAPM, have the same systematic risk as the market portfolio (i.e., they all have betas of one).

All points on the CML (except the tangency point) represent the risk-return characteristics of portfolios formed by either combining the market portfolio with the risk-free asset or borrowing at the risk-free rate in order to invest more than 100% of the portfolio's net value in the risky market portfolio (investing on margin). Point D in Figure 53.9 represents a portfolio that combines the market portfolio with the risk-free asset, while points above the point of tangency, such as Point E, represent portfolios created by borrowing at the risk-free rate to invest in the market portfolio. Portfolios that do not lie on the CML are not efficient and therefore have risk that will not be rewarded with higher expected returns in equilibrium.

According to the CAPM, all securities and portfolios, diversified or not, will plot on the SML in equilibrium. In fact, all stocks and portfolios along the line labeled β = 1 in Figure 53.9, including the market portfolio, will plot at the same point on the SML. They will plot at the point on the SML with beta equal to one and expected return equal to the expected return on the market, regardless of their total risk.

## LOS 53.h: Describe and demonstrate applications of the CAPM and the SML.

*CFA® Program Curriculum, Volume 6, page 217*

We have used beta to estimate a security's expected return based on our estimate of the risk-free rate and the expected return on the market. In equilibrium, a security's expected return and its required return (by investors) are equal. Therefore, we can use the CAPM to estimate a security's required return.

Because the SML shows the equilibrium (required) return for any security or portfolio based on its beta (systematic risk), analysts often compare their forecast of a security's return to its required return based on its beta risk. The following example illustrates this technique.

**EXAMPLE: Identifying mispriced securities**

The following figure contains information based on analyst's forecasts for three stocks. Assume a risk-free rate of 7% and a market return of 15%. Compute the expected and required return on each stock, determine whether each stock is undervalued, overvalued, or properly valued, and outline an appropriate trading strategy.

**Forecast Data**

| Stock | Price Today | E(Price) in 1 Year | E(Dividend) in 1 Year | Beta |
|---|---|---|---|---|
| A | $25 | $27 | $1.00 | 1.0 |
| B | 40 | 45 | 2.00 | 0.8 |
| C | 15 | 17 | 0.50 | 1.2 |

**Answer:**

Expected and required returns computations are shown in the following figure.

**Forecasts vs. Required Returns**

| Stock | Forecast Return | Required Return |
|---|---|---|
| A | ($27 − $25 + $1) / $25 = 12.0% | 0.07 + (1.0)(0.15 − 0.07) = 15.0% |
| B | ($45 − $40 + $2) / $40 = 17.5% | 0.07 + (0.8)(0.15 − 0.07) = 13.4% |
| C | ($17 − $15 + $0.5) / $15 = 16.6% | 0.07 + (1.2)(0.15 − 0.07) = 16.6% |

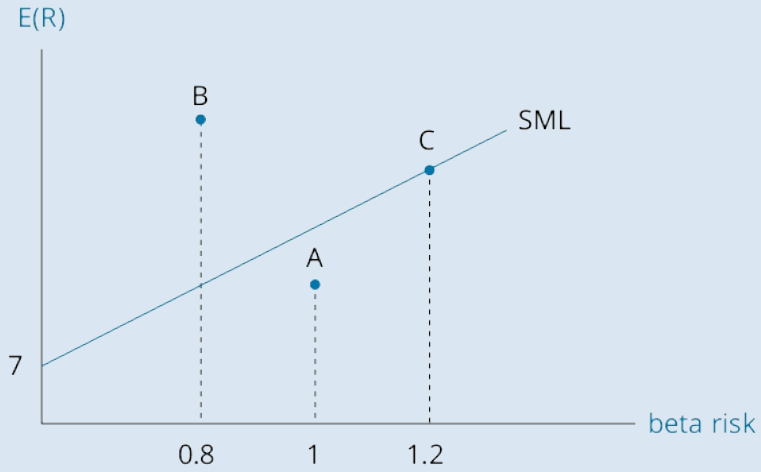
- Stock A is *overvalued*. It is expected to earn 12%, but based on its systematic risk, it should earn 15%. It plots *below* the SML.
- Stock B is *undervalued*. It is expected to earn 17.5%, but based on its systematic risk, it should earn 13.4%. It plots *above* the SML.
- Stock C is *properly valued*. It is expected to earn 16.6%, and based on its systematic risk, it should earn 16.6%. It plots *on* the SML.

The appropriate trading strategy is:

- Short sell Stock A.
- Buy Stock B.
- Buy, sell, or ignore Stock C.

We can do this same analysis graphically. The expected return/beta combinations of all three stocks are graphed in the following figure relative to the SML.

**Identifying Mispriced Securities**




**PROFESSOR'S NOTE**

If the estimated return plots "over" the SML, the security is "under" valued. If the estimated return plots "under" the SML, the security is "over" valued.

Remember, all stocks should plot on the SML; any stock not plotting on the SML is mispriced. Notice that Stock A falls below the SML, Stock B lies above the SML, and Stock C is on the SML. If you plot a stock's expected return and it falls below the SML, the stock is overpriced. That is, the stock's expected return is too low given its systematic risk. If a stock plots above the SML, it is underpriced and is offering an expected return greater than required for its systematic risk. If it plots on the SML, the stock is properly priced.

Because the equation of the SML is the capital asset pricing model, you can determine if a stock is over- or underpriced graphically or mathematically. Your answers will always be the same.

## LOS 53.i: Calculate and interpret the Sharpe ratio, Treynor ratio, *M2*, and Jensen's alpha.

*CFA® Program Curriculum, Volume 6, page 222*

**Performance evaluation** of an active manager's portfolio choices refers to the analysis of the risk and return of the portfolio. **Attribution analysis**, an analysis of the sources of returns differences between active portfolio returns and those of a passive benchmark portfolio, is part of performance evaluation. Success in active portfolio management cannot be determined simply by comparing portfolio returns to benchmark portfolio returns; the risk taken to achieve returns must also be considered. A portfolio with greater risk than the

benchmark portfolio (especially beta risk) is expected to produce higher returns over time than the benchmark portfolio.

When evaluating the performance of a portfolio with risk that differs from that of a benchmark portfolio, we need to adjust the active portfolio return's risk. Of the alternative ways to consider both risk and return in evaluating portfolio performance, the most commonly used is the **Sharpe ratio**. The Sharpe ratio of a portfolio is its excess returns per unit of total portfolio risk. Higher Sharpe ratios indicate better risk-adjusted portfolio performance.

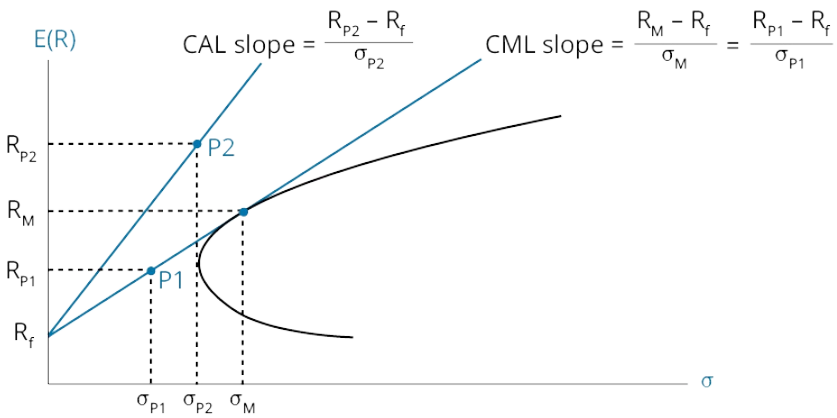
$$\text{Sharpe ratio} = \frac{E\left[R_{\text{portfolio}}\right] - R_f}{\sigma_{\text{portfolio}}}$$

We have shown the Sharpe ratio as an ex ante (before the fact) measure, using the expected values of portfolio returns and standard deviation. However, it can also be used as an ex post (after the fact) measure of portfolio performance, using mean returns and sample standard deviation over a period.

The Sharpe ratio is based on total risk (standard deviation of returns), rather than systematic risk (beta). For this reason, the Sharpe ratio can be used to evaluate the performance of concentrated portfolios (those affected by unsystematic risk) as well as well-diversified portfolios (those with only systematic, or beta, risk). Note that the value of the Sharpe ratio is only useful for comparison with the Sharpe ratio of another portfolio.

In Figure 53.10, we illustrate that the Sharpe ratio of a portfolio is the slope of the CAL for that portfolio and can be compared to the slope of the CML, which is the Sharpe ratio for portfolios that lie on the CML.

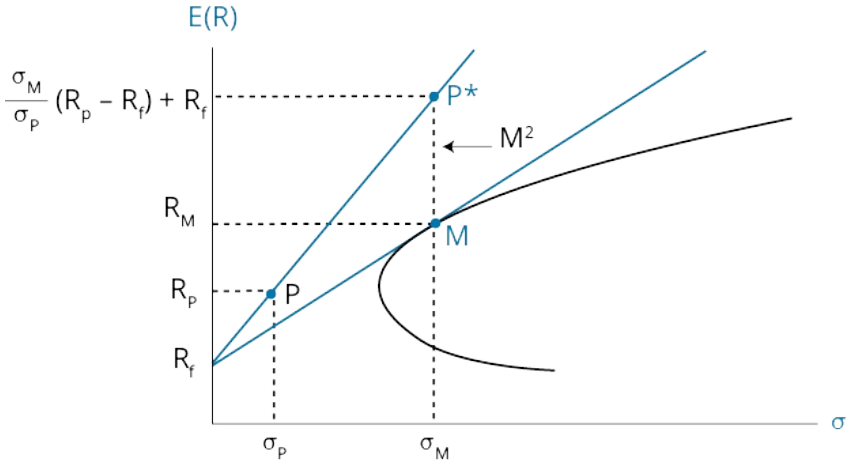
**Figure 53.10: Sharpe Ratios as Slopes**




The **M-squared** ($M^2$) measure produces the same portfolio rankings as the Sharpe ratio but is stated in percentage terms. It is calculated as $\left(R_P - R_f\right)\frac{\sigma_M}{\sigma_P} - \left(R_M - R_f\right)$.

The first term is the excess return on a Portfolio P*, constructed by taking a leveraged position in Portfolio P so that P* has the same total risk, $\sigma_M$, as the market portfolio. As shown in Figure 53.11, the excess return on such a leveraged portfolio differs from the return on the market portfolio by the vertical distance $M^2$.

**Figure 53.11: M-Squared for a Portfolio**




The difference between the Sharpe ratio and $M^2$ measure is that the Sharpe is a slope measure and $M^2$ is measured in percentage terms. $M^2$ is considered a measure of **risk-adjusted performance** (RAP). The intuition is that $M^2$ is the additional return that could have been earned by leveraging the active portfolio (borrowing at Rf) so that its risk is equal to that of the market portfolio.

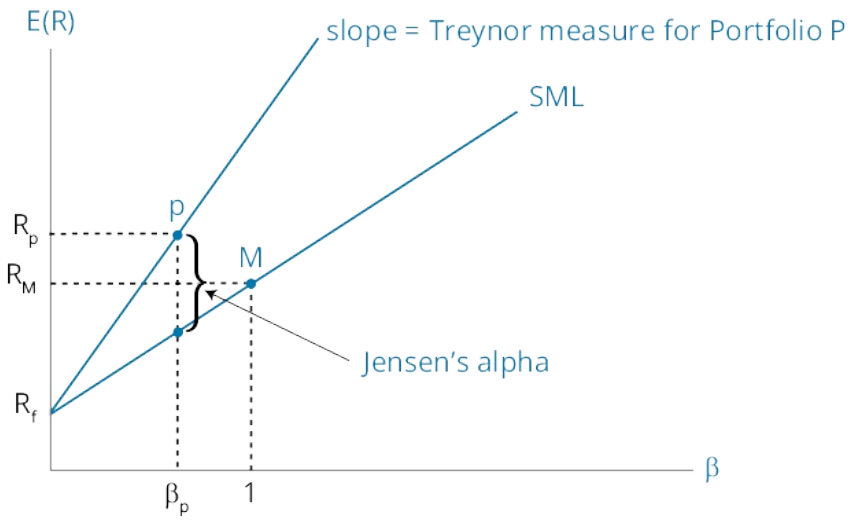
Two measures of portfolio performance based on systematic (beta) risk rather than total risk are the **Treynor measure** and **Jensen's alpha**. They are analogous to the Sharpe ratio and $M^2$ in that the Treynor measure is a measure of slope and Jensen's alpha is a measure of percentage returns in excess of those from a portfolio that has the same risk (beta) but lies on the SML.

The Treynor measure is calculated as $\frac{R_P - R_f}{\beta_P}$, interpreted as excess returns per unit of systematic risk, and represented by the slope of a line as illustrated in Figure 53.12. Jensen's alpha for Portfolio P is calculated as

$$\alpha_P = R_p - [R_f + \beta_P(R_M - R_f)]$$

and is the percentage portfolio return above that of a portfolio (or security) with the same beta as the portfolio that lies on the SML, as illustrated in Figure 53.12.

**Figure 53.12: Treynor Measure and Jensen's Alpha**



Whether risk adjustment should be based on standard deviation of returns or portfolio beta depends on whether a manager's portfolio bears unsystematic risk. If a single manager is used, then the total risk (including any nonsystematic risk) is the relevant measure and risk adjustment using total risk, as with the Sharpe and $M^2$ measures, is appropriate. If a fund uses multiple managers so that the overall fund portfolio is well diversified (has no unsystematic risk), then performance measures based on systematic (beta) risk, such as the Treynor measure and Jensen's alpha, are appropriate.

These measures of risk-adjusted returns are often used to compare the performance of actively managed funds to passively managed funds. Note in Figure 53.10 and Figure 53.11 that portfolios that lie above the CML have Sharpe ratios greater than those of any portfolios along the CML and have positive $M^2$ measures. Similarly, in Figure 53.12, we can see that portfolios that lie above the SML have Treynor measures greater than those of any security or portfolio that lies along the SML and also have positive values for Jensen's alpha.

One final note of caution is that estimating the values needed to apply these theoretical models and performance measures is often difficult and is done with error. The expected return on the market, and thus the market risk premium, may not be equal to its average historical value. Estimating security and portfolio betas is done with error as well.

## MODULE QUIZ 53.2

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

1. Which of the following statements about the SML and the CML is *least accurate*?
   A. Securities that plot above the SML are undervalued.
   B. Investors expect to be compensated for systematic risk.
   C. Securities that plot on the SML have no value to investors.
2. According to the CAPM, what is the expected rate of return for a stock with a beta of 1.2, when the risk-free rate is 6% and the market rate of return is 12%?
   A. 7.2%.
   B. 12.0%.
   C. 13.2%.
3. According to the CAPM, what is the required rate of return for a stock with a beta of 0.7, when the risk-free rate is 7% and the expected market rate of return is 14%?
   A. 11.9%.
   B. 14.0%.
   C. 16.8%.
4. The risk-free rate is 6%, and the expected market return is 15%. A stock with a beta of 1.2 is selling for $25 and will pay a $1 dividend at the end of the year. If the stock is priced at $30 at year-end, it is:
   A. overpriced, so short it.
   B. underpriced, so buy it.
   C. underpriced, so short it.
5. A stock with a beta of 0.7 currently priced at $50 is expected to increase in price to $55 by year-end and pay a $1 dividend. The expected market return is 15%, and the risk-free rate is 8%. The stock is:
   A. overpriced, so do not buy it.
   B. underpriced, so buy it.
   C. properly priced, so buy it.
6. Which of these return metrics is defined as excess return per unit of systematic risk?
   A. Sharpe ratio.
   B. Jensen's alpha.
   C. Treynor measure.

# KEY CONCEPTS

## LOS 53.a

The availability of a risk-free asset allows investors to build portfolios with superior risk-return properties. By combining a risk-free asset with a portfolio of risky assets, the overall risk and return can be adjusted to appeal to investors with various degrees of risk aversion.

## LOS 53.b

On a graph of return versus risk, the various combinations of a risky asset and the risk-free asset form the capital allocation line (CAL). In the specific case where the risky asset is the market portfolio, the combinations of the risky asset and the risk-free asset form the capital market line (CML).

## LOS 53.c

Systematic (market) risk is due to factors, such as GDP growth and interest rate changes, that affect the values of all risky securities. Systematic risk cannot be reduced by diversification. Unsystematic (firm-specific) risk can be reduced by portfolio diversification.

Because one of the assumptions underlying the CAPM is that portfolio diversification to eliminate unsystematic risk is costless, investors cannot increase expected equilibrium portfolio returns by taking on unsystematic risk.

## LOS 53.d

A return generating model is an equation that estimates the expected return of an investment, based on a security's exposure to one or more macroeconomic, fundamental, or statistical factors.

The simplest return generating model is the market model, which assumes the return on an asset is related to the return on the market portfolio in the following manner:

$$R_i = \alpha_i + \beta_i R_m + e_i$$

## LOS 53.e

Beta can be calculated using the following equation:

$$\beta_i = \frac{[\text{Cov}(R_i, R_m)]}{\sigma_m^2} = \rho_{im}\left(\frac{\sigma_i}{\sigma_m}\right)$$

where [Cov $(R_i,R_m)$] and $\rho_{i,m}$ are the covariance and correlation between the asset and the market, and $\sigma_i$ and $\sigma_m$ are the standard deviations of asset returns and market returns.

The theoretical average beta of stocks in the market is 1. A beta of zero indicates that a security's return is uncorrelated with the returns of the market.

## LOS 53.f

The capital asset pricing model (CAPM) requires several assumptions:

- Investors are risk averse, utility maximizing, and rational.
- Markets are free of frictions like costs and taxes.
- All investors plan using the same time period.

- All investors have the same expectations of security returns.
- Investments are infinitely divisible.
- Prices are unaffected by an investor's trades.

The security market line (SML) is a graphical representation of the CAPM that plots expected return versus beta for any security.

### LOS 53.g

The CAPM relates expected return to the market factor (beta) using the following formula:

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f]$$

### LOS 53.h

The CAPM and the SML indicate what a security's equilibrium required rate of return should be based on the security's exposure to market risk. An analyst can compare his expected rate of return on a security to the required rate of return indicated by the SML to determine whether the security is overvalued, undervalued, or properly valued.

### LOS 53.i

The Sharpe ratio measures excess return per unit of total risk and is useful for comparing portfolios on a risk-adjusted basis. The M-squared measure provides the same portfolio rankings as the Sharpe ratio but is stated in percentage terms:

$$\text{Sharpe ratio} = \left(\frac{R_P - R_f}{\sigma_P}\right)$$

$$\text{M-squared} = \left(R_P - R_f\right)\frac{\sigma_M}{\sigma_P} - \left(R_M - R_f\right)$$

The Treynor measure measures a portfolio's excess return per unit of systematic risk. Jensen's alpha is the difference between a portfolio's return and the return of a portfolio on the SML that has the same beta:

$$\text{Treynor measure} = \frac{R_P - R_f}{\beta_P}$$

$$\text{Jensen's alpha} = \alpha_P = R_P - [R_f + \beta_P(R_M - R_f)]$$

# ANSWER KEY FOR MODULE QUIZZES

## Module Quiz 53.1

1. **B** Expected return: (0.60 × 0.10) + (0.40 × 0.05) = 0.08, or 8.0%.
   Standard deviation: 0.60 × 0.08 = 0.048, or 4.8%. (LOS 53.a)

2. **C** The capital market line (CML) plots return against *total risk*, which is measured by standard deviation of returns. (LOS 53.b)

3. **B** A portfolio to the right of a portfolio on the CML has more risk than the market portfolio. Investors seeking to take on more risk will *borrow* at the risk-free rate to purchase more of the market portfolio. (LOS 53.b)

4. **A** When you increase the number of stocks in a portfolio, *unsystematic risk* will decrease at a decreasing rate. However, the portfolio's *systematic risk* can be increased by adding higher-beta stocks or decreased by adding lower-beta stocks. (LOS 53.c)

5. **C** Total risk equals systematic plus unsystematic risk. Unique risk is diversifiable and is unsystematic. Market (systematic) risk is nondiversifiable risk. (LOS 53.c)

6. **A** Macroeconomic, fundamental, and statistical factor exposures can be included in a return generating model to estimate the expected return of an investment. However, statistical factors may not have any theoretical basis, so analysts prefer macroeconomic and fundamental factor models. (LOS 53.d)

7. **C** beta = covariance / market variance
   market variance = $0.05^2 = 0.0025$
   beta = 0.005 / 0.0025 = 2.0 (LOS 53.e)

## Module Quiz 53.2

1. **C** Securities that plot on the SML are expected to earn their equilibrium rate of return and, therefore, do have value to an investor and may have diversification benefits as well. The other statements are true. (LOS 53.f)

2. **C** 6 + 1.2(12 − 6) = 13.2% (LOS 53.g)

3. **A** 7 + 0.7(14 − 7) = 11.9% (LOS 53.g)

4. **B** required rate = 6 + 1.2(15 − 6) = 16.8%
   return on stock = (30 − 25 + 1) / 25 = 24%
   Based on risk, the stock plots above the SML and is underpriced, so buy it. (LOS 53.h)

5. **A** required rate = 8 + 0.7(15 − 8) = 12.9%
   return on stock = (55 − 50 + 1) / 50 = 12%
   The stock falls below the SML, so it is *overpriced*. (LOS 53.h)

6. **C** The Treynor measure is excess return (return in excess of the risk-free rate) per unit of systematic risk (beta). The Sharpe ratio is excess return per unit of total risk

(portfolio standard deviation). Jensen’s alpha is the difference between a portfolio’s actual rate of return and the equilibrium rate of return for a portfolio with the same level of beta (systematic) risk. (LOS 53.i)

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 #54.

# READING 54: BASICS OF PORTFOLIO PLANNING AND CONSTRUCTION

**Study Session 19**

## EXAM FOCUS

There is nothing difficult here, but the material is important because it is the foundation for the portfolio construction material at Level II and especially Level III. You should be ready to explain why investment policy statements are created and what their major components are. You should be familiar with the objectives (risk and return) and the constraints: liquidity, legal, time horizon, tax treatment, and unique circumstances. Know the difference between ability and willingness to take risk, the factors that define an asset class, and how asset allocation is used in constructing portfolios.

## MODULE 54.1: PORTFOLIO PLANNING AND CONSTRUCTION

Video covering this content is available online.

### LOS 54.a: Describe the reasons for a written investment policy statement (IPS).

*CFA® Program Curriculum, Volume 6, page 248*

An investment manager is very unlikely to produce a good result for a client without understanding that client's needs, circumstances, and constraints.

A written **investment policy statement** will typically begin with the investor's goals in terms of risk and return. These should be determined jointly, as the goals of high returns and low risk (while quite popular) are likely to be mutually exclusive in practice. Investor expectations in terms of returns must be compatible with investor's tolerance for risk (uncertainty about portfolio performance).

### LOS 54.b: Describe the major components of an IPS.

*CFA® Program Curriculum, Volume 6, page 249*

The major components of an IPS typically address the following:

- *Description of Client* circumstances, situation, and investment objectives.
- *Statement of the Purpose* of the IPS.
- *Statement of Duties and Responsibilities* of investment manager, custodian of assets, and the client.
- *Procedures* to update IPS and to respond to various possible situations.
- *Investment Objectives* derived from communications with the client.
- *Investment Constraints* that must be considered in the plan.

- *Investment Guidelines* such as how the policy will be executed, asset types permitted, and leverage to be used.
- *Evaluation of Performance,* the benchmark portfolio for evaluating investment performance, and other information on evaluation of investment results.
- *Appendices* containing information on strategic (baseline) asset allocation and permitted deviations from policy portfolio allocations, as well as how and when the portfolio allocations should be rebalanced.

In any case, the IPS will, at a minimum, contain a clear statement of client circumstances and constraints, an investment strategy based on these, and some benchmark against which to evaluate the account performance.

## LOS 54.c: Describe risk and return objectives and how they may be developed for a client.

*CFA® Program Curriculum, Volume 6, page 250*

The **risk objectives** in an IPS may take several forms. An **absolute risk objective** might be to "have no decrease in portfolio value during any 12-month period" or to "not decrease in value by more than 2% at any point over any 12-month period." Low absolute percentage risk objectives such as these may result in portfolios made up of securities that offer guaranteed returns (e.g., U.S. Treasury bills).

Absolute risk objectives can also be stated in terms of the probability of specific portfolio results, either percentage losses or dollar losses, rather than strict limits on portfolio results. Examples are as follows:

- "No greater than a 5% probability of returns below –5% in any 12-month period."
- "No greater than a 4% probability of a loss of more than $20,000 over any 12-month period."

An absolute return objective may be stated in nominal terms, such as "an overall return of at least 6% per annum," or in real returns, such as "a return of 3% more than the annual inflation rate each year."

**Relative risk objectives** relate to a specific benchmark and can also be strict, such as, "Returns will not be less than 12-month euro LIBOR over any 12-month period," or stated in terms of probability, such as, "No greater than a 5% probability of returns more than 4% below the return on the MSCI World Index over any 12-month period."

Return objectives can be relative to a benchmark portfolio return, such as, "Exceed the return on the S&P 500 Index by 2% per annum." For a bank, the return objective may be relative to the bank's cost of funds (deposit rate). While it is possible for an institution to use returns on peer portfolios, such as an endowment with a stated objective to be in the top quartile of endowment fund returns, peer performance benchmarks suffer from not being *investable* portfolios. There is no way to match this investment return by portfolio construction before the fact.

In any event, the account manager must make sure that the stated risk and return objectives are compatible, given the reality of expected investment results and uncertainty over time.

### LOS 54.d: Distinguish between the willingness and the ability (capacity) to take risk in analyzing an investor's financial risk tolerance.

*CFA® Program Curriculum, Volume 6, page 252*

An investor's **ability to bear risk** depends on financial circumstances. Longer investment horizons (20 years rather than 2 years), greater assets versus liabilities (more wealth), more insurance against unexpected occurrences, and a secure job all suggest a greater ability to bear investment risk in terms of uncertainty about periodic investment performance.

An investor's **willingness to bear risk** is based primarily on the investor's attitudes and beliefs about investments (various asset types). The assessment of an investor's attitude about risk is quite subjective and is sometimes done with a short questionnaire that attempts to categorize the investor's risk aversion or risk tolerance.

When the adviser's assessments of an investor's ability and willingness to take investment risk are compatible, there is no real problem selecting an appropriate level of investment risk. If the investor's willingness to take on investment risk is high but the investor's ability to take on risk is low, the low ability to take on investment risk will prevail in the adviser's assessment.

In situations where ability is high but willingness is low, the adviser may attempt to educate the investor about investment risk and correct any misconceptions that may be contributing to the investor's low stated willingness to take on investment risk. However, the adviser's job is not to change the investor's personality characteristics that contribute to a low willingness to take on investment risk. The approach will most likely be to conform to the lower of the investor's ability or willingness to bear risk, as constructing a portfolio with a level of risk that the client is clearly uncomfortable with will not likely lead to a good outcome in the investor's view.

### LOS 54.e: Describe the investment constraints of liquidity, time horizon, tax concerns, legal and regulatory factors, and unique circumstances and their implications for the choice of portfolio assets.

*CFA® Program Curriculum, Volume 6, page 257*

**PROFESSOR'S NOTE**

When I was studying for the CFA exams over 20 years ago, we memorized R-R-T-T-L-L-U as a checklist for addressing the important points of portfolio construction, and it still works today. Then, as now, the important points to cover in an IPS were Risk, Return, Time horizon, Tax situation, Liquidity, Legal restrictions, and the Unique constraints of a specific investor.

**Investment constraints** include the investor's liquidity needs, time horizon, tax considerations, legal and regulatory constraints, and unique needs and preferences.

**Liquidity:** Liquidity refers to the ability to turn investment assets into spendable cash in a short period of time without having to make significant price concessions to do so. Investor needs for money to pay tuition, to pay for a parent's assisted living expenses, or to fund other possible spending needs may all require that some liquid assets be held. As we noted in an earlier topic review discussing property and casualty insurance companies, claims arrive unpredictably to some extent and therefore their portfolios must hold a significant proportion of liquid (or maturing) securities in order to be prepared to honor these claims. Illiquid investments in hedge funds and private equity funds, which typically are not traded and have

restrictions on redemptions, are not suitable for an investor who may unexpectedly need access to the funds.

**Time horizon:** In general, the longer an investor's time horizon, the more risk and less liquidity the investor can accept in the portfolio. While the expected returns on a broad equities portfolio may not be too risky for an investor with a 20-year investment horizon, they likely are too risky for an investor who must fund a large purchase at the end of this year. For such an investor, government securities or a bank certificate of deposit may be the most appropriate investments because of their low risk and high liquidity at the time when the funds will be needed.

**Tax situation:** Besides an individual's overall tax rate, the tax treatment of various types of investment accounts is also a consideration in portfolio construction. For a fully taxable account, investors subject to higher tax rates may prefer tax-free bonds (U.S.) to taxable bonds or prefer equities that are expected to produce capital gains, which are often taxed at a lower rate than other types of income. A focus on expected after-tax returns over time in relation to risk should correctly account for differences in tax treatments as well as investors' overall tax rates.

Some types of investment accounts, such as retirement accounts, may be tax exempt or tax deferred. Investors with such accounts may choose to put securities that generate fully taxed income, such as corporate bond interest, in accounts that are tax deferred, while seeking long-term capital gains, tax-exempt interest income, and dividend income (in jurisdictions where dividends receive preferential tax treatment) in their personal accounts, which have no tax deferral benefit.

**Legal and regulatory:** In addition to financial market regulations that apply to all investors, more specific legal and regulatory constraints may apply to particular investors. Trust, corporate, and qualified investment accounts may all be restricted by law from investing in particular types of securities and assets. There may also be restrictions on percentage allocations to specific types of investments in such accounts. Corporate officers and directors face legal restrictions on trading in the securities of their firms that the account manager should be aware of.

**Unique circumstances:** Each investor, whether individual or institutional, may have specific preferences or restrictions on which securities and assets may be purchased for the account. Some of these may be nonfinancial considerations, which are commonly categorized as **sustainable investing**. Ethical preferences, such as prohibiting investment in securities issued by tobacco or firearms producers, are not uncommon. Restrictions on investments in companies or countries where human rights abuses are suspected or documented would also fall into this category. Religious preferences may preclude investment in securities that make explicit interest payments.

Unique investor preferences may also be based on diversification needs when the investor's income depends heavily on the prospects for one company or industry. An investor who has founded or runs a company may not want any investment in securities issued by a competitor to that company.

### LOS 54.f: Explain the specification of asset classes in relation to asset allocation.

*CFA® Program Curriculum, Volume 6, page 265*

After having determined the investor objectives and constraints through the exercise of creating an IPS, a **strategic asset allocation** is developed which specifies the percentage allocations to the included asset classes. In choosing which asset classes to consider when developing the strategic asset allocation for the account, the correlations of returns *within* an asset class should be relatively high, indicating that the assets within the class are similar in their investment performance. On the other hand, it is low correlations of returns *between* asset classes that leads to risk reduction through portfolio diversification.

Historically, only the broad categories of equities, bonds, cash, and real estate were considered. More recently, a group of several investable asset classes, referred to collectively as alternative investments, has gained more prominence. Alternative investment asset classes include hedge funds of various types, private equity funds, managed or passively constructed commodity funds, artwork, and intellectual property rights.

We can further divide equities by whether the issuing companies are domestic or foreign, large or small, or whether they are traded in emerging or developed markets. An example of specifying asset classes is world equities. A U.S. investor may want to divide world equities into different regions.

With bonds, we can divide the overall universe of bonds into asset classes based on maturities or on criteria such as whether they are foreign or domestic, government or corporate, or investment grade or speculative (high yield). Overall, the asset classes considered should approximate the universe of permissible investments specified in the IPS.

Once the universe of asset classes has been specified, the investment manager will collect data on the returns, standard deviation of returns, and correlations of returns with those of other asset classes for each asset class.

Figure 54.1 illustrates the strategic asset allocation for a pension fund.

**Figure 54.1: Strategic Asset Allocation**

The Vermont Pension Investment Committee manages more than $4 billion in retirement assets for various teachers and state and municipal employees in that state. VPIC's investment policy specifies the following strategic asset allocation:

| Asset Class | Target |
|---|---|
| **Growth assets** | |
| Passive global equities | 24% |
| Active global equities | 5% |
| Large cap U.S. equities | 4% |
| Small-/mid-cap U.S. equities | 3% |
| Non–U.S. developed market equities | 5% |
| International small-cap equities | 2% |
| Private equity | 10% |
| Core plus fixed income | 6% |
| Emerging market debt | 4% |
| Private debt | 5% |
| Non-core real estate | 3% |
| **Total growth assets** | **71%** |
| | |
| **Downturn hedging assets** | |
| Core fixed income | 14% |

| | |
|---|---|
| Short-term quality credit | 5% |
| **Total downturn hedging** | **19%** |
| | |
| **Inflation hedging assets** | |
| Core real estate | 5% |
| U.S. TIPS | 3% |
| Infrastructure/farmland | 2% |
| **Total inflation hedging** | **10%** |

Source: State of Vermont, Office of the State Treasurer. Target allocation as of March 25, 2019. www.vermonttreasurer.gov/content/pension.

## LOS 54.g: Describe the principles of portfolio construction and the role of asset allocation in relation to the IPS.

*CFA® Program Curriculum, Volume 6, page 265*

Once the portfolio manager has identified the investable asset classes for the portfolio and the risk, return, and correlation characteristics of each asset class, an *efficient frontier*, analogous to one constructed from individual securities, can be constructed using a computer program. By combining the return and risk objectives from the IPS with the actual risk and return properties of the many portfolios along the efficient frontier, the manager can identify that portfolio which best meets the risk and return requirements of the investor. The asset allocation for the efficient portfolio selected is then the strategic asset allocation for the portfolio.

So far, we have not concerned ourselves with deviations from strategic asset allocations or with selection of individual securities within individual asset classes. These activities are referred to as active (versus passive) portfolio management strategies. A manager who varies from strategic asset allocation weights in order to take advantage of perceived short-term opportunities is adding **tactical asset allocation** to the portfolio strategy. **Security selection** refers to deviations from index weights on individual securities within an asset class. For example, a portfolio manager might overweight energy stocks and underweight financial stocks, relative to the index weights for U.S. large-cap equities as an asset class. For some asset classes, such as hedge funds, individual real estate properties, and artwork, investable indexes are not available. For these asset classes, selection of individual assets is required by the nature of the asset class.

While each of these active strategies may produce higher returns, they each also increase the risk of the portfolio compared to a passive portfolio of asset class indexes. A practice known as **risk budgeting** sets an overall risk limit for the portfolio and budgets (allocates) a portion of the permitted risk to the systematic risk of the strategic asset allocation, the risk from tactical asset allocation, and the risk from security selection.

Active portfolio management has two specific issues to consider.

1. An investor may have multiple managers actively managing to the same benchmark for the same asset class (or may have significant benchmark overlap). In this case, one manager may overweight an index stock while another may underweight the same stock. Taken together, there is no net active management risk, although each manager has reported active management risk. Overall, the risk budget is underutilized as there is less net active management than gross active management.

2. When all managers are actively managing portfolios relative to an index, trading may be excessive overall. This extra trading could have negative tax consequences, specifically potentially higher capital gains taxes, compared to an overall efficient tax strategy.

One way to address these issues is to use a **core-satellite approach**. The core-satellite approach invests the majority, or core, portion of the portfolio in passively managed indexes and invests a smaller, or satellite, portion in active strategies. This approach reduces the likelihood of excessive trading and offsetting active positions.

Clearly, the success of security selection will depend on the manager's skill and the opportunities (mispricings or inefficiencies) within a particular asset class. Similarly, the success of tactical asset allocation will depend both on the existence of short-term opportunities in specific asset classes and on the manager's ability to identify them.

### LOS 54.h: Describe how environmental, social, and governance (ESG) considerations may be integrated into portfolio planning and construction.

In our Corporate Finance review of "Introduction to Corporate Governance and Other ESG Considerations," we described several approaches to ESG investing. Here we look at some issues these approaches raise for portfolio management.

Recall that **negative screening** refers to excluding specific companies or industries from consideration for the portfolio based on ESG factors. If a portfolio's investment universe is constrained by negative screening, measuring its performance against a broad market index is unlikely to be appropriate. Indexes excluding companies or industries that investors with ESG concerns commonly avoid are available.

Investors using a **positive screening** or **best-in-class** approach invest in companies that have positive ESG practices. Which companies to invest in, and which ESG practices to focus on, differ among investors. Thus, portfolios and performance benchmarks must be customized under these approaches. Similarly, **thematic investing**, investing in sectors or companies in order to promote specific ESG-related goals, may require an investment manager who specializes in this style of investing.

**Engagement/active ownership investing** refers to using share ownership as a platform to promote improved ESG practices at a company, using share voting rights and by influencing management or board members. For investment managers with clients who wish to engage in active ownership, it is important to clarify whether the clients intend to vote their shares themselves or direct the managers to vote the shares according to specified ESG factors.

Regardless of the approach chosen, investors should be aware that imposing constraints based on ESG factors will likely affect portfolio performance. How these constraints will affect portfolio performance in practice is uncertain. Both limiting the universe of investment choices and incurring the costs involved in considering ESG factors may decrease returns. On the other hand, investing in companies with good corporate governance practices and avoiding those that face ESG-related risks may increase portfolio returns.

### MODULE QUIZ 54.1

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

1. The investment policy statement is *most accurately* considered:
   A. the starting point of the portfolio management process.

B. the key intermediate step in the portfolio management process.
C. the end product of the portfolio management process.

2. The component of an investment policy statement that defines the investment objectives is *most likely* to include information about:
   A. the investor's risk tolerance.
   B. unique needs and preferences of the investor.
   C. permitted asset types and use of leverage in the investment account.
3. When an investment advisor is developing return and risk objectives for a client:
   A. return objectives should be absolute and risk objectives should be relative.
   B. risk objectives should be absolute and return objectives should be relative.
   C. both return and risk objectives may be stated in absolute or relative terms.
4. A client exhibits an above-average willingness to take risk but a below-average ability to take risk. When assigning an overall risk tolerance, the investment adviser is *most likely* to assess the client's overall risk tolerance as:
   A. above average.
   B. average.
   C. below average.
5. Which of the following is *least likely* an example of a portfolio constraint?
   A. Higher tax rate on dividend income than on capital gains.
   B. Significant spending requirements in the near future.
   C. Minimum total return requirement of 8%.
6. For asset allocation purposes, asset classes should be specified such that correlations of returns are relatively:
   A. low within each asset class and low among asset classes.
   B. high within each asset class and low among asset classes.
   C. low within each asset class and high among asset classes.
7. In determining the appropriate asset allocation for a client's investment account, the manager should:
   A. consider only the investor's risk tolerance.
   B. incorporate forecasts of future economic conditions.
   C. consider the investor's risk tolerance and future needs, but not forecasts of market conditions.

# KEY CONCEPTS

## LOS 54.a

A written investment policy statement, the first step in the portfolio management process, is a plan for achieving investment success. An IPS forces investment discipline and ensures that goals are realistic by requiring investors to articulate their circumstances, objectives, and constraints.

## LOS 54.b

Many IPS include the following sections:

- Introduction—Describes the client.
- Statement of Purpose—The intentions of the IPS.
- Statement of Duties and Responsibilities—Of the client, the asset custodian, and the investment managers.
- Procedures—Related to keeping the IPS updated and responding to unforeseen events.
- Investment Objectives—The client's investment needs, specified in terms of required return and risk tolerance.
- Investment Constraints—Factors that may hinder the ability to meet investment objectives; typically categorized as time horizon, taxes, liquidity, legal and regulatory, and unique needs.
- Investment Guidelines—For example, whether leverage, derivatives, or specific kinds of assets are allowed.
- Evaluation and Review—Related to feedback on investment results.
- Appendices—May specify the portfolio's strategic asset allocation (policy portfolio) or the portfolio's rebalancing policy.

## LOS 54.c

Risk objectives are specifications for portfolio risk that are developed to embody a client's risk tolerance. Risk objectives can be either absolute (e.g., no losses greater than 10% in any year) or relative (e.g., annual return will be within 2% of FTSE return).

Return objectives are typically based on an investor's desire to meet a future financial goal, such as a particular level of income in retirement. Return objectives can be absolute (e.g., 9% annual return) or relative (e.g., outperform the S&P 500 by 2% per year).

The achievability of an investor's return expectations may be hindered by the investor's risk objectives.

## LOS 54.d

Willingness to take financial risk is related to an investor's psychological factors, such as personality type and level of financial knowledge.

Ability or capacity to take risk depends on financial factors, such as wealth relative to liabilities, income stability, and time horizon.

A client's overall risk tolerance depends on both his ability to take risk and his willingness to take risk. A willingness greater than ability, or vice versa, is typically resolved by choosing

the more conservative of the two and counseling the client.

### LOS 54.e

Investment constraints include:

- Liquidity—The need to draw cash from the portfolio for anticipated or unexpected future spending needs. High liquidity needs often translate to a high portfolio allocation to bonds or cash.
- Time horizon—Often the period over which assets are accumulated and before withdrawals begin. Risky or illiquid investments may be inappropriate for an investor with a short time horizon.
- Tax considerations—Concerns the tax treatments of the investor's various accounts, the relative tax treatment of capital gains and income, and the investor's marginal tax bracket.
- Legal and regulatory—Constraints such as government restrictions on portfolio contents or laws against insider trading.
- Unique circumstances—Restrictions due to investor preferences (religious, ethical, etc.) or other factors not already considered.

### LOS 54.f

An asset class is a group of securities with similar risk and performance characteristics. Examples of major asset classes include equity, fixed income, cash, and real estate. Portfolio managers also use more narrowly defined asset classes, such as large-cap U.S. equities or speculative international bonds, and alternative asset classes, such as commodities or investments in hedge funds.

### LOS 54.g

Strategic asset allocation is a set of percentage allocations to various asset classes that is designed to meet the investor's objectives. The strategic asset allocation is developed by combining the objectives and constraints in the IPS with the performance expectations of the various asset classes. The strategic asset allocation provides the basic structure of a portfolio.

Tactical asset allocation refers to an allocation that deviates from the baseline (strategic) allocation in order to profit from a forecast of shorter-term opportunities in specific asset classes.

### LOS 54.h

Imposing portfolio constraints based on ESG factors may affect performance. Limiting the universe of investment choices may decrease returns, but good corporate governance and low ESG-related risks may increase returns.

If a portfolio's investment universe is constrained by negative screening, its performance should be measured against a benchmark that excludes companies with negative ESG factors.

Positive screening, best-in-class, or thematic investing approaches typically require portfolio construction to be customized for the investor's choices of which ESG factors to focus on.

For active ownership, it is important to clarify whether investors intend to vote their shares themselves or direct managers to vote the shares according to specified ESG factors.

# ANSWER KEY FOR MODULE QUIZ

## Module Quiz 54.1

1. **A** An investment policy statement is considered to be the starting point of the portfolio management process. The IPS is a plan for achieving investment success. (LOS 54.a)

2. **A** Investment objectives are defined based on both the investor's return requirements and risk tolerance. Investment constraints include the investor's time horizon, liquidity needs, tax considerations, legal and regulatory requirements, and unique needs and preferences. Policies regarding permitted asset types and the amount of leverage to use are best characterized as investment guidelines. (LOS 54.b)

3. **C** Both risk and return objectives can be defined either in absolute terms or relative to some benchmark. (LOS 54.c)

4. **C** When assigning an overall risk tolerance, the prudent approach is to use the lower of ability to take risk and willingness to take risk. (LOS 54.d)

5. **C** Return objectives are part of a policy statement's objectives, not constraints. (LOS 54.e)

6. **B** Asset classes should be defined such that correlations of returns within the asset class are relatively high (because assets within a class should perform alike over time), while correlations of returns among asset classes are relatively low (to benefit from diversification). (LOS 54.f)

7. **B** An adviser's forecasts of the expected returns and expected volatilities (risk) of different asset classes are an important part of determining an appropriate asset allocation. (LOS 54.g)

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 #55.

# READING 55: INTRODUCTION TO RISK MANAGEMENT

**Study Session 19**

## EXAM FOCUS

Here we present a framework for risk management that is broad enough to be applied to corporations in general, financial firms, and individuals, as well as to the management of securities portfolios in any context. The main idea is that organizations should estimate the various risks they face and then reduce some risks and accept or increase other risks. The result should be a bundle of risks that simultaneously matches the risk tolerance of the organization and provides the greatest benefits in terms of reaching the organization's goals. Note that risk is not minimized though this process. The concept of risk budgeting, the categorization of types of risks, and the various methods of risk mitigation all offer testable material.

## MODULE 55.1: INTRODUCTION TO RISK MANAGEMENT

Video covering this content is available online.

### LOS 55.a: Define risk management.

*CFA® Program Curriculum, Volume 6, page 292*

The **risk management** process seeks to 1) identify the risk tolerance of the organization, 2) identify and measure the risks that the organization faces, and 3) modify and monitor these risks.

The process does not seek to minimize or eliminate all of these risks. The organization may increase its exposure to risks it decides to take because it is better able to manage and respond to them. The organization may decrease its exposure to risks that it is less well able to manage and respond to by making organizational changes, purchasing insurance, or entering into hedging transactions. Through these choices the firm aligns the risks it takes with its risk tolerances for these various types of risk.

Risk (uncertainty) is not something to be avoided by an organization or in an investment portfolio. Returns above the risk-free rate are earned by taking on risk. While returns for any period are not under the control of managers, the specific risks and overall level of risk the organization takes are under their control. We can think of risk management as determining organizational risks, determining the optimal bundle of risks for the organization, and implementing risk mitigation strategies to achieve that bundle of risks.

We describe the principles of risk management here in a framework that can be applied broadly, not only to firms or organizations in general, but also to the management of investment portfolios and financial firms, and even to individuals deciding how much risk

and which specific risks they will take. Individuals follow a similar approach, selecting a bundle of risks that is optimal for maximizing their expected utility (rather than returns or profit).

### LOS 55.b: Describe features of a risk management framework.

*CFA® Program Curriculum, Volume 6, page 293*

An overall **risk management framework** encompasses several activities, including:

- Establishing processes and policies for risk governance.
- Determining the organization's risk tolerance.
- Identifying and measuring existing risks.
- Managing and mitigating risks to achieve the optimal bundle of risks.
- Monitoring risk exposures over time.
- Communicating across the organization.
- Performing strategic risk analysis.

This framework is general, but all of these elements should be addressed in any comprehensive risk management framework. Only by understanding the risks the organization faces, and having the processes and procedures in place to effectively manage and monitor these risks, can an organization align its risk exposures to the goals of the organization.

### LOS 55.c: Define risk governance and describe elements of effective risk governance.

*CFA® Program Curriculum, Volume 6, page 299*

**Risk governance** refers to senior management's determination of the risk tolerance of the organization, the elements of its optimal risk exposure strategy, and the framework for oversight of the risk management function. Risk governance seeks to manage risk in a way that supports the overall goals of the organization so it can achieve the best business outcome consistent with the organization's overall risk tolerance. Risk governance provides organization-wide guidance on the risks that should be pursued in an efficient manner, risks that should be subject to limits, and risks that should be reduced or avoided.

A risk management committee can provide a way for various parts of the organization to bring up issues of risk measurement, integration of risks, and the best ways to mitigate undesirable risks.

### LOS 55.d: Explain how risk tolerance affects risk management.

*CFA® Program Curriculum, Volume 6, page 301*

Determining an organization's **risk tolerance** involves setting the overall risk exposure the organization will take by identifying the risks the firm can effectively take and the risks that the organization should reduce or avoid. Some of the factors that determine an organization's risk tolerance are its expertise in its lines of business, its skill at responding to negative outside events, its regulatory environment, and its financial strength and ability to withstand losses.

When analyzing risk tolerance, management should examine risks that may exist within the organization as well as those that may arise from outside. The various risks the firm is exposed to must each be considered and weighted against the expected benefits of bearing those risks and how these fit the overall goals of the organization.

### LOS 55.e: Describe risk budgeting and its role in risk governance.

*CFA® Program Curriculum, Volume 6, page 303*

**Risk budgeting** is the process of allocating firm resources to assets (or investments) by considering their various risk characteristics and how they combine to meet the organization's risk tolerance. The goal is to allocate the overall amount of acceptable risk to the mix of assets or investments that have the greatest expected returns over time.

The risk budget may be a single metric, such as portfolio beta, value at risk, portfolio duration, or returns variance. A risk budget may be constructed based on categories of investments, such as domestic equities, domestic debt securities, international equities, and international debt securities. Another way to allocate a risk budget is to identify specific risk factors that comprise the overall risk of the portfolio or organization. In this case, specific risk factors that affect asset classes to varying degrees, such as interest rate risk, equity market risk, and foreign exchange rate risk, are estimated and aggregated to determine whether they match the overall risk tolerance of the organization.

### LOS 55.f: Identify financial and non-financial sources of risk and describe how they may interact.

*CFA® Program Curriculum, Volume 6, page 307*

**Financial risks** are those that arise from exposure to financial markets. Examples are:

- **Credit risk.** This is the uncertainty about whether the counterparty to a transaction will fulfill its contractual obligations.
- **Liquidity risk.** This is the risk of loss when selling an asset at a time when market conditions make the sales price less than the underlying fair value of the asset.
- **Market risk.** This is the uncertainty about market prices of assets (stocks, commodities, and currencies) and interest rates.

**Non-financial risks** arise from the operations of the organization and from sources external to the organization. Examples are:

- **Operational risk.** This is the risk that human error, faulty organizational processes, inadequate security, or business interruptions will result in losses. An example of an operational risk is **cyber risk**, which refers to disruptions of an organization's information technology.
- **Solvency risk.** This is the risk that the organization will be unable to continue to operate because it has run out of cash.
- **Regulatory risk.** This is the risk that the regulatory environment will change, imposing costs on the firm or restricting its activities.
- **Governmental or political risk** (including **tax risk**). This is the risk that political actions outside a specific regulatory framework, such as increases in tax rates, will impose significant costs on an organization.

- **Legal risk.** This is the uncertainty about the organization's exposure to future legal action.
- **Model risk.** This is the risk that asset valuations based on the organization's analytical models are incorrect.
- **Tail risk.** This is the risk that extreme events (those in the tails of the distribution of outcomes) are more likely than the organization's analysis indicates, especially from incorrectly concluding that the distribution of outcomes is normal.
- **Accounting risk.** This is the risk that the organization's accounting policies and estimates are judged to be incorrect.

For individuals, risks, such as risk of death (**mortality risk**) prior to providing for their families' future needs and the risk of living longer than anticipated (**longevity risk**) so that assets run out, are very important in financial planning. Mortality risk is most often addressed with life insurance, and longevity risk can be reduced by purchasing a lifetime annuity. Risk of health care expenses is addressed with health insurance. Although the risks for an individual are in some ways different from those of organizations, the overall approach is the same, choosing which risks to bear (self-insure), which risks to prevent or avoid, and which risks to take in order to maximize the expected outcome in terms of personal utility or satisfaction.

The various risks an organization faces are not independent; they interact in many ways. Consider a firm with market risk that it reduces with option contracts. If markets decline significantly, the firm is owed a payment from the firm on the other side of the option trade, so now there is significant counterparty or credit risk. There also may be legal risks if the counterparty seeks to avoid the payment through loopholes in the contract. Credit losses and legal losses may result in greater liquidity risk as positions must be sold. Additional losses from selling in a declining or less liquid market may increase solvency risk because of the negative impact on the firm's cash position.

Interactions among risks must be considered because such interactions are many and frequent. They can be especially important during periods of stress in financial markets, when risk management is most important to the health and possibly the survival of the organization.

## LOS 55.g: Describe methods for measuring and modifying risk exposures and factors to consider in choosing among the methods.

*CFA® Program Curriculum, Volume 6, page 315*

Measures of risk for specific asset types include standard deviation, beta, and duration.

- **Standard deviation** is a measure of the volatility of asset prices and interest rates. Standard deviation may not be the appropriate measure of risk for non-normal probability distributions, especially those with negative skew or positive excess kurtosis (fat tails).
- **Beta** measures the market risk of equity securities and portfolios of equity securities. This measure considers the risk reduction benefits of diversification and is appropriate for securities held in a well-diversified portfolio, whereas standard deviation is a measure of risk on a stand-alone basis.
- **Duration** is a measure of the price sensitivity of debt securities to changes in interest rates.

**PROFESSOR'S NOTE**

We describe and calculate standard deviation in Quantitative Methods; duration in Fixed Income; and beta in the current topic area, Portfolio Management.

**Derivatives risks** (sometimes referred to as "the Greeks") include:

- **Delta.** This is the sensitivity of derivatives values to the price of the underlying asset.
- **Gamma.** This is the sensitivity of delta to changes in the price of the underlying asset.
- **Vega.** This is the sensitivity of derivatives values to the volatility of the price of the underlying asset.
- **Rho.** This is the sensitivity of derivatives values to changes in the risk-free rate.

**Tail risk** is the uncertainty about the probability of extreme (negative) outcomes. Commonly used measures of tail risk (sometimes referred to as **downside risk**) include Value at Risk and Conditional VaR.

**Value at risk (VaR)** is the minimum loss over a period that will occur with a specific probability. Consider a bank that has a one-month VaR of $1 million with a probability of 5%. That means that a one-month loss of at least $1 million is expected to occur 5% of the time. Note that this is not the maximum one-month loss the bank will experience; it is the minimum loss that will occur 5% of the time. VaR does not provide a maximum loss for a period. VaR has become accepted as a risk measure for banks and is used in establishing minimum capital requirements.

There are various methods of calculating VaR, and both the inputs and models used will affect the calculated value, perhaps significantly. As is always the case with estimates of risk, incorrect inputs or inappropriate distribution assumptions will lead to misleading results. Given these limitations, VaR should be used in conjunction with other risk measures.

**Conditional VaR (CVaR)** is the expected value of a loss, *given* that the loss exceeds a minimum amount. Relating this to the VaR measure presented previously, the CVaR would be the expected loss, given that the loss was at least $1 million. It is calculated as the probability-weighted average loss for all losses expected to be at least $1 million. CVaR is similar to the measure of loss given default that is used in estimating risk for debt securities.

## Subjective and Market-Based Estimates of Risk

Two methods of risk assessment that are used to supplement measures such as VaR and CVaR are stress testing and scenario analysis. **Stress testing** examines the effects of a specific (usually extreme) change in a key variable such as an interest rate or exchange rate. **Scenario analysis** refers to a similar what-if analysis of expected loss but incorporates changes in multiple inputs. A given scenario might combine an interest rate change with a significant change in oil prices or exchange rates.

Quantifying the risk to an organization of very infrequent events is quite difficult. The risk of the bankruptcy of a firm that has never experienced significant financial distress is often a subjective estimate rather than a data-driven estimate. Estimates of risk can also be based on the market prices of insurance, derivatives, or other securities that can be used to hedge those risks. These hedging costs provide information on market participants' aggregate estimate of the expected loss of specific risks.

Operational risks are difficult to quantify for a single organization because they are very difficult to predict and may result in very large costs to the organization. One way to approach this problem is to examine a large sample of firms in order to determine an overall probability of significant losses due to operational risks and the average loss of firms that have experienced such losses.

Unexpected changes in tax laws or the regulatory environment can impose large costs on an organization. The political nature of such changes makes them quite difficult to predict. Subjective estimates, rather than data-driven quantitative estimates, are necessary. As is often the case, even a subjective, non-quantitative estimate of risk probabilities and magnitudes is better than not addressing the risk factor at all.

## Modifying Risk Exposures

Risk management does not seek to eliminate all risks. The goal is to retain the optimal mix of risks for the organization. This may mean taking on more of some risks, decreasing others, and eliminating some altogether. Once the risk management team has estimated various risks, management may decide to prevent or avoid a risk, accept a risk, transfer a risk, or shift a risk.

One way to avoid a risk is to not engage in the activity with the uncertain outcome. If political risks in a country are to be avoided, simply not investing in securities of firms based in that country or not expanding a business enterprise to that country would avoid those risks. A decision to avoid certain risks typically would come from top management as a part of establishing the risk tolerance of the organization and would be instituted because the risks are judged to outweigh the potential benefits of specific activities.

Some risks can be prevented. The risk of a data breach can be prevented with a greater level of security for the data and stronger processes. In this case, the benefits of reducing or eliminating the risk are judged to be greater than the cost of doing so.

For risks that management has decided to bear, the organization will seek to bear them efficiently. **Diversification** may offer a way to more efficiently bear a specific risk.

**PROFESSOR'S NOTE**

We explain how diversification can reduce risk in our review of "Portfolio Risk and Return: Part I."

Sometimes the term **self-insurance** is used to describe a situation where an organization has decided to bear a risk. Note, however, that this simply means that it will bear any associated losses from this risk factor. It is possible that this represents inaction rather than the result of analysis and strategic decision making. In some cases, the firm will establish a reserve account to cover losses as a way of mitigating the impact of losses on the organization.

For a risk an organization has decided not to bear, risk transfer or risk shifting can be employed. With a **risk transfer**, another party takes on the risk. Insurance is a type of risk transfer. The risk of fire destroying a warehouse complex is shifted to an insurance company by buying an insurance policy and paying the policy premiums. Insurance companies diversify across many risks so the premiums of some insured parties pay the losses of others. Ideally, the various risks the insurance company insures are not highly correlated, as that can reduce or eliminate any diversification benefits. An insurance company with highly correlated risks (or a single very large risk) may itself shift some of the resulting risk by buying reinsurance from another company.

With a **surety bond**, an insurance company has agreed to make a payment if a third party fails to perform under the terms of a contract or agreement with the organization. For example, a company may be exposed to losses if a key supplier does not deliver on time, slowing a project and resulting in penalty payments by the company. Insurers also issue **fidelity bonds**, which will pay for losses that result from employee theft or misconduct. Managements that purchase insurance, surety bonds, or fidelity bonds have determined that the benefits of risk reduction are greater than the cost of the insurance.

**Risk shifting** is a way to change the distribution of possible outcomes and is accomplished primarily with derivative contracts. For example, financial firms that do not want to bear currency risk on some foreign currency denominated debt securities can use forward currency contracts, futures contracts, or swaps to reduce or eliminate that risk. A firm with a large position in a specific stock can buy put options that provide a minimum sale price for the securities, altering the distribution of possible outcomes (in this case providing a floor value for the securities). On the other hand, a firm could sell call options on a specific stock, altering the distribution of possible outcomes by giving up some of the upside potential of the stock but decreasing its downside risk by the amount of the premiums received from the sale of the call options.

## Choosing Among Risk Modification Methods

Organizations may use multiple methods of risk modification to reduce a single risk. The criterion is always a comparison of the costs and benefits of risk modification. Some risks may be mitigated by diversification, some shifted by insurance where it is available and economical, some shifted though the use of derivatives, and some simply borne or self-insured. The end result is a risk profile that matches the risk tolerance established for the organization and includes the risks that top management has determined match the goals of the organization in terms of cost versus potential returns.

### MODULE QUIZ 55.1

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

1. An investor has the *most* control over her portfolio's:
   A. risk.
   B. relative returns.
   C. risk-adjusted returns.
2. A risk management framework *least likely* includes:
   A. risk governance, risk mitigation, and strategic risk analysis.
   B. identifying and measuring risks, risk policies and processes, and risk governance.
   C. risk mitigation, tracking the organization's risk profile, and establishing position limits.
3. Risk governance should *most appropriately* be addressed within an organization at:
   A. the enterprise level.
   B. the business unit level.
   C. the individual employee level.
4. Effective risk management would *most likely* attempt to:
   A. maximize expected return for a given level of risk.
   B. minimize risk for a given level of expected return.
   C. reduce any significant risks the firm is exposed to.
5. Risk budgeting can *best* be described as:
   A. setting an annual limit on risk taken.
   B. selecting assets by their risk characteristics.
   C. establishing a maximum amount of risk to be taken.

6. Which of the following is *most appropriately* termed a financial risk?
   A. Credit risk.
   B. Solvency risk.
   C. Settlement risk.
7. Risk shifting is *most likely* achieved by:
   A. risk mitigation.
   B. using derivative securities.
   C. transferring risk to an insurance company.

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# KEY CONCEPTS

## LOS 55.a

Risk management is the process of identifying and measuring the risks an organization (or portfolio manager or individual) faces, determining an acceptable level of overall risk (establishing risk tolerance), deciding which risks should be taken and which risks should be reduced or avoided, and putting the structure in place to maintain the bundle of risks that is expected to best achieve the goals of the organization.

## LOS 55.b

An overall risk management framework should address the following activities:

- Identifying and measuring existing risks.
- Determining the organization's overall risk tolerance.
- Establishing the processes and policies for risk governance.
- Managing and mitigating risks to achieve the optimal bundle of risks.
- Monitoring risk exposures over time.
- Communicating across the organization.
- Performing strategic risk analysis.

## LOS 55.c

Risk governance refers to senior management's determination of the risk tolerance of the organization, the elements of its optimal risk exposure strategy, and the framework for oversight of the risk management function.

## LOS 55.d

The risk tolerance for an organization is the overall amount of risk it will take in pursuing its goals and is determined by top management.

## LOS 55.e

Risk budgeting is the process of allocating the total risk the firm will take (risk tolerance) to assets or investments by considering the risk characteristics of each and how they can be combined to best meet the organization's goals. The budget can be a single risk measure or the sum of various risk factors.

## LOS 55.f

Financial risks are those that arise from exposure to financial markets, including credit risk, liquidity risk, and market risk. Non-financial risks are the risks from the operation of the organization and from sources external to the organization. Individuals face mortality and longevity risk, in addition to financial risks.

Interactions among risks are frequent and can be especially significant during periods of stress in financial markets.

## LOS 55.g

Risk of assets is measured by standard deviation, beta, or duration. Derivatives risk measures include delta, gamma, vega, and rho. Tail risk is measured with value at risk (VaR) or

Conditional VaR. Some risks must be measured subjectively.

An organization may decide to bear a risk (self-insurance), avoid or take steps to prevent a risk, efficiently manage a risk through diversification, transfer a risk with insurance or a surety bond, or shift a risk (change the distribution of uncertain outcomes) with derivatives.

Organizations may use multiple methods of risk modification after considering the costs and benefits of the various methods. The end result is a risk profile that matches the organization’s risk tolerance and includes the risks that top management has determined match the organization’s goals.

# ANSWER KEY FOR MODULE QUIZ

## Module Quiz 55.1

1. **A** An investor can select securities to achieve a given level of portfolio risk. Returns cannot be controlled. (LOS 55.a)

2. **C** A risk management framework includes the procedures, analytical tools, and infrastructure to conduct the risk governance process. It includes all of the items listed with the exception of establishing position limits, which is an example of the operational implementation of a system of risk management. (LOS 55.b)

3. **A** Risk governance should be approached from an enterprise view, with senior management determining risk tolerance and a risk management strategy on an organization-wide level. (LOS 55.c)

4. **A** Risk management requires establishment of a risk tolerance (maximum acceptable level of risk) for the organization and will attempt to maximize expected returns for that level of risk. Some significant risks the firm is exposed to may be borne by the firm or even increased as a result of risk management. (LOS 55.d)

5. **B** Risk budgeting refers to selecting assets or securities by their risk characteristics up to the maximum allowable amount of risk. The maximum amount of risk to be taken is established through risk governance. (LOS 55.e)

6. **A** The main sources of financial risk are market risk, credit risk, and liquidity risk. Solvency risk and settlement risk are classified as non-financial risks. (LOS 55.f)

7. **B** Risk shifting changes the distribution of possible outcomes, typically through the use of derivative securities. Risk shifting is one technique for mitigating risk. Transferring risk to an insurance company is termed *risk transfer*. (LOS 55.g)

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 #56.

# READING 56: TECHNICAL ANALYSIS

**Study Session 19**

## EXAM FOCUS

This topic review introduces the "story" that underlies technical analysis, and you should understand how this differs from fundamental analysis. You should learn what the technical indicator names mean and how they are used, but don't worry about being able to calculate them. The LOS for this topic ask you to "explain" and "describe." You are responsible for knowing about the assumptions and tools of technical analysis and understanding how technical analysts reach their conclusions. You are not required to believe technical analysis can create positive risk-adjusted returns on average over time.

## MODULE 56.1: TECHNICAL ANALYSIS

Video covering this content is available online.

### LOS 56.a: Explain principles of technical analysis, its applications, and its underlying assumptions.

*CFA® Program Curriculum, Volume 6, page 338*

**Technical analysis** is the study of collective market sentiment, as expressed in buying and selling of assets. It is based on the idea that prices are determined by the interaction of supply and demand. The market price equates supply and demand at any instant. Only participants who actually trade affect prices, and better-informed participants tend to trade in greater volume. Thus, price and volume reflect the collective behavior of buyers and sellers.

A key assumption of technical analysis is that market prices reflect both rational and irrational investor behavior. This assumption implies that the *efficient markets hypothesis* does not hold. (The efficient markets hypothesis is described in the Study Session on securities markets.) Technical analysts believe investor behavior is reflected in trends and patterns that tend to repeat and can be identified and used for forecasting prices.

Technical analysis can be contrasted with fundamental analysis, which attempts to determine the intrinsic value of an asset. While fundamental analysis of a firm uses the company's financial statements and other information to analyze its financial position and determine its value, technical analysis uses only the firm's share price and trading volume data to project a target price. Technical analysis is not concerned with identifying buyers' and sellers' reasons for trading, but only with the trades that have occurred.

An advantage of only using actual price and volume data is that they are observable. Much of the data used in fundamental analysis is subject to assumptions or restatements, and might not be available at all for assets such as currencies or commodities. (This does not, however, imply that technical analysis itself is objective; both kinds of analysis require subjective judgment.) Another advantage of technical analysis is that it can be applied to the prices of assets that do not produce future cash flows (dividends or interest), such as commodities.

Technical analysis can also be useful when financial statement fraud occurs. Price and volume may reflect the true value of the company even before the fraud is widely known and before the financial statements are restated.

The usefulness of technical analysis is limited in markets where price and volume data might not truly reflect supply and demand. This may be the case in illiquid markets and in markets that are subject to outside manipulation (for example, currency market intervention by central banks). For stocks of bankrupt companies, short covering can create positive technical patterns even when it is known that the stock price will go to zero.

## LOS 56.b: Describe the construction of different types of technical analysis charts and interpret them.

*CFA® Program Curriculum, Volume 6, page 342*

Technical analysts primarily use charts of price and volume to analyze asset prices and overall market movement. Most of these charts have time on the horizontal axis. The time interval chosen (monthly, weekly, daily, or intraday periods) reflects the trading horizon of interest to the analyst. A technical analyst will typically start by observing longer-term trends on monthly and weekly charts, then look at recent activity on daily or intraday charts. If prices have changed exponentially (e.g., a stock index over several decades), an analyst may choose to draw charts on a logarithmic scale instead of the usual linear scale.

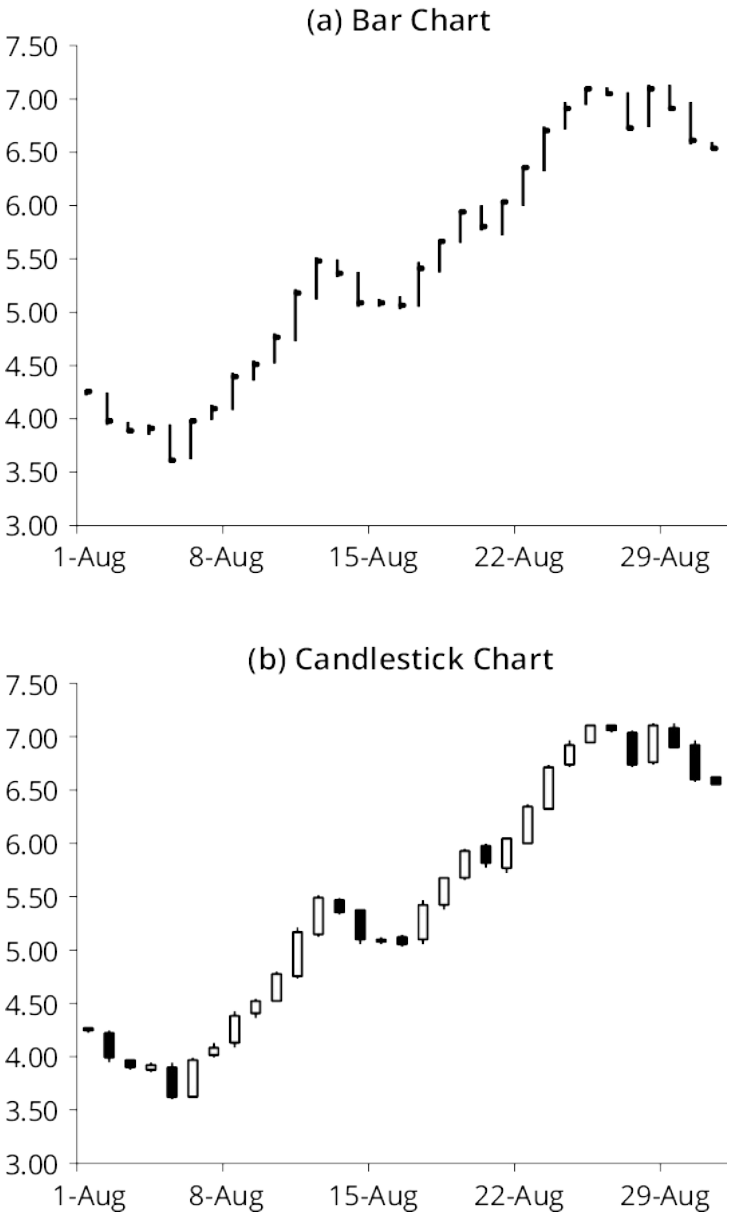
**Line charts** are the simplest technical analysis charts. They show closing prices for each period as a continuous line (see Figure 56.1).

**Bar charts** add the high and low prices for each trading period and often include the opening price as well. Each period is displayed as a vertical line, with the closing price indicated as a point or dash on the right side of the line. If the chart includes opening prices, these are shown on the left side of each vertical line.

**Candlestick charts** use the same data as bar charts but display a box bounded by the opening and closing prices. The box is clear if the closing price is higher than the opening price, or filled if the close is lower than the opening price. Candlestick charts can make patterns easier to recognize (see Figure 56.2).

**Figure 56.1: Line Chart**

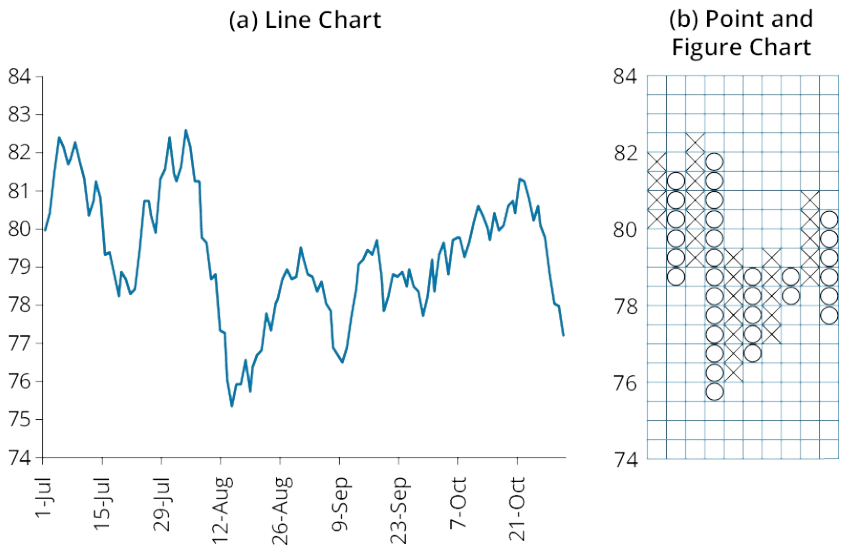

**Figure 56.2: Bar and Candlestick Charts**




**Point-and-figure charts** are helpful in identifying changes in the direction of price movements. These are drawn on graph paper, with price on the vertical axis. The price increment chosen is the “box size” for the chart. Unlike other technical charts, the horizontal axis does not represent discrete units of time. Instead, it represents the number of changes in direction. To determine when a change of direction has occurred, the analyst must choose a “reversal size” for the chart. A typical reversal size is three times the box size.

Starting from the opening price, the analyst will fill in a box in the first column if the closing price has changed by at least the box size. An X indicates an increase of one box size and an O indicates a decrease. If the price changes by more than one box size, the analyst will fill in multiple Xs or Os. If the price continues in the same direction in the next periods, the analyst will continue filling in the same column. When the price changes in the opposite direction by at least the reversal size, the analyst will begin the next column (see panel b of Figure 56.3).

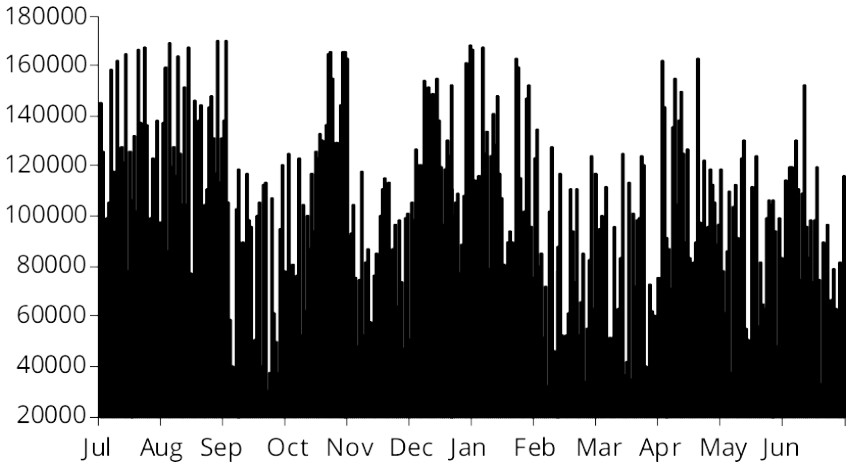
**Figure 56.3: Charts of Price Data**




Technical analysts are concerned with volume as well as price. **Volume charts** are usually displayed below price charts with each period's volume shown as a vertical line (see Figure 56.4).

To perform **relative strength analysis**, an analyst calculates the ratios of an asset's closing prices to benchmark values, such as a stock index or comparable asset, and draws a line chart of the ratios. An increasing trend indicates that the asset is outperforming the benchmark (positive relative strength) and a decrease shows that the asset is underperforming the benchmark (negative relative strength).

**Figure 56.4: Volume Chart**




## LOS 56.c: Explain uses of trend, support, resistance lines, and change in polarity.

*CFA® Program Curriculum, Volume 6, page 353*

The most basic concept in technical analysis is the **trend** in prices. A market is said to be in an **uptrend** if prices are consistently reaching higher highs and retracing to higher lows. An uptrend means demand is increasing relative supply.

A market is in a **downtrend** if prices are consistently declining to lower lows and retracing to lower highs. A downtrend suggests supply (i.e., selling pressure) is increasing relative to

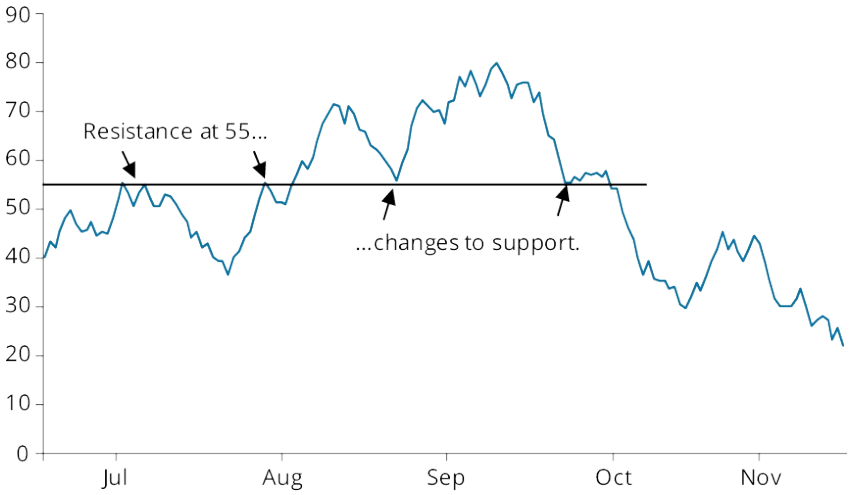
demand.

Drawing a **trendline** on a chart can help to identify whether a trend is continuing or reversing. In an uptrend, a trendline connects the increasing lows in price. In a downtrend, the trendline connects the decreasing highs in price. When the price crosses the trendline by what the analyst considers a significant amount, a **breakout** from a downtrend or a **breakdown** from an uptrend is said to occur. Either a breakout or a breakdown may signal the end of the previous trend.

Breakouts and breakdowns are important because the trendline is thought to represent a level of support or resistance. At a **support level**, buying is expected to emerge that prevents further price decreases. At a **resistance level**, selling is expected to emerge that prevents further price increases. In addition to trendlines, support and resistance levels frequently appear at psychologically important prices such as round-number prices or historical highs and lows.

An important principle in technical analysis is the **change in polarity**. This refers to a belief that breached resistance levels become support levels and that breached support levels become resistance levels. In Figure 56.5, the area of 55 is viewed as a resistance level until the price breaks above that level, then 55 becomes a support level as prices decline from their new highs.

**Figure 56.5: Change in Polarity**




## LOS 56.d: Describe common chart patterns.

*CFA® Program Curriculum, Volume 6, page 355*

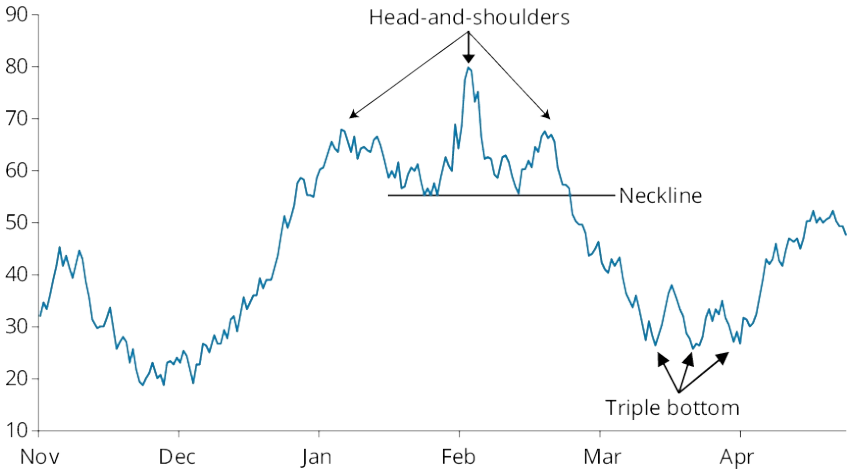
Technical analysts look for recurring patterns in charts that suggest the future course of prices. Some patterns tend to appear at the end of trends, while other patterns indicate that a trend is likely to continue.

**Reversal patterns** occur when a trend approaches a range of prices but fails to continue beyond that range. A well-known example is the **head-and-shoulders pattern**, as shown in Figure 56.6. This pattern suggests the demand that has been driving the uptrend is fading, especially if each of the highs in the pattern occurs on declining volume.

Technical analysts commonly use the size of a head-and-shoulders pattern to project a price target for the ensuing downtrend. The size is the difference in price between the “head,” the highest price reached, and the “neckline,” the support level to which the price retraced after the left “shoulder” and the head have formed. If the price declines beyond the neckline after the right shoulder forms, the downtrend is projected to continue from that breakdown price by about the size of the head-and-shoulders pattern. In Figure 56.6, the top of the head is at 80 and the neckline is at 55, so the size of the pattern is 80 − 55 = 25. The price target for the ensuing downtrend is 55 − 25 = 30.

**Double top** and **triple top** patterns are similar to the head-and-shoulders pattern in that they indicate weakening in the buying pressure that has been driving an uptrend. In both cases, the price reaches a resistance level at which selling pressure appears repeatedly, preventing any further increase in the price. As with the head-and-shoulders, the size of a double or triple top pattern can be used to project a price target for the next downtrend.

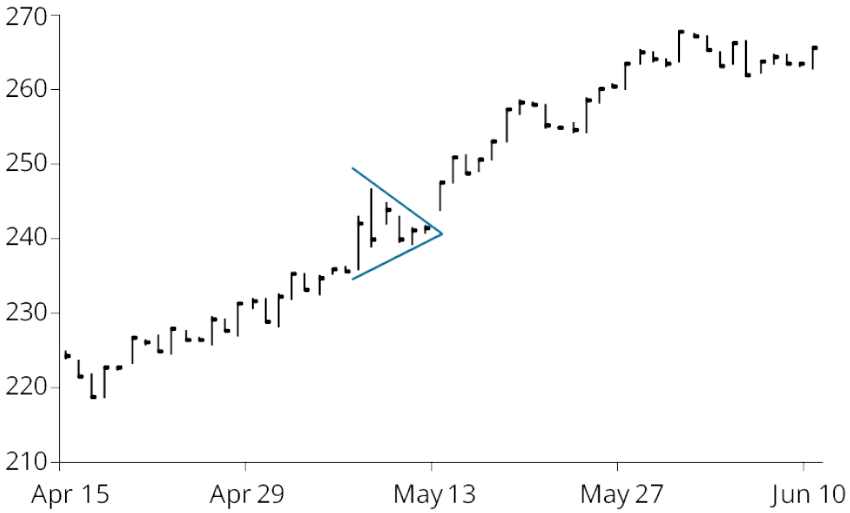
**Figure 56.6: Reversal Patterns**




Reversal patterns for downtrends are called **inverse head-and-shoulders**, **double bottom**, and **triple bottom** patterns and can be analyzed in the same way as the reversal patterns for uptrends.

**Continuation patterns** suggest a pause in a trend rather than a reversal. **Triangles** form when prices reach lower highs and higher lows over a period of time (see Figure 56.7). Trendlines on the highs and on the lows thus converge when they are projected forward. Triangles can be symmetrical (higher lows and lower highs), ascending (higher lows and a resistance level), or descending (lower highs and a support level).

**Figure 56.7: Triangle Continuation Pattern**




Triangles suggest buying and selling pressure have become roughly equal temporarily, but they do not imply a change in direction of the trend. The size of a triangle, or the difference between the two trendlines at the time when the pattern begins to form, can be used to set a price target, assuming the price breaks out of the triangle and the previous trend continues.

**Rectangles** form when trading temporarily forms a range between a support level and a resistance level. As with a triangle, a rectangle suggests the prevailing trend will resume and can be used to set a price target. **Flags** and **pennants** refer to rectangles and triangles that appear on short-term price charts.

**LOS 56.e: Describe common technical analysis indicators (price-based, momentum oscillators, sentiment, and flow of funds).**

*CFA® Program Curriculum, Volume 6, page 366*

## Price-Based Indicators

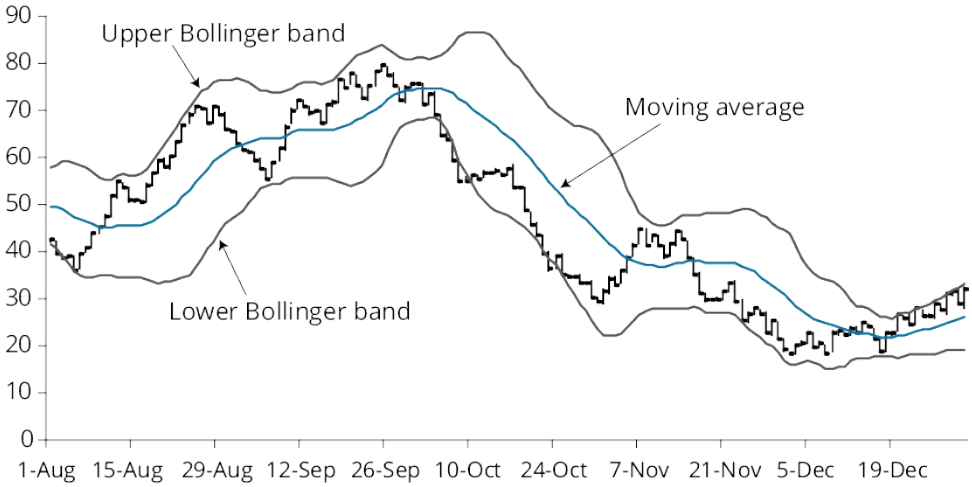
**Moving average lines** are a frequently used to smooth the fluctuations in a price chart (or a chart of any time series). A moving average is simply the mean of the last *n* closing prices. The larger the chosen value of *n*, the smoother the moving average line. Analysts often use moving average periods that make intuitive sense, such as 20 days to represent the number of trading days in a month. In an uptrend, the price is higher than the moving average, and in a downtrend, the price is lower than the moving average. Moving average lines are often viewed as support or resistance levels.

Analysts use moving average lines to make changes in the trend easier to see. The longer the period used to calculate the moving average, the more short-term fluctuations are removed from the line. Overly long periods may, in fact, obscure changes in a price trend.

Moving averages for different periods can be used together, such as 20-day and 250-day averages. Points where the short-term average (more volatile) crosses the long-term average (smoother) can indicate changes in the price trend. When the short-term average crosses above long-term average (a “golden cross”), this is often viewed as an indicator of an emerging uptrend or a “buy” signal by technical analysts. The short-term average crossing below the long-term average (a “dead cross”) is often viewed as an indicator of an emerging downtrend or a “sell” signal.

**Bollinger bands** are constructed based on the standard deviation of closing prices over the last *n* periods. An analyst can draw high and low bands a chosen number of standard deviations (typically two) above and below the *n*-period moving average. The bands move away from one another when price volatility increases and move closer together when prices are less volatile (see Figure 56.8).

**Figure 56.8: Moving Average and Bollinger Bands**




Bollinger bands are viewed as useful for indicating when prices are extreme by recent standards on either the high or low side. Prices at or above the upper Bollinger band may be viewed as indicating an **overbought** market, one that is "too high" and likely to decrease in the near term. Likewise, prices at or below the lower Bollinger band may be viewed as indicating an **oversold** market, one that is "too low" and likely to increase in the near term. A possible trading strategy using Bollinger bands is to buy when the price is at the lower band or sell when the price is at the upper band. This is an example of a **contrarian strategy**—one that buys when most traders are selling and sells when most traders are buying. Contrarians believe markets get overbought or oversold because most investors tend to buy and sell at the wrong times, and thus it can be profitable to trade in the opposite direction.

## *Oscillators*

Oscillators are another group of tools technical analysts use to identify overbought or oversold markets. These indicators are based on market prices but scaled so that they "oscillate" around a given value, such as zero, or between two values such as zero and 100. Extreme high values of an oscillator are viewed as indicating that a market is overbought, while extreme low values are viewed as indicating an oversold market. Technical analysts use charts of oscillators over time to highlight periods when they are near their high or low extremes.

Oscillator charts can also be used to identify **convergence** or **divergence** of the oscillator and market prices. Convergence occurs when the oscillator shows the same pattern as prices (e.g., both reaching higher highs), and divergence occurs when the oscillator shows a different pattern than prices (e.g., failing to reach a higher high when the price does). Convergence suggests the price trend is likely to continue, while divergence may indicate a potential change in the price trend.

Examples of oscillators include the rate of change (ROC) oscillator, Relative Strength Index (RSI), moving average convergence/divergence (MACD) lines, and the stochastic oscillator.

- **Rate of change oscillator.** An ROC or *momentum oscillator* is calculated as 100 times the difference between the latest closing price and the closing price *n* periods earlier. Thus, it oscillates around zero. One way technical analysts use the ROC is to buy when the oscillator changes from negative to positive during an uptrend in prices, and sell when the ROC changes from positive to negative during a downtrend. Some analysts prefer to use the ratio of the current price to the past price in place of the difference. Calculated this way, the ROC oscillates around 100.
- **Relative Strength Index.** An RSI is based on the ratio of total price increases to total price decreases over a selected number of periods. This ratio is then scaled to oscillate between 0 and 100, with high values (typically those greater than 70) indicating an overbought market and low values (typically those less than 30) indicating an oversold market.
- **Moving average convergence/divergence.** MACD oscillators are drawn using exponentially smoothed moving averages, which place greater weight on more recent observations. The "MACD line" is the difference between two exponentially smoothed moving averages of the price, and the "signal line" is an exponentially smoothed moving average of the MACD line. The lines oscillate around zero but are not bounded. The MACD oscillator can be used to indicate overbought or oversold conditions or to identify convergence or divergence with the price trend. Points where the two lines cross can be used as trading signals, much like the use of two different moving averages discussed previously. The MACD line crossing above the smoother signal line is viewed as a buy signal and the MACD line crossing below the signal line is viewed as a sell signal.
- **Stochastic oscillator.** A stochastic oscillator is calculated from the latest closing price and highest and lowest prices reached in a recent period, such as 14 days. In a sustainable uptrend, prices tend to close nearer to the recent high, and in a sustainable downtrend, prices tend to close nearer to the recent low. Stochastic oscillators use two lines that are bounded by 0 and 100. The "%K" line is the difference between the latest price and the recent low as a percentage of the difference between the recent high and low. The "%D" line is a 3-period average of the %K line. Technical analysts typically use stochastic oscillators to identify overbought and oversold markets. Points where the %K line crosses the %D line can also be used as trading signals in the same way as the MACD lines.

**PROFESSOR'S NOTE**

Is this fun or what? Remember, no calculations are required. Just know the terms as best you can.

## Non-Price-Based Indicators

While the technical indicators mentioned so far assume investor sentiment is reflected in price and volume data, technical analysts can also look at indicators of investor sentiment and capital flows to gain insight into potential emerging trends. **Sentiment** indicators can be used to discern the views of potential buyers and sellers. Market sentiment is said to be "bullish" when investors expect increasing prices and "bearish" when they expect decreasing prices.

Indicators can include **opinion polls** that try to measure investor sentiment directly, as well as several measures that are based on market data:

- **Put/call ratio.** Put options increase in value when the price of an underlying asset decreases, while call options increase in value if the price of the underlying asset increases. For financial assets that have actively traded options, the volume of put and call options reflects activity by investors with negative and positive outlooks, respectively, about the asset. The put/call ratio is put volume divided by call volume. Increases in the put/call ratio indicate a more negative outlook for the price of the asset. This ratio is generally viewed as a contrarian indicator. Extremely high ratios indicate strongly bearish investor sentiment and possibly an oversold market, while extremely low ratios indicate strongly bullish sentiment and perhaps an overbought market.
- **Volatility Index (VIX)**. The Chicago Board Options Exchange calculates the VIX, which measures the volatility of options on the S&P 500 stock index. High levels of the VIX suggest investors fear declines in the stock market. Technical analysts most often interpret the VIX in a contrarian way, viewing a predominantly bearish investor outlook as a bullish sign.
- **Margin debt.** The amount of margin debt is a readily available indicator because brokers are required to report this data. Increases in total margin debt outstanding suggest aggressive buying by bullish margin investors. As margin investors reach their limits of margin credit, their ability to continue buying decreases, which can cause prices to begin declining. As prices decrease, investors may need to sell securities to meet margin calls, and these sales drive prices lower still. Increasing margin debt tends to coincide with increasing market prices and decreasing margin debt tends to coincide with decreasing prices.
- **Short interest ratio.** Just as an increase in margin debt suggests aggressive buying and strong positive sentiment, increases in shares sold short indicate strong negative sentiment. **Short interest** is the number of shares investors have borrowed and sold short. As with margin debt, short interest must be reported by brokerage firms. The short interest ratio is short interest divided by average daily trading volume. While a high short interest ratio means investors expect the stock price to decrease, it also implies future buying demand when short sellers must return their borrowed shares. Thus, technical analysts' opinions are divided as to how the short interest ratio should be interpreted.

Since technical analysis is based on changes in supply and demand conditions, indicators of the **flow of funds** in the financial markets can be useful for observing changes in the supply of securities and the demand for them.

- The **Arms index** or **short-term trading index (TRIN)** is a measure of funds flowing into advancing and declining stocks.

  The index is calculated as:

  $$\text{TRIN} = \frac{\text{number of advancing issues/number of declining issues}}{\text{volume of advancing issues/volume of declining issues}}$$

  An index value close to one suggests funds are flowing about evenly to advancing and declining stocks. Index values greater than one mean the majority of volume is in declining stocks, while an index less than one means more of the volume is in advancing stocks. On charts of the TRIN for U.S. stocks, spikes upward have coincided

with large daily losses in the stock market, while spikes downward have coincided with large daily gains in the stock market.

- *Margin debt*, besides indicating investor sentiment as described previously, is also a useful flow of funds indicator. Increasing margin debt may indicate that investors want to buy more stocks. Decreasing margin debt indicates increased selling.
- The **mutual fund cash position** is the ratio of mutual funds' cash to total assets. During uptrends, fund managers want to invest cash quickly because cash earns only the risk-free rate of return and thus decreases fund returns. During downtrends, fund cash balances increase overall fund returns. As a result, mutual fund cash positions tend to increase when the market is falling and decrease when the market is rising. Technical analysts typically view mutual fund cash as a contrarian indicator. When mutual funds accumulate cash, this represents future buying power in the market. A high mutual fund cash ratio therefore suggests market prices are likely to increase. On the other hand, when mutual funds' cash is low, they are already invested and market prices reflect their purchases.
- **New equity issuance** (i.e., initial public offerings) and **secondary offerings** (sales of additional shares by the issuer) add to the supply of stocks. Because issuers tend to sell new shares when stock prices are thought to be high, increases in issuance of new shares may often coincide with market peaks.

## LOS 56.f: Explain how technical analysts use cycles.

## LOS 56.g: Describe the key tenets of Elliott Wave Theory and the importance of Fibonacci numbers.

*CFA® Program Curriculum, Volume 6, page 384*

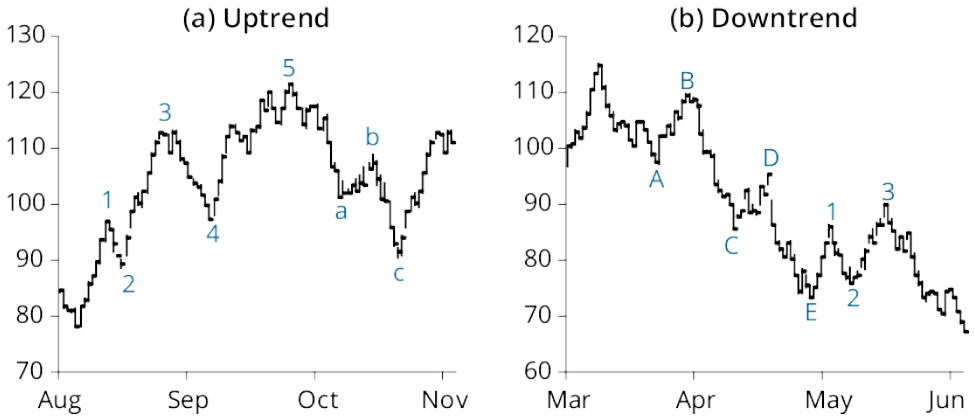
Cycle theory is the study of processes that occur in cycles, as many natural phenomena tend to do. Some technical analysts apply cycle theory to financial markets in an attempt to identify cycles in prices.

Some of the cycle periods favored by technical analysts are 4-year **presidential cycles** related to election years in the United States; **decennial patterns** or 10-year cycles; 18-year cycles; and 54-year cycles called the **Kondratieff wave**.

One of the more developed cycle theories is **Elliott wave theory**. Elliott wave theory is based on a belief that financial market prices can be described by an interconnected set of cycles. The cycle periods range from a few minutes (a "subminuette" cycle) to centuries (a "Grand Supercycle").

"Waves" refer to chart patterns associated with Elliott wave theory. In a prevailing uptrend, upward moves in prices consist of five waves and downward moves occur in three waves (see Figure 56.9). If the prevailing trend is down, downward moves have five waves and upward moves have three waves. Each of these waves, in turn, is composed of smaller waves of the same general form.

**Figure 56.9: Elliott Wave Patterns**




The sizes of these waves are thought to correspond with **Fibonacci ratios**. Fibonacci numbers are found by starting with 0 and 1, then adding each of the previous two numbers to produce the next (0, 1, 1, 2, 3, 5, 8, 13, 21, and so on). Elliott wave theorists believe that the ratios of Fibonacci numbers are useful for estimating price targets. For example, a down leg can be 1/2 or 2/3 the size of an up leg, or a price target can be 13/8 of the previous high. Ratios of consecutive Fibonacci numbers converge to 0.618 and 1.618 as the numbers in the sequence get larger. These two values are commonly used to project price targets.

## LOS 56.h: Describe intermarket analysis as it relates to technical analysis and asset allocation.

*CFA® Program Curriculum, Volume 6, page 388*

**Intermarket analysis** refers to analysis of the interrelationships among the market values of major asset classes, such as stocks, bonds, commodities, and currencies. Relative strength ratios (described earlier in this topic review) are a useful tool for determining which asset classes are outperforming others. After identifying attractive asset classes, an analyst can apply relative strength analysis to identify which assets within these classes are outperforming others. This approach is also useful for comparing the relative performance of equity market sectors or industries, and of various international markets.

## MODULE QUIZ 56.1

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

1. An assumption of technical analysis is that market prices:
   A. exhibit identifiable trends and patterns that persist and repeat.
   B. are the only information necessary to analyze a freely trading market.
   C. reflect supply and demand conditions because actual transactions reflect rational decisions by buyers and sellers.
2. From which of the following charts can an analyst read the opening price for a trading period?
   A. Line chart.
   B. Candlestick chart.
   C. Point-and-figure chart.
3. A stock has been in a downtrend for several days. When its price decreases to near $30, many investors enter orders to buy the stock and the price increases to $31. This is *most likely* an example of:
   A. a support level.
   B. a resistance level.
   C. a change in polarity.

4. An analyst who uses the standard deviation of recent prices to identify overbought or oversold conditions is *most likely* to employ:
    A. Bollinger bands.
    B. a Relative Strength Index.
    C. a rate of change oscillator.
5. A momentum indicator based on the ratio of price increases to price decreases over the last 14 days is *most likely*:
    A. a stochastic oscillator.
    B. a Relative Strength Index.
    C. a moving average convergence/divergence oscillator.
6. An increase in which of the following is *most likely* when stock market sentiment is becoming more bullish?
    A. Short interest ratio.
    B. Margin debt outstanding.
    C. Put/call ratio for a stock index.
7. The Kondratieff wave is a cycle of:
    A. 18 years.
    B. 36 years.
    C. 54 years.
8. For an asset with a current price of 100, which of the following price targets is *most likely* based on a Fibonacci ratio?
    A. 129.40.
    B. 145.60.
    C. 161.80.
9. If a stock's relative strength ratio increases, the stock is:
    A. increasing in price.
    B. outperforming its benchmark.
    C. increasing on high volume or decreasing on low volume.

# KEY CONCEPTS

## LOS 56.a

Underlying all of technical analysis are the following assumptions:

- Prices are determined by investor supply and demand for assets.
- Supply and demand are driven by both rational and irrational behavior.
- While the causes of changes in supply and demand are difficult to determine, the actual shifts in supply and demand can be observed in market prices.
- Prices move in trends and exhibit patterns that can be identified and tend to repeat themselves over time.

## LOS 56.b

Technical analysts use charts to identify trends and patterns in prices over time. A line chart is a continuous line that connects closing prices for each period. Bar charts and candlestick charts show the open, high, low, and close for each period. Volume charts often accompany price charts. Point-and-figure charts indicate significant changes in the direction of price trends.

## LOS 56.c

In an uptrend, prices are reaching higher highs and higher lows. An uptrend line is drawn below the prices on a chart by connecting the increasing lows with a straight line.

In a downtrend, prices are reaching lower lows and lower highs. A downtrend line is drawn above the prices on a chart by connecting the decreasing highs with a straight line.

Support and resistance are price levels or ranges at which buying or selling pressure is expected to limit price movement. Commonly identified support and resistance levels include trendlines and previous high and low prices.

The change in polarity principle is the idea that breached resistance levels become support levels and breached support levels become resistance levels.

## LOS 56.d

Technical analysts look for recurring patterns in price charts. Head-and-shoulders patterns, double tops, and triple tops are thought to be reversal patterns at the ends of uptrends. Inverse head-and-shoulders patterns, double bottoms, and triple bottoms are thought to be reversal patterns at the ends of downtrends.

Triangles, rectangles, flags, and pennants are thought to be continuation patterns, which indicate that the trend in which they appear is likely to go further in the same direction.

## LOS 56.e

Price-based indicators include moving averages, Bollinger bands, and momentum oscillators such as the Relative Strength Index, moving average convergence/divergence lines, rate of change oscillators, and stochastic oscillators. These indicators are commonly used to identify changes in price trends, as well as “overbought” markets that are likely to decrease in the near term and “oversold” markets that are likely to increase in the near term.

Sentiment indicators include opinion polls, the put/call ratio, the volatility index, margin debt, and the short interest ratio. Margin debt, the Arms index, the mutual fund cash position, new equity issuance, and secondary offerings are flow-of-funds indicators. Technical analysts often interpret these indicators from a “contrarian” perspective, becoming bearish when investor sentiment is too positive and bullish when investor sentiment is too negative.

## LOS 56.f

Some technical analysts believe market prices move in cycles. Examples include the Kondratieff wave, which is a 54-year cycle, and a 4-year cycle related to U.S. presidential elections.

## LOS 56.g

Elliott wave theory suggests that prices exhibit a pattern of five waves in the direction of a trend and three waves counter to the trend. Technical analysts who employ Elliott wave theory frequently use ratios of the numbers in the Fibonacci sequence to estimate price targets and identify potential support and resistance levels.

## LOS 56.h

Intermarket analysis examines the relationships among various asset markets such as stocks, bonds, commodities, and currencies. In the asset allocation process, relative strength analysis can be used to identify attractive asset classes and attractive sectors within these classes.

# ANSWER KEY FOR MODULE QUIZ

## Module Quiz 56.1

1. **A** Technical analysis assumes persistent trends and repeating patterns in market prices can be used to forecast price behavior. Technical analysts believe prices reflect supply and demand, but that buying and selling can be motivated by both rational and irrational causes. Volume, along with price, is important information to a technical analyst. (LOS 56.a)

2. **B** Candlestick charts show the open, high, low, and close for each trading period. Line charts use only the closing price. Point-and-figure charts do not necessarily show distinct trading periods. (LOS 56.b)

3. **A** The downtrend reached a support level where buying demand sustained the price. A resistance level is a price at which selling pressure emerges that stops an uptrend. The change in polarity principle holds that breached support levels become resistance and breached resistance levels become support. With no information given on the stock's history, we cannot determine whether $30 had once been a resistance level. (LOS 56.c)

4. **A** Bollinger bands are based on the standard deviation of prices over some number of the most recent periods. An RSI is based on the sums of positive and negative price changes during a period. An ROC oscillator is based on the difference between the most recent closing price and the closing price a given number of periods earlier. (LOS 56.e)

5. **B** The RSI is calculated from the ratio of total price increases to total price decreases over a chosen number of days, then scaled to fluctuate between 0 and 100 using the formula RSI = 100 − [100 / (1 + ratio of increases to decreases)]. Stochastic oscillators are based on the highest and lowest prices over a chosen number of days. MACD oscillators are calculated based on exponentially smoothed moving averages. (LOS 56.e)

6. **B** "More bullish" means investors expect prices to increase in the near term. Increasing margin debt suggests investors are bullish and buying aggressively. Increases in put volume relative to call volume, or in the number of shares sold short, indicate bearish investor sentiment. (LOS 56.e)

7. **C** The Kondratieff wave is a 54-year cycle. (LOS 56.f)

8. **C** The value 1.618 is the ratio of large consecutive Fibonacci numbers. Technical analysts who employ Elliott wave theory frequently use Fibonacci ratios to set price targets. (LOS 56.g)

9. **B** If the relative strength ratio (stock price / benchmark value) increases, the stock is outperforming the benchmark stock or index against which it is being measured. This does not imply that the stock is increasing in price; if the stock price decreases but the benchmark decreases by a larger percentage, the ratio will increase. Volume is not an input into a relative strength ratio. (LOS 56.e, 56.h)

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 #57.

# READING 57: FINTECH IN INVESTMENT MANAGEMENT

**Study Session 19**

## EXAM FOCUS

Fintech (financial technology) is increasing in its importance to the financial services industry. As terms like *Big Data*, *blockchain*, and *algorithmic trading* come into common use, CFA exam candidates are expected to be familiar with them and how they relate to investment management. That being said, we do not believe the exam writers expect finance professionals to become data scientists. The Learning Outcome Statements for this topic only ask candidates to describe these fintech concepts. Focus on their applications, such as cryptocurrencies and robo-advisors, the advantages of their use in finance, and the challenges their adoption may present.

## MODULE 57.1: FINTECH IN INVESTMENT MANAGEMENT

Video covering this content is available online.

### LOS 57.a: Describe "fintech."

*CFA® Program Curriculum, Volume 6, page 402*

The term **fintech** refers to developments in technology that can be applied to the financial services industry. Companies that are in the business of developing technologies for the finance industry are often referred to as fintech companies.

Some of the primary areas where fintech is developing include:

- Increasing functionality to handle large sets of data that may come from many sources and exist in a variety of forms.
- Tools and techniques such as artificial intelligence for analyzing very large datasets.
- Automation of financial functions such as executing trades and providing investment advice.
- Emerging technologies for financial recordkeeping that may reduce the need for intermediaries.

### LOS 57.b: Describe Big Data, artificial intelligence, and machine learning.

*CFA® Program Curriculum, Volume 6, page 403*

**Big Data** is a widely used expression that refers to all the potentially useful information that is generated in the economy. This includes not only data from traditional sources, such as financial markets, company financial reports, and government economic statistics, but also **alternative data** from non-traditional sources. Some of these non-traditional sources are:

- Individuals who generate usable data such as social media posts, online reviews, email, and website visits.
- Businesses that generate potentially useful information such as bank records and retail scanner data. These kinds of data are referred to as **corporate exhaust**.
- Sensors, such as radio frequency identification chips, are embedded in numerous devices such as smart phones and smart buildings. The broad network of such devices is referred to as the **Internet of Things**.

Characteristics of Big Data include its volume, velocity, and variety.

The volume of data continues to grow by orders of magnitude. The units in which data can be measured have increased from megabytes and gigabytes to terabytes (1,000 gigabytes) and even petabytes (1,000 terabytes).

Velocity refers to how quickly data are communicated. Real-time data such as stock market price feeds are said to have low **latency**. Data that are only communicated periodically or with a lag are said to have high latency.

The variety of data refers to the varying degrees of structure in which data may exist. These range from structured forms such as spreadsheets and databases, to semistructured forms such as photos and web page code, to unstructured forms such as video.

The field of **data science** concerns how we extract information from Big Data. Data science describes methods for processing and visualizing data. Processing methods include:

- *Capture*—collecting data and transforming it into usable forms.
- *Curation*—assuring data quality by adjusting for bad or missing data.
- *Storage*—archiving and accessing data.
- *Search*—examining stored data to find needed information.
- *Transfer*—moving data from their source or a storage medium to where they are needed.

Visualization techniques include the familiar charts and graphs that display structured data. To visualize less-structured data requires other methods. Some examples of these are word clouds that illustrate the frequency that words appear in a sample of text, or mind maps that display logical relations among concepts.

Taking advantage of Big Data presents a number of challenges. Analysts must ensure that the data they use are of high quality, accounting for the possibilities of outliers, bad or missing data, or sampling biases. The volume of data collected must be sufficient and appropriate for its intended use.

The need to process and organize data before using it can be especially problematic with qualitative and unstructured data. This is a process to which **artificial intelligence**, or computer systems that can be programmed to simulate human cognition, may be applied usefully. **Neural networks** are an example of artificial intelligence in that they are programmed to process information in a way similar to the human brain.

An important development in the field of artificial intelligence is **machine learning**. In machine learning, a computer algorithm is given inputs of source data, with no assumptions about their probability distributions, and may be given outputs of target data. The algorithm is

designed to learn, without human assistance, how to model the output data based on the input data or to learn how to detect and recognize patterns in the input data.

Machine learning typically requires vast amounts of data. A typical process begins with a *training* dataset in which the algorithm looks for relationships. A *validation* dataset is then used to refine these relationship models, which can then be applied to a *test* dataset to analyze their predictive ability.

In **supervised learning**, the input and output data are labelled, the machine learns to model the outputs from the inputs, and then the machine is given new data on which to use the model. In **unsupervised learning**, the input data are not labelled and the machine learns to describe the structure of the data. **Deep learning** is a technique that uses layers of neural networks to identify patterns, beginning with simple patterns and advancing to more complex ones. Deep learning may employ supervised or unsupervised learning. Some of the applications of deep learning include image and speech recognition.

Machine learning can produce models that overfit or underfit the data. **Overfitting** occurs when the machine learns the input and output data too exactly, treats noise as true parameters, and identifies spurious patterns and relationships. In effect, the machine creates a model that is too complex. **Underfitting** occurs when the machine fails to identify actual patterns and relationships, treating true parameters as noise. This means the model is not complex enough to describe the data. A further challenge with machine learning is that its results can be a "black box," producing outcomes based on relationships that are not readily explainable.

### LOS 57.c: Describe fintech applications to investment management.

*CFA® Program Curriculum, Volume 6, page 411*

Applications of fintech that are relevant to investment management include text analytics, natural language processing, risk analysis, algorithmic trading, and robo-advisory services.

**Text analytics** refers to the analysis of unstructured data in text or voice forms. An example of text analytics is analyzing the frequency of words and phrases. In the finance industry, text analytics have the potential to partially automate specific tasks such as evaluating company regulatory filings.

**Natural language processing** refers to the use of computers and artificial intelligence to interpret human language. Speech recognition and language translation are among the uses of natural language processing. Possible applications in finance could be to check for regulatory compliance in an examination of employee communications, or to evaluate large volumes of research reports to detect more subtle changes in sentiment than can be discerned from analysts' recommendations alone.

As we saw in our topic review of "Risk Management: An Introduction," risk governance requires an understanding of a firm's exposure to a wide variety of risks. Financial regulators require firms to perform risk assessments and stress testing. The simulations, scenario analysis, and other techniques used for risk analysis require large amounts of quantitative data along with a great deal of qualitative information. Machine learning and other techniques related to Big Data can be useful in modeling and testing risk, particularly if firms use real-time data to monitor risk exposures.

**Algorithmic trading** refers to computerized securities trading based on a predetermined set of rules. For example, algorithms may be designed to enter the optimal execution instructions

for any given trade based on real-time price and volume data. Algorithmic trading can also be useful for executing large orders by determining the best way to divide the orders across exchanges. Another application of algorithmic trading is **high-frequency trading** that identifies and takes advantage of intraday securities mispricings.

**Robo-advisors** are online platforms that provide automated investment advice based on a customer's answers to survey questions. The survey questions are designed to elicit an investor's financial position, return objectives, risk tolerance, and constraints such as time horizon and liquidity needs. Robo-advisor services may be fully automated or assisted by a human investment advisor.

Robo-advisory services tend to offer passively managed investments with low fees, low minimum account sizes, traditional asset classes, and conservative recommendations. The primary advantage of robo-advisors is their low cost to customers, which may make advice more accessible to a larger number of investors.

A disadvantage of robo-advisors is that the reasoning behind their recommendations might not be apparent. Without a human investment advisor to explain the reasoning, customers may hesitate to trust the appropriateness of a robo-advisor's recommendations, particularly in crisis periods.

Regulation of robo-advisors is still emerging. However, in many countries robo-advisory services are subject to the same regulations and registration requirements as any other investment advisor.

### LOS 57.d: Describe financial applications of distributed ledger technology.

*CFA® Program Curriculum, Volume 6, page 416*

A **distributed ledger** is a database that is shared on a network so that each participant has an identical copy. A distributed ledger must have a consensus mechanism to validate new entries into the ledger. Distributed ledger technology uses cryptography to ensure only authorized network participants can use the data.

A **blockchain** is a distributed ledger that records transactions sequentially in blocks and links these blocks in a chain. Each block has a cryptographically secured "hash" that links it to the previous block. The consensus mechanism in a blockchain requires some of the computers on the network to solve a cryptographic problem. These computers are referred to as **miners**. Mining requires vast resources of computing power and electricity. This imposes substantial costs on any attempt to manipulate a blockchain's historical record. To do so would also require one party to control a majority of the network. For this reason, a blockchain is more likely to succeed with a large number of participants in its network.

Distributed ledgers can take the form of permissionless or permissioned networks. In **permissionless networks**, all network participants can view all transactions. These networks have no central authority, which gives them the advantage of having no single point of failure. The ledger becomes a permanent record visible to all, and its history cannot be altered (short of the manipulation described previously). This removes the need for trust between the parties to a transaction.

In **permissioned networks**, users have different levels of access. For example, a permissioned network might allow network participants to enter transactions while giving government regulators permission to view the transaction history. A distributed ledger that

allowed regulators to view records that firms are required to make available would increase transparency and decrease compliance costs.

## Financial Applications of Distributed Ledger Technology

**Cryptocurrencies** are a current example of distributed ledger technology in finance. A cryptocurrency is an electronic medium of exchange that allows participants to engage in real-time transactions without a financial intermediary. Cryptocurrencies typically reside on permissionless networks.

Demonstrating the impact cryptocurrencies are already having in finance, companies have raised capital through **initial coin offerings**, in which they sell cryptocurrency for money or another cryptocurrency. This reduces the cost and time frame compared to carrying out a regulated IPO, and initial coin offerings typically do not come with voting rights. Investors should note that fraud has occurred with initial coin offerings and they may become subject to securities regulations.

Post-trade clearing and settlement is an area of finance to which distributed ledger technology might be applied productively. Distributed ledgers could automate many of the processes currently carried out by custodians and other third parties. The technology has the potential to bring about real-time trade verification and settlement, which (as we will see in Equity Investments) currently takes one or more days for many securities. This would reduce trading costs and counterparty risk. On the other hand, the inability to alter past transactions on a distributed ledger is problematic when cancelling a trade is required.

Other potential applications of distributed ledger technology in finance include smart contracts and tokenization. **Smart contracts** are electronic contracts that could be programmed to self-execute based on terms agreed to by the counterparties. For example, an options contract could be set up to be exercised automatically if certain defined conditions exist in the market. **Tokenization** refers to electronic proof of ownership of physical assets, which could be maintained on a distributed ledger. For example, such a ledger could potentially replace the paper real estate deeds currently filed at government offices.

### MODULE QUIZ 57.1

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

1. Fintech is *most accurately* described as:
   A. the application of technology to the financial services industry.
   B. the replacement of government-issued money with electronic currencies.
   C. the clearing and settling securities trades through distributed ledger technology.
2. Which of the following technological developments is *most likely* to be useful for analyzing Big Data?
   A. Machine learning.
   B. High-latency capture.
   C. The Internet of Things.
3. A key criticism of robo-advisory services is that:
   A. they are costly for investors to use.
   B. the reasoning behind their recommendations can be unclear.
   C. they tend to produce overly aggressive investment recommendations.
4. Which of the following statements about distributed ledger technology is *most accurate?*
   A. A disadvantage of blockchain is that past records are vulnerable to manipulation.
   B. Tokenization can potentially streamline transactions involving high-value physical assets.

C. Only parties who trust each other should carry out transactions on a permissionless network.

# KEY CONCEPTS

## LOS 57.a

Fintech refers to developments in technology that can be applied to the financial services industry. Companies that develop technologies for the finance industry are referred to as fintech companies.

## LOS 57.b

Big Data refers to the potentially useful information that is generated in the economy, including data from traditional and non-traditional sources. Characteristics of Big Data include its volume, velocity, and variety.

Artificial intelligence refers to computer systems that can be programmed to simulate human cognition. Neural networks are an example of artificial intelligence.

Machine learning is programming that gives a computer system the ability to improve its performance of a task over time and is often used to detect patterns in large sets of data.

## LOS 57.c

Applications of fintech to investment management include text analytics, natural language processing, risk analysis, algorithmic trading, and robo-advisory services.

Text analytics refers to analyzing unstructured data in text or voice forms. Natural language processing is the use of computers and artificial intelligence to interpret human language. Algorithmic trading refers to computerized securities trading based on predetermined rules.

Robo-advisors are online platforms that provide automated investment advice based on a customer's answers to survey questions. The primary advantage of robo-advisors is their low cost to customers. A disadvantage is that the reasoning behind their recommendations might not be apparent.

## LOS 57.d

A distributed ledger is a database that is shared on a network, with a consensus mechanism so that each participant has an identical copy of the ledger.

A cryptocurrency is an electronic medium of exchange that allows network participants in a distributed ledger to engage in real-time transactions without a financial intermediary.

Potential financial applications of distributed ledger technology include smart contracts, tokenization, and more efficient post-trade clearing and settlement.

# ANSWER KEY FOR MODULE QUIZ

## Module Quiz 57.1

1. **A** Fintech refers to the application of technology to the financial services industry and to companies that are involved in developing and applying technology for financial services. Cryptocurrencies and distributed ledger technology are examples of fintech-related developments. (LOS 57.a)

2. **A** Machine learning is a computer programming technique useful for identifying and modeling patterns in large volumes of data. The Internet of Things refers to the network of devices that is one of the sources of Big Data. Capture is one aspect of processing data. Latency refers to the lag between when data is generated and when it is needed. (LOS 57.b)

3. **B** One criticism of robo-advisory services is that the reasoning behind their recommendations might not be readily apparent to customers. Recommendations from robo-advisors tend to be conservative rather than aggressive. Low cost is a primary advantage of robo-advisors. (LOS 57.c)

4. **B** By enabling electronic proof of ownership, tokenization has the potential to streamline transfers of physical assets such as real estate. The high cost and difficulty of manipulating past records is a strength of blockchain technology. Permissionless networks do not require trust between the parties to a transaction because the record of a transaction is unchangeable and visible to all network participants. (LOS 57.d)

# TOPIC ASSESSMENT: PORTFOLIO MANAGEMENT

*You have now finished the Portfolio Management topic section. The following Topic Assessment provides immediate feedback on how effective your study has been for this material. The number of questions on this test is equal to the number of questions for the topic on one-half of the actual Level I CFA exam. Questions are more exam-like than typical Module Quiz or QBank questions; a score of less than 70% indicates that your study likely needs improvement. These tests are best taken timed; allow 1.5 minutes per question.*

*After you've completed this Topic Assessment, you may additionally log in to your Schweser.com online account and enter your answers in the Topic Assessments product. Select "Performance Tracker" to view a breakdown of your score. Select "Compare with Others" to display how your score on the Topic Assessment compares to the scores of others who entered their answers.*

1. Which of the following activities is *most likely* to be performed as part of the execution step of the portfolio management process?
   A. Completion of the investment policy statement.
   B. Top-down analysis based on macroeconomic conditions.
   C. Rebalancing the portfolio to the desired asset class exposures.

2. A manager who evaluates portfolios' investment performance adjusted for systematic risk is *most likely* to rank portfolios based on their:
   A. Sharpe ratios.
   B. Treynor measures.
   C. M-squared measures.

3. Neural networks are an example of:
   A. machine learning.
   B. artificial intelligence.
   C. algorithmic trading applications.

4. Which of the following risk management strategies is *most accurately* described as shifting a risk?
   A. A retail store owner buys a fire insurance policy on the building.
   B. A farmer takes a short position in a futures contract to deliver wheat.
   C. A portfolio manager diversifies her investments across different industries.

5. An analyst has estimated that the returns for an asset, conditional on the performance of the overall economy, are:

| Return | Probability | Economic Growth |
|---|---|---|
| 5% | 20% | Poor |
| 10% | 40% | Average |
| 14% | 40% | Good |

   The conditional expected returns on the market portfolio are:

| Return | Probability | Economic Growth |
|---|---|---|
| 2% | 20% | Poor |
| 10% | 40% | Average |

| | | |
|---|---|---|
| 15% | 40% | Good |

According to the CAPM, if the risk-free rate is 5% and the risky asset has a beta of 1.1, with respect to the market portfolio, the analyst should:

A. sell (or sell short) the risky asset because its expected return is less than equilibrium expected return on the market portfolio.
B. buy the risky asset because the analyst expects the return on it to be higher than its required return in equilibrium.
C. sell (or sell short) the risky asset because its expected return is not sufficient to compensate for its systematic risk.

6. Portfolios that plot inside the minimum-variance frontier represent:
   A. efficient portfolios.
   B. inefficient portfolios.
   C. unattainable portfolios.

7. A written investment policy statement should *most appropriately*:
   A. establish a target asset allocation strategy.
   B. focus predominantly on a long-term time horizon.
   C. include risk objectives that are consistent with the investor’s return requirements.

# TOPIC ASSESSMENT ANSWERS: PORTFOLIO MANAGEMENT

1. **B** The execution step of the portfolio management process typically begins with a top-down analysis of economic variables. The investment policy statement is completed during the planning step. Asset class rebalancing is part of the feedback step. (Study Session 18, Module 51.1, LOS 51.d)

2. **B** The Treynor measure is stated in terms of systematic (beta) risk. The Sharpe ratio and M-squared measure are defined in terms of total risk (standard deviation). (Study Session 18, Module 53.2, LOS 53.i)

3. **B** *Artificial intelligence* refers to systems that can be programmed to simulate human cognition. Neural networks are one example of this type of system. (Study Session 19, Module 57.1, LOS 57.b)

4. **B** Shifting a risk is changing the distribution of possible outcomes. An example of shifting a risk is hedging price risk with a derivatives contract. Insurance is an example of transferring a risk. Diversification is best described as a method for bearing a risk efficiently. (Study Session 19, Module 55.1, LOS 55.g)

5. **C** The analyst's forecast of the expected return on the risky asset is 5(0.2) + 10(0.4) + 14(0.4) = 10.6%. The expected/equilibrium return on the market portfolio is 2(0.2) + 10(0.4) + 15(0.4) = 10.4%. The CAPM equilibrium expected return (required return in equilibrium) on the risky asset is 5 + 1.1(10.4 – 5) = 10.94%. Because the analyst's forecast return on the risky asset is less than its required return in equilibrium, the asset is overpriced and the analyst would sell if he owned it and possibly sell it short. (Study Session 18, Module 53.2, LOS 53.h)

6. **B** Portfolios that plot inside the minimum-variance frontier are inefficient because another portfolio exists with a higher expected return for the same level of risk, or a lower level of risk for the same expected return. Portfolios that plot on the minimum-variance frontier above the global minimum-variance portfolio are efficient. Portfolios that plot above the minimum-variance frontier are unattainable. (Study Session 18, Module 52.3, LOS 52.g)

7. **A** Strategic asset allocation is often a part of the written IPS because it helps solidify desired initial weightings to specific asset classes. Different investors will have different applicable time horizons which must be considered and evaluated appropriately as part of the investment policy statement. Required returns should be consistent with risk objectives, but high return requirements should not necessarily imply high risk objectives. (Study Session 19, Module 54.1, LOS 54.a)

# FORMULAS

no-arbitrage forward price: $F_0(T) = S_0 (1 + Rf)^T$

payoff to long forward at expiration = $S_T - F_0(T)$

value of forward at time *t*: $V_t\left(T\right) = S_t + PV_t\left(\text{cost}\right) - PV_t\left(\text{benefit}\right) - \frac{F_0(T)}{(1+Rf)^{T-t}}$

intrinsic value of a call = Max[0, S − X]

intrinsic value of a put = Max[0, X − S]

option value = intrinsic value + time value

put-call parity: $c + X / (1 + Rf)^T = S + p$

put-call-forward parity: $F_0(T) / (1 + Rf)^T + p_0 = c_0 + X / (1 + Rf)^T$

$$\text{holding period return} = \frac{\text{end-of-period value}}{\text{beginning-of-period value}} - 1 = \frac{P_t + Div_t}{P_0} - 1 = \frac{P_t - P_0 + Div_t}{P_0}$$

$$\text{arithmetic mean return} = \frac{(R_1 + R_2 + R_3 + ... + R_n)}{n}$$

$$\text{geometric mean return} = \sqrt[n]{(1 + R_1) \times (1 + R_2) \times (1 + R_3) \times ... \times (1 + R_n)} - 1$$

$$\text{correlation:} \rho_{1,2} = \frac{Cov_{1,2}}{\sigma_1 \times \sigma_2}$$

standard deviation for a two-asset portfolio:

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho_{1,2}} \text{or} \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2Cov_{1,2}}$$

equation of the CML: $E(R_P) = R_f + \left(\frac{E(R_M) - R_f}{\sigma_M}\right)\sigma_P$

$$E\left(R_P\right) = R_f + (E(R_M) - R_f)\left(\frac{\sigma_P}{\sigma_M}\right)$$

total risk = systematic risk + unsystematic risk

$$\beta_i = \frac{Cov_{i,mkt}}{\sigma_{mkt}^2} = \rho_{i,mkt}\frac{\sigma_i}{\sigma_{mkt}}$$

capital asset pricing model (CAPM): $E(R_i) = R_f + \beta_i[E(R_{mkt}) - R_f]$

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