2020 CFA®

PROGRAM EXAM PREP

SchweserNotes™ Level III

Capital Market Expectations, Asset Allocation, and Derivatives and Currency Management

eBook 2

KAPLAN SCHWESER

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LEARNING OUTCOME STATEMENTS (LOS)

STUDY SESSION 4

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

10. Capital Market Expectations, Part 1: Framework and Macro Considerations

The candidate should be able to:

a. discuss the role of, and a framework for, capital market expectations in the portfolio management process. (page 1)
b. discuss challenges in developing capital market forecasts. (page 2)
c. explain how exogenous shocks may affect economic growth trends. (page 7)
d. discuss the application of economic growth trend analysis to the formulation of capital market expectations. (page 8)
e. compare major approaches to economic forecasting. (page 9)
f. discuss how business cycles affect short- and long-term expectations. (page 11)
g. explain the relationship of inflation to the business cycle and the implications of inflation for cash, bonds, equity, and real estate returns. (page 14)
h. discuss the effects of monetary and fiscal policy on business cycles. (page 17)
i. interpret the shape of the yield curve as an economic predictor and discuss the relationship between the yield curve and fiscal and monetary policy. (page 20)
j. identify and interpret macroeconomic, interest rate, and exchange rate linkages between economies. (page 21)

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

11. Capital Market Expectations, Part 2: Forecasting Asset Class Returns

The candidate should be able to:

a. discuss approaches to setting expectations for fixed-income returns. (page 33)
b. discuss risks faced by investors in emerging market fixed-income securities and the country risk analysis techniques used to evaluate emerging market economies. (page 37)
c. discuss approaches to setting expectations for equity investment market returns. (page 38)
d. discuss risks faced by investors in emerging market equity securities. (page 38)
e. explain how economic and competitive factors can affect expectations for real estate investment markets and sector returns. (page 46)
f. discuss major approaches to forecasting exchange rates. (page 49)
g. discuss methods of forecasting volatility. (page 51)
h. recommend and justify changes in the component weights of a global investment portfolio based on trends and expected changes in macroeconomic factors. (page 55)

STUDY SESSION 5

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

12. Introduction to Asset Allocation

The candidate should be able to:

a. describe elements of effective investment governance and investment governance considerations in asset allocation. (page 69)
b. prepare an economic balance sheet for a client and interpret its implications for asset allocation. (page 72)
c. compare the investment objectives of asset-only, liability-relative, and goals-based asset allocation approaches. (page 73)
d. contrast concepts of risk relevant to asset-only, liability-relative, and goals-based asset allocation approaches. (page 74)
e. explain how asset classes are used to represent exposures to systematic risk and discuss criteria for asset class specification. (page 75)
f. explain the use of risk factors in asset allocation and their relation to traditional asset class–based approaches. (page 77)
g. select and justify an asset allocation based on an investor's objectives and constraints. (page 78)
h. describe the use of the global market portfolio as a baseline portfolio in asset allocation. (page 80)
i. discuss strategic implementation choices in asset allocation, including passive/active choices and vehicles for implementing passive and active mandates. (page 81)
j. discuss strategic considerations in rebalancing asset allocations. (page 83)

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

13. Principles of Asset Allocation

The candidate should be able to:

a. describe and critique the use of mean–variance optimization in asset allocation. (page 93)
b. recommend and justify an asset allocation using mean–variance optimization. (page 100)
c. interpret and critique an asset allocation in relation to an investor's economic balance sheet. (page 103)
d. discuss asset class liquidity considerations in asset allocation. (page 104)
e. explain absolute and relative risk budgets and their use in determining and implementing an asset allocation. (page 105)
f. describe how client needs and preferences regarding investment risks can be incorporated into asset allocation. (page 107)
g. discuss the use of Monte Carlo simulation and scenario analysis to evaluate the robustness of an asset allocation. (page 103)
h. describe the use of investment factors in constructing and analyzing an asset allocation. (page 107)
i. recommend and justify an asset allocation based on the global market portfolio. (page 100)
j. describe and evaluate characteristics of liabilities that are relevant to asset allocation. (page 109)
k. discuss approaches to liability-relative asset allocation. (page 110)
l. recommend and justify a liability-relative asset allocation. (page 110)

m. recommend and justify an asset allocation using a goals-based approach. (page 112)
n. describe and critique heuristic and other approaches to asset allocation. (page 113)
o. discuss factors affecting rebalancing policy. (page 115)

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

14. Asset Allocation with Real-World Constraints

The candidate should be able to:

a. discuss asset size, liquidity needs, time horizon, and regulatory or other considerations as constraints on asset allocation. (page 123)
b. discuss tax considerations in asset allocation and rebalancing. (page 129)
c. recommend and justify revisions to an asset allocation given change(s) in investment objectives and/or constraints. (page 132)
d. discuss the use of short-term shifts in asset allocation. (page 134)
e. identify behavioral biases that arise in asset allocation and recommend methods to overcome them. (page 136)

STUDY SESSION 6

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

15. Option Strategies

The candidate should be able to:

a. demonstrate how an asset's returns may be replicated by using options. (page 156)
b. discuss the investment objective(s), structure, payoff, risk(s), value at expiration, profit, maximum profit, maximum loss, and breakeven underlying price at expiration of a covered call position. (page 158)
c. discuss the investment objective(s), structure, payoff, risk(s), value at expiration, profit, maximum profit, maximum loss, and breakeven underlying price at expiration of a protective put position. (page 163)
d. compare the delta of covered call and protective put positions with the position of being long an asset and short a forward on the underlying asset. (page 180)
e. compare the effect of buying a call on a short underlying position with the effect of selling a put on a short underlying position. (page 164)
f. discuss the investment objective(s), structure, payoffs, risk(s), value at expiration, profit, maximum profit, maximum loss, and breakeven underlying price at expiration of the following option strategies: bull spread, bear spread, straddle, and collar. (page 166)
g. describe uses of calendar spreads. (page 187)
h. discuss volatility skew and smile. (page 190)
i. identify and evaluate appropriate option strategies consistent with given investment objectives. (page 193)
j. demonstrate the use of options to achieve targeted equity risk exposures. (page 193)

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

16. Swaps, Forwards, and Futures Strategies

The candidate should be able to:

a. demonstrate how interest rate swaps, forwards, and futures can be used to modify a portfolio's risk and return. (page 211)
b. demonstrate how currency swaps, forwards, and futures can be used to modify a portfolio's risk and return. (page 224)
c. demonstrate how equity swaps, forwards, and futures can be used to modify a portfolio's risk and return. (page 231)
d. demonstrate the use of volatility derivatives and variance swaps. (page 239)
e. demonstrate the use of derivatives to achieve targeted equity and interest rate risk exposures. (page 249)
f. demonstrate the use of derivatives in asset allocation, rebalancing, and inferring market expectations. (page 251)

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

17. Currency Management: An Introduction

The candidate should be able to:

a. analyze the effects of currency movements on portfolio risk and return. (page 280)
b. discuss strategic choices in currency management. (page 284)
c. Formulate an appropriate currency management program given financial market conditions and portfolio objectives and constraints. (page 287)
d. compare active currency trading strategies based on economic fundamentals, technical analysis, carry-trade, and volatility trading. (page 291)

e. describe how changes in factors underlying active trading strategies affect tactical trading decisions. (page 296)
f. describe how forward contracts and FX (foreign exchange) swaps are used to adjust hedge ratios. (page 298)
g. describe trading strategies used to reduce hedging costs and modify the risk–return characteristics of a foreign-currency portfolio. (page 302)
h. describe the use of cross-hedges, macro-hedges, and minimum-variance-hedge ratios in portfolios exposed to multiple foreign currencies. (page 305)
i. discuss challenges for managing emerging market currency exposures. (page 307)

The following is a review of the Capital Market Expectations principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #10.

READING 10: CAPITAL MARKET EXPECTATIONS, PART 1: FRAMEWORK AND MACRO CONSIDERATIONS

Study Session 4

EXAM FOCUS

Combining capital market expectations with the investor's objectives and constraints leads to the portfolio's strategic asset allocation. A variety of economic tools and techniques are useful in forming capital market expectations for return, risk, and correlation by asset class. Unfortunately, no one technique works consistently, so be prepared for any technique and its issues as covered here.

MODULE 10.1: FORMULATING CAPITAL MARKET EXPECTATIONS

Video covering this content is available online.

LOS 10.a: Discuss the role of, and a framework for, capital market expectations in the portfolio management process.

CFA® Program Curriculum, Volume 2, page 167

Capital market expectations are risk and return expectations regarding classes of assets. Investors should establish long-term expectations for each allowable asset class specified in the investment policy statement. They can also create short-term expectations for making active investment decisions. Using a disciplined approach to set short- and long-term expectations leads to more effective security selection, asset allocation, and risk management.

Achieving long-term investment objectives is largely dependent on constructing proper asset allocations. Although projecting asset class returns may be subject to forecasting errors, investors should ensure that portfolios are internally consistent. **Cross-sectional consistency** refers to consistency across asset classes regarding portfolio risk and return characteristics. **Intertemporal consistency** refers to consistency over various investment horizons regarding portfolio decisions over time.

To formulate capital market expectations, an analyst should use the following seven-step process:

Step 1: Determine the specific capital market expectations needed according to the investor's allowable asset classes and investment horizon(s). Time horizon is particularly important in determining the set of capital market expectations that are needed.

Step 2: Investigate assets' historical performance to determine the drivers that have affected past performance and to establish some range for plausible future performance. With the drivers of past performance established, the analyst can use these to forecast expected future performance as well as compare the forecast to past results to see if the forecast appears reasonable.

Step 3: Identify the valuation model to be used and its requirements. For example, a comparables-based, relative value approach used in the United States may be difficult to apply in an emerging market analysis.

Step 4: Collect the best data possible. The use of faulty data will lead to faulty conclusions. Financial publications and commercial databases are likely the best sources for reliable information on asset classes.

Step 5: Use experience and judgment to interpret current investment conditions and decide what values to assign to the required inputs. Verify that the inputs used for the various asset classes are consistent across classes.

Step 6: Formulate capital market expectations. Any assumptions and rationales used in the analysis should be recorded.

Step 7: Monitor performance and use it to refine the process for setting expectations. If actual performance varies significantly from forecasts, the process and model should be refined.

Problems in Forecasting

LOS 10.b: Discuss challenges in developing capital market forecasts.

CFA® Program Curriculum, Volume 2, page 172

Poor forecasts can result in inappropriate asset allocations. Analysts should be aware of potential problems in data, models, and the resulting capital market expectations. Nine problems encountered in producing forecasts are (1) limitations to using economic data, (2) data measurement error and bias, (3) limitations of historical estimates, (4) the use of ex-post risk and return measures, (5) non-repeating data patterns, (6) failing to account for conditioning information, (7) misinterpreting of correlations, (8) psychological bias, and (9) model uncertainty.

1. There are several **limitations to using economic data:**
    - The time lag between collection and distribution is often quite long. The International Monetary Fund, for example, reports data with a lag of as much as two years.
    - Data are often revised and the revisions are not made at the same time as the publication. Additionally, data definitions and methodology change over time. For example, the basket of goods in the Consumer Price Index (CPI) is updated every few years.
    - Data indexes are often rebased over time (i.e., the base upon which they are calculated is changed). Although a rebasing is not a substantial change in the data itself, the unaware analyst could calculate changes in the value of the indexes incorrectly if she does not make an appropriate adjustment.
2. There are numerous possible **data measurement errors and biases**. *Transcription errors* are the misreporting or incorrect recording of information and are most serious if they are biased in one direction. *Survivorship bias* commonly occurs if a manager or a security return series is deleted from the historical performance record of managers or firms. Deletions are often tied to poor performance and bias the historical return upward. *Appraisal data* for illiquid and infrequently priced assets makes the path of returns appear smoother than it actually is. This biases downward the calculated

standard deviation and makes the returns seem less correlated (closer to 0) with more liquid priced assets. This is a particular problem for some types of alternative assets such as real estate.

3. The **limitations of historical estimates** can also hamper the formation of capital market expectations. Values from historical data must often be adjusted going forward as economic, political, regulatory, and technological environments change. This is particularly true for volatile assets such as equity. These changes are known as *regime changes* and result in *nonstationary* data. For example, the global financial crisis in 2007–2009 resulted in returns data that were markedly different than those from the previous five years. Nonstationarity would mean different periods in the time series have different statistical properties and create problems with standard statistical testing methods.

   Two questions can be used to help resolve the issue of which time period to select:

   a. Is there a reason to believe the entire (longer) time period is not appropriate?
   b. If the answer to the first question is yes, does a statistical test confirm there is a regime change and the point in the time series where it occurs?

   If both answers are yes, the analyst must use judgment to select the relevant subperiod.

   Historical data are a starting point for estimating expected returns, standard deviations, and correlations. A long time period is preferable for several reasons:

   - It may be statistically required: To calculate historical covariance (and correlation), the number of data points must exceed the number of covariances to be calculated.
   - A larger data set (time period) provides more precise statistical estimates with smaller variance to the estimates.
   - Using a short time period creates a temptation to use more frequent data, such as weekly data, rather than monthly data points in order to have a larger sample size. Unfortunately, more frequent data points are often more likely to have missing or outdated values (this is called *asynchronous* data) and can result in lower, distorted correlation calculations. Also, it has been found that more frequent data will not improve the precision of expected returns.

   However, long time periods also create the potential problem of including regime changes, which are shifts in underlying fundamentals. Each regime change creates a subperiod with distinctly different characteristics.

   In addition to selecting time periods, caution should be exercised when data are assumed to be normally distributed. Asset returns have historically exhibited “fat tails” and skewness, which adds complexity to statistical tests. In some cases, the benefits of accounting for non-normality might not outweigh the costs of introducing complexity to a model.

PROFESSOR’S NOTE

Most candidates should recognize that the previous discussions have been referring to statistical testing issues covered in Level I and II. The focus is not on performing such tests or even knowing which specific tests to use, but on recognizing times and ways testing can be relevant. Think of a senior portfolio manager who understands the larger issues and when to ask others with relevant technical skills to do further analysis. This is a common perspective at Level III.

4. Using **ex post data** (after the fact) to determine **ex ante** (before the fact) risk and return can be problematic. For example, suppose that several years ago investors were fearful that the Federal Reserve was going to have to raise interest rates to combat inflation. This situation would cause depressed stock prices. If inflation abated without the Fed's intervention, then stock returns would increase once the inflation scenario passed. Looking back on this situation, the researcher would conclude that stock returns were high while being blind to the prior risk that investors had faced. The analyst would then conclude that future (ex ante) returns for stocks will be high. In sum, the analyst would underestimate the risks that equity investors face and overestimate their potential returns.

   This issue could also lead to an underestimation of risk when sample data include rare negative events. Using a data subset that includes outliers will likely distort the estimation of value at risk (VaR). This would suggest that rare negative events are expected with more frequency than would be observed in practice.
5. Using historical data, analysts can also uncover patterns in security returns that are unlikely to occur in the future and can produce biases in the data. One such bias is *data mining*. Just by random chance, some variables will appear to have a relationship with security returns, when, in fact, these relationships are unlikely to persist. For example, if the analyst uses a 5% significance level and examines the relationship between stock returns and 40 randomly selected variables, two (5%) of the variables are expected to show a statistically significant relationship with stock returns just by random chance. Another potential bias results from the time span of data chosen (*time period bias*). For example, small-cap U.S. stocks are widely thought to outperform large-cap stocks, but their advantage disappears when data from the 1970s and 1980s are excluded.

   To avoid these biases, an analyst should first ask if there is any economic basis for the variables found to be related to stock returns. Second, he should scrutinize the modeling process for susceptibility to bias. Third, the analyst should test the discovered relationship with out-of-sample data to determine if the relationship is persistent. This would be done by estimating the relationship with one portion of the historical data and then reexamining it with another portion.
6. Analysts' forecasts may also fail to account for **conditioning information**. The relationship between security returns and economic variables is not constant over time. Historical data reflect performance over many different business cycles and economic conditions. Thus, analysts should account for current conditions in their forecasts. As an example, suppose a firm's beta is estimated at 1.2 using historical data. If, however, the original data are separated into two ranges by economic expansion or recession, the beta might be 1.0 in expansions and 1.4 in recessions. Going forward, the analyst's estimate of the firm's beta should reflect whether an expansion is expected (i.e., the expected beta is 1.0) or a recession is expected (i.e., the expected beta is 1.4).
7. Another problem in forming capital market expectations is the **misinterpretation of correlations** (i.e., causality). Suppose the analyst finds that corn prices were correlated with rainfall in the midwestern United States during the previous quarter. It would be reasonable to conclude that rainfall influences corn prices. It would not be reasonable to conclude that corn prices influence rainfall. Rainfall is an exogenous variable (i.e., it arises outside the model), whereas the price of corn is an endogenous variable (i.e., it arises within the model).

It is also possible that the correlation between two variables is spurious or that a third variable influences both variables. In addition, two variables may have a nonlinear relationship that is missed by the correlation statistic, which measures linear relationships.

8. Analysts are susceptible to **psychological biases:**
    - In the **anchoring bias**, the first information received is overweighted. If, during a debate on the future of the economy, the first speaker forecasts a recession, that forecast is given greater credence.
    - In the **status quo bias**, predictions are highly influenced by the recent past. If inflation is currently 4%, that becomes the forecast, rather than choosing to be different and potentially making an active error of commission.
    - In the **confirmation bias**, only information supporting the existing belief is considered, and such evidence may be actively sought while other evidence is ignored. To counter these tendencies, analysts should give all evidence equal scrutiny and seek out contrary opinions.
    - In the **overconfidence bias**, past mistakes are ignored, the lack of comments from others is taken as agreement, and the accuracy of forecasts is overestimated. To counter this bias, consider a range of potential outcomes.
    - In the **prudence bias**, forecasts are overly conservative to avoid the regret from making extreme forecasts that could end up being incorrect. This bias can also be mitigated by considering a range of potential outcomes.
    - In the **availability bias**, what is easiest to remember (often an extreme event) is overweighted. Many believe that the U.S. stock market crash of 1929 may have depressed equity values in the subsequent 30 years. To counter this bias, base predictions on objective data rather than emotions or recollections of the past.
9. **Model uncertainty** refers to selecting the correct model. An analyst may be unsure whether to use a discounted cash flow (DCF) model or a relative value model to evaluate an expected stock return. *Parameter uncertainty* refers to estimation errors in model parameters. *Input uncertainty* refers to knowing the correct input values for the model. For example, even if the analyst knew that the DCF model was appropriate, the correct growth and discount rates are still needed. Among the three types of uncertainty, model uncertainty is the most serious given that an incorrect model will likely lead to invalid conclusions.

MODULE QUIZ 10.1

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

1. An analyst uses a variety of valuation approaches for different asset classes and collects the necessary data from multiple sources. The analyst does not make any effort to systematically compare the data used. As a result, the analyst uses relatively low discount rates for equity analysis (overestimating theoretical value) and high discount rates for fixed income (underestimating theoretical value). **Discuss** the likely effect on the analyst's asset allocation recommendations.

2. An analyst would like to forecast U.S. equity returns. He is considering using either the last 3 years of historical annual returns or the last 50 years of historical annual returns. **Provide** an argument for and against each selection of data length.

3. **Explain** why smoothed data may be present for some types of alternative investments and the consequences for their risk and correlation with other assets from using such data.

MODULE 10.2: THE TREND RATE OF GROWTH

Video covering this content is available online.

LOS 10.c: Explain how exogenous shocks may affect economic growth trends.

CFA® Program Curriculum, Volume 2, page 180

Identifying problems in developing forecasts is important when setting capital market expectations. However, a far greater concern is the connection between investment outcomes and economic output. In general, economic growth can be partitioned into cyclical variations and growth trends. The former is more short-term focused whereas the latter is more relevant

for determining long-term return expectations. Later in this topic review, we will discuss how the business cycle influences short- and long-term expectations. In this section, we will discuss the application of growth trends when formulating expectations.

Economic growth trends are subject to unexpected surprises or shocks that are exogenous to the economy. Many shocks and their impact on capital markets cannot be predicted. For example, turmoil in the Middle East may change the long-term trend for oil prices, inflation, and economic growth in the developed world. Shocks may also arise through the banking system. An extreme example is the U.S. banking crisis of the 1930s, when a severe slowdown in bank lending paralyzed the economy.

Exogenous shocks are unanticipated events that occur outside the normal course of an economy. Because the events are unanticipated, they are not already built into current market prices, whereas normal trends in an economy, which would be considered endogenous, are built into market prices. Note that the impact of these events will likely produce statistical regime changes. Exogenous shocks can be caused by several factors:

- **Changes in government policies.** Government policies that can encourage long-term growth include sound fiscal policy, minimal government interference with free markets, facilitating competition in the private sector, development of infrastructure and human capital, and sound tax policies.
- **Political events.** Geopolitical tensions that divert resources to less productive uses may lead to decreases in growth. Conversely, cuts in defense spending due to higher levels of world peace may lead to increases in growth.
- **Technological progress.** The creation of new and innovative markets, products, and technologies has the potential to improve growth.
- **Natural disasters.** Natural disasters likely reduce short-term growth, but may (arguably) encourage long-term growth if more efficient capacity replaces previous capacity.

PROFESSOR'S NOTE

The counterargument here is that the owners of capital already replace old facilities with newer and more efficient ones when the time is right.

- **Discovery of natural resources.** Production of new natural resources or the introduction of new ways to recover existing resources can enhance growth. In addition, decreases in resource production costs will improve growth while decreases in resource supply will restrict growth.
- **Financial crises.** Shocks to the financial system will lead to a crisis of confidence among market participants. Financial crises may reduce the level of economic output in the short term and may also decrease the trend rate of growth.

LOS 10.d: Discuss the application of economic growth trend analysis to the formulation of capital market expectations.

CFA® Program Curriculum, Volume 2, page 183

The trend rate of growth is an important input when setting capital market expectations. Some of the key considerations of economic growth trend analysis are as follows:

- Forecasting returns with DCF models incorporate the trend rate of growth. The need to keep these forecasts consistent with long-term economic growth imposes discipline on the models. The trend rate of growth acts as an anchor for long-term bond and equity returns.
- Higher trend growth rates may lead to higher stock returns assuming the growth is not already reflected in stock prices.
- When we speak of higher trend growth rates, we mean the economy can grow at a faster pace before inflation becomes a major concern. This consideration influences monetary policy and the level of bond yields.
- Higher trend growth rates tend to generate higher government bond yields.

Overall, the trend rate of growth is relatively stable in developed economies. In emerging economies, that growth rate can be less predictable and include longer periods of rapid growth as those economies catch up with developed economies.

A basic model for forecasting the economic growth rate focuses on the following:

- *Labor input,* based on growth in the labor force and labor participation. Growth in the labor force depends on population growth and demographics. Labor participation refers to the percentage of the population working and is affected by real wages, work/leisure decisions, and social factors.
- *Capital per worker,* which increases labor productivity.
- *Total factor productivity,* which is reflected in technological progress and changes in government policies.

> **EXAMPLE: Forecasting the long-term economic growth rate**
>
> Assume that the population is expected to grow by 2% and that labor force participation is expected to grow by 0.25%. If spending on new capital inputs is projected to grow at 2.5% and total factor productivity will grow by 0.5%, what is the long-term projected growth rate?
>
> **Answer:**
>
> The sum of the components equals 2% + 0.25% + 2.5% + 0.5% = 5.25%, so the economy is projected to grow by this amount.

High rates of growth in capital investment are associated with high rates of growth in the economy. However, these high growth rates are not necessarily linked to favorable equity returns. This may be the case because growth rates are already factored into equity prices. An additional explanation is that the source of equity returns is related to the rate of return on capital. If the rate of growth of capital is faster than the rate of economic growth, return on capital may decrease and equity returns may become less attractive.

Market Forecasting

LOS 10.e: Compare major approaches to economic forecasting.

CFA® Program Curriculum, Volume 2, page 186

Three approaches to economic forecasting are econometric modeling, use of economic indicators, and a checklist approach.

Econometric analysis uses statistical methods to explain economic relationships and formulate forecasting models. *Structural models* are based on economic theory while *reduced-form models* are compact versions of structural approaches. These types of models range from being quite simple to very complex, involving several or hundreds of relationships. For example, an analyst may want to forecast GDP using current and lagged consumption and investment values. Ordinary least squares regression is most often used, but other statistical methods are also used to develop these models.

Advantages:

- Modeling can incorporate many variables.
- Once the model is specified, it can be reused.
- Output is quantified and based on a consistent set of relationships.

Disadvantages:

- Models are complex and time-consuming to construct.
- The data may be difficult to forecast and the relationships can change.
- Output may require interpretation or be unrealistic.
- It does not work well to forecast turning points.

Economic indicators are available from governments, international organizations (e.g., the Organization of Economic Cooperation and Development), and private organizations (e.g., the Conference Board in the United States).

Many analysts use a combination of publicly available indicators and their own proprietary indicators. The most useful indicators are **leading indicators** that move ahead of the business cycle with a reasonable stable lead time. These can be used to predict what will happen next. The leading indicators can be used individually or as a **composite**. For example, the Conference Board provides 10 leading indicators for the United States, which they combine into an index. Traditionally, three consecutive months of increase (decrease) for the index are expected to signal the start of an economic expansion (contraction) within a few months. A composite can also be interpreted as a **diffusion index** by observing the number of indicators pointing toward expansion versus contraction in the economy.

There are also **coincident** and **lagging indicators** that move with and after changes in the business cycle. These can be used to confirm what is happening in the economy.

Advantages:

- Economic indicators are simple, intuitive, and easy to interpret.
- Data are often readily available from third parties.
- Indicator lists can be tailored to meet specific forecasting needs.

Disadvantages:

- Forecasting results have been inconsistent.
- Economic indicators have given false signals.

- Indicators are revised frequently, which can make them appear to fit past business cycles better than they did when the data were first released.

A **checklist approach** is more subjective. In this approach, an analyst considers a series of questions. For example, to forecast GDP, the analyst may consider, "What was the latest employment report? What is the central bank's next move, given the latest information released? What is the latest report on business investment?" Then the analyst uses judgment and perhaps some statistical modeling to interpret the answers and formulate a forecast. Judgment is required both in determining which factors to consider and how to interpret them.

Advantages:

- Less complex than econometrics.
- Flexible in mixing objective statistical analysis with judgment to incorporate changing relationships.

Disadvantages:

- Subjective.
- Time-consuming.
- Complexity must be limited due to manual process.

MODULE 10.3: THE BUSINESS CYCLE

Video covering this content is available online.

LOS 10.f: Discuss how business cycles affect short- and long-term expectations.

CFA® Program Curriculum, Volume 2, page 190

As mentioned, the trend rate of growth provides guidance on setting long-term expectations. Any deviations from this trend tend to cancel out over the long run; however, identifying these deviations can be very useful when making shorter-term projections. Fluctuations in economic growth over short to intermediate time horizons are often associated with the business cycle.

A fundamental reason why economic activity is cyclical is the nature of business decisions. Decision makers allocate resources to what they believe are their highest valued uses, but can only do so with imperfect information. Adjustments to unexpected events take time to implement and reversing incorrect decisions can be costly.

Understanding business cycle phases is important for forming capital market expectations, but their relationship is not straightforward for the following reasons:

1. Business cycles vary in duration and intensity, and their turning points are difficult to predict. Their variations may be thought of as resulting from the interactions of many subcycles with a wide range of frequencies.
2. Although we typically think of and model economic activity in terms of cycles fluctuating around a long-term trend, it can be difficult to distinguish which effects

result from shorter-term factors that arise from the business cycle and which are related to longer-term factors that affect the trend rate of economic growth.

3. Returns in the capital market are strongly related to activity in the real economy, but they also depend on factors such as investors' expectations and risk tolerances.

Business cycle analysis is most useful for identifying opportunities within the time horizon of a typical business cycle. For longer investment horizons that are likely to include one or more full business cycles, information about the current state of the economy is less valuable.

Business Cycle Phases

> **For the Exam:** Have a working knowledge of, and be able to explain, the general relationships between interest rates, inflation, stock and bond prices, et cetera, as you progress over the business cycle. For example, as the peak of the cycle approaches, everything is humming along. Confidence and employment are high, but inflation is starting to have an impact on markets. As inflation increases, bond yields increase and both bond and stock prices start to fall.

The business cycle can be subdivided into five phases: (1) initial recovery, (2) early expansion, (3) late expansion, (4) slowdown, and (5) contraction. The phases have the following characteristics:

Initial recovery

- Duration of a few months.
- Business confidence rising.
- Government stimulus provided by low interest rates and/or budget deficits.
- Falling inflation.
- Large output gap.
- Low or falling short-term interest rates.
- Bond yields bottoming out.
- Rising stock prices.
- Cyclical, riskier assets such as small-cap stocks and high yield bonds doing well.

Early expansion

- Duration of a year to several years.
- Increasing growth with low inflation.
- Increasing confidence.
- Rising short-term interest rates.
- Output gap is narrowing.
- Stable or rising bond yields.
- Rising stock prices.

Late expansion

- High confidence and employment.
- Output gap eliminated and economy at risk of overheating.
- Increasing inflation.
- Central bank limits the growth of the money supply.
- Rising short-term interest rates.
- Rising bond yields.
- Rising/peaking stock prices with increased risk and volatility.

Slowdown

- Duration of a few months to a year or longer.
- Declining confidence.
- Inflation still rising.
- Short-term interest rates at a peak.
- Bond yields peaking and possibly falling, resulting in rising bond prices.
- Possible inverting yield curve.
- Falling stock prices.

Contraction

- Duration of 12 to 18 months.
- Declining confidence and profits.
- Increase in unemployment and bankruptcies.
- Inflation topping out.
- Falling short-term interest rates.
- Falling bond yields, rising prices.
- Stock prices increasing during the latter stages, anticipating the end of the recession.

Inflation Implications

LOS 10.g: Explain the relationship of inflation to the business cycle and the implications of inflation for cash, bonds, equity, and real estate returns.

CFA® Program Curriculum, Volume 2, page 194

Inflation means generally rising prices. For example, if the CPI increases from 100 to 105, inflation is 5%. Inflation typically accelerates late in the business cycle (near the peak).

Disinflation means a deceleration in the rate of inflation. For example, if the CPI then increases from 105 to 108, the rate of inflation decreases to approximately 3%. Inflation typically decelerates as the economy approaches and enters recession.

Deflation means generally falling prices. For example, if the CPI declines from 108 to 106, the rate of inflation is approximately –2%. Deflation is a severe threat to economic activity for the following reasons:

- It encourages default on debt obligations. Consider a homeowner who has a home

worth $100,000 and a mortgage of $95,000; the homeowner's equity is only $5,000. A decline of more than 5% in home prices leads to negative equity and can trigger panic sales (further depressing prices), defaulting on the loan, or both.

- With negative inflation, interest rates decline to near zero and this limits the ability of central banks to lower interest rates and stimulate the economy. Following the financial crisis of 2007–2009 and the resulting very low interest rates, several central banks tried a new monetary policy of **quantitative easing** (QE) to stimulate the economies of their countries. Traditionally, central banks have used open market operations to increase the money supply and decrease short-term interest rates on a temporary basis by buying high quality fixed-income instruments. QE was different in that it was larger in scale, the purchases included other security types such as mortgage-backed securities and corporate bonds, and the intent was a long-term increase in bank reserves.

Monetary policy and inflation levels will vary over the business cycle. In general, moderate levels of inflation only create moderate costs for the economy. As a result, central banks tend to target a slightly positive inflation rate. Investors generally expect that equity and bond prices will reflect some level of positive inflation.

Figure 10.1 summarizes the relationship of inflation to the business cycle. Figure 10.2 describes the typical behavior of asset class returns in different inflation scenarios.

Figure 10.1: Inflation and the Business Cycle

The Business Cycle	Inflation	Economic Policy	Markets
Initial recovery	Initially declining inflation	Stimulative	Short-term rates low or declining Long-term rates bottoming and bond prices peaking Stock prices increasing
Early expansion	Low inflation and good economic growth	Becoming less stimulative	Short-term rates increasing Long-term rates bottoming or increasing with bond prices beginning to decline Stock prices increasing
Late expansion	Inflation rate increasing	Becoming restrictive	Short-term and long-term rates increasing with bond prices declining Stock prices peaking and volatile
Slowdown	Inflation continues to accelerate	Becoming less restrictive	Short-term and long-term rates peaking and then declining with bond prices starting to increase Stock prices declining
Contraction	Real economic activity declining and inflation peaking	Easing	Short-term and long-term rates declining with bond prices increasing Stock prices begin to increase later in the recession

Figure 10.2: Inflation Expectations and Asset Classes

Inflation within expectations	Cash equivalents: Earn the real rate of interest Bonds: Shorter-term yields more volatile than longer-term yields Equity: No impact given predictable economic growth Real estate: Neutral impact with typical rates of return
Inflation above or below expectations	Cash equivalents: Positive (negative) impact with increasing (decreasing) yields Bonds: Longer-term yields more volatile than shorter-term yields

	Equity: Negative impact given the potential for central bank action or falling asset prices, though some companies may be able to pass rising costs on to customers Real estate: Positive impact as real asset values increase with inflation
Deflation	Cash equivalents: Positive impact if nominal interest rates are bound by 0% Bonds: Positive impact as fixed future cash flows have greater purchasing power (assuming no default on the bonds) Equity: Negative impact as economic activity and business declines Real estate: Negative impact as property values generally decline

PROFESSOR'S NOTE

These generalizations will not hold in every case. They are a good starting point for a forecaster taking a macro approach. Even if the generalizations always held, it is not easy to determine when a business cycle phase starts, how long it will last, or when it ends.

MODULE QUIZ 10.2, 10.3

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

1. An analyst believes that GDP is best forecasted using a system of equations that can capture the fact that GDP is a function of many variables, both current and lagged values. Which economic forecasting method is she *most likely* to use?

2. The phase of the business cycle in which we *most likely* expect to observe rising short-term interest rates and stable bond yields is:
   A. late expansion.
   B. initial recovery.
   C. early expansion.
3. Describe how bonds and equities typically perform during deflationary periods.

MODULE 10.4: MONETARY AND FISCAL POLICY

Video covering this content is available online.

LOS 10.h: Discuss the effects of monetary and fiscal policy on business cycles.

CFA® Program Curriculum, Volume 2, page 197

Monetary Policy

Central banks often use monetary policy as a countercyclical force, attempting to optimize the economy's performance. Most central banks strive to balance price stability against economic growth. The ultimate goal is to keep growth near its long-run sustainable rate, because growth faster than the long-run rate usually results in increased inflation. As

discussed previously, the later stages of an economic expansion are often characterized by increased inflation. As a result, central banks usually resort to restrictive policies toward the end of an expansion. The risk at this stage is that they may overtighten and cause a recession.

To spur growth, a central bank can take actions to reduce short-term interest rates. This results in greater consumer spending, greater business spending, higher stock prices, and higher bond prices. Lower interest rates also usually result in a lower value of the domestic currency, which is thought to increase exports. In addition to the direction of change, the level of interest rates is important. If, for example, rates are increased to 4% to combat inflation, but this is still low compared to the average of 6% in a country, then this absolute rate may still be low enough to allow growth while the rise in rates may begin to dampen inflation. The equilibrium interest rate in a country (the rate at which a balance between growth and inflation is achieved) is referred to as the neutral rate. It is generally thought that the neutral rate is composed of an inflation component and a real growth component. If, for example, inflation is targeted at 3% and the economy is expected to grow by 2%, then the neutral rate would be 5%.

The neutral rate is the rate that most central banks strive to achieve as they attempt to balance the risks of inflation and recession. If inflation is too high, the central bank should increase short-term interest rates. If economic growth is too low, it should decrease interest rates. The **Taylor rule** embodies this concept. Thus, it is used as a prescriptive tool (i.e., it states what the central bank should do). It also is fairly accurate at predicting central bank action.

The Taylor rule determines the target interest rate using the neutral rate, expected GDP relative to its long-term trend, and expected inflation relative to its targeted amount. It can be formalized as follows:

$$n_{target} = r_{neutral} + i_{target} + [0.5(GDP_{expected} - GDP_{trend}) + 0.5(i_{expected} - i_{target})]$$

where:

n_{target} = target nominal short-term interest rate

$r_{neutral}$ = neutral real short-term interest rate

$GDP_{expected}$ = expected GDP growth rate

GDP_{trend} = long-term trend in the GDP growth rate

$i_{expected}$ = expected inflation rate

i_{target} = target inflation rate

EXAMPLE: Calculating the short-term interest rate target

Given the following information, **calculate** the nominal short-term interest rate target.

Neutral rate	3%
Inflation target	2%
Expected inflation	4%
GDP long-term trend	2%
Expected GDP growth	0%

Answer:

n_{target} = 3% + 2% + [0.5(0% – 2%) + 0.5(4% – 2%)]

= 5% + (–1% + 1%) = 5%

> In this example, weak projected economic growth would call for cutting interest rates if inflation were not a consideration. If the central bank was only concerned with growth, the target interest rate would be 1% lower than the neutral rate. However, the higher projected inflation overrides the growth concern because projected inflation is 2% greater than the target inflation rate. In net, the target rate is 5% because the concern over high inflation overrides the weak growth concern.

Negative Interest Rates

Negative interest rates were generally considered a hypothetical curiosity before the 2007–2009 financial crisis. A *negative rate* is defined as a net payment made to keep money on deposit at a financial institution or payment of a net fee to invest in short-term instruments.

Zero was regarded as the sustainable lower rate of interest because investors could hold physical cash instead (earning no interest). As investors withdrew funds from banks to hold cash, bank balance sheets would shrink as they paid out funds and stopped making loans. Simple supply and demand analysis should dictate that with a smaller supply of funds available to lend, the price paid (interest rate) to borrow increases.

The flaw in this analysis was that negative interest rates did not cause the expected large move into physical cash. The daily exchange of funds in modern economies is too large. The implicit advantages of being able to quickly transfer large amounts of money held on deposit to settle transactions outweighed the explicit cost of holding those deposits at negative rates. Without the exit of funds from the banking system, it turned out that negative interest rates were sustainable for extended periods.

As mentioned earlier, the slowdown in economic activity during the crisis and already very low interest rates led some central banks to experiment with less-tested monetary policy—QE approach. QE led to larger injections of funds by central banks into the commercial banking system with the announced intent that these injections were long term in nature. The hope was this would stimulate bank lending and increase economic activity.

Negative interest rates should, in theory, have similar effects. Holders of funds would find it more desirable to spend the money, stimulating economic activity; or, they would invest in longer-term stocks and bonds, driving up prices and creating a wealth effect. Or, negative rates would lead consumers and businesses to borrow at zero or negative rates to spend now.

How these new policies actually end up working remains to be seen. For the policies to work, consumers, investors, and businesses have to believe the risk of spending now is worth it. Purchases and investments made now provide positive economic benefit in the future. But negative interest rates also signal uncertainty as to what the future holds.

Negative interest rates complicate the process of forming capital market expectations:

- The risk-free rate is the starting point for buildup models used to estimate long-run returns for asset classes. When the risk-free rate is negative, a sustainable expected risk-free rate, such as the policy neutral rate in the Taylor rule, is more appropriate as that starting point. That rate is generally not regarded as fully risk free, so a modest default premium can be removed.
- Forming capital market expectation over shorter time horizons is further complicated by a need to forecast the time path over which negative rates will converge to a long-run sustainable risk-free rate. Multiple path projections should be considered to allow for uncertainty regarding how the convergence will occur.

- Another approach to shorter-term projections of asset class returns is to interpret negative risk-free rates as being consistent with contraction or early recovery stages of the business cycle.
- Using historical data as a starting point for forecasting is more problematic because few comparable periods exist, and the negative rates suggest significant structural economic changes are occurring. This kind of regime change makes statistics based on historical data less reliable, requiring more subjective assessments. Anticipating the effects of negative rates when combined with less-tested QE makes forecasting even more challenging.

Fiscal Policy

Another tool at the government's disposal for managing the economy is fiscal policy. If the government wants to stimulate the economy, it can implement loose fiscal policy by decreasing taxes or increasing spending, thereby increasing the budget deficit. If they want to rein in growth, the government does the opposite to implement fiscal tightening.

There are two important aspects to fiscal policy. First, it is not the level of the budget deficit that matters—it is the change in the deficit. For example, a deficit by itself does not stimulate the economy, but increases in the deficit are required to stimulate the economy. Second, changes in the deficit that occur naturally over the course of the business cycle are not stimulative or restrictive. In an expanding economy, deficits will decline because tax receipts increase and disbursements to the unemployed decrease. The opposite occurs during a recession. Only changes in the deficit directed by government policy will influence growth.

The Yield Curve

LOS 10.i: Interpret the shape of the yield curve as an economic predictor and discuss the relationship between the yield curve and fiscal and monetary policy.

CFA® Program Curriculum, Volume 2, page 204

The yield curve demonstrates the relationship between interest rates and the maturity of debt securities. The curve is sensitive to government actions as well as current and expected economic conditions. When both fiscal and monetary policies are expansive, for example, the yield curve is sharply upward sloping (i.e., short-term rates are lower than long-term rates), and the economy is likely to expand in the future. When fiscal and monetary policies are restrictive, the yield curve is downward sloping (i.e., it is *inverted*, as short-term rates are higher than long-term rates), and the economy is likely to contract in the future.

Fiscal and monetary policies may reinforce or conflict with each other. If the policies reinforce each other, the implications for the economy are clear. In all cases, there are likely implications for the yield curve:

- If both policies are stimulative, the yield curve is steep and the economy is likely to grow.
- If both policies are restrictive, the yield curve is inverted and the economy is likely to contract.
- If monetary policy is restrictive and fiscal policy is stimulative, the yield curve is flat and the implications for the economy are less clear.

- If monetary policy is stimulative and fiscal policy is restrictive, the yield curve is moderately steep and the implications for the economy are less clear.

In terms of the business cycle, the yield curve is typically steep at the bottom of the cycle. As the cycle moves toward expansion, the curve tends to flatten. At the top of the cycle, the yield curve will likely be flat to inverted. During contraction, the curve will begin to re-steepen. Given these expectations, analysts can use the yield curve as a predictor of the state of the economy as well as the future path of interest rates. However, analysts should also exercise caution that these relationships may not always hold.

International Considerations

LOS 10.j: Identify and interpret macroeconomic, interest rate, and exchange rate linkages between economies.

CFA® Program Curriculum, Volume 2, page 205

Economic links between countries have become increasingly important with globalization, especially for small countries with undiversified economies. Larger countries with diverse economies, such as the United States, are less affected but still influenced by globalization.

Macroeconomic links can produce convergence in business cycles among economies. International trade produces one such link, as a country's exports and economy are depressed by a slowdown in a trading partner's economy and level of imports. International capital flows produce another link if cross-border capital investing by a trading partner declines as its economy contracts.

A country's current account and capital account are measures of macroeconomic linkages. The current account largely consists of a country's net exports while the capital account reflects net investment flows. The two accounts are opposites of each other in that a surplus in one account will produce a deficit in the other.

A useful relationship for understanding how the current account influences economic activity is the following formula:

net exports = net private saving + government surplus

Interest rates and currency exchange rates can also create linkages. A strong link is created when a smaller economy "pegs" its currency to that of a larger and more developed economy. The peg is a unilateral declaration by the pegging country to maintain the exchange rate. In general, the linkage between the business cycles of the two economies will increase, as the pegged currency country must follow the economic policies of the country to which it has pegged its currency. If not, investors will favor one currency over the other and the peg will fail.

Generally, the interest rates of the pegged currency will exceed the interest rates of the currency to which it is linked, and the interest rate differential will fluctuate with the market's confidence in the peg. If confidence is high, the rate differential can be small. If there is doubt the peg will be maintained, investors will require a larger interest rate differential as compensation for the risk of holding the pegged currency. A common problem arises if investors begin to lose confidence in the pegged currency and it begins to decline in value. The pegging country must then increase short-term interest rates to attract capital and maintain the value of the currency at the peg.

In the absence of pegging, the relationship of interest rate differentials and currency movement can reflect several factors:

- If a currency is substantially overvalued and expected to decline, bond interest rates are likely to be higher to compensate foreign investors for the expected decline in the currency value.
- Relative bond yields, both nominal and real, increase with strong economic activity and increasing demand for funds.
- Savings and investment decisions as well as capital productivity drive the level of real rates. Although real rates may differ across countries, there is a tendency for them to move up and down together given that global savings and investing are linked through the current account.

PROFESSOR'S NOTE

The relationship between currency values and interest rates is complicated. You may recall a theory from earlier levels that if real interest rates are equal and the movement of currency value consistently reflects the difference in inflation rates, then the forward exchange rate is a good predictor of what will happen in the currency market. The Level III material will not support those assumptions and does not support the use of the forward exchange rate as a predictor of what will happen. This is addressed in multiple study sessions.

MODULE QUIZ 10.4

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

1. During an economic expansion, an analyst notices that the budget deficit has been declining. She concludes that the government's fiscal policy has shifted to a more restrictive posture. **Comment** on her conclusion.

2. **Calculate** the nominal short-term interest rate target given the following information.

Neutral real rate	2%
Inflation target	3%
Expected inflation	5%
GDP long-term trend	3%
Expected GDP	4%

3. A forecaster notes that the yield curve is steeply upwardly sloping. **Comment** on the likely monetary and fiscal policies in effect and the future of the economy.

4. An analyst is evaluating two countries. Maldavia has a GDP of $60 billion and an economy that is dominated by the mining industry. Ceania has a GDP of $1.2 trillion and an economy that sells a variety of items. He is predicting a global economic slowdown. Which country is at greater risk?

5. At a conference, Larry Timmons states that a pegged exchange rate allows a less developed country to achieve greater currency and economic stability, as well as relatively lower and more stable interest rates, and to pursue the fiscal and economic policies to maximize the country's real economic growth. **Explain** what is correct and incorrect in Timmons's statement.

KEY CONCEPTS

LOS 10.a

Capital market expectations help in formulating the strategic asset allocation. They can also assist in detecting short-term asset mispricings exploitable through tactical asset allocation. Asset allocations should display both cross-sectional and intertemporal consistency.

To formulate capital market expectations, use the following process:

- Determine the relevant capital market expectations given the investor's allowable asset classes and investment horizon(s).
- Investigate assets' historical performance as well as the determinants of their performance.
- Identify the valuation model used and its requirements.
- Collect the best data possible.
- Use experience and judgment to interpret current investment conditions.
- Formulate capital market expectations.
- Monitor performance and use it to refine the process.

LOS 10.b

Limitations in the use of economic data for forecasting include the following:

- Data are reported with a lag, subject to revision, and defined inconsistently in different countries.
- Data are subject to biases and errors such as transcription errors, survivorship bias, and smoothed (appraised) data estimates.
- Using historical data is less appropriate when economic conditions change (regime change and nonstationary issues).
- Ex-post risk generally understates ex-ante risk, as surviving the past does not guarantee the future cannot be worse.
- Data mining or selection of time periods may introduce biases.
- Models should be conditioned for the likely state of the economy.
- Correlation does not imply causation. Does A cause B, does B cause A, or are both associated with some other factor C?
- Psychological biases and cognitive errors may affect an analysis.
- Models, parameters, and inputs are subject to uncertainty.

LOS 10.c

Exogenous shocks are unanticipated events that occur outside the normal course of an economy and may have either a positive or negative impact on growth. They can be caused by different factors, such as changes in government policies, political events, technological progress, natural disasters, discovery of natural resources, and financial crises.

LOS 10.d

In forecasting a country's long-term economic growth trend, the trend growth rate can be decomposed into two main components and their respective subcomponents:

- Changes in employment levels, which are related to population growth and labor force participation.
- Changes in productivity, which are related to capital inputs and technological advancement.

LOS 10.e

Econometric analysis uses statistical methods to formulate forecasting models. These models range from being quite simple to very complex, involving several data items of various time period lags to predict the future.

Economic indicators attempt to characterize an economy's phase in the business cycle and are separated into lagging indicators, coincident indicators, and leading indicators. Analysts prefer leading indicators because they help predict the future path of the economy.

In a checklist approach, the analyst checks off a list of questions that should indicate the future growth of the economy. Given the answers to these questions, the analyst can then use her judgment to formulate a forecast or derive a more formal model using statistics.

LOS 10.f

Understanding business cycle phases is important for forming capital market expectations, but their relationship is not straightforward. Business cycles vary in duration and intensity, and their turning points are difficult to predict. It can be difficult to distinguish among factors that arise from the business cycle and factors that affect the trend rate of growth. Returns in the capital market are strongly related to activity in the real economy, but also depend on factors such as investors' expectations and risk tolerances.

The business cycle can be subdivided into five phases: (1) initial recovery, (2) early expansion, (3) late expansion, (4) slowdown, and (5) contraction.

LOS 10.g

Inflation varies over the business cycle, rising in the latter stages of an expansion and falling during a recession and the initial recovery. Deflation reduces the value of investments financed with debt (e.g., real estate) because leverage magnifies losses.

Bond prices will rise during a recession when inflation and interest rates are declining. In a strong expansion, bonds tend to decline in price as inflation expectations and interest rates rise.

Equities provide an inflation hedge when inflation is moderate. High inflation can be problematic because slow growth may result from central bank action to combat inflation. Deflation is harmful because it encourages defaults and limits the scope for monetary policy.

LOS 10.h

Central banks often use monetary policy as a countercyclical force. The goal is to keep growth near its long-run sustainable rate, because growth faster than the long-run rate usually results in increased inflation. To spur growth, a central bank can take actions to reduce short-term interest rates.

The Taylor rule determines the target interest rate using the neutral rate, expected GDP relative to its long-term trend, and expected inflation relative to its targeted level:

$$n_{target} = r_{neutral} + i_{target} + [0.5(GDP_{expected} - GDP_{trend}) + 0.5(i_{expected} - i_{target})]$$

- A central bank can use the Taylor rule to determine the appropriate level for short-term interest rates.
- An investment strategist who expects unanticipated changes in the inputs to the Taylor rule can use the rule to anticipate changes in short-term interest rates by the central bank.

Another tool at the government's disposal for managing the economy is fiscal policy. If the government wants to stimulate the economy, it can implement loose fiscal policy by decreasing taxes or increasing spending, thereby increasing the budget deficit. If they want to rein in growth, the government does the opposite to implement fiscal tightening.

LOS 10.i

The yield curve demonstrates the relationship between interest rates and the maturity of debt securities. The curve is sensitive to government actions as well as current and expected economic conditions.

When both fiscal and monetary policies are expansive, the yield curve is sharply upward sloping, which indicates that the economy is likely to expand in the future. When fiscal and monetary policies are restrictive, the yield curve is downward sloping, indicating that the economy is likely to contract in the future.

When fiscal and monetary policies are in disagreement, the shape of the yield curve is less definitively formed. If monetary policy is expansive while fiscal policy is restrictive, the yield curve tends to be upward sloping, though less steep than when both policies are expansive. If monetary policy is restrictive while fiscal policy is expansive, the yield curve tends to be flatter.

LOS 10.j

Macroeconomic links refer to similarities in business cycles across countries. Economies are linked by both international trade and capital flows so that a recession in one country dampens exports and investment in a second country, thereby creating a slowdown in the second country.

Exchange rate links are found when countries peg their currency to others. The benefit of a peg is that currency volatility is reduced and inflation can be brought under control. Interest rates in the pegging country often reflect a risk premium relative to the country to which it pegs.

Interest rate differentials between countries can also reflect differences in economic growth, monetary policy, and fiscal policy.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 10.1

1. The analyst has not been systematic and has used inconsistent assumptions. In this case, the result is overstating the attractiveness of equity and understating the attractiveness of fixed income. The result would be allocating too much to equity. (LOS 10.a)

2. Pro: The recent three-year period is more likely to reflect the current economic and political environment.

   Con: The recent shorter period does not reflect the full course of a business cycle or a variety of possible economic conditions.

   Pro: The longer period is more likely to reflect various economic conditions that can occur.

   Con: The longer period is more likely to be subject to regime change, be nonstationary, and reflect conditions that are no longer relevant.

   (LOS 10.b)

3. Some types of alternative investments are not regularly traded, and only infrequent prices (smoothed data) are available. This makes the calculated standard deviation lower because there are no actual periodic changes in value (there are no prices to examine). The smoothed return data also appears to be less correlated with the more erratic pricing of other asset classes that have and report actual trading prices. The correlation will appear closer to zero. (LOS 10.b)

Module Quiz 10.2, 10.3

1. Econometric analysis would be the best approach to use. It can model the complexities of reality using both current and lagged values. Ordinary least squares regression is most often used, but other statistical methods are also available. (Module 10.2, LOS 10.e)

2. **C** *Early Expansion*: In this period of the business cycle, we expect to observe rising short-term interest rates and stable or rising bond yields.

   The expectations of short-term and long-term yields for the other phases are listed as follows:

   Late Expansion: Both short-term and long-term rates increase.

   Initial Recovery: Low or falling short-term rates, and bond yields have bottomed out. (Module 10.3, LOS 10.f)

3. Bonds tend to perform well during periods of falling inflation or deflation because interest rates are declining. This holds true as long as credit risk does not increase. Equities do poorly in periods of declining inflation or deflation due to declining economic growth and asset prices. (Module 10.3, LOS 10.g)

Module Quiz 10.4

1. Her conclusion may not be warranted. In an economic expansion, the budget deficit will decline naturally because tax receipts increase and disbursements to the unemployed decrease. The changes she is observing may be independent of the government's fiscal policy.

   Note that only government-directed changes in fiscal policy influence the growth of the economy. Changes in the deficit that occur naturally over the course of the business cycle are not stimulative or restrictive. (LOS 10.h)

2. $n_{target} = 2\% + 5\% + [0.5 \times (4\% - 3\%) + 0.5 \times (5\% - 3\%)]$

   $= 7\% + [0.5\% + 1\%] = 8.5\%$

   In this example, the higher-than-targeted growth rate and higher-than-targeted inflation rate argue for a targeted nominal interest rate of 8.5%. This rate hike is intended to slow down the economy and inflation. (LOS 10.h)

3. If the yield curve is steeply upwardly sloping, then it is likely that both fiscal and monetary policies are expansive. The economy is likely to expand in the future. (LOS 10.i)

4. A global economic slowdown would affect smaller countries with undiversified economies more because economic links are more important for these types of countries. Larger countries with diverse economies are less affected by events in other countries. (LOS 10.j)

5. Greater currency and economic stability: true. The peg is likely to create a more stable currency that provides confidence for investors and business, both of which promote economic stability. Maintaining the peg prevents excessive money creation, which holds down inflation and also promotes economic stability. The peg is a commitment to follow the policies needed to maintain the value of the currency.

   Relatively lower and more stable interest rates: partially true (or partially false). Interest rates will be related to but higher than the country to which the currency is pegged. The interest rate premium will reflect the investor's perception of the country's commitment and ability to maintain the peg. If that comes into question, the country will likely have to increase interest rates in order to maintain the currency value. The goal of the peg is lower and more stable rates, but if the peg fails, the opposite can occur.

   Pursue the fiscal and economic policies to maximize the country's real economic growth: false. The country must largely follow the economic policies of the country to which it is pegged. These may or may not be optimal for the country's growth. (LOS 10.j)

The following is a review of the Capital Market Expectations principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #11.

READING 11: CAPITAL MARKET EXPECTATIONS, PART 2: FORECASTING ASSET CLASS RETURNS

Study Session 4

EXAM FOCUS

This reading builds on the preceding capital markets section and expands it for setting expectations for the various asset classes. The section begins with an overview of tools used for forecasting capital market returns. Forecasting the returns of different asset classes is next: fixed income, equities, real estate, and currencies. Make sure you are able to distinguish between risk analysis techniques used for developed and emerging market economies. The final two sections focus on forecasting volatilities, including the variance-covariance matrix, followed by a discussion on how an analyst can make recommendations for adjusting an asset portfolio. Although this is a new reading for 2020, several of the concepts have been consistently tested in the Level 3 exams, including the Grinold-Kroner model and the Singer-Terhaar model.

INTRODUCTION

PROFESSOR'S NOTE

While this is a longer introduction, it contains necessary information to understand the subsequent sections on forecasting returns. It is also a synthesis of many of the valuation approaches discussed in this reading.

Forecasting returns requires not only assessing expected returns, variances and correlations, but also understanding that time horizons are important. Investment opportunities, and therefore investment decisions, can change over time. At their core, investment techniques assume that investments tend to return to their fundamental levels over time, knows as *central tendency*. There are three approaches to forecasting capital market expectations: formal tools, surveys, and judgments.

Formal Tools

The use of **formal tools** helps the analyst set capital market expectations. When applied to reputable data, formal tools provide forecasts replicable by other analysts. The formal tools we examine are statistical methods, discounted cash flow models, and risk premium models.

Statistical methods involve sample statistics, shrinkage estimation, and time series estimation. Sample statistics use well-known data, including means, variance, and correlation, to forecast future data. This is the clearest approach in forecasting, but it can be imprecise. Alternatively, a *shrinkage estimate* can be applied to the historical estimate if the analyst believes simple historical results do not fully reflect expected future conditions. A shrinkage estimate is a weighted average estimate based on history and some other projection. A *time series estimate* can also be used to make forecasts. A time series estimate forecasts a variable

using lagged values of the same variable and combines it with lagged values of other variables, which allows for incorporating dynamics (volatilities) into the forecasts.

Discounted cash flow models express the intrinsic value of an asset as the present value of future cash flows. The advantage of these models is their correct emphasis on the future cash flows of an asset and the ability to back out a required return.

An alternative to estimating expected return is a **risk premium** or buildup model. Risk premium approaches can be used for both fixed income and equity. The approach starts with a risk-free interest rate and then adds compensation for *priced risks*, or risks for which an investor would want to be compensated. Risk premium models include equilibrium models (e.g., the Capital Asset Pricing Model), a factor model, and building blocks.

Surveys and Judgment

Capital market expectations can also be formed using **surveys**, which can be the most useful ways to gauge consensus. In this method, a poll is taken of market experts, such as economists and analysts, for their opinions regarding the economy or capital market. For example, the U.S. Federal Reserve Bank of Philadelphia conducts an ongoing survey regarding the U.S. consumer price index and GDP.

Judgment can also be applied to project capital market expectations by using qualitative information based on experience. Although quantitative models provide objective numerical forecasts, there are times when an analyst must adjust those expectations using experience and insight to improve upon those forecasts.

MODULE 11.1: FORECASTING FIXED INCOME RETURNS

Video covering this content is available online.

LOS 11.a: Discuss approaches to setting expectations for fixed-income returns.

CFA® Program Curriculum, Volume 2, page 220

Forecasting fixed income returns can be done through the **discounted cash flow (DCF) method**, the **risk premium approach**, or the **equilibrium model**. We previously introduced the basics of the DCF and risk premium approaches. The equilibrium approach assumes that supply and demand in global asset markets are in balance.

DCF Analysis

The DCF analysis of fixed income securities is useful when there are known future cash flows, or when cash flows can be estimated reasonably accurately. The DCF analysis supports the use of yield to maturity (YTM) as an estimate of expected return. As you recall, the YTM is the discount rate that makes the present value of future bond cash flows equal to the bond's price. The YTM is an IRR calculation and, like any IRR calculation, it will be the realized return earned if the cash flows are reinvested at the YTM and the bond is held to maturity. For zero-coupon bonds, there are no cash flows to reinvest, though the held-to-maturity assumption still applies. For bond portfolios, the YTM is the weighted average of the portfolio bonds' individual YTMs, which is generally considered a good approximation.

The assumption of holding the bond to maturity does not factor in optionality, which may result in cash flows not being received as expected. However, even if all expected cash flows are received, there are several reasons why the bond's realized return may deviate from the initial YTM. First, an investor may sell the bond prior to maturity, generating a capital gain or loss. Second, rising or falling interest rates may result in not only changing bond prices, but changing reinvestment returns. For example, falling (rising) interest rates will decrease (increase) reinvestment returns. The overall gain or loss to the investor will depend on the investment horizon. For an investment horizon that is shorter than the Macaulay duration, the capital gain/loss impact will be more dominant than the reinvestment impact, meaning for example that falling (rising) interest rates will result in a higher (lower) realized return. For an investment horizon longer than the Macaulay duration, the reinvestment risk dominates, meaning that falling (rising) interest rates will result in a lower (higher) realized return.

> **For the Exam:** Remember that the Macaulay duration can be calculated from modified duration (i.e., by multiplying modified duration by the bond's YTM).

> **EXAMPLE: Forecasting bond investment returns**
>
> Jordan Turk manages a $200 million bond portfolio. The portfolio has a YTM of 5.5 and a modified duration of 6.25. Turk has an investment horizon of four years and expects bond yields to fall by 25 bps each year over the investment horizon. Will Turk likely realize a higher or lower overall return than the initial YTM?
>
> **Solution:**
>
> No detailed calculations are required. The Macaulay duration is 6.6 (= 6.25 × 1.055). Given that the investment horizon (four years) is shorter than the Macaulay duration, a decline in bond yields will result in a realized return that is higher than the YTM because the gain on the bond price will outweigh the decline in reinvestment yield.

The Risk Premium (Building Block) Approach

The building block approach starts with a risk-free rate and then adds compensation for additional risks. The required return will include the one-period default-free rate, a term premium, a credit premium, and a liquidity premium.

1. *The short-term default-free rate*

   The short-term default-free rate matches the forecast horizon and is calculated from the most liquid instrument. As a result, it is closest to the government zero-coupon yield and is closely tied to the central bank policy rate. The observed risk-free rate is typically sufficient as the default-free rate, although it may be necessary to normalize this rate. When the investment horizon is much longer than the maturity of the short-term instrument, alternative approaches may be optimal, either by using the yield of a longer maturity zero-coupon bond, or taking the return that could be realized by rolling over the short-term instrument over the investment horizon. Futures contract rates provide useful proxies for this expected path of short-term interest rates.
2. *Term premium*

   While the rates implied from the spot yield curve gives us useful information about the term premium, the real term premium cannot be derived from the yield curve alone. Empirical evidence suggests that the term premiums are positive and are related to duration. There are four primary drivers of the term premium:

- *Inflation uncertainty*: Higher inflation levels typically correspond to higher inflation uncertainty, causing nominal yields to rise and the term premium to increase.
- *Recession hedge*: When inflation is caused by strong aggregate demand, nominal bond returns are negatively correlated with growth, corresponding to low term premiums. When inflation is caused by strong aggregate supply, nominal bond returns are positively correlated with growth, corresponding to higher term premiums.
- *Supply and demand*: The relative supply of short- and long-term default-free bonds determines the slope of the yield curve, which influences the level of term premiums.
- *Business cycles*: The slope of the yield curve and level of term premiums are also related to the business cycle.

Other indicators also influence the term premium forecasts:

- *Ex ante* (forecast) real yield.
- *Cochrane and Piazzesi curve factor*: a measure that captures the yield curve slope.
- *Kim and Wright premium*: a three-factor model of the term structure.
- *Slope of the yield curve*.
- *Supply indicator*: proportion of debt with a maturity greater than 10 years.
- *Cyclical proxies*: corporate profit-to-GDP ratio, business confidence, unemployment rate.

3. *Credit premium*

   The credit premium compensates for the expected level of losses and for the risk of default losses, both of which are components of the credit spread.

   Empirical evidence suggests that while average yield spreads include a small return premium, the premiums earned tend to be uneven and are subject to significant clustering of persistent high and low default rates. As a result, the yield spread is typically not considered a good predictor of future default rates. Spreads are affected primarily by financial market conditions and the credit premium, but only to a lesser extent by expected default losses. The financial market variables with the strongest predictive power of the credit spread are stock returns, stock volatility, and the risk-free rate, while GDP growth and default rate changes do not have strong predictive capabilities.

   Bonds with very high credit quality (AAA and AA) have extremely low default rates, and their credit premium and spreads are mainly driven by *downgrade bias*—this is an asymmetrical risk indicating that a downgrade is more likely than a credit improvement or an upgrade. The credit premium and spreads of low(er) rated bonds, especially non-investment grade bonds, reflect much higher compensation for credit risk.

   Historical evidence for U.S. investment grade corporate bonds suggests that high corporate option-adjusted spreads correspond to a higher credit premium, and steep Treasury curves correspond to declining default rates. Overall, steep yield curves indicate both high credit and term premiums, both of which are bullish indicators because they imply larger compensation for credit losses. However, it is interesting to note that credit premiums are not positively related to maturity. In fact, credit

premiums tend to be higher at shorter maturities, possibly due to *event risk* (defaults are large credit negative events, but a bond will not pay more than its face value), and illiquidity (bonds with a short time left to maturity tend to be illiquid older bonds that are not actively traded). To take advantage of these credit features, portfolio managers often use a barbell strategy, in which they take on credit risk from shorter maturity bonds and take duration risk from long maturities.

4. *Liquidity premium*

   Liquidity tends to be the highest at the earliest stages of a bond's life, typically during the first few weeks only. Securities with the highest liquidity are the newest sovereign bond issues, current coupon mortgage-backed securities, and some high quality corporate bonds. As a general rule, liquidity is higher for bonds that are (1) issued at close to par or market rates, (2) new, (3) large in size, (4) issued by a frequent and well-known issuer, (5) simple in structure, and (6) of high credit quality. An analyst could gauge the "true" liquidity premium by comparing the yield spread between the highest quality issuer (usually the sovereign) and the next highest quality issuer. The analyst can then make adjustments to this spread as he moves further away from the features described previously.

MODULE QUIZ 11.1

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

1. An investor has a bond portfolio with a yield to maturity (YTM) of 4 and a modified duration of 5. The investor expects to hold on to the bond portfolio for at least the next six years but expects that bond yields will gradually rise over the investment horizon by a total of 100 bps. **Determine** whether the investor will realize a higher or lower overall yield than the initial YTM.

Use the following information to answer questions 2 and 3.

Lou Bee is looking to add two new securities to his fixed income portfolio and considers the following bonds (both noncallable):

- One-year government bond
- Five-year AA rated corporate bond

Bee has also gathered the following information:

Risk-free interest rate (one year)	2.5%
Term premium (five-year vs. one-year government bond)	60 bps
Credit premium (five-year AA corporate bond vs.five-year government bond)	30 bps
Liquidity premium on five-year AA corporate bonds	25 bps

2. The expected return of an equal-weighted investment in the two securities will be *closest* to:
   A. 2%.
   B. 3%.
   C. 4%.
3. The expected total risk premium of the two securities will be *closest* to:
   A. 0.6%.
   B. 1.2%.

C. 1.7%.

MODULE 11.2: EMERGING MARKET BOND RISK

Video covering this content is available online.

LOS 11.b: Discuss risks faced by investors in emerging market fixed-income securities and the country risk analysis techniques used to evaluate emerging market economies.

CFA® Program Curriculum, Volume 2, page 228

Emerging market debt offers the investor high expected returns at the expense of higher risk. Many emerging countries are dependent on foreign borrowing, which can later create crisis situations in their economy, currency, and financial markets.

Many emerging countries also have unstable political and social systems. Their undiversified nature makes them susceptible to volatile capital flows and economic crises. The investor must carefully analyze the risk in these countries. For the bond investor, a significant risk is credit risk—does the country have the ability and willingness to pay back its debt? Economic, political, and legal risks are also important.

Signs that an emerging market is more susceptible to risk include:

- Wealth concentration.
- Greater dominance of cyclical industries, including commodities and less pricing power.
- Restrictions on capital flows and trade; currency restrictions.
- Inadequate fiscal and monetary policies.
- Poor workforce education and infrastructure and weak technological advancement.
- Large amounts of foreign borrowing in foreign currencies.
- Less developed and smaller financial markets.
- Exposure to volatile capital flows.

There are several guidelines that look at the health of an emerging market. Potential bond investors should look at these factors before committing to invest funds in these markets:

- To gauge fiscal policy, most analysts examine the *deficit-to-GDP ratio*. Ratios greater than 4% indicate substantial credit risk. Most emerging counties borrow short term and must refinance on a periodic basis. A buildup of debt increases the likelihood that the country will not be able to make its payments. The *debt-to-GDP ratio* of 70% to 80% has been troublesome for emerging countries.
- To compensate for the higher risk in these countries, investors should expect a *real growth rate* of at least 4%. Growth rates less than that may indicate that the economy is growing slower.
- A *current account deficit* exceeding 4% of GDP has been a warning sign of potential difficulty.
- Although emerging countries are dependent on foreign financing for growth, too much debt can eventually lead to a financial crisis if foreign capital flees the country. These financial crises are accompanied by currency devaluations and declines in emerging market asset values. *Foreign debt levels* greater than 50% of GDP indicate that the

country may be overleveraged. *Debt levels* greater than 200% of the current account receipts also indicate high risk.

- *Foreign exchange reserves* relative to short-term debt is important because many emerging country loans must be paid back in a foreign currency. Foreign exchange reserves less than 100% of short-term debt is a sign of trouble (greater than 200% is considered strong).

The government's stance regarding structural reforms and property rights is important. If the government is supportive of structural reforms necessary for growth, then the investment environment is more hospitable. When the government is committed to responsible fiscal policies, competition, and the privatization of state-owned businesses, there are better prospects for growth. Weak enforcement laws, property rights laws, nationalization of property, and corruption are hazard signs. Coalition governments are also seen as riskier because of the inherent political, and therefore policy, instability.

MODULE QUIZ 11.2

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

1. An analyst is evaluating an emerging market for potential investment. She notices that the country's current account deficit has been growing. Is this a sign of increasing risk? If so, **explain** why.

MODULE 11.3: FORECASTING EQUITY RETURNS

Video covering this content is available online.

LOS 11.c: Discuss approaches to setting expectations for equity investment market returns.

LOS 11.d: Discuss risks faced by investors in emerging market equity securities.

CFA® Program Curriculum, Volume 2, pages 230 and 238

When looking at a very long time horizon—over 100 years—mean real returns of equity markets in various countries do not show statistically meaningful differences. These sample averages tend to be imprecise, unless the volatility of the data is small. As we saw, shrinkage estimators are typically more reliable as predictors of equity returns.

Discounted Cash Flow Approach

A second tool for setting capital market expectations is **DCF models**. These models say that the intrinsic value of an asset is the present value of future cash flows. The advantage of these models is their correct emphasis on the future cash flows of an asset and the ability to back out a required return. The models are most suitable for long-term valuation.

Applied to equity markets, the most common application of DCF models is the Gordon growth model, or constant growth model. It is most commonly used to back out the expected

return on equity and is often applied to entire markets. In this case, the growth rate is proxied by the nominal growth in GDP, which is the sum of the real growth rate in GDP plus the rate of inflation. The growth rate can be adjusted for any differences between the economy's growth rate and that of the equity index.

Grinold and Kroner (2002) take this model one step further by including a variable that adjusts for stock repurchases—which companies use to transfer cash to shareholders—and changes in market valuations as represented by changes in the price-earnings (P/E) ratio. The **Grinold-Kroner model** states that the expected return of a stock is its dividend yield, plus the inflation rate, plus the real earnings growth rate, minus the change in stock outstanding, plus changes in the P/E ratio:

$$E(Re) \approx D/P + (\%\Delta E - \%\Delta S) + \%\Delta P/E)$$

where:
E(Re) = expected equity return
D/P = dividend yield
%ΔE = expected percentage change in total earnings
%ΔS = expected percentage change in shares outstanding (share repurchases)
%ΔP/E = expected percentage change in the P/E ratio

PROFESSOR'S NOTE

Candidates often get confused by the variable %ΔS, and when to deduct or add as a number within the GK model.

Remember, a share repurchase is a reduction in shares outstanding, which means the company buys back shares and pays cash to investors. This cash payment is a form of positive return and increases cash flow to investors, which increases expected return (mathematically, a share repurchase is a negative %ΔS term, so subtracting a negative term becomes a positive number).

The variables of the Grinold-Kroner model can be regrouped into three components: the expected income return, the expected nominal growth in earnings, and the expected repricing return.

1. The **expected cash flow return** (income return):

   $$D/P - \%\Delta S = \text{income return}$$

   D/P is the current yield as seen in the constant growth dividend discount model. It is the expected dividend expressed as a percentage of the current price. The Grinold-Kroner model goes a step further in expressing the expected current yield by considering any repurchases or new issues of stock.
2. The **expected nominal earnings growth** is the real growth in earnings plus expected inflation:

   $$\text{expected nominal earnings growth return} = \%\Delta E$$
3. The **expected repricing return** is captured by the expected change in the P/E ratio:

   $$\text{expected repricing return} = \%\Delta(P/E)$$

It is helpful to view the Grinold-Kroner model as the sum of the (1) expected cash flow return, (2) expected nominal earnings growth rate, and (3) expected repricing return.

$$E(Re) \approx (D/P - \%\Delta S) + (\%\Delta E) + (\%\Delta P/E)$$

It is important to understand that the assumptions of the Grinold-Kroner model may lead to irrational results. Because the model assumes an infinite time horizon, it ignores an investor's time horizon. For example, an investor may assume that the P/E ratio would revert to its long-term average. However, by selecting any positive growth rate for the P/E ratio, the model would assume an infinitely rising P/E ratio, an implausible result. For very long-term time horizons, the theoretically appropriate $\%\Delta P/E = 0$ (and also $\%\Delta S = 0$).

EXAMPLE: Calculating expected equity return using the Grinold-Kroner model

Suppose an analyst uses the Grinold-Kroner model to estimate the stock market return. The analyst estimates a 2.1% dividend yield, real earnings growth of 4.0%, long-term inflation of 3.1%, a 0.5% increase in shares outstanding, and an expansion of the P/E multiple of 0.3%.

What is the implied return on the stock market given these assumptions?

Expected *cash flow* (income) return = dividend yield – increase in shares outstanding

$= 2.1\% - 0.5\% = 1.6\%$

Expected nominal earnings growth = real earnings growth + inflation

$= 4.0\% + 3.1\% = 7.1\%$

Expected repricing return = change in P/E ratio

$= 0.3\%$

The total expected return on the stock market is $1.6\% + 7.1\% + 0.3\% = 9.0\%$.

It is relatively easy to observe the inputs of the model, which can be obtained from published statistical data. It is more challenging to estimate the change in the P/E ratio. The assumption of the P/E ratio (or price relative to other metrics including cash flow or sales) is that it has an observable long-term mean and the ratio will revert to this mean. Empirical evidence suggests that this is true in the long term, but not in the short term.

MODULE QUIZ 11.3

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

1. At the beginning of the fiscal year, Tel-Pal, Inc. stock sells for $75 per share. There are 2 million shares outstanding. An analyst predicts that the annual dividend to be paid in one year will be $3 per share. The expected inflation rate is 3.5%. The firm plans to issue 40,000 new shares over the year. The price-to-earnings ratio is expected to stay the same, and nominal earnings will increase by 6.8%.

   Based upon these figures, **calculate** the expected return on a share of Tel-Pal, Inc. stock in the next year.

2. An analyst uses the Grinold-Kroner model and assumes an infinite time horizon and a P/E growth rate of 2%. **Discuss** one shortcoming of the P/E growth assumption.

MODULE 11.4: THE RISK PREMIUM APPROACH

The equity risk premium is generally defined as the amount by which the equity return exceeds the risk-free rate. An alternative way is to think about the equity premium as the amount by which the equity return exceeds the expected return on a default-free bond. Whereas the approach relative to the risk-free rate looks at a single premium for equity, the approach relative to bonds uses a building block approach.

Video covering this content is available online.

Forecasting the equity premium is generally quite challenging, regardless of the approach selected. An analyst must therefore supplement her forecasts with other methods of analyses.

The Equilibrium Approach

The financial equilibrium approach assumes that financial models will value securities correctly. The **Singer-Terhaar model** is based on two versions of the international *Capital Asset Pricing Model* (CAPM): one in which global asset markets are fully integrated, and another in which markets are fully segmented. The model then looks at the expectations of actual segmentation/integration and takes a weighted average of the two assumptions to calculate returns. The Singer-Terhaar approach begins with the CAPM:

$R_i = R_f + \beta_{i,M} (R_M - R_f)$, or alternatively $RP_i = \beta_{i,M} \times RP_M$

where:

R_i = expected return on asset *i*

R_f = risk-free rate of return

$\beta_{i,M}$ = sensitivity (systematic risk) of asset *i* returns to the global investable market

R_M = expected return on the *global* investable market

RP_i = the asset's risk premium

RP_M = the market's risk premium

Think of the global investable market as consisting of all investable assets, traditional and alternative. We can manipulate this formula to solve for the risk premium on a debt or equity security using the following steps:

Step 1: $\beta_{i,M} = \frac{\text{Cov}(R_i, R_M)}{\text{Var}(R_M)} = \rho_{i,M} \left(\frac{\sigma_i}{\sigma_M} \right)$

where:

$\rho_{i,M}$ = correlation between the returns on asset *i* and the global market portfolio

σ_i = standard deviation of the returns on asset *i*

σ_M = standard deviation of the returns on the global market portfolio

$\text{Cov}(R_i, R_m)$ = covariance of asset *i* return with the global market portfolio return

Step 2: Rearranging the CAPM, we arrive at the expression for the risk premium for asset *i*, RP_i:

$$RP_i = \beta_{i,M} RP_M = \rho_{i,M} \sigma_i \left(\frac{RP_M}{\sigma_M} \right)$$

This expression states that the risk premium for an asset is equal to the product of its correlation with the global market portfolio and the standard deviation of the asset, multiplied by the Sharpe ratio for the global portfolio (in parentheses). From this formula, we forecast the risk premium and expected return for a market.

EXAMPLE: Calculating equity and bond risk premiums

Given the following data, **calculate** the equity and debt risk premiums for Country X:

	Expected Standard Deviation	Correlation With Global Investable Market
Country X bonds	10%	0.40
Country X equities	15%	0.70
Market Sharpe ratio = 0.35		

Solution:

$RP_{bonds} = 10\% \times 0.40 \times 0.35 = 1.40\%$

$RP_{equities} = 15\% \times 0.70 \times 0.35 = 3.68\%$

The Singer-Terhaar model then adjusts the CAPM for market imperfections, such as segmentation. When markets are segmented, capital does not flow freely across borders. The opposite of segmented markets is integrated markets, where capital flows freely. Government restrictions on investing are a frequent cause of market segmentation. If markets are segmented, two assets with the same risk can have different expected returns because capital cannot flow to the higher return asset. The presence of investment barriers increases the risk premium for securities in segmented markets.

In reality, most markets are neither fully segmented nor fully integrated. Investors have a preference for their own country's equity markets, which prevents them from fully exploiting investment opportunities overseas. Developed world equity markets have been estimated as 75% to 90% integrated, whereas emerging market equities have been estimated as 50% to 75% integrated. In the example that follows, we will adjust for partial market segmentation by estimating an equity risk premium assuming full integration and an equity risk premium assuming full segmentation, and then taking a weighted average of the two. Under the full segmentation assumption, the relevant global portfolio is the individual asset as its own market portfolio, meaning that the asset is perfectly correlated with itself ($\beta_{i,M} = \rho_{i,M} = 1$).

Step 3: Calculate the risk premium for asset *i* assuming a fully segmented market:

$$\text{if } \rho_{i,M} = 1 \Rightarrow RP_i = \sigma_i \left(\frac{RP_M}{\sigma_M} \right)$$

Step 4: The last piece is to take a weighted average of the two risk premiums (calculated under full integration and full segmentation) to calculate the asset's risk premium:

$$RP = \Phi RP^G + (1 - \Phi) RP^S$$

where Φ measures the degree of the asset's integration with the global markets, and the superscripts are G (globally integrated) and S (segmented).

EXAMPLE: Calculating the risk premium using the Singer-Terhaar model

Suppose an analyst is valuing two equity markets. Market A is a developed market, and Market B is an emerging market. The investor's time horizon is five years. The other pertinent facts are as follows:

	Market A	Market B
Sharpe ratio	0.29	0.40
Volatility (standard deviation)	17%	28%
Correlation with global market	0.82	0.63
Degree of integration	80%	65%
Illiquidity premium	0%	2.3%
Risk-free rate is 5.0%		
Sharpe ratio of the global market is 0.29		

Calculate the risk premiums and expected returns for each market.

Solution:

First, we calculate the risk premium for both markets assuming full integration. Note that for the emerging market, the illiquidity risk premium is included:

$RP_i = \rho_{i,M}\sigma_i$(market Sharpe ratio)

$RP_A = (0.82)(0.17)(0.29) = 4.04\%$

$RP_B = (0.63)(0.28)(0.29) + 0.0230 = 7.42\%$

Next, we calculate the equity risk premium for both markets assuming full segmentation:

$RP_i = \sigma_i$(market Sharpe ratio)

$RP_A = (0.17)(0.29) = 4.93\%$

$RP_B = (0.28)(0.29) + 0.0230 = 10.42\%$

Note that when we calculate the risk premium under full segmentation, we use the local market as the reference market instead of the global market, so the correlation between the local market and itself is 1.0.

We then take a weighted average of the integrated and segmented risk premiums by the degree of integration and segmentation in each market to arrive at the weighted average risk premium:

RP_i = (degree of integration of *i*)(ERP assuming full integration) + (degree of segmentation of *i*) (ERP assuming full segmentation)

$RP_A = (0.80)(0.0404) + (1 - 0.80)(0.0493) = 4.22\%$

$RP_B = (0.65)(0.0742) + (1 - 0.65)(0.1042) = 8.47\%$

Finally, the expected return in each market also incorporates the risk-free rate:

$$\widehat{R}_A = 5\% + 4.22\% = 9.22\%$$
$$\widehat{R}_B = 5\% + 8.47\% = 13.47\%$$

PROFESSOR'S NOTE

Theoretically, a fully segmented market's Sharpe ratio would be independent of the world market Sharpe ratio. However, the CFA text makes the simplifying assumption to use the world market Sharpe ratio in both the segmented and integrated calculations. This is a reasonable assumption as we are valuing partially integrated/segmented markets. There is no reason to analyze the fully segmented market as outsiders *cannot*, by definition, invest in such markets.

Emerging Market Equity Risk

Emerging markets are often characterized by fragile economies, political and policy instability, and weaker legal protections, including weak property rights, and weak disclosure and enforcement standards. They tend to exhibit idiosyncratic risks where local country effects tend to be more important than global effects. Emerging markets tend to be less fully integrated than developed markets.

MODULE QUIZ 11.4

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

Use the following data to answer the questions below:

Sharpe ratio of the global portfolio	0.29
Standard deviation of the global portfolio	8.0%
Risk-free rate of return	4.5%
Degree of market integration for Market A	80%
Degree of market integration for Market B	65%
Standard deviation of Market A	18%
Standard deviation of Market B	26%
Correlation of Market A with global portfolio	0.87
Correlation of Market B with global portfolio	0.63

1. **Calculate** the risk premiums for Market A and Market B.

2. **Calculate** the expected return for each market.

MODULE 11.5: FORECASTING REAL ESTATE RETURNS

Video covering this content is available online.

LOS 11.e: Explain how economic and competitive factors can affect expectations for real estate investment markets and sector returns.

CFA® Program Curriculum, Volume 2, page 240

Unlike traditional asset classes (think equities, bonds, and cash or cash equivalents), real estate is generally immobile and illiquid, and each property is part of a heterogeneous group with its unique characteristics. Managing real estate also requires maintenance and, therefore, operating costs can be significant. Calculating returns is often done through appraisals, which

are subject to time lags and data smoothing given that they are done infrequently, so appraised values may differ significantly from market values.

Real Estate Cycles

As a general asset class, real estate values are subject to business cycle movements, but they also drive business cycles. Given that supply is fixed at any given point in time, property values exhibit *cyclicality*, and demand will be strongly influenced by the quality and type of property available. High quality properties tend to fluctuate less with business cycles, while low quality properties will show more cyclicality. When looking at real estate and business cycles, we observe the following characteristics:

- *Boom*: Increased demand will drive up property values and lease rates, which induces construction activity. This higher activity translates to stronger economic activity.
- *Bust*: Falling demand leads to overcapacity and overbuilding, driving values and lease rates down. Because leases lock in tenants for longer terms and moving costs are high, excess supply can't be quickly absorbed.

A recent study suggests that the U.S. commercial real estate collapse following the global financial crisis was caused by leverage and speculation rather than business cycle movements.

Capitalization Rates

The **capitalization rate**, or **cap rate** for short, is a commercial real estate property's earnings yields, and is calculated by dividing current **net operating income** (NOI) by the property value. The cap rate is similar to the denominator of the Gordon Growth model, looking at expected return less the NOI growth rate. When an infinite time period is assumed, the cap rate can be calculated as:

$$\text{cap rate} = E(R_{re}) - \text{NOI growth rate}$$

$$E(R_{re}) = \text{Cap rate} + \text{NOI growth rate}$$

During stable periods, the long-run NOI growth rate should be close to GDP growth. If an investor has a finite time period, the formula changes by subtracting from expected return the change in the cap rate:

$$E(R_{re}) = \text{cap rate} + \text{NOI growth rate} - \%\Delta\text{cap rate}$$

As you likely observed, this formula has similarities with the Grinold-Kroner model, noting that NOI growth is also a nominal measure, incorporating real growth plus inflation.

The cap rate is quite sensitive to competitive pressures. With the rapid growth of online retailers, the difference in the cap rates of malls in the United States with high and low productivity grew from 1.2% in 2008 to 3.2% in 2018.

Similar to the expected return net of growth rate for equities, the cap rate is used as a long-term discount rate for real estate property valuations. Cap rates are positively related to changes in interest rates and vacancy rates. They are inversely related to the availability of credit and the availability of debt financing. Credit spreads, which are countercyclical, mitigate the cyclical sensitivity of cap rates.

Risk Premiums on Real Estate

Real estate assets require several risk premiums to compensate for their higher risk. These include a term premium for holding long-term assets, a credit premium to compensate for the risk of tenant nonpayment, and an equity risk premium above corporate bond returns for the fluctuation in real estate values, leases and vacancies. Overall, the combined risk premium is higher than that of corporate bonds but lower than equities.

Liquidity risk is also important for real estate. For publicly traded real estate, including REITs, the liquidity risk is the risk that the asset cannot be sold quickly at a reasonable price. For real estate as an asset group, liquidity risk reflects an inability to sell the asset except at periodic times. The liquidity premium is considered to be between 2% and 4% for commercial real estate.

Once the appropriate risk premiums are calculated, real estate can be used in equilibrium models including Singer-Terhaar. However, analysts must make two adjustments: the impact of smoothing must be removed from the data, and the analyst should adjust for illiquidity by incorporating a liquidity premium. The local, rather than global, nature of real estate should also be considered.

Public vs. Private Real Estate

Wealthy individuals and large institutional investors can create diversified real estate portfolios. Investors with less wealth can choose publicly traded real estate, including REITs, to benefit from diversification. REITs are generally strongly correlated with equities in the short term, while direct real estate shows low correlation. However, the low correlation is partly due to the smoothing of return data. Over long time horizons, REITs have a relatively high correlation with direct real estate.

Given that REITs use significant leverage, their returns and risks must be first unlevered to provide the appropriate comparison with direct real estate holdings. When adjusted for leverage, REITs as an asset class historically show higher returns and lower volatility than direct real estate. This difference may be due to investors capturing much of the liquidity risk premium of direct investments, while also profiting from professional management.

However, there are significant differences between apartment, office, industrial and retail classes. Retail REITs had the highest return and second lowest volatility. Industrial REITs had the lowest return and highest volatility. Within directly owned real estate, apartments had the highest return while office had the lowest.

Residential Real Estate Returns

Residential real estate is the largest class of developed properties, accounting for 75% of global values. Overall, residential real estate outperformed equities on an inflation-adjusted basis with lower volatility. Nevertheless, their return performance differed before and after World War II, with relatively weaker postwar returns. The strongest postwar period returns were during 1950–1980 when residential real estate generally outperformed equities, but had comparably weaker returns during 1980–2015. However, and important for diversification, residential real estate returns were uncorrelated across countries after the war, while equity returns showed rising correlations.

MODULE QUIZ 11.5

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

1. **List** two adjustments that analysts must make to the risk premiums calculated using equilibrium models.

2. **Discuss** how cap rates are related to vacancy rates and the availability of debt financing.

MODULE 11.6: EXCHANGE RATE FORECASTING

Video covering this content is available online.

LOS 11.f: Discuss major approaches to forecasting exchange rates.

CFA® Program Curriculum, Volume 2, page 247

Currency exchange rate forecasting is particularly difficult, causing investment managers to either fully hedge currency exposure, or accept the volatility. Currencies are units of account in which asset prices are quoted. Movements in exchange rates change the value of all assets denominated in one currency relatively to all other currencies. Exchange rates are determined by factors influenced by trading, governments, financial systems and geographies, as well as by laws, regulations, and customs of a country.

Trade in goods and services affects exchange rates through (1) trade flows, (2) purchasing power parity, and (3) competitiveness and sustainability of the current account.

- *Trade flows*: The impact of net trade flows (gross trade flows less exports) tends to be relatively small on exchange rates assuming they can be financed. Large trade flows without large financing flows in foreign exchange markets likely indicates a crisis.
- *Purchasing power parity (PPP)*: PPP implies that the prices of goods and services in different countries should reflect changes in exchange rates. As a result, the expected exchange rate movement should follow the expected inflation rate differentials. Furthermore, the expected change in real exchange rates should be zero, if real exchange rates are the ratio of price levels converted through a common exchange rate. PPP does not work well in explaining short-term exchange rate changes, but works better in the long term and when inflation differences are large and are determined through money supply.

  Actual real exchange rates may differ from those predicted through PPP. For example, there could be trade barriers or certain goods may not be traded. PPP does not account for capital flows, which may exert significant influence on exchange rates. Exchange rates may also be influenced by economic development independent of PPP.
- *Current account and exchange rates*: When restrictions are placed on capital flows, exchange rate sensitivity tends to increase relative to the current account (trade)

balance. Current account balances will have the largest influence on exchange rates when they are persistent and sustained. However, it is not the size of the current account balance that matters as much as the length of the imbalance.

Structural imbalances in the current account can exist from (1) fiscal imbalances that persist over time, (2) demographics and trade preferences that impact savings decisions, (2) how abundant or scare resources are, (4) availability (or lack) of viable investment opportunities, and (5) the terms of trade.

Adjustments to capital flows will place substantial pressure on exchange rates. Three important considerations to look at are the implications on capital mobility, uncovered interest rate parity, and portfolio balances and compositions.

1. *Capital mobility*: The expected percentage change in the exchange rate can be computed as the difference between nominal short-term interest rates and the risk premiums of the domestic portfolio over the foreign portfolio:

   $$E(\%\Delta S_{d/f}) = (r^d - r^f) + (Term^d - Term^f) + (Credit^d - Credit^f) + (Equity^d - Equity^f) + (Liquid^d - Liquid^f)$$

   When there is a relative improvement in investment opportunities in a country, the currency initially tends to see significant appreciation but "overshoot". There are three phases of the response to stronger investment opportunities: (1) the exchange rate will initially significantly appreciate, (2) following an extended level of stronger exchange rates in the intermediate term, investors will start to expect a reversal, and (3) the exchange rate in the long run will tend to start reverting once the investment opportunities have been realized.
2. *Uncovered interest rate parity* (UIP): UIP states that exchange rate changes should equal differences in nominal interest rates. UIP implies that in the previous equation, only the interest rate differential matters and not the premium differentials. In contrast to UIP, *carry trades* involve borrowing in a low-rate currency and lending in a high-rate currency. Carry trades are considered to be successful because they include a risk premium, confirming the validity of the risk premiums in the equation.

   When capital flows into a country given exchange rate differentials, this is referred to as *hot money*. Hot money creates monetary policy issues. First, central banks' ability to use monetary policy effectively is limited. Second, firms use short-term financing to fund long-term investments, which increases financial market risk. Third, exchange rates tend to overshoot, creating business disruption. Central banks may try to counter the effects of hot money flows through intervention in the currency markets, including selling government securities or maintaining interest rate targets.
3. *Portfolio balance and composition*: Strong economic growth in a country tends to correspond to an increasing share of that country's currency in the global market portfolio. Investors need to be induced to increase their allocations to that country and currency, which weakens the currency and increases the risk premiums. However, a few factors could mitigate this impact:
   - Investors tend to have a strong home country bias, which leads them to absorb a larger share of the new assets.
   - If growth is due to productivity gains, investors may fund it with financial flows and foreign direct investment.

- Countries that experience high trend rates tend to be smaller, emerging markets. Increasing the weight in these countries generally does not weaken their currency.

Similarly, large current account deficits also weaken exchange rates, but several mitigating factors exist:

- Current account deficits due to large investment spending are easier to finance if they are expected to be profitable.
- Small current account deficits in global reserve currencies, including the U.S. dollar, help provide global liquidity and are beneficial to the financial system.

MODULE QUIZ 11.6

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

1. Assume that Japanese inflation is projected to be a cumulative 8.2% over the next five years, while U.S. inflation is 13.2% over the same period. U.S. inflation is thus projected to be 5% higher. Stock prices have just started to rise and will continue to do so for some time. **Explain** which asset class should an investor in Japanese assets favor.

MODULE 11.7: VOLATILITY FORECASTING

Video covering this content is available online.

LOS 11.g: Discuss methods of forecasting volatility.

CFA® Program Curriculum, Volume 2, page 255

Estimating the variance for a single asset is relatively easy. Estimating variances for many assets is more complex, and requires the use of a **variance-covariance (VCV) matrix** or other forecasting tools.

The VCV Matrix

Sample VCV Matrix

Estimating a constant VCV matrix can most easily be done from deriving variances and covariances from sample statistics. However, choosing the appropriate sample size for large portfolios will be critical. If the sample size is small relative to the number of assets (i.e., the number of assets cannot exceed the number of historical observations), the outcomes may be meaningless; for example, it may show that a large portfolio is riskless. It is recommended that the number of observations should be at least 10 times larger than the number of portfolio assets.

PROFESSOR'S NOTE

There are a large number of formulas in this section. They are included primarily to explain the underlying concepts, but it is unlikely that you would be required to do these calculations on the exam. The LOS only asks you to *discuss* methods of volatility forecasts.

Factor-Based VCV Matrices

The main advantage of using multifactor models for VCV matrices is that it significantly reduces the number of required observations. Correlations can be estimated from a few common factors, while variances require factors related to specific assets.

The return of the *i*th asset in a multifactor model can be calculated as:

$$r_i = \alpha_i + \sum_{k=1}^{K} \beta_{ik} F_k + \varepsilon_i$$

where *K* represents the number of common factors, α_i is the intercept, β_{ik} is the *i*th asset's sensitivity to the k_{th} factor, F_k is the *k*th factor return, and ε_i is a factor term unique to asset *i* with a zero mean.

The variance of the *i*th asset can be derived as:

$$\sigma_i^2 = \sum_{m=1}^{K} \sum_{n=1}^{K} \beta_{im} \beta_{in} \rho_{mn} + v_i^2$$

where ρ_{mn} is the covariance between the *m*th and *n*th factors, and v_i^2 is the variance of the ε_i unique factor.

The last step is to look at the covariance between the *i*th and *j*th asset:

$$\sigma_{ij} = \sum_{m=1}^{K} \sum_{n=1}^{K} \beta_{im} \beta_{jn} \rho_{mn}$$

Assuming these factors are not redundant and do not have zero terms will help us ensure that the matrix outcomes are not meaningless and that portfolios do not incorrectly appear riskless.

The factor model also helps simplify the number of calculations used in the VCV matrix. For example, whereas the VCV matrix would need (*N(N – 1) / 2*) covariances, the factor model would need only (*N* × *K*) factor sensitivities and (*K(K + 1) / 2*) factor elements. For *N* = 50 and *K* = 6, the VCV matrix would need (50(49) / 2) = 1,225 sensitivities, whereas the factor model would need only (50 × 6) = 300 sensitivities and (6 × 7 / 2) = 21 elements.

Despite their significant advantages, factor-based VCV matrices have several shortcomings:

1. The matrix is *biased*: Matrix inputs need to be estimated and will be misspecified. As a result, the matrix will be biased, meaning it will not be a predictor of the true returns, not even on average.
2. The matrix is *inconsistent*: As the sample size increases in the factor-based VCV matrix, the model does not converge to the true matrix. In contrast, the sample VCV matrix will be both consistent and unbiased.

Shrinkage Estimates

Combining information in the sample VCV matrix with a target matrix (e.g., the factor-based VCV matrix) will result in more precise data and reduced estimation error. The shrinkage estimate is a weighted average estimate of the sample and target (e.g., factor-based) matrix,

with the same weights used for all elements of the matrix, including the variance and covariance factors. The resulting figures will be more efficient because they will have smaller error terms. Even though shrinkage estimates may be biased, more precise (less biased) target matrices will result in greater improvement.

For example, suppose that the sample covariance between two assets is 180 and the target (from a factor-based model) estimated covariance is 220. If the analyst weights the historical covariance by 60% and the target by 40%, the shrinkage estimate would be 196 (= 180 × 0.60 + 220 × 0.40). If conditions of the model and weights are well chosen, the shrinkage estimate covariances are likely to be more accurate.

Smoothed Returns to Estimate Volatility

Smoothing of data leads to underestimating risk and overstating returns and diversification benefits. Not adjusting for smoothing tends to lead to distorted portfolio analysis and suboptimal asset allocation decisions. As a result, it is important that analysts adjust the data for the impact of smoothing, by taking a weighted average of the current "true" returns and previously observed returns:

$R_t = (1-\lambda)r_1 + \lambda R_{t-1}$ where λ is a weight between 0 and 1

The portfolio variance is then calculated as:

$$\text{var}(r) = \left(\frac{1+\lambda}{1-\lambda}\right)\text{var}(R) > \text{var}(R)$$

One shortcoming of this model is that the true current return is not directly observable. Proxies for estimating the true return include using an asset index.

ARCH Models

PROFESSOR'S NOTE

You previously encountered the concept of ARCH in Level II. Use that knowledge to your advantage.

Asset returns generally show periods of high and low volatilities, leading to **volatility clustering**. These volatilities can be addressed through autoregressive conditional heteroskedasticity (ARCH) models. ARCH models can be used for portfolios with multiple assets in VCV matrix estimations. The simplest ARCH formula can be written as:

$$\sigma_t^2 = \gamma + \alpha\sigma_{t-1}^2 + \beta\eta_t^2 = \gamma + (\alpha+\beta)\sigma_{t-1}^2 + \beta\left(\eta_t^2 - \sigma_{t-1}^2\right)$$

where α, β, and γ are nonnegative parameters and (α + β) < 1, and η_t is a random variable indicating the unexpected return component.

Higher α + β terms indicate higher emphasis on past information, leading to volatility clustering.

MODULE QUIZ 11.7

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

1. A portfolio manager determines that in order to estimate the variance-covariance matrix used in the portfolio's asset allocation, the matrix will need 17 asset classes. The manager has obtained weekly sample return data over the last 6 months. The manager decided to

also use the factor-based matrix approach, but does not use shrinkage estimation.
Determine the strengths and shortcomings of the manager's approach.

2. **Discuss** one potential remedy to the manager's shortcomings.

MODULE 11.8: GLOBAL PORTFOLIO ADJUSTMENTS

Video covering this content is available online.

LOS 11.h: Recommend and justify changes in the component weights of a global investment portfolio based on trends and expected changes in macroeconomic factors.

CFA® Program Curriculum, Volume 2, page 260

> **For the Exam:** This LOS asks you to use much of what you have learned here and apply it to portfolio management. Given that the emphasis of the Level III exam is portfolio management, you need to be able to pull all this material together.

In this section, we apply what we have learned so far to adjust portfolio allocations. The main focus here is *how* to adjust a portfolio rather than get caught up in the particular forecast details. For example, if the starting point is a typical portfolio of equities and bonds, we may want to consider changing the weighting between equities and bonds, changing the weights between domestic and international investments, or adjusting the credit quality, duration, yield curve positioning or currency exposures of the underlying assets. To aid this decision-making process, it is helpful to keep in mind the following questions:

- Have the drivers of trend growth changed significantly?
- Are markets becoming more or less integrated?
- Where is the country positioned within the business cycle, and are fiscal and monetary policies consistent with the business cycle phase?
- What is the trend in current account balances?
- Are currencies strong or weak, and how are currencies affecting economic growth and competitiveness?

Trend growth is generally favorable to equities because it implies long-term earnings growth. Trend growth is unfavorable to bonds because it typically results in higher interest rates. The

analyst can use country-specific and global expectations through VCV matrices to adjust the allocations between equities and bonds.

As markets become more integrated globally, required returns will fall. We saw this relationship in the Singer-Terhaar model. The analyst should increase allocations towards emerging markets that are expected to see increased integration, and away from those markets that are already highly integrated.

When the economy is at the *trough* of the business cycle, equities perform well, and valuation ratios and earnings growth are expected to increase. The analyst could also use the Grinold-Kroner model to compute the required equity risk premium and increase the portfolio's equity weights. At this stage, the yield curve is steep with high credit and term premiums. However, the expectation of rising interest rates means that bonds tend to underperform, and the analyst should reduce the portfolio's bond allocation. The overall bond duration should also be reduced, and a barbell strategy may be optimal (increased short-term and long-term exposure and reduced medium-term exposure). If the economy is at its peak, the reverse strategy should be followed (i.e., reduce the equity exposure and increase bond exposure and durations).

Monetary and fiscal policy changes can also be important considerations. The analyst should focus less on monetary and fiscal policy activities, which are expected to be already reflected in asset values, but rather on structural changes in policy direction. For example, changes in the tax code or changes from standard interest rate targeting to other policies, including quantitative easing, can influence the direction of portfolio reallocation changes.

Current account balances fluctuate with business cycles. It is the long-term trend in current account balances that is more important in setting portfolio expectations. Rising current account balances tend to be associated with rising required returns (and therefore falling asset prices), and increased capital flows to the deficit country to fund its deficit. Capital flows also influence currencies. If assets in a particular currency offer higher risk-adjusted return potential than in other currencies, capital will flow to that country and put upward pressure on its currency. The analyst will need to determine whether the currency still has potential to appreciate, or whether it is at its peak.

MODULE QUIZ 11.8

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

A portfolio manager has a global portfolio invested in several countries and is considering other countries as well. The decisions the manager faces and the economic conditions in the countries are described in the following. In each case, the portfolio manager must reallocate assets based on economic conditions.

The portfolio manager has noticed that the yield curve is downward sloping in this country. The current portfolio in this country is 60% stocks and 40% bonds.

1. **Determine** the appropriate reallocation within Country A. **Suggest** changes to the portfolio based on this information.

2. Country B has experienced declining prices and this trend is expected to continue. The manager has no funds invested in this country yet but is considering investments in bonds, equity, and real estate.

   Determine the appropriate reallocation within Country B. In which assets should the manager invest?

3. The manager is considering the purchase of government bonds in either emerging Country C or Country D. The countries have the following characteristics:

   Characteristics of Countries C and D

	Country C	Country D
Foreign exchange/short-term debt	147%	78%
Debt to GDP	42%	84%

   Determine the appropriate reallocations within emerging Country C and Country D.

KEY CONCEPTS

LOS 11.a

The three approaches to forecast fixed income returns are the DCF method, the risk premium approach, and the equilibrium model.

The DCF method is used to estimate the required return of an asset. It is the most precise method for fixed income securities. It includes analysis of the YTM and the Macaulay duration. The Macaulay duration will determine whether an expected yield change will generate positive or negative returns (by looking at its impact on prices vs. return from reinvestment of cash flow).

The risk premium (or building block) approach starts with the risk-free rate and adds on different risk premiums, including the term premium, credit premium, and liquidity premium.

The short-term risk-free rate can be estimated from government zero-coupon yields. The term premium is positively related to duration and the slope of the yield curve, and is influenced by inflation uncertainty, recession hedges, supply and demand of bonds, and business cycle movements.

Credit premiums compensate for the expected level of losses and for the risk of default losses, and are also positively related to the slope of the yield curve.

Steep yield curves generally indicate both high credit and term premiums, both of which are considered bullish indicators.

Liquidity tends to be highest for bonds that are (1) issued at close to par or market rates, (2) new, (3) large in size, (4) issued by a frequent and well-known issuer, (5) simple in structure, and (6) of high credit quality. Liquidity premiums can be established by comparing the yield spread between the highest quality issuer (usually the sovereign) and the next highest quality issuer.

LOS 11.b

Investors in emerging market debt face higher risks associated with the foreign government's ability and willingness to repay its obligations, and are exposed to other political, legal, and economic risks.

Indicators of heightened credit risk in emerging market bonds include (1) deficit-to-GDP ratio greater than 4%; (2) debt-to-GDP ratio greater than 70%–80%; (3) real growth rate less than 4%; (4) a current account deficit exceeding 4% of GDP; (5) foreign debt levels greater than 50% of GDP or debt levels greater than 200% of the current account receipts; and (6) foreign exchange reserves less than 100% of short-term debt.

LOS 11.c

Equity market returns can be estimated using the DCF analysis, a risk premium approach, and the equilibrium approach.

The DCF analysis can also be used for equity valuation and establish the intrinsic value of an asset as the present value of its future cash flows.

The Grinold-Kroner model calculates the expected equity return as its dividend yield plus the inflation rate plus the real earnings growth rate minus the change in stock outstanding plus changes in the P/E ratio.

The Grinold-Kroner model can also be viewed as the (1) expected cash flow return (dividend yield minus change in shares outstanding), (2) nominal earnings growth (real earnings growth plus inflation), and (3) expected repricing return (change in the P/E ratio).

The risk premium approach looks at the equity risk premium as the amount by which the equity return exceeds the expected return of a default-free bond. However, forecasting the equity premium can be challenging.

The Singer-Terhaar model combines two versions of the international CAPM: one in which global asset markets are fully integrated and another in which markets are fully segmented.

The Singer-Terhaar model calculates the risk premium for an asset in a fully integrated market as the product of its correlation with the global market portfolio and the standard deviation of the asset, multiplied by the Sharpe ratio of the global portfolio. The model calculates the risk premium for an asset in a fully segmented market as the product of the standard deviation of the asset and the Sharpe ratio of the global portfolio.

The Singer-Terhaar model then calculate the asset's overall risk premium as the weighted average of the risk premiums calculated under full integration and full segmentation.

LOS 11.d

Emerging equity markets tend to be characterized by political and policy instability, weaker legal protections, and weak disclosure and enforcement standards. Emerging markets tend to be more segmented than developed markets.

LOS 11.e

Real estate values are subject to business cycle movements, including boom (higher demand drives up property values) and bust (falling demand drives values and lease rates down).

Real estate valuation is measured by the cap rate, which is calculated by dividing current NOI by the value of a commercial real estate property.

Real estate returns assets include a term premium for holding long-term assets, a credit premium to compensate for the risk of tenant nonpayment, and an equity risk premium above corporate bond returns for the fluctuation in real estate values, leases, and vacancies.

REITs are generally strongly correlated with equities in the short term, while direct real estate shows low correlation, although the low correlation is partly due to the smoothing of return data.

Over the very long run, residential real estate outperformed equities on a real basis with lower volatility, although their return has been relatively weak over the last 40 years.

LOS 11.f

Trade in goods and services affects exchange rates through trade flows, purchasing power parity (PPP), and competitiveness and sustainability of the current account.

Net trade flows have small impacts on exchange rates; large trade flows without large financing flows in foreign exchange markets likely indicate a crisis. PPP does not work well in explaining short-term exchange rate changes but works better in the long term and when

inflation differences are large and are determined through changes in the money supply. Current account balances will have the largest influence on exchange rate when they are persistent and sustained.

Adjustments to capital flows place substantial pressure on exchange rates. Three important considerations include the implications on capital mobility, UIP, and portfolio balances and compositions.

Under ideal capital mobility conditions, the expected percentage exchange rate change will equal the “excess” risk-adjusted expected portfolio return denominated in the domestic currency relative to the foreign currency. However, the exchange rate may overshoot in the short run, which results from hot money chasing higher returns.

Carry trades tend to be profitable, but this contradicts the assumptions of UIP, which states that exchange rate changes should equal differences in nominal interest rates.

Looking at the portfolio balance and composition, exchange rates tend to adjust given changes in the relative sizes and compositions of the aggregate portfolios denominated in each currency.

LOS 11.g

A sample variance-covariance matrix is a popular tool to estimate the true VCV structure. Problems with the sample VCV matrix is that it cannot be used for large numbers of asset classes and it is subject to sampling error.

Factor-based (multifactor) models allow the VCV matrix to handle large numbers of asset classes. However, the factor-based VCV matrix is biased and inconsistent.

The shrinkage estimate is a weighted average estimate of the sample and target (e.g., factor-based) matrix, with the same weights used for all elements of the matrix.

Smoothing of data leads to underestimating risk and overstating returns and diversification benefits. Not adjusting for smoothing tends to lead to distorted portfolio analysis and suboptimal asset allocation decisions.

ARCH models can be used for portfolios with multiple assets to address volatility clustering of financial asset returns.

LOS 11.h

Be able to discuss how the relationships covered in the previous LOS can be used in assessing the relative attractiveness of asset classes (i.e., estimating expected return and risk through the VCV matrices, using the Singer-Terhaar model or the Grinold-Kroner model, phases of the business cycle, capital flows, and expectations of currency movements).

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 11.1

1. The investor will realize a gain. The portfolio's Macaulay duration is 5.2 (= 5 × 1.04). Given that the investor's investment horizon of six years is longer than the Macaulay duration, a rise in bond yields will result in a return that is higher than the YTM because the increase in reinvestment yield will outweigh the fall in the bond price. (LOS 11.a)

2. **B** The expected annual return of the one-year government bond is 2.5% (no risk premiums). The expected one-year return of the corporate bond is 3.65% (= 2.5% + 0.6% + 0.3% + 0.25%). The estimated weighted average return of an equal-weighted investment in the two securities is 3.08% (= (2.5% + 3.65%) / 2). (LOS 11.a)

3. **A** The average spread (vs. one-year government bond) is 0.58% (= [0 + (0.6 + 0.3 + 0.25)] / 2). (LOS 11.a)

Module Quiz 11.2

1. When exports are less than imports, a current account deficit usually results. This can be problematic because the deficit must be financed through external borrowing. If the emerging country becomes overleveraged, it may not be able to pay back its foreign debt. A financial crisis may ensue where foreign investors quickly withdraw their capital. These financial crises are accompanied by currency devaluations and declines in emerging market asset values. (LOS 11.b)

Module Quiz 11.3

1. The equation for expected return on Tel-Pal, Inc. using these inputs is:

   $E(Re) \approx D/P + (\%\Delta E - \%\Delta S) + \%\Delta P/E)$

   $$\widehat{R}_T = \left(\frac{\$3}{\$75} \times 100\right) + 6.8\% - 2\% + 0 = 8.8\%$$

   The expected return is 8.8%. The expected dividend yield is 4%, and the expected percentage increase in the number of shares is 2% (= 40,000 / 2,000,000). Nominal earnings of 6.8% includes expected inflation of 3.5%, which would be subtracted from the nominal earnings forecast to get the forecast of real earnings growth of 3.3%. The change in P/E is expected to stay the same for a value of 0. (LOS 11.c)

2. An infinite time horizon ignores the fact that the P/E ratio would likely revert to its long-term average. A 2% constant growth rate of the P/E ratio would result in an infinitely rising P/E ratio, which is considered an implausible outcome. (LOS 11.c)

Module Quiz 11.4

1. First, we calculate the risk premium assuming full integration.

   $RP_i = \rho_{i,M}\sigma_i$(market Sharpe ratio)

   $RP_A = (0.87 \times 0.18 \times 0.29) = 4.54\%$

$RP_B = (0.63 \times 0.26 \times 0.29) = 4.75\%$

Then, we calculate the risk premium assuming full segmentation.

$$RP_i = \sigma_i \left(\frac{RP_M}{\sigma_M} \right)$$

$RP_A = (0.18 \times 0.29) = 5.22\%$

$RP_B = (0.26 \times 0.29) = 7.54\%$

Finally, weight the integrated and segmented risk premiums by the degree of integration and segmentation:

$RP_A = (0.80 \times 0.0454) + [(1 - 0.80) \times 0.0522] = 4.68\%$

$RP_B = (0.65 \times 0.0475) + [(1 - 0.65) \times 0.0754] = 5.73\%$

(LOS 11.c)

2. The expected return in each market is then:

$R_A = 4.68\% + 4.50\% = 9.18\%$

$R_B = 5.73\% + 4.50\% = 10.23\%$

(LOS 11.c)

Module Quiz 11.5

1. Once an analyst estimates the risk premiums using equilibrium models, the analyst should (1) remove the impact of smoothing from the data, and (2) adjust for illiquidity using a liquidity premium. (LOS 11.e)
2. Cap rates are positively related to changes in interest rates and vacancy rates. They are inversely related to the availability of credit and the availability of debt financing. (LOS 11.e)

Module Quiz 11.6

1. The PPP relationship states that countries with high inflation will see their currency depreciate, so the manager should invest in Japan. Within Japan, the investor should invest in stocks because stock prices have just started to rise and will continue to do so for some time. Bond yields will soon rise and their prices will fall as the economy expands. (LOS 11.f)

Module Quiz 11.7

1. The manager can use the sample VCV matrix because the sample size (26 weeks) exceeds the number of assets (17). However, this will be subject to large sample errors unless the number of observations is at least 10 times the number of assets. This condition is not satisfied. The factor matrix approach in this regard is superior because it can be used for any number of assets. However, the factor model is biased and inconsistent. (LOS 11.g)
2. The manager could have avoided these issues by using shrinkage estimation of the weighted averages of the sample and factor-based VCV matrices. (LOS 11.g)

Module Quiz 11.8

1. The downward sloping yield curve indicates that the economy is likely to contract in the future. In recessions, bonds outperform stocks because inflation and interest rates decrease and economic growth is slow. Assuming the accuracy of the yield curve forecast and that interest rates will fall further, the portfolio manager should consider reallocating from stocks into bonds. (LOS 11.h)
2. The manager should invest in bonds. In periods of declining prices or deflation, bonds perform well because there is no inflation and interest rates are declining. Stocks usually perform poorly during deflationary periods because economic growth is slowing. Real estate also performs poorly during deflationary times, particularly when the investment is financed with debt. (LOS 11.h)
3. The manager should purchase the bonds of Country C. Many emerging market bonds are denominated in a hard currency, so less risky countries have greater foreign currency reserves. Low levels of leverage are also preferred. One measure of leverage is the debt-to-GDP ratio. (LOS 11.h)

TOPIC ASSESSMENT: CAPITAL MARKET EXPECTATIONS

Use the following information for Questions 1 through 6.

Economist James Jones prepares economic forecasts for Global Bancorp, a large U.S.-based investment bank. Recent market volatility and political changes have many investors worried about the future. Jones is preparing market forecasts and as a first step plans to look at several approaches to the task.

He begins by looking at the shape of the yield curve, which is flat. He also considers the Taylor rule, which he has found useful for predicting changes in central bank policy. He gathers the following economic data, which includes his predictions for inflation and economic growth:

Current short-term nominal rate target:	4.15%
Policy neutral real rate:	1.57%
Target inflation rate:	2.00%
Expected inflation rate:	0.60%
Expected GDP growth, current year:	3.84%
Target GDP growth rate:	3.27%

Jones next considers the business cycle. He forecast declining consumer confidence and corporate profits, concluding that we are in the slowdown phase.

Finally, he turns to an analysis of Venvakia, an emerging market that several of Bankcorp's managers are interested in adding to their global portfolio. In his research, Jones learns:

- Venvakia's real earnings growth is 3.2% with a long-term inflation rate of 1.8%. Its stock market is estimated to have a 2.5% dividend yield, a 1.0% increase in shares outstanding, and an expansion of the P/E multiple of 0.5%.
- The global portfolio has a Sharpe ratio of 0.25 and a standard deviation of 8.0%. Venvakia's stock market has a standard deviation of 15%, a correlation with the global portfolio of 0.65, and a degree of market integration of 75%.

Jones is not yet ready to form any final conclusions. He first wants to assess each of these approaches independent of the others.

1. Based on the flat shape of the yield curve, what is the *most likely* current blend of fiscal and monetary policy?

	Monetary policy	Fiscal policy
A.	Restrictive	Expansive
B.	Expansive	Restrictive
C.	Expansive	Expansive

2. Based on the Taylor rule and the data collected by Jones (including his inflation and growth forecasts), he will *most likely* predict the next central bank action is to:
   A. decrease interest rates.
   B. increase interest rates.
   C. make no change.

3. Based on Jones's assessment of the business cycle, he will *most likely* predict:
    A. cash will outperform bonds.
    B. bonds will outperform stocks.
    C. stocks will outperform cash.

4. Again, based only on Jones's assessment of the business cycle, he will *most likely*:
    A. increase duration.
    B. decrease duration.
    C. overweight cyclical stocks.

5. Based on the Grinold-Kroner model and Jones's forecasts, Venvakia's implied return on its stock market is *closest* to:
    A. 5%.
    B. 7%.
    C. 9%.

6. Based on all of Jones's information about Venvakia, he would conclude its stock market has a risk premium *closest* to:
    A. 2.75%.
    B. 3.50%.
    C. 6.00%.

TOPIC ASSESSMENT ANSWERS: CAPITAL MARKET EXPECTATIONS

1. **A** The flat yield curve is generally associated with a mix of expansive and contractionary policies, specifically expansive fiscal and restrictive monetary policy. (Study Session 4, Module 10.4, LOS 10.i)

2. **A** Using Jones's forecasts and other data, he would calculate the target rate as:

   neutral real rate + target inflation + 0.5 × (expected GDP – GDP trend) + 0.5 × (expected inflation – target inflation)

   1.57% + 2.0% + 0.5 × (3.84% – 3.27%) + 0.5 × (0.6% – 2.0%) = 3.15%

   The current central bank target is higher at 4.15%, so the most likely change is to lower interest rates. (Study Session 4, Module 10.4, LOS 10.h)

3. **B** In the slowdown, short- and long-term rates have likely peaked and at some point should start to decline. Declines in long-term rates will lead to increasing bond prices and good performance. The stock market is likely to continue to decline as economic recovery is still well in the future. The clearest conclusion would be bonds outperform stocks. If bond prices start increasing, bonds are likely to outperform cash. Stocks are simply the worst choice at this stage. (Study Session 4, Module 10.3, LOS 10.f, 10.g)

4. **A** Based on the discussion in question 3 and the expectation that long-term interest rates can start to decline, Jones will want to increase duration to magnify the increases in bond price. Cyclical stocks are likely to do even worse than the general stock market. (Study Session 4, Module 10.3, LOS 10.f, 10.g)

5. **B** The Grinold-Kroner model states that the expected return of a stock (or stock market) is its real earnings growth rate, plus the inflation rate, plus the dividend yield, minus the change in stock outstanding, plus changes in the P/E ratio:

   3.2% + 1.8% + 2.5% – 1.0% + 0.5% = 7.0%

   (Study Session 4, Module 11.3, LOS 11.c)

6. **A** First, we calculate the risk premium assuming full integration:

   $RP_I = (0.65 \times 0.15 \times 0.25) = 2.44\%$

   Then, we calculate the risk premium assuming full segmentation:

   $RP_S = (0.15 \times 0.25) = 3.75\%$

   Weighting the integrated and segmented risk premiums by the degree of integration and segmentation, yields a risk premium equal to:

   $RP = (0.75 \times 0.0244) + [(1 – 0.75) \times 0.0375] = 0.0183 + 0.00938 = 2.77\%$

   (Study Session 4, Module 11.4, LOS 11.c)

The following is a review of the Asset Allocation and Related Decisions in Portfolio Management principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #12.

READING 12: OVERVIEW OF ASSET ALLOCATION

Study Session 5

EXAM FOCUS

Strategic asset allocation is often considered the most important decision in the portfolio management process. This reading provides a big picture overview of asset allocation and its relationship to the investor's objectives and constraints. It discusses issues related to an investor's overall financial situation and use of an economic balance sheet. It also provides an overview of three major asset allocation approaches (asset-only, liability-relative, and goals-based), passive versus active approaches to implementing the asset allocation, and key issues to consider when rebalancing the asset allocation.

MODULE 12.1: INVESTMENT GOVERNANCE

Video covering this content is available online.

LOS 12.a: Describe elements of effective investment governance and investment governance considerations in asset allocation.

CFA® Program Curriculum, Volume 3, page 8

Investment governance ensures that appropriate individuals or groups make informed investment decisions and conduct oversight activities on behalf of investors. The objective of effective governance is to match the investor's objectives with their constraints while ensuring that investment decisions comply with relevant laws and regulations. Investment governance also seeks to improve investment performance by aligning asset allocation with implementation.

Effective investment governance models:

1. Establish long-term and short-term investment objectives.
2. Allocate rights and responsibilities within the governance structure.
3. Specify processes for creating an investment policy statement (IPS).
4. Specify processes for creating a strategic asset allocation.
5. Apply a reporting framework to monitor the investment program's stated goals and objectives.
6. Periodically perform a governance audit.

Investment Objectives

Long-term and short-term objectives articulate what the investor would like to achieve. Some examples of investment objectives are as follows:

- The objective for a pension fund is for plan assets to meet current and ongoing plan liabilities.
- The objective for an endowment is to achieve a rate of return that exceeds the return required to fund current and ongoing distributions.
- The objective for an individual investor is to have sufficient assets for retirement while adhering to constraints and risk preferences.

At the core of the investment objective statement is the return requirement. Additional information that provides context to this required return includes the investor's willingness and ability to tolerate risk, the obligations that require funding, and how cash flows transfer into and out of the fund. The overall goal of the investment objective is to discover the optimal risk/return combination that accounts for the investor's constraints and risk tolerance.

Effective investment governance should also evaluate the liquidity aspects of investments. An allocation that has a relatively high number of illiquid assets will make it difficult to fund obligations during periods of market stress. In addition to liquidity risk, risks to consider include volatility risk and the risk of selling at the worst possible time. Investors should understand that asset allocations that provide high expected returns with high risk will lead to greater price swings. Overall, investors making asset allocation decisions must consider how risk sensitivities influence their required return.

Rights and Responsibilities

Investment governance assists with allocating the rights and responsibilities of the investment program. This allocation will vary depending on the investment program size; the availability of internal staff members; and the knowledge, skills, and abilities of internal staff. Effective governance aims to delegate investment decision-making to the best-qualified individuals. These individuals should have the knowledge and experience to make informed investment decisions. They should also have the capacity to manage the investment program responsibilities and be able to execute the investment program in a timely fashion.

Resource availability will impact the allocation of rights and responsibilities as well as investment program complexity. For example, smaller investment programs will likely have less complex investment options due to smaller asset sizes and fewer internal staff for managing those assets. On the other hand, large investment programs may pursue more complex strategies as long as a robust internal control process exists and the internal staff has appropriate knowledge and experience. However, large investment programs may run into governance issues due to capacity constraints where too many managers are involved in the investment decision-making process.

Investment Policy Statement

An effective investment program begins with a well-developed investment policy statement (IPS). The IPS serves as a roadmap for portfolio management and provides confidence to stakeholders that the investment program will be managed with due diligence and care.

Strategic Asset Allocation

The investment committee, which is the highest level of the governance structure, will typically approve the strategic asset allocation decision. A proposed asset allocation will be developed after (1) the IPS is constructed, (2) investment results are simulated over the

appropriate time horizon(s), and (3) the risk and return attributes of all possible asset allocation strategies are considered. In addition to approving the asset allocation, good governance should also specify rebalancing decisions and responsibilities.

Reporting Framework

A reporting framework allows stakeholders to evaluate performance, investment guideline compliance, and the investment program's progress toward achieving its stated goals and objectives. The framework should outline the current status of the program, where it is in relation to its goals and objectives, and how management decisions have added or subtracted value. Proper benchmarking is important for evaluating the performance of investment managers and staff. Also, management reporting is needed for determining which sections of the portfolio are ahead or behind schedule. In addition, governance reporting should be conducted regularly to address investment program strengths and weaknesses.

Governance Audit

An independent third party should audit the effectiveness of the governance structure, policies, and procedures. The auditor examines governing documents, determines the organization's capacity to effectively execute decisions based on those documents, and reviews portfolio efficiency given any governance constraints. Effective investment governance aims to minimize *decision-reversal risk*, which is the risk of reversing investment decisions at the worst possible time (i.e., creating the maximum loss). This action helps the investment program survive unexpected periods of market stress. Effective investment governance also aims to provide durability by evaluating the turnover of the investment program staff and the investment committee as well as any overreliance on one staff member. New investment committee and staff members should be properly trained on investment documentation, policies, procedures, and decision-making skills to ensure the continued success of the investment program.

MODULE 12.2: ECONOMIC BALANCE SHEET

Video covering this content is available online.

LOS 12.b: Prepare an economic balance sheet for a client and interpret its implications for asset allocation.

CFA® Program Curriculum, Volume 3, page 15

The traditional accounting balance sheet encompasses an organization's assets, liabilities, and owner's equity. It is used by accountants to illustrate the financial position of an organization. In contrast, an **economic balance sheet** contains an organization's financial assets and liabilities, as well as any nonfinancial assets and liabilities that are applicable to the asset allocation decision. These nonfinancial assets and liabilities are referred to as **extended portfolio assets and liabilities** because they are not included on traditional balance sheets.

Investors making appropriate asset allocation decisions should recognize assets and liabilities in both the financial portfolio and the extended portfolio. Extended portfolio assets may include the present value of expected earnings (i.e., human capital) and the present value of pension income (for individual investors) as well as the present value of expected intellectual property royalties and underground mineral resources (for institutional investors). Extended portfolio liabilities may include the present value of expected consumption (for individual

investors) and the present value of expected foundation payouts (for institutional investors). An example of an economic balance sheet for an institutional investor can be seen in Figure 12.1.

Figure 12.1: Economic Balance Sheet

Assets		Liabilities and Net Worth	
Financial Assets		*Financial Liabilities*	
Domestic equity	400	Short-term borrowing	100
Real estate	250	Mortgage obligations	200
Extended Assets		*Extended Liabilities*	
PV of expected royalties	150	PV of expected payouts	300
		Economic Net Worth	
		Economic assets − Economic liabilities	200
Total	800	**Total**	800

A practical application of an investment that includes human capital is a life-cycle balanced fund (i.e., target retirement fund). These funds consider the changing levels of human capital and financial capital for an individual investor over time. When an individual enters the workforce, human capital will be much greater than financial capital. However, as the individual ages, financial capital will begin to outweigh human capital because the present value of expected future earnings will gradually decline. At retirement, an individual's total wealth will be made up of financial capital.

Life-cycle balanced funds adjust asset allocations for individual investors over time by taking into account both financial assets and extended portfolio assets. For example, at age 25, a target-date fund may be invested in 85% equity and 15% bonds. This considers the fact that human capital has significant bond-like characteristics. As the investor ages, the equity/bond mix will increase its allocation to bonds as human capital decreases. At retirement (e.g., age 65), the target-date fund may be invested in an asset mix that is closer to 50% equity and 50% bonds.

MODULE 12.3: APPROACHES TO ASSET ALLOCATION

Video covering this content is available online.

LOS 12.c: Compare the investment objectives of asset-only, liability-relative, and goals-based asset allocation approaches.

CFA® Program Curriculum, Volume 3, page 18

There are three types of asset allocation approaches: (1) asset-only, (2) liability-relative, and (3) goals-based. In this section, we will discuss the investment objectives of each approach. These asset allocation approaches attempt to match investors' goals with their optimal level of risk.

Asset-only approaches make asset allocation decisions based solely on the investor's assets. An example of an asset-only approach is *mean-variance optimization* (MVO), which incorporates the expected returns, volatility, and correlations of asset classes. The investment objective for this approach is to maximize the expected return per unit of risk (e.g., maximize

the Sharpe ratio). The chosen investments should consider investor constraints (stated in the IPS) as well as investor risk tolerance.

Liability-relative approaches involve asset allocation decisions based on funding liabilities, with the objective of paying liabilities when they come due. An example of a liability-relative approach is *surplus optimization*, which is based on principles from mean-variance asset allocation. The surplus is computed as the investor assets value minus the present value of investor liabilities. Modeling liabilities may be achieved by shorting an amount of bonds that matches the duration and present value of liabilities. Liabilities may also be modeled by creating a portfolio designed to hedge the liabilities. Asset allocation focused on funding liabilities is also known as *liability-driven investing* (LDI).

Goals-based approaches are geared toward asset allocations for subportfolios, which help individuals or families achieve lifestyle and aspirational financial objectives. For example, goals could involve maintaining a current lifestyle or donating money to a university at some point in the future. In order to achieve the stated goals, it is necessary to specify the type of cash flows needed (e.g., even, uneven, or bullet payment), the time horizon(s), and the level of risk tolerance in terms of the probability of attaining a certain goal. Each sub-portfolio will have a unique asset allocation designed to meet the stated goals. Summing these asset allocations will produce the investor's overall portfolio strategic asset allocation. Asset allocation focused on investor's goals is also known as *goals-based investing* (GBI).

Both liability-relative and goals-based asset allocation approaches are based on meeting liabilities. The main difference is that liability-relative approaches focus on the liabilities of institutional investors while goals-based approaches focus on the liabilities of individual investors. Institutional investors have legal obligations or debts, whereas individual investors wish to meet specific lifestyle goals. This suggests that penalties for not meeting liabilities are much higher for liability-relative approaches. In addition, the type and number of obligations will differ between approaches. Institutional investor obligations are constant and numerous (e.g., life insurance and pension benefit payments are the future liabilities of insurance companies and defined benefit pension plans), while individual investor goals are much less predictable. This suggests that institutional liabilities can be more confidently forecasted since the average of a large number of obligations is more certain than the uncertain time horizon needs of one individual investor.

RELEVANT RISK CONCEPTS

LOS 12.d: Contrast concepts of risk relevant to asset-only, liability-relative, and goals-based asset allocation approaches.

CFA® Program Curriculum, Volume 3, page 21

Risk concepts associated with asset-only approaches focus on asset class risk as well as constructing effective asset class combinations. The relevant risk measure for MVO, the most popular asset-only approach, is the standard deviation of portfolio returns, which incorporates asset class volatilities and asset class return correlations. Other risk sensitivities, such as relative risk and downside risk, can also be measured with a mean-variance framework. For example, the risk relative to a benchmark can be modeled with tracking error, and downside risk can be modeled with value at risk (VaR), semivariance, or maximum drawdown.

Monte Carlo simulation is a statistical modeling tool often used to complement MVO. For example, a manager could begin by selecting several optimal portfolios using MVO that have acceptable risk and return for the client and then use Monte Carlo simulation to generate multiple simulated paths, which display how these portfolios would perform over time. This action would provide useful information on downside risk when portfolios encounter a market stress scenario. These results can then be used to refine asset allocation decisions.

Risk concepts associated with liability-relative approaches focus on not having enough assets to pay liabilities when they come due. The volatility of contributions used for funding liabilities is also a risk. The standard deviation of the surplus may be used as the relevant risk measure. In general, the differences between asset and liability characteristics (e.g., size, sensitivity to interest rate changes) are the main drivers of risk for liability-relative asset allocation approaches.

Risk concepts associated with goals-based approaches focus on the risk of not being able to achieve the stated financial goals. If an investor has multiple goals, then the risks will encompass multiple future time periods. Thus, portfolio risk under a goals-based approach is the weighted sum of the risk that is attached to each goal.

MODULE QUIZ 12.1, 12.2, 12.3

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

1. Which of the following investment objectives would *most likely* be associated with a defined benefit pension fund?
   A. Plan assets should meet current and future plan liabilities.
   B. Assets should provide for retirement subject to each investor's constraints and risk tolerance.
   C. The rate of return should meet the current distribution rate plus future inflation.
2. Which of the following investments would *most likely* be part of the extended portfolio of the assets and liabilities sections on an economic balance sheet?
   A. Human capital.
   B. Financial assets.
   C. Financial liabilities.
3. Which of the following asset allocation approaches is focused on achieving lifestyle and aspirational financial objectives?
   A. Asset-only approach.
   B. Goals-based approach.
   C. Liability-relative approach.
4. The asset allocation approach that is concerned with the risk of not having enough assets to pay liabilities when they come due is known as:
   A. asset-only.
   B. goals-based.
   C. liability-relative.

MODULE 12.4: ALLOCATION BY ASSET CLASS OR RISK FACTOR

Video covering this content is available online.

LOS 12.e: Explain how asset classes are used to represent exposures to systematic risk and discuss criteria for asset class specification.

An asset class is a group of assets that have similar investment characteristics. Each asset class has its own quantifiable systematic risk, and strategic asset allocation is a conscious effort to gain the desired exposure to systematic risk via specific weights to individual asset classes. Exposure to specific asset classes in specific proportions enables portfolio managers to effectively monitor and control their systematic risk exposure. In other words, strategic asset allocation reflects the investor's desired systematic risk exposure.

In a generic sense, there are three categories of "super asset classes": (1) capital assets, which provide a continuous source of value (e.g., dividends), (2) consumable or transformable assets, which can be consumed or transformed into a source of value (e.g., commodities), and (3) store-of-value assets, which provide value when exchanged or sold (e.g., currencies, art).

For the purposes of asset allocation, it is necessary to define asset classes. With this information, investors and managers can better distinguish among asset classes when developing an investment strategy. For example, combining emerging market equities and domestic equities into a single asset class labeled *equities* would be appropriate only from a general description standpoint; their risk and return characteristics are obviously different. The following criteria can be used to specify asset classes:

- *Assets in an asset class should have similar attributes from both a descriptive and statistical perspective*.
- *Assets cannot be classified into more than one asset class*. If it can be legitimately argued that assets can be placed in more than one class, the descriptions of the classes are too vague.
- *Asset classes should not be highly correlated in order to provide desired diversification*. A high correlation between classes would indicate that the classes are related from a risk and return standpoint. This would defeat the purpose of holding separate classes in an allocation.
- *Asset classes should cover all possible investable assets*. This factor not only increases the set of investable assets, but also pushes up the efficient frontier (i.e., increases expected return at all levels of risk).
- *Asset classes should contain a sufficiently large percentage of liquid assets*. If liquidity and transaction costs are significant, the asset class may not be ideal for investment because it lacks sufficient liquidity.

Some well-accepted asset classes include domestic equity, domestic fixed income, global equity, global fixed income, cash and equivalents, and alternative investments, which may be further divided into classes such as real estate, private equity, et cetera.

Too much granularity (number of subdivisions of classes used) in the asset allocation can make it difficult to construct an optimal portfolio based on an investor's required level of return and risk. Within each asset class, sub–asset classes can be created that are less distinct than their corresponding broad asset classes. For example, Figure 12.2 shows how the asset class of global equity can be broken down into U.S. and non–U.S. equity securities. The sub–asset class of U.S. equities can be further segmented into large-cap and small-cap equities.

Figure 12.2: Asset Classes and Sub–Asset Classes

Asset Classes	Sub–Asset Classes	
	U.S. equities	Large-cap equities

Global equity		Small-cap equities
	Non–U.S. equities	Developed countries
		Emerging countries
Global fixed income	U.S. debt	Investment-grade debt
		High-yield debt
	Non–U.S. debt	Developed countries
		Emerging countries

Strategic asset allocation should focus primarily on the asset class divisions that have distinctly different characteristics and will provide diversification (i.e., global equity versus fixed income). As you move down in granularity (level of subdivision) the differential between classes will shrink (i.e., U.S. and non–U.S. equity will be less distinctly different from each other than global equity versus global fixed income). However, when progressing from strategic asset allocation to policy implementation and tactical asset allocation, decisions may focus more on the sub–asset classes.

COMMON RISK FACTORS

LOS 12.f: Explain the use of risk factors in asset allocation and their relation to traditional asset class–based approaches.

CFA® Program Curriculum, Volume 3, page 26

Asset classes have traditionally been used as units of analysis when making asset allocation decisions. This process is known as *asset-based asset allocation*. For example, MVO incorporates expected return, volatility, and correlation estimates from the selected asset classes. However, using asset classes in this fashion may be problematic due to overlapping risk factors among asset classes.

An investor selects asset classes based on their desired exposure to common risk factors. Examples of risk factors include volatility, liquidity, inflation, interest rates, duration, foreign exchange, and default risk. As mentioned, risk factor exposures may overlap across multiple asset classes. For example, the asset classes of domestic equity and domestic fixed income will both share exposures to foreign exchange (in the sense that changes in value of the domestic currency can affect profitability of issuers and return on investments in their debt and equity), liquidity, and volatility risk factors. Examining these overlapping risk factors can help investors identify the correlations among asset classes.

Due to overlapping risk factors, it may be insightful to focus on risk factors rather than traditional asset classes as units of analysis. This is accomplished by identifying the risk factors as well as the desired exposure to each factor. Multifactor models can then be used for asset allocation by creating factor portfolios, which isolate systematic risk exposures (i.e., nondiversifiable risks). This process is known as *factor-based asset allocation*.

This does not mean risk factor analysis is inherently more useful. It has its own limitations. For example investors may not be able to directly invest in all risk factors. But risk factor analysis may offer additional insight, and risk factors often correspond to expected return premiums. Some risk factors may be investable with spread positions, which take long and short positions in assets, or by using derivatives. For example, to isolate inflation risk, an investor would go long Treasuries (which reflect compensation for consensus-expected

inflation) and short inflation-linked bonds (which will adjust and compensate for actual future inflation); or an investor would invest in volatility index (VIX) futures with payoffs based on actual change in volatility.

STRATEGIC ASSET ALLOCATION

LOS 12.g: Select and justify an asset allocation based on an investor's objectives and constraints.

CFA® Program Curriculum, Volume 3, page 28

Strategic asset allocation combines capital market expectations (expected return, volatility, and correlation) with an investor's risk, return, and investment constraints (from the IPS). Strategic asset allocation is long term in nature, and the weights are called *targets* and the portfolio represented by the strategic asset allocation is a *policy portfolio, target portfolio,* or *benchmark.*

Most quantitative approaches to asset allocation are based on utility theory. This framework uses a utility function that incorporates investor risk aversion. Expected utility for a certain asset allocation is determined with a distribution of ending wealth values, which is based on asset class weights, asset class returns, and beginning wealth values. The maximum level of utility, subject to asset class constraints, will represent the investor's optimal asset association given the investment horizon.

Selecting and justifying a strategic asset allocation based on investor objectives and constraints is outlined in the following steps:

1. *Determine investor objectives.* Relevant questions include the following: How will the investor use these assets? What would the investor like to achieve? What are the investor liabilities and goals? How should the objectives be measured?
2. *Determine investor tolerance for risk.* Relevant questions include the following: What are the investor's sensitivities to risk? How should risk be measured in terms of asset allocation?
3. *Determine investor time horizon(s).* Relevant questions include the following: What investment horizon should be used to evaluate investor objectives? What investment horizon should be used to evaluate investor risk tolerance?
4. *Determine investor constraints.* Relevant questions include the following: What is the investor's tax situation? Are there any social, environmental, or governance considerations? Are legal, regulatory, and political issues a consideration? Does the IPS indicate any additional constraints?
5. *Select the asset allocation approach.* This is the asset allocation that is most ideal for the investor's situation (e.g., asset-only, liability-relative, goals-based).
6. *Specify the asset classes.* Once the asset classes are appropriately specified, capital market expectations can be established.
7. *Develop potential asset allocations.* With optimization procedures, a number of asset allocation choices can be constructed for investor consideration.
8. *Simulate results of potential asset allocations.* The potential asset allocations should be tested to see if the results align with the investor's objectives and risk tolerance for the chosen investment horizon.

9. *Repeat Step 7 until the optimal asset allocation is discovered.*

Once the strategic allocation has been implemented, it should be monitored regularly as specified in the IPS. The monitoring process should contain a feedback loop so that changes in long-term market factors can be incorporated back into the model. An assessment can then be made to determine whether adjustments to the strategic allocation are justified. If the market changes are only short term in nature, the manager should consider implementing tactical allocation measures, as will be discussed elsewhere.

MODULE QUIZ 12.4

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

1. Which of the following investment objectives would *most likely* be associated with a defined benefit pension fund?
   A. Plan assets should meet current and future plan liabilities.
   B. Assets should provide for retirement subject to each investor's constraints and risk tolerance.
   C. The rate of return should meet the current distribution rate plus future inflation.
2. Which of the following statements identifies one criterion for specifying an asset class when making asset allocation decisions?
   A. Assets may be classified into more than one asset class.
   B. Asset classes cover all possible investable assets.
   C. Asset classes should be highly correlated in order to provide desired diversification.
3. Duration and convexity would *most likely* be risk factors for which type of asset class?
   A. Domestic equities.
   B. Domestic real estate.
   C. Domestic fixed income.

MODULE 12.5: EXAMPLE: STRATEGIC ASSET ALLOCATION

Video covering this content is available online.

PROFESSOR'S NOTE

The following example provides a general overview of constructing a strategic asset allocation.

EXAMPLE: Strategic asset allocation

Nathan Tillman is a 50-year-old entrepreneur who plans to retire in five years. He is considering purchasing an annuity for retirement. He has a $5 million portfolio with $1 million in real estate and $700,000 in mortgage debt. He would like to eliminate all mortgage debt before retirement. His son, David, is 18 years old and starting college this year with eventual plans for medical school. Tillman estimates he will contribute $500,000 to his son's education. Tillman is generally conservative with his investments, does not like portfolio volatility, and does not have any social or environmental investment constraints. For asset allocation A and then for asset allocation B:

- **State** whether it is most consistent with (1) an asset-only, (2) a liability-relative, or (3) a goals-based approach to asset allocation.
- **Give** one reason based on Tillman's situation that the approach is appropriate for Tillman.

Do not draw any conclusion as to the optimal overall approach to allocation for Tillman.

Asset Allocation	Cash	Global Equities	Global Fixed Income	Diversifying Strategies
A	45%	15%	40%	5%
B	10%	50%	20%	25%

Answer:

Asset allocation A is consistent with a goal-based approach because:

- It has more than sufficient cash for liquidity needs of $1.2 million to pay the mortgage and education expense. The cash can also be used for the possible annuity purchase.
- The high allocation to cash would reduce portfolio volatility.
- It fits his conservative investment views.

Asset allocation B is consistent with an asset-only approach because:

- It emphasizes higher growth equity.
- It provides diversification with alternative investments and some fixed income.

Note that you were directed not to draw any final conclusion. This was an initial step that illustrates the need to develop a complete IPS and consider additional asset allocations that may best meet those objectives.

MODULE 12.6: OTHER APPROACHES AND ISSUES

Video covering this content is available online.

LOS 12.h: Describe the use of the global market portfolio as a baseline portfolio in asset allocation.

CFA® Program Curriculum, Volume 3, page 34

Financial theory proposes that the first asset allocation to consider should be the **global market portfolio**. This portfolio contains all available risky assets (i.e., global equity, global fixed income, real estate, etc.) in proportion to their total market values. It is also the portfolio that minimizes diversifiable risk since it is the most diversified portfolio possible. The market portfolio is found on the efficient frontier by drawing a line from the risk-free asset that is tangent to the efficient frontier (known as the capital market line). The point of tangency is the location of the global market portfolio.

The asset class weights within the global market portfolio serve as a good starting point for asset allocation. The portfolio's weights can then be adjusted to meet specific investor objectives, constraints, and desires (e.g., a home-country or small-cap basis).

Note that it's challenging to invest in some asset classes within the global market portfolio. For example, investments in residential real estate or private equity may not be practical for individual investors. For this reason, investors often use a proxy to represent the global market portfolio, such as a portfolio of exchange-traded funds (ETFs).

PROFESSOR'S NOTE

Recall that nondiversifiable risk can also be called market, priced, or systematic risk. Diversifiable risk can also be called non-market, non-priced, company-specific, or unsystematic risk. Remember that you should expect compensation in the form of higher expected return for taking nondiversifiable risk but not for taking diversifiable risk.

STRATEGIC IMPLEMENTATION CHOICES

LOS 12.i: Discuss strategic implementation choices in asset allocation, including passive/active choices and vehicles for implementing passive and active mandates.

CFA® Program Curriculum, Volume 3, page 43

Once the strategic asset allocation has been constructed, implementation choices must be made regarding passive/active management for both asset class weights and allocations within asset classes. The first aspect of passive/active choices is to determine if the investor should deviate from the strategic asset allocation by adjusting the asset mix. The second aspect is to decide how investors should make allocations within selected asset classes. Managing and monitoring the portfolio in terms of a client's changing needs is an important element of portfolio management.

Passive/Active Choices for Asset Class Weights

Tactical asset allocation (TAA) is an active management strategy that deviates from the strategic asset allocation (SAA) to take advantage of perceived *short-term* opportunities in the market. TAA introduces additional risk, seeking incremental return, often called alpha. These deviations from the SAA weightings by asset class should be restricted by risk budgets or rebalancing ranges that control the amount of deviation. The deviations may be based on forecasted asset class valuation, business cycle state, or stock price momentum. A multiperiod view of the investment horizon is sometimes referred to as **dynamic asset allocation** (DAA). DAA recognizes that asset (and liability) performance in one period affects the required rate of return and acceptable level of risk for subsequent periods. Changes to the SAA may be limited to simply adjusting the mix between stocks, bonds, and cash. Conversely, global TAA may involve a broader and more complex multiasset approach.

With tactical asset allocation, there is a tradeoff between potential outperformance and tracking error. A key limitation of this approach is the additional trading and monitoring costs as well as possible capital gains taxes. Thus, the decision to implement a tactical asset allocation should be evaluated under a cost-benefit approach.

Passive and Active Choices Within Asset Classes

Passive and active management choices can also be made regarding the allocations within asset classes. Under **passive management**, investor insights or expectations do not impact the composition of the portfolio. Examples of a passive approach include indexing or holding bonds to maturity. With indexing, the portfolio may add or drop positions based on the index holdings, but it would not react to the changing expectations of investors regarding valuations. In contrast, under **active management**, the portfolio composition changes when investor insights or expectations change. The goal of active management is to earn risk-adjusted returns that exceed an associated passive benchmark.

To better understand the degree of passive/active management in a portfolio, we can view decisions along a spectrum from most passive to most active. The most passive approach would include buying and holding a self-rebalancing, broad index of risky assets, such as the global market portfolio. Tilting the allocation toward a certain investment style index (e.g., growth equity index) is slightly more active given that it involves an active decision, but it still uses the passive implementation of indexing. The next step toward a more active approach would involve taking a growth investment approach while using security selection to enhance returns. The most active approach would include unconstrained mandates where the portfolio is not managed with regard to traditional benchmarks.

In general, indexing is considered a low-cost means of investing. However, some transaction costs are involved when the portfolio must adjust positions based on the changing composition of the index. Furthermore, if the index is tracked with a different weighting

approach, such as equally weighted rather than market-cap weighted, additional transaction costs will apply. Portfolios that follow a fixed-income index will also incur transaction costs as bonds reach maturity, are called, or default. As a portfolio moves from passive to active, tracking error and expected active return relative to a benchmark will increase. These measures quantify the degree of active management within a portfolio.

The decision of where to invest along the active/passive spectrum depends on the following factors:

- Availability of appropriate investments (e.g., a relevant index).
- Active management scalability in terms of value added from each active decision.
- Investor constraints, such as social and environmental concerns, when using a passive approach.
- An investor belief in efficient markets, which would discourage the use of active management.
- The cost-benefit tradeoff where additional transaction costs are needed for achieving excess returns.
- The tax status of investors, which differs between taxable and tax-exempt investors.

Risk Budgeting

Asset allocation can also be conducted with a risk perspective. The types of risk to take, as well as the amount of risk to take, is addressed with **risk budgeting**. Measuring risk may differ depending on the risk focus, such as volatility of returns or tail risk. In these cases, risk would be quantified with the standard deviation of returns and value at risk (VaR), respectively. Risk budgets can be established in either relative or absolute terms and stated in either money or percentage terms (e.g., 10% return volatility). These risk budgets specify how risk should be distributed among portfolio assets without regard to asset expected returns.

In the context of making passive/active asset allocation choices, active risk budgeting determines how much additional risk the investor is willing to take relative to the benchmark. The objective of this approach is to outperform the benchmark while sticking to the investor's risk budget. Regarding passive/active choices for the asset class mix, active risk is determined relative to the strategic asset allocation benchmark. Regarding passive/active choices for allocation within asset classes, active risk is determined relative to the asset class benchmark.

REBALANCING

LOS 12.j: Discuss strategic considerations in rebalancing asset allocations.

CFA® Program Curriculum, Volume 3, page 48

Strategic asset allocation responds to the interaction of the investor's long-term strategic (policy) needs and long-run capital market expectations. The investor's goals are expressed in terms of IPS objectives and constraints. The allocation itself is typically specified in a range of percentages (e.g., a strategic allocation for domestic equity of 30% to 40%), and if the actual percentage wanders outside that range, the portfolio needs to be rebalanced. Rebalancing can be triggered by normal asset price changes, which cause the asset mix to fluctuate from its target weights.

The primary benefit of rebalancing is maintaining the investor's desired exposure to systematic risk factors. If the portfolio is allowed to simply drift, the riskier assets in the portfolio tend to take over. For example, as the value of the equities in a portfolio increases, the equities become an ever larger percentage of the portfolio and the risk of the portfolio increases accordingly. Only by rebalancing the portfolio (e.g., selling equities and buying debt) will the portfolio return to its original risk and return characteristics as specified in the investor's IPS.

Rebalancing also provides discipline. Often the investor will see significant gains in the equity portion of the portfolio and want to "let it ride." Successful performance may lead the client to react to temporary market conditions rather than follow a long-term, disciplined approach. But "letting it ride" can also lead to the failure to realize the gains from temporarily overvalued securities before they fall back to their true values. This could be considered a potential cost of not rebalancing.

Of course, when equities become too large of a portion within the portfolio and we sell them to rebalance, there is an associated tax liability. In addition, the investor will face transaction costs. The costs of rebalancing can be affected by the conditions under which the trade is made (i.e., whether the trade requires liquidity from or provides liquidity to the market). If the manager is selling when other managers are selling, the trade requires liquidity and the associated transaction cost (bid-ask spread) can be substantial. If the trade provides liquidity, on the other hand (e.g., selling when others are buying), the costs may be minimal.

Rebalancing Approaches

Rebalancing an allocation to its precise target weight requires more or less constant trading. With constant analysis and trading come the associated transaction costs and the inability to time trades. Rather than set strict target allocations, managers will set allowable ranges that they consider optimal for the asset classes. In order to provide discipline to portfolio rebalancing, managers can adopt either calendar-based rebalancing or range-based balancing.

Calendar rebalancing. As its name implies, calendar rebalancing is rebalancing the portfolio to its strategic allocation on a predetermined, regular basis (e.g., monthly or quarterly). Generally, the frequency of rebalancing depends on the volatility of the portfolio, but sometimes rebalancing is scheduled to coincide with review dates.

The primary benefit to calendar rebalancing is that it provides discipline without the requirement for constant monitoring. The drawback is that the portfolio could stray considerably between rebalancing dates and return to its strategic allocation ranges on the rebalancing date. In other words, rebalancing is related to the passage of time rather than the value of the portfolio.

Percentage-range rebalancing. With this approach, rebalancing is triggered by changes in value rather than calendar dates. The manager sets what are called tolerance bands or corridors that are considered optimal for each asset class. For example, a corridor of 50% ± 5% would indicate that the related asset class must stay within a band of 45% to 55%. If the asset class wanders outside that corridor, which would no doubt mean other classes have violated their corridors also, the portfolio is rebalanced.

By not waiting for specified rebalancing dates, range-based rebalancing provides the benefit of minimizing the degree to which asset classes can violate their allocation corridors. Cost is increased by the time and expense of constantly monitoring the portfolio (as compared to

only checking valuations on the specified calendar dates) and by potentially more frequent trading.

When applying range-based rebalancing, the following four questions need to be addressed:

- Who is ultimately responsible for rebalancing the portfolio?
- How frequently should the portfolio be monitored for rebalancing decisions?
- What is the size of the rebalancing corridors?
- Should rebalancing to target weights be fully or only partially corrected?

Strategic Considerations

The optimal width of the corridor for an asset class will depend on the following:

- **Transaction costs.** Obviously, the more expensive it is to trade, the less frequently you should trade. If an asset is particularly illiquid, for example, trading can be quite expensive. In that case, the corridor for the class should be wide. In general, the more illiquid the asset, the wider the corridor.
- **Risk tolerance.** More (less) risk-averse investors will have tighter (wider) rebalancing corridors.
- **Correlations.** The more highly correlated the assets (allocations) in a portfolio, the less frequently the portfolio will require balancing. If all assets tend to move together, their values will tend to stay within acceptable ranges. For example, if stocks and bonds both increase 20% in value (assuming only stocks and bonds in the portfolio), their weights in the portfolio will probably stay within acceptable limits. However, if stocks increase 20% while bonds decrease 20%, they will probably both violate their corridors.
- **Momentum.** If investors believe that current trends will continue, an argument can be made for using wider rebalancing corridors. Conversely, if investors anticipate mean reversion, tighter rebalancing corridors should be applied.
- **Liquidity.** Illiquid investments, such as private equity and real estate, are typically associated with larger trading costs. These liquidity costs encourage the use of wider rebalancing corridors.
- **Derivatives.** Rather than selling underlying assets, a derivatives overlay strategy can be used to synthetically rebalance a portfolio. This approach results in lower transaction costs, lower taxes, and can be executed quicker and easier compared to rebalancing with only the underlying stock and bonds. The tradeoff is that derivatives require additional risk management when used as a rebalancing tool.
- **Taxes.** When making rebalancing decisions, taxes must be considered since realized capital gains and losses will impact investor taxes. Therefore, taxable portfolios will typically have wider rebalancing corridors than tax-exempt portfolios. The corridors may also be asymmetric due to tax savings (i.e., loss harvesting). This suggests that the range may be less below a certain target weight than above (e.g., the tolerance band may go from 48% to 55% for a 50% target weight).

Asset class **volatility** also has an impact on optimal corridor width. In the simplest situations, higher volatility *most likely* calls for narrower corridors in order to control risk. But the impact of volatility can be more complex than that. **Higher volatility** (in the absence of high positive correlation between classes) will lead asset class weights to shift more quickly.

- But more frequent rebalancing increases transaction costs. This argues for wider corridors to control transaction costs, particularly when those costs are substantial.
- This argues for narrower corridors to control risk exposure. (Consider this the most likely conclusion.)

Ultimately the choice of corridor width depends on a trade-off between risk control, transaction costs, and correlations between classes. In complex situations, a quantified cost-benefit analysis will be required.

MODULE QUIZ 12.5, 12.6

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

1. Jack Manning, CFA, and Tess Brown, CFA, have just joined a financial planning firm. They will work as a team assessing and managing the portfolios of individual clients. Manning will specialize in forming long-term capital market expectations. Brown focuses on relative value models to assess shorter-term over- and undervaluation. Based on this information, we would define the focus of:
   A. both Manning and Brown as tactical asset allocation.
   B. both Manning and Brown as strategic asset allocation.
   C. Manning as strategic asset allocation and Brown as tactical asset allocation.
2. Which of the following statements is *most correct* regarding the global market portfolio as the baseline portfolio in asset allocation?
   A. The market portfolio contains most investable risky assets.
   B. The market portfolio minimizes total risk since it is the most diversified portfolio.
   C. Investors can use a proxy to represent the market portfolio, such as a portfolio of exchange-traded funds (ETFs).
3. Deviation from strategic asset allocation due to short-term capital market expectations is *most correctly* called:
   A. active management.
   B. tactical asset allocation (TAA).
   C. alpha management.
4. Which of the following asset allocation rebalancing techniques provides discipline without need for constant monitoring?
   A. Range-based balancing.
   B. Corridor-based rebalancing.
   C. Calendar-based rebalancing.

KEY CONCEPTS

LOS 12.a

Investment governance models should:

- Establish long-term and short-term investment objectives.
- Allocate the rights and responsibilities of all the involved parties.
- Specify processes for creating an investment policy statement (IPS).
- Specify processes for creating a strategic asset allocation.
- Apply a reporting framework to monitor the investment program's stated goals and objectives.
- Include periodic review of the governance policies by an independent third party.

LOS 12.b

An economic balance sheet contains an organization's financial assets and liabilities, as well as any nonfinancial assets and liabilities that are applicable to the asset allocation decision. These nonfinancial assets and liabilities are referred to as extended portfolio assets and liabilities because they are not included on traditional balance sheets. A practical application of an investment that includes human capital (an extended portfolio asset) is a life-cycle balanced fund. These funds consider the changing levels of human capital and financial capital for an individual investor over time.

LOS 12.c

There are three types of asset allocation approaches: (1) asset-only, (2) liability-relative, and (3) goals-based. Asset-only approaches make asset allocation decisions based on the investor's assets. Liability-relative approaches involve asset allocation decisions based on funding liabilities. Goals-based approaches are geared toward asset allocations for subportfolios, which help an individual achieve lifestyle and aspirational financial objectives.

LOS 12.d

Risk concepts associated with asset-only approaches focus on asset class risk as well as constructing effective asset class combinations. The relevant risk measure is the standard deviation of portfolio returns. Risk concepts associated with liability-relative approaches focus on not having enough assets to pay liabilities when they come due. The relevant risk measure is the standard deviation of the surplus. Risk concepts associated with goals-based approaches focus on the risk of not being able to achieve the stated financial goals.

LOS 12.e

Asset classes have been appropriately specified if:

- Assets in an asset class have similar attributes from both a descriptive and statistical perspective.
- Assets cannot be classified into more than one asset class.
- Asset classes are not highly correlated.
- Asset classes cover all possible investable assets.
- Asset classes contain a sufficiently large percentage of liquid assets.

LOS 12.f

Investors select asset classes based on their desired exposure to common risk factors. Examples of risk factors include volatility, liquidity, inflation, interest rates, duration, foreign exchange, and default risk. Risk factor exposures may overlap across multiple asset classes. Examining these overlapping risk factors can help investors identify the correlations among asset classes.

LOS 12.g

Strategic asset allocation is long term in nature; hence, the weights are called *targets* and the portfolio represented by the strategic asset allocation is called the *policy portfolio*.

Selecting and justifying a strategic asset allocation based on investor objectives and constraints is outlined in the following nine steps:

1. Determine investor objectives.
2. Determine investor tolerance for risk.
3. Determine investor time horizon(s).
4. Determine investor constraints.
5. Select the asset allocation approach.
6. Specify the asset classes.
7. Develop potential asset allocations.
8. Simulate results of potential asset allocations.
9. Repeat Step 7 until the optimal asset allocation is discovered.

LOS 12.h

Investors may consider the global market portfolio as a baseline asset allocation. It will minimize (eliminate) diversifiable risk. Because it's challenging to invest in some asset classes within the market portfolio, investors often use a proxy, such as a portfolio of exchange-traded funds (ETFs).

LOS 12.i

The SAA can be implemented with passive or active management for both asset class weights and allocations within asset classes.

- TAA introduces active decisions to deviate from the SAA in an effort to add value, but it is likely to increase error.
- Active management security selection is based on investor insights or expectations.

Risk budgeting specifies which risks and how much of each risk can be taken. Active risk budgeting specifies risk as allowable deviations from the portfolio's benchmark.

LOS 12.j

Calendar rebalancing is done on a periodic basis, and percentage-range rebalancing is done when a corridor is breached.

Wider optimal corridors are associated with:

- Higher transaction costs (including costs due to tax and illiquidity).
- Increased investor risk tolerance.

- Higher correlations among asset classes.
- Belief in momentum and that trends persist.
- Less volatile asset classes.

Derivatives may allow synthetic rebalancing at a lower cost.

Capital gains taxation suggests setting asymmetric rebalancing corridors (e.g., a 28% to 35% range around a 30% target weight).

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 12.1, 12.2, 12.3

1. **A** The objective for a defined benefit pension fund is for plan assets to meet current and ongoing plan liabilities. Choice B is generally appropriate but phrased more for an individual investor, and choice C is appropriate for a foundation or endowment fund (and sometimes for individuals). Defined benefit plan inflation issues are already reflected in the actuary provided present value of the liabilities (PVL). (Module 12.1, LOS 12.a)

2. **A** An economic balance sheet contains all of an organization's financial assets and liabilities, as well as any nonfinancial assets and liabilities that are applicable to the asset allocation decision. Extended portfolio assets may include the present value of expected earnings (i.e., human capital). The others are already part of a more traditional balance sheet. They are part of the economic balance sheet but not the extended section. (Module 12.2, LOS 12.b)

3. **B** Goals-based approaches are geared toward asset allocations for subportfolios, which help individuals or families achieve lifestyle and aspirational financial objectives. (Module 12.3, LOS 12.c)

4. **C** Risk concepts associated with liability-relative asset allocation approaches focus on not having enough assets to pay liabilities when they come due. (Module 12.3, LOS 12.c)

Module Quiz 12.4

1. **A** The objective for a defined benefit pension fund is for plan assets to meet current and ongoing plan liabilities. Choice B is generally appropriate but phrased more for an individual investor, and Choice C is appropriate for a foundation or endowment fund (and sometimes for individuals). Defined benefit plan inflation issues are already reflected in the actuary provided PVL. (LOS 12.d, 12.e, 12.f)

2. **B** As a group, asset classes cover all possible investable assets. Assets cannot be classified into more than one asset class. Also, asset classes should not be highly correlated. (LOS 12.e)

3. **C** The asset class of domestic fixed income would most likely include default risk, duration, and convexity risk factors in addition to foreign exchange, liquidity, and volatility risk factors. (LOS 12.f)

Module Quiz 12.5, 12.6

1. **C** Manning is using longer-term capital market expectations to form strategic asset allocation, while Brown is looking at shorter-term indicators, which is TAA. (Module 12.6, LOS 12.i)

2. **C** The global market portfolio contains *all* available risky assets in proportion to their total market values. It is also the portfolio that minimizes *diversifiable* risk since it is

the most diversified portfolio possible. The total risk (standard deviation) of the market portfolio is not the lowest possible. Over any specific time period the risk-free asset has zero standard deviation. It's challenging to invest in some asset classes within the global market portfolio. For this reason, investors often use a proxy to represent the global market portfolio, such as a portfolio of ETFs. (Module 12.6, LOS 12.h)

3. **B** Short-term deviations from the strategic asset allocation to take advantage of short-term capital market expectations is called TAA. The motives for TAA may well include active management and adding alpha, but they are less accurate labels for what was described. (Module 12.6, LOS 12.i)

4. **C** The primary benefit to calendar rebalancing is that it provides discipline without the requirement for constant monitoring. Range- or corridor-based rebalancing provides the benefit of minimizing the degree to which asset classes can violate their allocation corridors, but it can be more costly in that it requires continual monitoring of the portfolio. (Module 12.6, LOS 12.j)

The following is a review of the Asset Allocation and Related Decisions in Portfolio Management principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #13.

READING 13: PRINCIPLES OF ASSET ALLOCATION

Study Session 5

EXAM FOCUS

The reading reviews the mean-variance optimization (MVO) approach to strategic asset allocation (SAA) that has been taught at Levels I and II. The focus then shifts to MVO pitfalls and how MVO can be more practically applied to real-world portfolios.

The mathematics behind many of these discussions is beyond the scope of the exam or a typical charterholder. Do not try to learn details that are not covered in the material. If you want to pursue some of these for personal interest after the exam, a Google search is a good starting point.

MODULE 13.1: BASIC MEAN-VARIANCE OPTIMIZATION

Video covering this content is available online.

LOS 13.a: Describe and critique the use of mean–variance optimization in asset allocation.

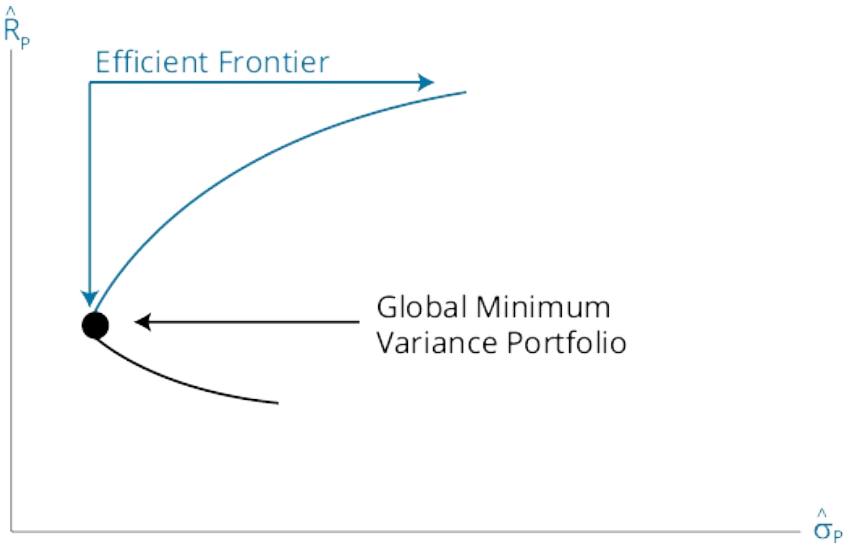
CFA® Program Curriculum, Volume 3, page 65

Creating a diversified portfolio with allocations to multiple asset classes requires:

- Asset allocation decision: using the investors' objectives and constraints to identify the appropriate portfolio weights for the various asset classes.
- Implementation decisions: identifying the specific assets within each asset class according to the weights specified in the first step.

Mean-variance optimization (MVO) is the most common approach to asset allocation. It assumes investors are risk averse, so they prefer more return for the same level of risk. Given an opportunity set of investable assets, their expected returns and variances, as well as the pairwise correlations between them, MVO identifies the portfolio allocations that maximize return for every level of risk. If the MVO analysis includes all investable risky assets, the result is the familiar "efficient frontier" (at least it should be familiar to the Level III candidate!), as shown in Figure 13.1. The analysis can also be constrained by an investor's objectives and constraints to some subset of assets suitable to that investor.

Figure 13.1: Mean-Variance Efficient Frontier



One approach to finding the optimal point on the efficient frontier for a given investor is to maximize that investor's utility:

Utility maximization: $U_m = E(R_m) - 0.005 \times \lambda \times Var_m$

U_m = the investor's utility from investing in a portfolio with asset allocation m

$E(R_m)$ = the expected return of the portfolio with asset allocation m (expressed as a %)

λ = the investor's risk aversion coefficient ("lambda")

$Var_m = \sigma^2_m$ = the variance of the portfolio with asset allocation m (expressed as a %)

PROFESSOR'S NOTE

The investor's utility function as shown assumes the expected return and variance are expressed in percentage terms (e.g., 8% is input as 8.00) so that the appropriate coefficient is 0.005. If the expected return and variance are expressed in decimal terms (e.g., 0.08), you should use the coefficient 0.5.

Lambda captures each individual investor's preference for trading off risk and return. If you look closely at the formula, you'll see that higher expected return for the same level of risk will increase the investor's utility, while a higher risk for the same level of return will decrease the investor's utility. This is consistent with a risk-averse investor, as it imposes a "penalty" for risk. U_m is also referred to as the *certainty-equivalent return*.

Lambda is unique to each individual and is based on the investor's willingness and capacity to take on risk. A risk-neutral investor will have a lambda of 0, although in practice it is typically assumed to be between 1 and 10 with an average level of 4.

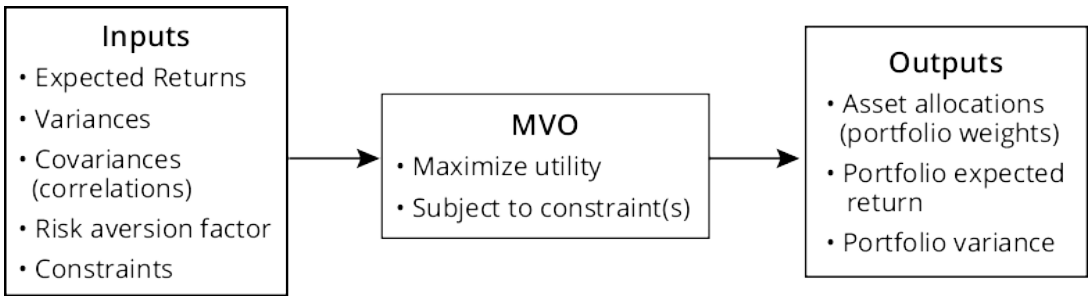
Maximization problems in general usually also have constraints. In other words, the objective function is maximized subject to one or more constraints. These are restrictions on the variables in the objective function. In MVO, the constraints typically involve the portfolio weights, but they can also reflect restrictions on portfolio expected return, variance, or both.

The most common constraint in MVO is called the *budget constraint* or the *utility constraint*, which means the asset weights must add up to 100%. The next most common constraint used in MVO is the *nonnegativity constraint*, which means all weights in the portfolio are positive

and between 0% and 100% (there are no short positions in the SAA). We will discuss other common constraints throughout this topic review.

A graphical depiction of MVO is shown in Figure 13.2.

Figure 13.2: MVO Process



Levels I and II focused on a more academic treatment of MVO. That approach assumed:

- All tradable assets were included in the optimization and efficient frontier.
  - We will no longer assume all assets are used or that the efficient frontier constructed from all assets is necessarily optimal for a given investor.
- That a true risk-free asset exists and the optimal allocation line between the risk-free asset and the efficient frontier identifies an optimal (the market) portfolio that all investor's should use (allocating between the tangent portfolio and risk-free asset). That optimal tangent portfolio is the portfolio on the efficient frontier with the highest Sharpe ratio.
  - We will no longer assume a true risk-free asset exists where risk-free means the variance of return is zero and return is uncorrelated with the return of other assets (correlation = 0).

Criticisms of MVO

There are a number of criticisms of MVO that we will address throughout this reading.

1. **GIGO**: The quality of the output from the MVO (portfolio allocations) is highly sensitive to the quality of the inputs (i.e., expected returns, variances, and correlations). In other settings, this is often called the "garbage-in-garbage-out" (GIGO) problem. Although all three inputs are a source of estimation error in MVO, expected returns are particularly problematic, so we focus here on addressing the quality of the expected return inputs.
2. **Concentrated asset class allocations**: MVO often identifies efficient portfolios that are highly concentrated in a subset of asset classes, with zero allocation to others; in other words, lowest calculated standard deviation is not the same thing as practical diversification.
3. **Skewness and kurtosis**: MVO analysis, by definition, only looks at the first two moments of the return distribution: expected return and variance; it does not take into account skewness or kurtosis. But empirical evidence suggests quite strongly that asset returns are not normally distributed: there is significant skewness and kurtosis in actual returns.

4. **Risk diversification**: MVO identifies an asset allocation diversified across asset classes but not necessarily the sources of risk. For example, equities and fixed-income securities are two different asset classes, but they are driven by some common risk factors, and diversifying across the two classes won't necessarily diversify those risk factors.
5. **Ignores liabilities**: MVO also does not account for the fact that investors create portfolios as a source of cash to pay for something in the future: individual investors are looking to fund their consumption spending in retirement, for example, while pension funds are focused on funding the pension liability and repaying employees the retirement benefits promised to them. A more robust approach needs to account for the factors that affect these liabilities and the correlations between changes in value of the liabilities and returns on the asset portfolio.
6. **Single-period framework**: MVO is a single-period framework that does not take into account interim cash flows or the serial correlation of asset returns from one time period to the next. This means it ignores the potential costs and benefits of rebalancing a portfolio as capital market conditions change and asset allocations drift away from their optimal starting point.

We address critiques 1 through 4 in this LOS; critique 5 in LOS 13.j, 13.k, and 13.l; and critique 6 in LOS 13.g and 13.o.

The first two criticisms of MVO—GIGO and concentrated asset class allocations—can be addressed by:

- Improving the quality of the inputs, particularly expected return.
- Adding more constraints beyond the budget constraint and the nonnegativity constraint.
- Resampling MVO.

MODULE 13.2: REVERSE OPTIMIZATION, BLACK LITTERMAN, RESAMPLING, AND OTHER APPROACHES

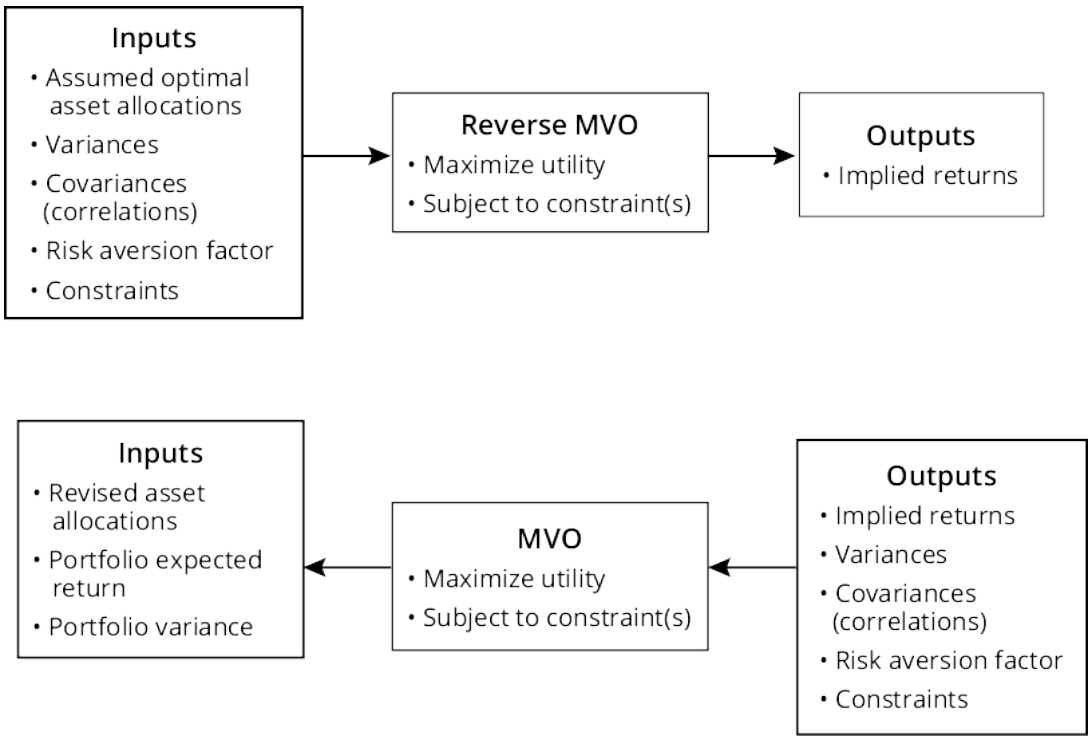
Video covering this content is available online.

Improving the Quality of the Inputs

Reverse optimization (Black-Litterman is an extension of this) can be used to improve the return estimates.

Reverse optimization is just what it sounds like: instead of starting with expected returns (and the other inputs) and deriving optimal portfolio weights, start with what we assume to be "optimal" portfolio weights from the global market portfolio and derive the expected returns consistent with those weights. Then we use these return estimates (called implied returns) to do a traditional MVO and derive optimal portfolio weights for our particular investor. This process is depicted in Figure 13.3.

Figure 13.3: Reverse Optimization

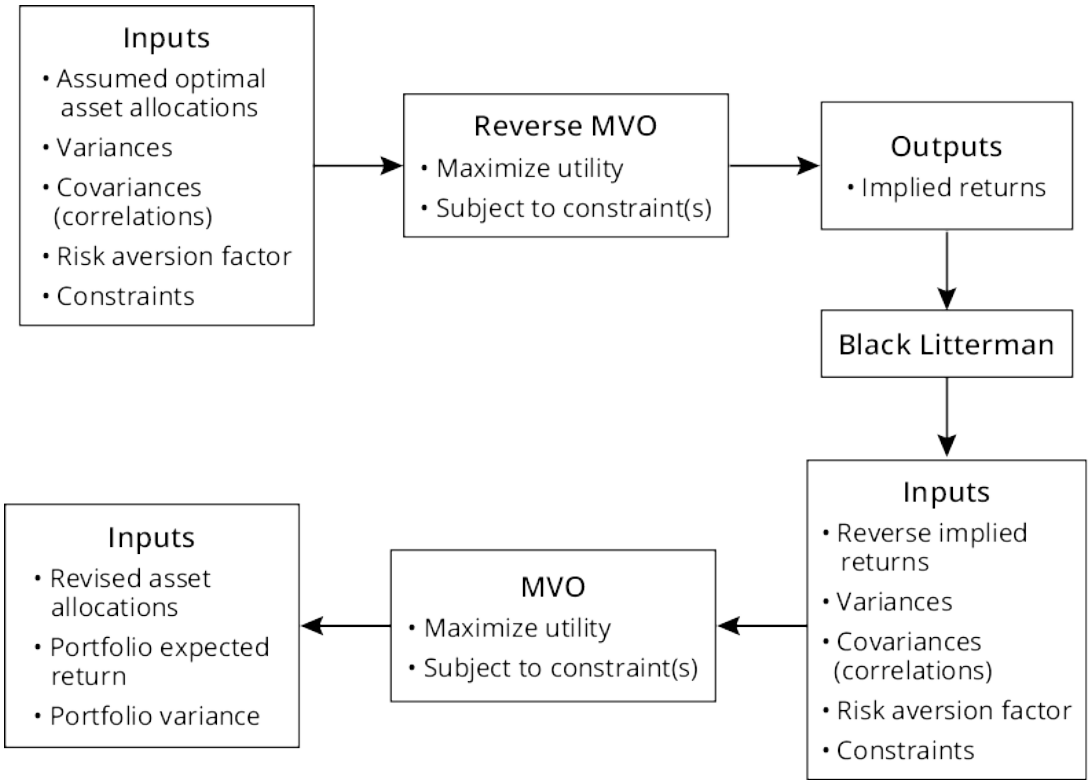


It is common to assume the world market portfolio provides optimal diversification and is therefore the appropriate starting point for weights to use in reverse optimization. The advantage of this is the derived returns already reflect a highly diversified portfolio and you avoid the tendency of MVO to come up with highly concentrated (in a few asset classes) allocations. Other starting points are possible, such as the weights from an existing IPS of the client.

The **Black-Litterman model** is an extension of reverse optimization in which the implied returns (actually implied excess returns) from a reverse optimization are subsequently adjusted to reflect the investor's unique views of future returns. For example, if reverse optimization:

- Derives an expected return for emerging market equities of 6.5% and you believe this is too low, you could adjust the expected return by 75 basis points to 7.25%. You can then rerun the MVO using your adjusted return estimates.
- Projects a return for U.K. large-cap equities of 8.2% and U.S. large-cap equities of 8.0% (a return differential of 20 basis points) and you believe that U.S. large-cap equities will outperform U.K. large-cap equities by 100 basis points, adjust the differential. Figure 13.4 displays a schematic view of the Black-Litterman model.

Figure 13.4: Black-Litterman Model



Adding More Constraints

Adding constraints beyond the budget and nonnegativity constraint can be used to address the GIGO and highly concentrated allocation issues. These constraints are usually intended to make the asset allocation more acceptable to an investor's desires to include or exclude (in total or in part) certain asset classes. Typical examples of additional constraints include:

- Specifying a fixed allocation to one or more assets, often human capital or other nontradable assets. (This will be discussed in more detail shortly.)
- Setting an asset allocation range for an asset class (e.g., 10% to 15% for global REITs).
- Setting an upper limit on the asset allocation to an asset class to address liquidity issues (e.g., no more than 10% to private equity).
- Specifying a relative allocation between two or more classes (e.g., the allocation to Asia bonds must be less than Asia equities).
- In a liability-relative setting, including a constraint to require an allocation to assets that hedge the liability. (This will also be discussed in more detail shortly.)

However, if too many such constraints exist, you're not really optimizing anymore; you're trying to force the asset allocation outcome you want.

Resampled MVO

Resampling can also be used to address the GIGO and highly concentrated issues:

- Resampling starts with the basic MVO using the best estimates of expected returns, sigma, and correlations to generate the efficient frontier and associated asset allocations for each point on the frontier.

- Then Monte Carlo simulation is used to generate thousands of random variations for the inputs around the initial estimates, resulting in efficient frontier and associated asset allocations for each point on the frontier.
- The resampled efficient frontier is an average of all the simulated efficient frontiers, and the asset allocation for any single point on the resampled efficient frontier is an average of the possible portfolios for that point on the frontier.

PROFESSOR'S NOTE

Use some professional common sense. This is too much math for you to be asked to do on the exam, but the concept is simple (e.g., here are my best guesses of inputs, here are lots of variations around those best guesses, and here is the average of the asset allocations to get me to a 5% expected portfolio return). An average has to be more stable than the allocation from any one set of guesses. Furthermore, every asset class that appears in a single possible allocation will be included in the average asset allocation, so the average allocation will likely include more asset classes than found in a single allocation.

Non-Normal Distributions (Skewness and Kurtosis)

The third critique of MVO, that it ignores skewness and kurtosis in asset returns, can be addressed by various extensions of MVO. You could directly incorporate skewness, kurtosis, or both into the utility function and use an asymmetric definition of risk, such as conditional value-at-risk (VAR), instead of variance.

PROFESSOR'S NOTE

The details of these models are beyond the scope of the Level III curriculum.

MODULE 13.3: EXAMPLE

Video covering this content is available online.

LOS 13.b: Recommend and justify an asset allocation using mean–variance optimization.

LOS 13.i: Recommend and justify an asset allocation based on the global market portfolio.

CFA® Program Curriculum, Volume 3, pages 65 and 135

EXAMPLE: Recommending and justifying an asset allocation using MVO

Marsha Bronsten has come to her investment adviser for help to determine an appropriate asset allocation. The adviser discerns in conversations with Bronsten that her risk tolerance is average ($\lambda = 4$) and that she would also like to minimize the chance of earning less than 3%. The available asset allocations are as follows:

	Expected Return	Variance
Allocation 1	8%	0.0225
Allocation 2	6%	0.0144
Allocation 3	4%	0.0025

Recommend which of the three strategic asset allocations is appropriate for Bronsten.

Answer:

The first step is to calculate the certainty-equivalent return for each allocation using the equation $U_m = E(R_m) - 0.5 \times \lambda \times Var_m$.

$U_1 = 0.08 - 0.5 \times 4 \times 0.0225 = 0.0350 = 3.50\%$

$U_2 = 0.06 - 0.5 \times 4 \times 0.0144 = 0.0312 = 3.12\%$

$U_3 = 0.04 - 0.5 \times 4 \times 0.0025 = 0.0350 = 3.50\%$

Based solely on the criteria of the certainty-equivalent return, Bronsten is indifferent between allocations 1 and 3, but prefers them both to allocation 2.

The second step is to calculate Roy's safety-first criterion, which is equal to $\frac{R_P - R_L}{\sigma_P}$ and identifies the portfolio with the highest probability of exceeding the threshold return of R_L = 3%.

$$\text{Allocation 1}: \frac{0.08-0.03}{\sqrt{0.0225}} = 0.33$$

$$\text{Allocation 3}: \frac{0.04-0.03}{\sqrt{0.0025}} = 0.2$$

Allocation 1 has a higher probability of exceeding the threshold return than allocation 3, so the adviser should recommend allocation 1 to Bronsten.

Note that the data was given in a mixture of percent and decimal forms. The solution converted all data to decimal form. You could have also converted everything to percent form. For example:

$U_1 = 8.00 - 0.005 \times 4 \times 225 = 3.50\%$

$$\text{Allocation 1}: \frac{8-3}{\sqrt{225}} = 0.33$$

The ranking and conclusions will be the same. The approach you take is just personal preference.

EXAMPLE: Recommending and justifying an asset allocation using MVO

The Plowshare University endowment fund has an annual return objective of 9%, which is sufficient to cover its spending rate, expected inflation, and cost of earning investment returns. Its risk objective is to minimize risk (as measured by standard deviation of returns) while meeting its minimum expected return objective. The table provides the output from an MVO with a budget constraint and a nonnegativity constraint. Allocations AA, BB, CC, and DD can also be referred to as corner portfolios.[1]

	Expected Return	Standard Deviation of Returns
Allocation AA	15%	24%
Allocation BB	18%	27%
Allocation CC	12%	20%
Allocation DD	10%	14%

The risk-free rate is 3%. If the client and manager believe a true risk-free asset exists and can be used to construct the SAA, **identify** the appropriate asset allocation for Plowshare and **calculate** the risk of the optimal allocation.

Answer:

The first step is to calculate the Sharpe ratio for each allocation.

$$\text{Sharpe ratio AA} = \frac{15\%-3\%}{24\%} = 0.5$$

$$\text{Sharpe ratio BB} = \frac{18\%-3\%}{27\%} = 0.56$$

$$\text{Sharpe ratio CC} = \frac{12\%-3\%}{20\%} = 0.45$$

$$\text{Sharpe ratio DD} = \frac{10\%-3\%}{14\%} = 0.5$$

The optimal risk allocation is BB as it has the highest Sharpe ratio.

The second step is to calculate the mix between BB and the risk-free asset assuming the return objective is 9%. Allowing w_{BB} to be w is calculated as follows:

$9\% = 18\%(w) + 3\%(1 - w)$

$9 = 18w + 3 - 3w$

$6 = 15w$; therefore, $w_{BB} = 0.40$

The optimal portfolio invests 40% in allocation BB and 60% in the risk-free asset.

The risk (standard deviation) of the optimal portfolio is as follows:

$\sigma_{BB} \times w_{BB} = 27\% \times 0.40 = 10.8\%$

MODULE QUIZ 13.1, 13.2, 13.3

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

1. Which of the following methods is *most appropriate* for addressing highly concentrated allocations in portfolios?
   A. Reverse optimization.
   B. Monte Carlo simulation (MCS).
   C. Liability-relative MVO.

2. Jane Cullis is considering three potential asset allocations. She wishes to earn a nominal return of no less than 4%, and she has a high risk tolerance with a lambda of 2.

   The following asset allocations are available:

	Expected return	Variance
Allocation 1	6%	0.02
Allocation 2	8%	0.03
Allocation 3	10%	0.04

   Based on the information provided, which of the following allocations should Cullis choose?
   A. Allocation 1.
   B. Allocation 2.
   C. Allocation 3.

3. Melody Chan is considering three potential asset allocations. She wishes to earn a nominal return of no less than 4% and maximize her chances of exceeding a 4% return.

   The following asset allocations are available:

	Expected return	Variance
Allocation 1	6%	0.02
Allocation 2	8%	0.09
Allocation 3	10%	0.16

   Based on the information provided, which of the following allocations would Chan *most likely* choose?
   A. Allocation 1.
   B. Allocation 2.
   C. Allocation 3.

MODULE 13.4: ISSUES FOR INDIVIDUALS

Video covering this content is available online.

LOS 13.c: Interpret and critique an asset allocation in relation to an investor's economic balance sheet.

CFA® Program Curriculum, Volume 3, page 81

So far, we have only considered tradable financial assets such as equities and bonds. However, a significant portion of the typical investor's asset portfolio is human capital, as well as the residential real estate property the investor owns and lives in. We can adapt the MVO framework to incorporate these kinds of assets into the analysis.

For investors who have stable jobs with consistent wages that increase with inflation, we can model the cash flows associated with human capital (future wages) as an inflation-linked bond. For individuals with less certain and more volatile future wages, we could model their human capital as a mix of inflation-linked bonds, equities, and corporate bonds. By including this source of economic value in the investor's portfolio, the individual's capacity to take on additional risk is increased. Because human capital is not tradable, one of the constraints must be to set the percentage allocation to human capital at whatever it is currently valued at in relation to the investor's total portfolio value.

Residential real estate owned by the investor can be treated in a similar fashion, with return and risk inputs estimated using a residential real estate property index for the investor's geographic region. Once again, the allocation to the property must be constrained to its current value as a percentage of the investor's total portfolio.

Because human capital and residential real estate property are two large but often overlooked components of an investor's total investment portfolio, including them in the analysis along with traditional investment vehicles increases the investor's capacity to bear risk.

LOS 13.g: Discuss the use of Monte Carlo simulation and scenario analysis to evaluate the robustness of an asset allocation.

CFA® Program Curriculum, Volume 3, page 77

MCS can be used to:

- Address the limitations of MVO as a single-period model and the related issues of rebalancing and taxes in a multiperiod framework. In a single-period model, taxes are easy to incorporate into the analysis, and rebalancing the portfolio is irrelevant. However, in a multiperiod framework, rebalancing to move toward a strategic allocation target will involve buying and selling investments that trigger taxable capital gains and losses. Also, investors will save (add) money into and spend money out of their portfolio, resulting in interim cash flows. It is relatively straight-forward to do this at each future point in an MCS.
- Guide individual investors to identify their risk tolerance level. MCS can be useful in illustrating the range and likelihood of possible outcomes given various assumptions. Clients planning for retirement can visually see how often and when they are likely to run out of money.

PROFESSOR'S NOTE

Monte Carlo simulation (MCS) has multiple uses. It is essentially a random number generator, but random means random within user-defined boundaries. We saw MCS used in resampling to generate a range of possible inputs for MVO where the range was around the best guess of inputs. Here, MCS is being used another way—to simulate multiple future return paths for a portfolio over time. The various paths are based around a best guess of expected return and risk for the portfolio.

LOS 13.d: Discuss asset class liquidity considerations in asset allocation.

Less-liquid asset classes like direct real estate, infrastructure, and private equity require a liquidity return premium to compensate the investor for the additional liquidity risk. However, these asset classes are difficult to include in MVO because:

- There are few indexes available that accurately track these illiquid investments, making it harder to find data to use for estimating return, risk, and correlations.
- Even where indexes exist to provide return data, they are generally not investable as a passive alternative to active management of these asset classes.
- The risk-return characteristics of a specific real estate, private equity, or infrastructure investment are different from those of its asset class. For example, investing in the infrastructure asset class (assuming it is possible) should reflect the characteristics of a portfolio of all infrastructure, with only systematic risk priced. However, any one infrastructure fund is not fully diversified and, therefore, its risk and return characteristics reflect both systematic and nonsystematic risk.

To address these issues:

- Exclude illiquid asset classes when running an MVO, but use them to meet separately set target asset allocations.
- Include the illiquid asset classes in MVO and model the inputs of the specific (not asset class) investments you plan to use (i.e., the risk estimate will be based on both nonsystematic and systematic).
- Include the illiquid asset classes in MVO using highly diversified asset class inputs, recognizing that the actual investments made may have different characteristics. The input estimates for this approach are normally made using reported alternative investment indexes. Such indexes are usually not pure representations of the asset class but include characteristics of other asset classes as well. This violates the requirement that asset classes be mutually exclusive and biases the reported correlations upward.

MODULE QUIZ 13.4

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

1. Louise Davey is 26 years old and has just paid off her student loans from college and hopes to begin saving to accumulate a portfolio. She is currently set to begin a career as a licensed insurance salesperson, working primarily on a commission-based pay structure. Louise is an only child and will be the sole beneficiary of her parents' substantial estate, which she estimates she will receive in about 30 years.

   Based on the information provided, which of the following statements is *most accurate*?
   A. Louise's human capital could likely be modeled as an inflation-linked bond.
   B. Louise's capacity to bear investment risk is relatively high.
   C. Louise's human capital is a small component of her total economic worth.
2. When dealing with illiquid assets, such as the investor's personal residence or a private company he owns, it is *most accurate* to say:
   A. a liquidity premium reduces the assets' expected return.
   B. the positions can be excluded when running mean variance optimization for the client.
   C. use data on publicly available funds to model the specific characteristics of the client's holdings when running mean variance optimization for the client.
3. Which of the following methods is the *least appropriate* way of incorporating client risk preferences into asset allocations?

A. Specify additional constraints.
B. Specify a maximum return.
C. Use MCS.

4. Which of the following statements regarding MCS is *most accurate*?
   A. MCS replaces mean variance optimization (MVO) by addressing the limitations of MVO.
   B. There is a high level of consistency between the MCS tools available in the marketplace.
   C. MCS is not necessary to model taxes and portfolio rebalancing in a single period.

MODULE 13.5: A RISK BUDGETING APPROACH

Video covering this content is available online.

LOS 13.e: Explain absolute and relative risk budgets and their use in determining and implementing an asset allocation.

CFA® Program Curriculum, Volume 3, page 95

The goal of risk budgeting is to maximize return per unit of risk, where we can define risk as total portfolio risk, active risk, or residual risk.

The marginal contribution to portfolio risk is the change in total portfolio risk for a small change in the asset allocation to a specific asset class. For those of you with calculus backgrounds, it's the partial derivative of risk with respect to changes in portfolio allocations. Absolute contribution to total risk (ACTR) is the asset classes' contribution to portfolio volatility.

By estimating each asset classes' marginal contribution to total risk (MCTR), we can (1) see what happens to portfolio risk as we change individual allocations, (2) identify optimal allocations, and (3) develop a risk budget.

Here are some useful formulas:

Marginal contribution to total risk:	$MCTR_i$ = (beta of asset class$_i$ with respect to the portfolio)(total portfolio risk as measured by standard deviation)
Absolute contribution to total risk:	$ACTR_i = (weight_i)(MCTR_i)$ % of risk contributed by position$_i$ = $ACTR_i$ / total portfolio risk

The optimal allocations to each asset class occur when the ratio of excess return to MCTR is equal for all asset classes and is equal to the portfolio Sharpe ratio.

A simple example of a portfolio with an optimal risk allocation is shown in Figure 13.5.

Figure 13.5: Optimal Risk Allocation Example

	Weight	Excess Return	Beta	MCTR	ACTR	% Contribution to Risk	Ratio of Excess Return to MCTR
U.S. equities	60%	6.50%	1.300	15.60%	9.36%	78.03%	0.417
U.S. bonds	30%	3.66%	0.732	8.78%	2.64%	21.97%	0.417
Cash	10%	0.00%	0.000	0.00%	0.00%	0.00%	
Total portfolio	100%	5.00%	1.000		12.00%	100.00%	

Note that the portfolio excess return is 5% (the weighted average of the excess returns of each asset class) and the portfolio standard deviation is 12%. Here are the calculations for U.S. equities:

$MCTR_{equities} = 1.300 \times 12.00\% = 15.60\%$

$ACTR_{equities} = 0.60 \times 15.60\% = 9.36\%$

% contribution to total $risk_{equities} = 9.36\% / 12.00\% = 78.00\%$

ratio of excess return to $MCTR_{equities} = 6.5\% / 15.60\% = 0.417$

Note also that the portfolio Sharpe ratio of 5% / 12% = 0.417 is equal to the ratio of excess return to MCTR for both U.S. equities and U.S. bonds. Therefore, the 60/30/10 allocation is optimal from a risk-budgeting perspective.

LOS 13.f: Describe how client needs and preferences regarding investment risks can be incorporated into asset allocation.

CFA® Program Curriculum, Volume 3, page 89

We have discussed a number to ways to incorporate client risk preferences into the asset allocation:

- Specify additional constraints, such as setting limits on allocations to risky asset classes or setting a ceiling on portfolio risk. We did this in the Plowshare example.
- Specify a risk aversion factor for the investor, as we did in the first example with Marsha Bronsten when we assumed she was an average investor and her risk aversion factor was 4.
- Use MCS to illustrate to the investor the various wealth outcomes possible from assuming allocations with different levels of risk.

LOS 13.h: Describe the use of investment factors in constructing and analyzing an asset allocation.

CFA® Program Curriculum, Volume 3, page 97

Up to this point, our opportunity set of investments consisted of asset classes, such as equities, fixed income, REITs, etc. Another approach is to define the opportunity set as factors, such as market exposure, size, valuation, momentum, liquidity, duration, credit, and volatility.

This approach is consistent with fundamental factor return models, such as the Fama-French model, in which the factors are the market portfolio, size, and value-growth.

The factors themselves are zero-dollar investment portfolios that are long the better performing attribute and short the underperforming attribute. For example, there are three factors in the Fama-French model:

- A zero-dollar portfolio long in small stocks and short in large stocks (the size factor).
- A zero-dollar portfolio long in value (high book-to-market) stocks and short growth (low book-to-market) stocks (the value-growth factor).
- The market portfolio.

Because of the way the factors are formed, they are not highly correlated with each other or the market portfolio, which improves the risk-return tradeoff from the optimal portfolios and expands the efficient frontier.

Once the factor portfolios, their expected returns, variances, and covariances are identified, MVO can be used in the same manner as we've previously discussed to identify portfolios with optimal allocations to the factors.

Research comparing the results of MVOs using asset class exposures versus factor exposures indicates that when the two opportunity sets broadly reflect the same exposures (underlying assets), the resulting efficient frontiers are not significantly different (i.e., one approach is not clearly superior). The choice of approach depends on how you form capital market expectations (i.e., the space in which you operate). If you collect data and think in terms of asset class, allocate risk by asset class. If you collect data and think in terms of risk factors, allocate risk by risk factor.

MODULE QUIZ 13.5

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

1. The following portfolio is being analyzed. The data is incomplete and does not show other asset classes held in the portfolio.

	Weight	Excess Return	Beta
Canadian equities	50%	8.25%	1.19
Canadian bonds	15%	2.75%	0.88

   The portfolio standard deviation is 10%.

   Which of the following amounts is *closest* to the ratio of excess returns to marginal contribution to total risk (MCTR) for the Canadian equities within the portfolio?

   A. 0.313.
   B. 0.595.
   C. 0.693.

2. Regarding the use of investment factors in forming an asset allocation, it is *most accurate* to say:
   A. this method is superior to asset class–based allocations for institutional portfolios.
   B. this method will replicate the allocations produced by asset class–based allocations for institutional portfolios.
   C. factor exposures may be investable by forming a series of zero-dollar long/short portfolios.

MODULE 13.6: AN ALM APPROACH

Video covering this content is available online.

Liability-Relative Asset Allocation

In this section, we address critique 5 of MVO, that MVO as discussed so far does not address the relationship between the asset investment portfolio and the liabilities that the investor will repay using the cash flow from the asset portfolio. We will focus our attention here on institutional investors such as pension funds, insurance companies, and banks. All three have liabilities they are obligated to meet at some point in the future, and they face strict regulatory rules and penalties for failure to meet those obligations.

Let's use the example of a defined benefit (DB) pension plan to illustrate the key issues and provide some definitions. There are two components to a DB pension plan: the pension

liability and the investment portfolio that is managed to meet the cash flow requirements of the liability. A pension plan promises workers a stream of payments upon retirement that is usually dependent on how long the employee has worked for the company, as well as the worker's salary in the last few years before retirement. The pension liability represents the present value (calculated at the appropriate discount rate) of those future retirement obligations of the plan.

The plan surplus and the funding ratio are calculated as follows:

plan surplus = market value of investment portfolio assets − present value of the pension liabilities

funding ratio = market value of assets / present value of liabilities

A pension plan is fully funded if the funding ratio = 1 (which means the plan surplus is 0). An underfunded plan has a funding ratio less than 1, and an overfunded plan has a funding ratio greater than 1.

The characteristics of the pension liability drive the return and risk requirements of the investment portfolio and ultimately the asset allocation decision. Furthermore, the analysis should recognize that the value of the assets and the liabilities are driven by some of the same factors, so the correlations between changes in value of the two are important.

LOS 13.j: Describe and evaluate characteristics of liabilities that are relevant to asset allocation.

CFA® Program Curriculum, Volume 3, page 101

The following characteristics of liabilities are relevant to the asset allocation decision:

- Fixed versus contingent: Fixed liabilities have cash flows whose amount and timing are specified in advance, such as a fixed-rate corporate bond. Contingent liabilities have cash flows that depend on uncertain future events, such as the pension liability associated with a defined pension plan.
- Legal versus quasi-legal: Legal liabilities are obligations defined in a legal agreement. Quasi-legal liabilities are not legal obligations but are cash outflows expected to occur in the future and are essential to the mission of the institution. University endowments can be considered to have quasi-legal liabilities.
- Duration and convexity measure the change in value of a liability for a given change in interest rates. In the CFA curriculum, we typically talk about duration and convexity in relation to fixed-income securities, but the concept can be applied to any liability.
- Liability value versus size of sponsoring organization: A large liability in relation to the size of the sponsoring organization will necessarily be accounted for in the asset allocation decision; a small liability can usually be ignored as its effect on the optimal asset allocation is minimal.
- Factors that affect future cash flows: These factors include inflation, interest rates, risk premiums, and other economic conditions. DB pension obligations are influenced by the choice of the discount rate, for example.
- Timing considerations, including longevity risk.
- Regulations affecting the determination of the liability's value, typically found in the insurance industry.

LOS 13.k: Discuss approaches to liability-relative asset allocation.

LOS 13.l: Recommend and justify a liability-relative asset allocation.

CFA® Program Curriculum, Volume 3, page 104

We will discuss three approaches to liability-relative asset allocation. They are summarized here and then discussed in more detail:

- Surplus optimization: This is an extension of MVO in which we determine an efficient frontier based on the surplus with its volatility as our measure of risk, stated either in money or percentage terms.
- Two-portfolio approach: In this approach, we separate the asset portfolio into two subportfolios: a hedging portfolio and a return-seeking portfolio.
- Integrated asset-liability approach: This approach integrates both the assets and the liabilities in a joint optimization method.

Surplus Optimization

We can define the surplus return as:

$R_{s,m}$ = surplus return = (change in asset value − change in liability value) / initial asset value

Then the objective function to maximize is:

$$U_m = E(R_{s,m}) - 0.005 \times \lambda \times Var_{s,m}$$

where:
$E(R_{s,m})$ = expected surplus return
$Var_{s,m}$ = variance of surplus return

We then proceed with the same MVO as previous, except we also include the expected returns and variances of the liabilities. The correlations reflect the extent to which the assets are useful to hedge the liabilities.

There are a number of ways to estimate the expected returns and variances of the liabilities. The first is to make the assumption that the liabilities behave like corporate bonds and the liability inputs can be estimated using the expected return and volatility of corporate bonds. The second is to use a factor approach and identify the common factors that affect both the asset classes and the liabilities.

Two-Portfolio Approach (Also Known as the Hedging or Return-Seeking Approach)

Conceptually this is a straight-forward approach. We create an asset portfolio that hedges the liabilities, and the remainder is managed independently using MVO to maximize utility and identify the optimal risk-return tradeoff.

The hedging portfolio can be created using the various techniques outlined elsewhere in the Level III curriculum fixed-income readings: cash flow matching, duration matching, and immunization.

This approach is most often used for insurance companies and overfunded pension plans that want to minimize the risk of underfunding.

This approach can be modified by (1) only partially hedging the liabilities and allocating more capital to the return-seeking portfolio or (2) increasing the allocation to the hedging portfolio as the funding ratio and the surplus increase. Both of these approaches are more aggressive than completely hedging the liabilities, as they trade off higher expected return for higher risk.

There are two limitations of this approach:

- If the funding ratio is less than one, it's difficult to create a hedging portfolio that completely hedges the liabilities.
- A hedging portfolio may not be available to hedge certain kinds of risk (like earthquakes).

Integrated Asset-Liability Approach

The distinctive feature of the previous two approaches is that the composition of the liabilities is already in place when the asset allocation decisions are made, so the two decisions are made independently. Banks, hedge funds with short positions, and insurance companies, however, make decisions about the composition of their liabilities jointly with their asset allocation decisions. There is a continuous feedback loop between the two, which requires a multiperiod model. This is often referred to as an integrated asset-liability approach.

For example, a key risk faced by large global banks, which are very highly leveraged, is whether the bank's capital is sufficient to absorb losses when their asset values decline, their liability values increase, or both. And as both bank assets (loans) and liabilities (deposits) are affected by changes in interest rates, although to varying degrees, stress testing requires a framework that can simultaneously account for both sides of the balance sheet. An integrated asset-liability approach is therefore necessary for banks to identify the optimal mix of assets and liabilities to meet their return and risk objectives.

MODULE QUIZ 13.6

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

1. Which of the following items is *best* described as a contingent liability?
   A. A company's fixed-coupon debt.
   B. An insurance company's obligations to pay policyholders.
   C. Planned distributions by a foundation.
2. A bank is *most likely* to use which of the following approaches to liability-relative asset allocation?
   A. Surplus efficient frontier approach.
   B. Integrated asset-liability approach.
   C. Two-portfolio approach.

MODULE 13.7: GOALS-BASED AND MISCELLANEOUS APPROACHES

Video covering this content is available online.

LOS 13.m: Recommend and justify an asset allocation using a goals-based approach.

The **goals-based approach** to asset allocation is useful for individual investors, who typically have a number of (sometimes conflicting) objectives, with different time horizons and different levels of urgency, which we will measure as specified required probabilities of success. For example, an individual investor might define one goal as saving enough for college tuition in 10 years and specify that she requires a 90% probability of success, while another goal is having $1,000,000 in 30 years to set up a foundation when she retires, with a 60% probability of success. The first goal in this case is more urgent than the second goal.

In this approach:

- The investor's portfolio is composed of subportfolios, and each investment goal is addressed individually with these subportfolios.
- Taxable and tax-exempt investments are part of the opportunity set.
- Instead of expressing an investment goal as an expected average return on the portfolio, we identify and document "minimum expectations" for each goal, which is the minimum expected return necessary to provide a specified minimum required probability of success over the given time horizon.

Often, the advisor will select from a set of pre-established subportfolios (modules) to meet specific goals of a client rather than create new subportfolios for each client. The modules are distinguished by differences in risk-return tradeoffs, liquidity requirements, and the inclusion or exclusion of certain asset classes.

The asset allocation is determined by identifying, for each goal, the module that provides the highest expected return with the specified probability of success over the required time horizon. Then the size of the investment in that module is simply the present value of the future goal discounted at the expected return of that module. The portfolio allocation is then the sum of all of the individual investments necessary to achieve each goal.

EXAMPLE: Goals-based approach

An investor has a goal of having $500,000 to fund his daughter's undergraduate and graduate education beginning in 10 years with a 90% required probability of success. He also has a goal of transferring $6,000,000 to his daughter in 30 years with a required probability of success of 75%.

The modules in the table are available to the adviser to implement each of these goals.

	Module A	Module B	Module C
Expected return	5%	6%	8%
Expected volatility	4%	7%	14%

The annual minimum expected returns at various probabilities of success over the 10-year time horizon are as follows:

Required Success	Module A	Module B	Module C
90%	3.0%	2.4%	–2.2%
75%	3.6%	3.8%	1.7%

The annual minimum expected returns at various probabilities of success over the 30-year time horizon are as follows:

Required Success	Module A	Module B	Module C

90%	4.0%	4.3%	4.7%
75%	4.1%	4.8%	5.2%

Determine the module to use and **calculate** the amount to invest in that module to meet each goal. Treat each goal separately.

Answer:

For the first goal, Module A has the highest expected return given a 90% required probability of success of 3.0% over the 10-year time horizon. The investment necessary today in Module A to fund the $500,000 college tuition in 10 years is the present value of $500,000 discounted at 3.0% for 10 years, or $372,047.

For the second goal, Module C has the highest expected return given a 75% required probability of success of 5.2% over the 30-year time horizon. The investment necessary today in Module C to fund the $6,000,000 transfer in 30 years is the present value of $6,000,000 discounted at 5.2% for 30 years, or $1,311,231.

LOS 13.n: Describe and critique heuristic and other approaches to asset allocation.

CFA® Program Curriculum, Volume 3, page 134

There are additional approaches to optimal asset allocation that are ad hoc and not based on theoretical models and don't require sophisticated mathematics, but also don't necessarily lead an optimal allocation in the way in which we have defined it up to this point.

120 Minus Your Age

This one is easy. It relates your age to your allocation to equities so that 120 − age = % allocation to equities, with the remainder going to fixed incomes. That means a 40-year-old woman would have an 80/20 split between stocks and bonds, and when she is 50, it would be 70/30.

It's consistent with the idea that as the value of human capital declines as we age, our capacity to bear risk in the rest of the portfolio declines, suggesting that we move from equities into fixed incomes. What's interesting about this approach is that it seems to come close to mimicking the allocations of target-date retirement funds.

60/40 Split

This one is even easier than the 120-minus-your-age rule. You simply maintain your asset allocation at 60% stocks and 40% bonds. This is not nearly as off-the-wall as it sounds, as the global financial asset portfolio has historically been split approximately 60/40 between stocks and bonds.

PROFESSOR'S NOTE

I guess the assumption with this method is that you are 60 years old throughout your entire life!

Endowment Model or Yale Model

Under this approach, you allocate larger amounts to alternative investment asset classes (private equity, real estate, or natural resources) than is typically recommended by a strict MVO. Presumably these markets are less-than-perfectly informationally efficient, so investment managers with expertise in these markets can outperform expectations. Also, they are less liquid, and certain institutional investors are positioned to take on additional liquidity

risk in return for a liquidity premium because of their longer time horizons. The approach is popular with university endowment funds.

Risk Parity

The idea with the risk parity asset allocation approach is that diversification is achieved by ensuring that each asset class contributes the same amount to the total portfolio risk. This addresses critique 4 of MVO that diversification across asset classes does not guarantee diversification across risk sources. The criticism of this approach is that it ignores expected returns and focuses only on risk.

1/N Rule

If we create an equally weighted portfolio in which we allocate the same percentage to each asset class, we have in effect weighted each class by 1/N, where N is the number of classes. For example, with 8 asset classes, this approach suggests we invest 1/8 = 12.5% in each class. One common method is to rebalance to equally weighted each quarter. Although it sounds very simple, there is some empirical evidence that this type of approach actually performs better than we would expect.

MODULE 13.8: REBALANCING POLICY

Video covering this content is available online.

LOS 13.o: Discuss factors affecting rebalancing policy.

CFA® Program Curriculum, Volume 3, page 139

Investment managers rebalance portfolios for a number of reasons, including in response to changing client goals and capital market expectations or changes in tactical allocations. Here we will stick to the CFA curriculum definition: adjusting asset allocations to move toward the originally defined strategic allocation goal. Percentage range rebalancing involves setting trigger points around the optimal percentage allocation and rebalancing back to the target allocation or partially correcting when those trigger points are hit.

The key factors that impact the optimal corridor width (or the rebalancing range) of an asset class include transaction costs, risk tolerance, correlations with the rest of the portfolio, and the volatility of the rest of the portfolio.

The higher the transaction costs, the wider the optimal corridor, as the benefits of rebalancing have to “pay” for higher costs to rebalance. The higher the investor’s risk tolerance, the wider the corridor, because the investor is less concerned about deviations from the optimal allocation. The higher the correlation of the asset class with the rest of the portfolio, the wider the corridor, because a portfolio tends to move with the asset class, and the allocations tend to stray more slowly from the target. Finally, the higher the volatility of the asset classes, the narrower the optimal corridor. This is because higher volatility increases the likelihood that the actual allocation will diverge over time from the target allocation.

Ultimately, the choice of corridor width depends on a trade-off between risk control, transaction costs, and correlations between classes. In complex situations, a quantified cost-benefit analysis will be required.

MODULE QUIZ 13.7, 13.8

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

1. Which of the following statements regarding subportfolios within the context of the goals-based approach to asset allocation is *most accurate*?
    A. The most significant difference between the subportfolios is the return-risk tradeoff.
    B. Higher priority goals require higher return assets.
    C. The size of the investment in a particular subportfolio is the present value of the future goal discounted by the risk-free rate.
2. Which of the following statements regarding the “120 minus your age” heuristic is *most correct*?
    A. A 70-year old individual should have 50% of the investment portfolio invested in equity securities.
    B. A 60-year old individual should have 60% of the investment portfolio invested in fixed-income securities.
    C. The approach generally does a poor job of mimicking the allocations of target-date retirement funds.
3. A portfolio has invested in asset class Z and the manager is setting the optimal rebalancing corridor. The corridor will be wider if:
    A. the rest of the portfolio is highly volatile.
    B. the correlation of Z with the rest of the portfolio is highly positive.
    C. transaction costs are low.

KEY CONCEPTS

LOS 13.a

Given an opportunity set of investable assets, their expected returns and variances, as well as the pairwise correlations between them, MVO identifies the portfolio allocations that maximize return for every level of risk. If we assume the opportunity set includes all assets, the result is the efficient frontier.

MVO is criticized for:

1. **GIGO:** The quality of the output from the MVO (portfolio allocations) is highly sensitive to the quality of the inputs.
2. **Concentrated asset class allocations:** MVO often identifies efficient portfolios that are highly concentrated in a subset of asset classes.
3. **Skewness and kurtosis:** These are ignored.
4. **Risk diversification:** MVO identifies an asset allocation diversified across asset classes, but not necessarily the sources of risk.
5. **Ignores liabilities:** MVO also does not account for the fact that investors create portfolios as a source of cash to pay for something in the future.
6. **Single-period framework:** MVO is a single-period framework that does not take into account interim cash flows or the serial correlation of asset returns from one time period to the next.

LOS 13.b, 13.i

MVO provides an efficient frontier of asset allocation choices. However, the allocation selected will depend on the specific investor:

- How do they quantify return to risk?
- Do they require specific assets or asset classes to be excluded or included?
- Do they use an asset-only, liability-relative, or goals-based approach?

Variations on MVO may be used:

- Resampling uses multiple sets of inputs to make the final result less dependent on initial assumptions and typically results in more asset classes being included in the portfolio.
- Reverse optimization solves for expected return by asset class based on the classes' weights in the world market portfolio and uses those consensus return expectations to determine asset allocation for an investor.
- Black-Litterman allows the manager to view adjust those consensus return expectations.
- MCS complements MVO; MCS is covered later.

LOS 13.c

A significant portion of the typical investor's asset portfolio is human capital and also the residential real estate property the investor owns and lives in. We can adapt the MVO

framework to incorporate these kinds of assets into the analysis by estimating the expected return and risk inputs for these assets and constraining the allocations to match current values.

LOS 13.d

Less-liquid asset classes like direct real estate, infrastructure, and private equity require a liquidity return premium to compensate the investor for the additional liquidity risk.

LOS 13.e

The goal of risk budgeting is to maximize return per unit of risk, where we can define risk as total portfolio risk, active risk, or residual risk.

LOS 13.f

Ways to incorporate client risk preferences into asset allocation include:

- Specifying additional constraints.
- Specifying a risk aversion factor for the investor.
- Using Monte Carlo simulation.

LOS 13.g

Monte Carlo simulation can be used to (1) address the limitations of MVO as a single-period model and the related issues of rebalancing and taxes in a multiperiod framework and (2) guide individual investors to identify their risk tolerance level.

LOS 13.h

Investment factors can be used in asset allocation by defining the opportunity set as risk factors that affect expected return. Such factors include market exposure, size, valuation, momentum, liquidity, duration, credit, and volatility.

LOS 13.j

The following characteristics of liabilities are relevant to the asset allocation decision:

- Fixed versus contingent.
- Legal versus quasi-legal.
- Duration and convexity.
- Liability value versus size of sponsoring organization.
- Factors that affect future cash.
- Timing considerations.
- Regulations affecting the determination of the liability’s value.

LOS 13.k, 13.l

There are three common approaches to liability-relative asset allocation.

- Surplus optimization: Use MVO to determine an efficient frontier based on the surplus with its volatility as our measure of risk, stated either in money or percentage terms.
- Two-portfolio approach: Separate the asset portfolio into two subportfolios: a hedging portfolio and a return-seeking portfolio.
- Integrated asset-liability approach: Jointly optimize the selection of both the assets and the liabilities.

LOS 13.m

The goals-based approach is useful for individual investors, who typically have a number of (sometimes conflicting) objectives, with different time horizons and different levels of urgency.

- The investor's portfolio is composed of subportfolios, and each investment goal is addressed individually with these subportfolios.
- Taxable and tax-exempt investments are part of the opportunity set.
- Minimum expectations are specified for each goal.

LOS 13.n

Additional ad hoc approaches to asset allocation include:

- 120 minus your age.
- 60/40 split.
- Endowment model or Yale model.
- Risk parity.
- 1/N rule.

LOS 13.o

The following indicate wider corridors for asset classes:

- Higher transaction costs.
- Higher investor risk tolerance.
- Higher correlation of the asset class with the rest of the portfolio.
- Higher volatility of asset classes indicates a narrower corridor to control risk.

Ultimately, the choice of corridor width depends on a trade-off between risk control, transaction costs, and correlations between classes. In complex situations, a quantified cost-benefit analysis will be required.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 13.1, 13.2, 13.3

1. **A** Reverse optimization is most likely to produce a more diversified portfolio because it starts with the weights of all assets in the global world market portfolio and solves for the consensus expected returns consistent with that highly diversified portfolio. MCS does not address this issue at all because it is used to model behavior over time of any one specific asset allocation. Liability-relative MVO is focused on the change in value of the surplus (PVA − PVL). Resampled MVO is another way to address the concentration issue, but that was not a choice. (Module 13.2, LOS 13.a)

2. **C** Step 1 is to exclude any portfolios that do not meet the 4% minimum return objective. Next, calculate the certain equivalent returns:

   Allocation 1: $0.06 – (0.5 \times 2 \times 0.02) = 0.04$

   Allocation 2: $0.08 – (0.5 \times 2 \times 0.03) = 0.05$

   Allocation 3: $0.10 – (0.5 \times 2 \times 0.04) = 0.06$

   Allocation 3 has the highest certainty-equivalent return, so it should be chosen by Cullis. (Module 13.1, LOS 13.a)

3. **C** Step 1 is to exclude any portfolios that do not meet the 4% minimum return objective. Next, calculate the safety-first ranking to determine highest probability of exceeding the 4%:

   Allocation 1: $(0.06 – 0.04) / (0.02)^{1/2} = 0.141$

   Allocation 2: $(0.08 – 0.04) / (0.09)^{1/2} = 0.133$

   Allocation 3: $(0.10 – 0.04) / (0.16)^{1/2} = 0.150$

   Allocation 3 has the highest probability of exceeding the threshold return. (Module 13.3, LOS 13.i)

Module Quiz 13.4

1. **B** She is young, starting a job, and apparently debt free. A high ability to take risk is plausible. She appears to have no financial capital, so human capital (the new job) appears to be her only capital. Her HC is somewhat riskier and uncertain, so not at all like an inflation-linked bond, which would require her income to be linked directly to changes in inflation. (LOS 13.c)

2. **B** Ignoring the positions and running MVO for the rest of the client's portfolio is a method of dealing with such preexistent positions. This essentially recognizes the client will not sell such positions. Two other methods exist. Include the positions in MVO by (1) modeling the specific characteristics of what that client actually owns, or (2) using data on public funds but realizing that such data will not reflect the specific characteristics of the client's positions. However, you cannot use public data to model the highly specific characteristics of what the client owns. Also, a liquidity premium increases expected return. (LOS 13.d)

3. **B** The reading lists three methods: specifying additional constraints, specifying a risk

aversion factor for the investor, and using MCS. (LOS 13.g)

4. **C** In a single-period model, taxes are easy to incorporate into the analysis, and rebalancing the portfolio is irrelevant. Therefore, MVO can address taxes in a single-period model and MCS is not necessary. MCS becomes useful in dealing with a multi-period framework, where the analysis of taxes and rebalancing becomes much more mathematically challenging otherwise.

   MCS *complements* (does not replace) MVO by addressing the limitations of MVO as a single-period framework.

   MCS tools can be quite different. They vary significantly in their ability to model non-normal returns, serial correlations, tax rates, and non-traditional investments, for example. (LOS 13.g)

Module Quiz 13.5

1. **C** $MCTR_{equities} = 1.19 \times 10\% = 11.9\%$

   Ratio of excess return to $MCTR_{equities} = 8.25\% / 11.9\% = 0.693$

   (LOS 13.e)

2. **C** Not all factors are replicable, but the ones that are can be obtained with a position that is long the desired factor (e.g., growth) and short the undesired factor (e.g., value). Neither asset class–based allocation nor factor-based allocation is superior. It is a matter of which method better resonates with how the manager looks at investing, not the kind of client. (LOS 13.h)

Module Quiz 13.6

1. **B** Insurance company obligations to policyholders are typically contingent (uncertain in timing, amount, or both) liabilities (a legal obligation to pay). Fixed-coupon debt is a fixed obligation to pay, and foundation distributions are not legal liabilities (but may be regarded as quasi liabilities). (LOS 13.j)

2. **B** A bank can typically vary the nature of both its assets and liabilities. A joint optimization (deciding how to set up both) is common. The other approaches take the liabilities as a given and only focus on managing the assets. (LOS 13.l)

Module Quiz 13.7, 13.8

1. **A** The priority of the goal determines the amount of risk taken. Thus, you expect significant differences in risk and return between subportfolios. The allocation to a subportfolio is the future need discounted by the expected return of the assets used in that subportfolio, not by risk-free rates. High-priority goals require more certainty and would be funded by lower, not higher, risk and return assets. (Module 13.7, LOS 13.m)

2. **A** The percentage allocation to equities is based on 120 minus your age. Such an approach has been found to come close to mimicking the allocations of target-date retirement funds. (Module 13.7, LOS 13.n)

3. **B** High correlation allows wider corridors because if the assets move in sync, divergence between them is less likely. Low transaction costs allow narrower corridors

because the cost of rebalancing is reduced. High volatility in either Z or the rest of the portfolio increases risk and calls for narrower corridors. (Module 13.8, LOS 13.o)

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1. See CFA® Program Curriculum Volume 3, page 71, footnote #6.

The following is a review of the Asset Allocation and Related Decisions in Portfolio Management principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #14.

READING 14: ASSET ALLOCATION WITH REAL-WORLD CONSTRAINTS

Study Session 5

EXAM FOCUS

Asset allocation is not an exercise in abstract math. This reading continues the discussion of practical considerations that may arise. Be prepared to recognize the potential impact of the issues discussed on a particular client's asset allocation.

MODULE 14.1: REAL WORLD ISSUES

Video covering this content is available online.

LOS 14.a: Discuss asset size, liquidity needs, time horizon, and regulatory or other considerations as constraints on asset allocation.

CFA® Program Curriculum, Volume 3, page 164

ADDITIONAL CONSTRAINTS WHEN CHOOSING AN OPTIMAL ASSET ALLOCATION

Asset Size

Smaller funds often lack the expertise and governance structure to invest in complex strategies, and therefore, often face a problem of how to achieve an adequate level of diversification. In addition, many capital markets impose local legislation, restricting investment in some assets to investors with a given level of capital or experience. Smaller funds may use commingled investment accounts (pooling money from a small group of investors) to achieve adequate size to diversify. To enable investment in assets where local legislation requires minimum investment levels, families may pool their assets to qualify.

Larger portfolios can generally access greater management expertise in the governance capacity, allowing them to consider complex strategies that smaller funds cannot. Their larger capital base also enables investment in accounts with relatively high minimum investment requirements. This allows large funds to achieve higher levels of diversification.

Large portfolios benefit from economies of scale via cost savings regarding internal management and greater negotiating power regarding management fees, allowing higher allocations to alternative investments. As the size of the fund increases, the *per-participant* cost of the internal governance infrastructure decreases, giving the fund a competitive advantage in private equity, hedge fund, and infrastructure investing.

Funds that are too large may not be able to take advantage of asset classes that lack the capacity to absorb large amounts of funds. For example, active equity strategies involving

small-cap stocks may be less suitable because the size of investment can be too large for an external manager to take on. A small-cap manager may suffer diseconomies of scale as: larger trades have increased price impact, the inflow of capital may encourage managers to abandon their core strategies, and the need for increased numbers of staff may slow the decision-making process. A potential solution is to split the allocation among several managers, but identifying and monitoring suitable managers is an added burden and cost. The result is that large funds often take a passive approach in such situations.

Very large funds may find that there are not enough alternative investments (e.g., too few hedge funds) available and may choose a fund-of-funds (FoF). But this carries a double fee structure for the FoF manager and the underlying fund managers. In addition, the strategies of one hedge fund manager may be offset by strategies of another manager.

Liquidity Needs

The key to successfully addressing the liquidity constraint for a portfolio is to integrate the needs of the owner and the characteristics of the asset class. Some owners require extremely high levels of liquidity and hence typically invest in high-quality, short-term, liquid assets. Other owners with lower needs and much longer time horizons can take advantage of the illiquidity premium inherent in alternative investments, such as real estate and infrastructure.

The following table summarizes the typical liquidity needs of a range of portfolio owners.

Portfolio Owner	Typical Liquidity Needs
Banks	High liquidity needed to support day to day operations and stand ready to repay deposits
Sovereign Wealth Funds, Endowments, Pension Plans, Foundations	Longer time horizons and lower liquidity needs
Property and Casualty Insurance	Relatively high due to unpredictability of claims
Life and Auto Insurance	Relatively low due to predictability of claims
Individuals	Varies by individual circumstance

But there are always case-specific exceptions, such as a bank with highly liquid loan assets that can provide necessary liquidity that is normally provided by the investment portfolio or a foundation supporting research that requires high liquidity to fund potential but unpredictable breakthrough research opportunities.

The possibility of extreme market conditions should also be considered when planning liquidity levels. Investor behavior changes during times of stress, and a successful allocation should take account of the resulting change in cash flows. Portfolio governance is also important in this context. In times of stress, unsophisticated investors may panic sell assets, leading to permanent losses and lower total returns from the capital base when returns revert to precrisis levels.

Time Horizon

A portfolio’s time horizon is defined by a liability to be paid or a goal to be funded at a future date. Asset allocations must consider the horizons defined by each liability and goal, as well as adapting to the changing mix of assets and liabilities as time progresses. The value of human capital, for example, declines over time. As a result, the asset allocation will likely shift towards lower risk asset classes such as fixed income.

The changing nature of liabilities over time also requires changes in asset allocation. A pension fund catering for a young workforce, for example, would be heavily invested in long-term bonds. A more mature scheme would move towards intermediate and short-term bonds.

The time horizon is also associated with the ability to take on risk. Portfolios with longer time horizons are often invested in assets with higher risk. There is evidence that risky asset returns mean revert over time, evening out below and above average levels of return. This concept is known as time diversification.

Asset allocations for individual investors also change over time, as illustrated in the following examples.

EXAMPLE: Older retired individual

Barry Garland is 70 years old and recently retired. He has two goals that require funding from his current portfolio:

- Goal 1: To maintain a constant standard of living to age 85.
- Goal 2: To maintain a constant standard of living from age 85 to 100.

Goal 1 is fully funded, but Goal 2 is only partially funded. Barry's life expectancy at age 70 is 17.5 years.

Goal 1 will have the higher priority as his chances of living decline as he ages. Goal 1 is fully funded and higher priority so the subportfolio will emphasize more conservative investments.

Goal 2 is of a lower priority and currently not fully funded. This subportfolio can be invested more aggressively with more growth potential.

EXAMPLE: Families with multiple funding goals

Jane and Arthur Bigstone are both 52 years old and work as lawyers in their home town. The Bigstones have a daughter, Alice, age 16, who they intend to send to college, and a son Mark, a promising young politician, age 27, who aims to run for mayor of the nearest city in 8 years. If their financial situation allowed it, they would like to make a donation to any campaign he ran. They would also like to set up a scholarship at the local school to fund talented children from underprivileged neighborhoods. Ideally, they would like to do this when they are 80 years old to celebrate the 40^{th} anniversary of Arthur setting up his own practice.

The Bigstones have 4 goals for their portfolio:

1. Funding lifestyle and consumption needs.
2. Funding Alice's college education.
3. Donating to Mark's mayoral campaign.
4. Funding the scholarship.

A typical allocation could split the lifestyle/consumption goal into a worst-case scenario of reduced standard-of-living, a baseline case maintaining standard-of-living, and an aspirational case where the standard-of-living improves. This would mean the Bigstones would have 6 subportfolios with risk preferences similar to those shown in Figure 14.1.

Figure 14.1: Subportfolios

Goals	Risk	Allocation	% of Total Portfolio
Minimum	Conservative	100% Bonds & Cash	65%
Maintain	Moderate	60% Equity & 40% Bonds	12%
Aspirational	Aggressive	100% Equity	8%
College Fund	Conservative	100% Bonds & Cash	6%
Campaign Donation	Aggressive	100% Equity	6%
Scholarship	Aggressive	100% Equity	3%

Aggregate	25% Equity & 75% Bonds	100%

In another 15 years, the allocation for the Bigstones would look very different. With fewer years of consumption to fund, the assets required to fund future consumption are much lower. The college and mayoral campaign have been funded and only the scholarship remains as an aspirational goal. The allocation may now look similar to Figure 14.2, assuming the goals as defined earlier have not changed. Clearly, as the Bigstone's children grow up and pursue careers, it is entirely possible that new goals (e.g., a run for congress for Mark) would replace the aspirational goal of the scholarship.

Figure 14.2: Subportfolios 15 Years Later

Goals	Risk	Allocation	% of Total Portfolio
Minimum	Conservative	100% Bonds & Cash	60%
Maintain	Moderate	60% Equity & 40% Bonds	10%
Aspirational	Aggressive	100% Equity	6%
Scholarship	Aggressive	100% Equity	24%
Aggregate		35% Equity & 65% Bonds	100%

PROFESSOR'S NOTE

It should be evident the specific allocations shown are somewhat arbitrary. There is no formula to determine the numbers. Your task is to see the logic behind choosing a higher or lower allocation to equity, bond, and cash in one subportfolio relative to another.

REGULATORY AND OTHER EXTERNAL CONSTRAINTS

Each portfolio faces its own set of regulatory and other external constraints. Several of these portfolios are addressed in the following.

Insurance Companies

Investment returns are a large contributor to the performance of an insurance company. The asset class with the largest allocation will be fixed income, reflecting the need for the insurer to match assets to the projected cash flows of the risks being insured. Local accounting laws often require fixed income investments to be stated at book value, so the insurer can focus primarily on the pattern of cash flow receipts rather than the volatility of market value.

The main risk considerations are the need to maintain enough capital to meet claims made by policyholders, along with factors that directly affect the company's financial strength metrics. These include:

- Risk-based capital measures.
- Liquidity.
- Yield levels.
- Credit ratings.
- Potential to liquidate assets to meet claims.

Local legislation often limits the allocation insurance companies can make to asset classes. Equity investment maybe limited to as little as 10%, with caps also placed on allocations to private equity investments and high-yield bonds.

Pension Funds

As well as capping the allocation to certain asset classes, local legislation often places a wide range of tax, accounting, reporting, and funding constraints on pension funds. There may be tax incentives offered to invest in domestic assets. Accounting rules may allow deferred recognition of losses.

These factors will be considered in the fund's decision on the level of risk exposure. The final asset allocation is likely to consider the anticipated funding cost, and the implication for the pension expense that is likely to be reported in the financial statements.

When considering funding as a constraint, the pension fund will compare the risk of funding cost exceeding a given threshold for the asset allocation (a risk the fund would like to minimize), to the present value of expected contributions (which the fund would also like to minimize).

For example, higher allocations to equities rather than bonds will increase the volatility of returns. In turn, this increases the risk that low returns increase the required contributions. However, there is a benefit in that the higher expected return would decrease the present value of expected contributions.

The fund will need to decide on the optimal combination of risk (that contributions exceed a given level) and return (as measured by the PV of expected contributions) whilst taking into account the external regulatory requirements and allocation limits.

Endowments and Foundations

Endowments and foundations are both assumed to have an infinite time horizon and are subject to very few regulatory constraints compared to other entities. In some countries, there may be a minimum required annual distribution or socially responsible investment required to maintain a tax-exempt status. The long time horizon usually allows investment in risky assets, but if the endowment is part of the funding of an organization, covenants placed on the organization by lenders may constrain the activities of the portfolio.

Sovereign Wealth Funds

Sovereign wealth funds are government-owned entities investing on behalf of the state, and are typically not looking to match assets and liabilities. They are, however, subject to scrutiny from the citizens of that state which may reduce the level of risk that their long time horizon would otherwise allow them to take on.

In addition, each fund self-governs by capping the allocation of funds to certain assets. The aim of these constraints may include:

- Minimum investment requirements in socially or ethically acceptable assets.
- Maximum investments in risky assets such as alternative investments.
- Limits on the investment allowed in certain currencies.

Investing in ethically acceptable assets involves considering environmental, social, and governance goals. This is usually not part of the initial asset allocation process. Rather, an allocation will be set aside and invested in acceptable assets.

LOS 14.b: Discuss tax considerations in asset allocation and rebalancing.

In the presence of taxation, pre-tax, after-tax risk, and return characteristics may be significantly different. For this reason, taxable entities should consider after-tax characteristics during the allocation process. Adjusting for taxes after allocations have been made may lead to suboptimal allocations.

Although each country has its own unique tax legislation, there are several common characteristics that should be noted.

- Interest income is usually taxed at a higher rate than dividends or capital gains, and often at progressively higher rates. As a result, tax-exempt bonds (such as munis in the United States) may form a large part of a taxable investor's fixed income allocation.
- Dividends are usually taxed at a lower rate than interest. Some investors may invest in preferred stocks in place of bonds for this reason.
- Capital gains are usually taxed at a lower rate than income, and capital losses can be used to offset capital gains elsewhere in the portfolio.
- Certain investment accounts may be tax deferred or tax exempt. The least tax-efficient (most heavily taxed) assets should be placed in the most tax-advantaged accounts.

Taxes complicate the portfolio optimization process. Return and risk need to be considered on both a pre- and after-tax basis, although correlations will be unaffected by taxes.

EXAMPLE: After-tax return

An investor subject to income tax on interest earned at a rate of 40% is considering investing in a bond with a 5% coupon that is expected to be held to maturity. What return should the investor use as an input into the asset allocation process?

Answer:

As the investor is taxable, the after-tax return of $0.05(1 - 0.4) = 0.03$ or 3% should be used.

Equity returns include both dividend income and capital gains. Therefore, the after-tax calculation must adjust for income tax and capital gains tax.

EXAMPLE: Multi-step after-tax return calculation

An investor is subject to income tax at a rate of 30% on dividend income and 20% on capital gains. One potential investment under consideration is a stock with an estimated pre-tax return of 16%. Ten percent of this return is expected be realized in the form of dividend income and 90% as price appreciation (capital gains are assumed to be realized annually). What is the after-tax return to be used in the asset allocation process?

Answer:

Pre-tax dividend income:	16% × 0.1	= 1.6%
After-tax divided income:	1.6% (1 − 0.3)	= 1.12%
Pre-tax capital gain:	16% × 0.9	= 14.4%
After-tax capital gain:	14.4% (1 − 0.2)	= 11.52%
After-tax return:	**1.12 + 11.52**	**= 12.64%**

When an asset has a cost basis (for tax purposes) that differs from the market value, it has an existing unrealized gain (cost basis is below market value) or loss (cost basis is above market

value). Unrealized gains imply an embedded tax liability and losses imply an embedded tax asset. There are three potential ways in which the current market value may be adjusted to reflect the liability or asset.

1. Subtract the value of the embedded capital gains tax from the current market value of the asset as if it were to be sold today.
2. Assume the asset is to be sold in the future and discount the tax liability to its present value using the asset's after-tax return as a discount rate.
3. Assume the asset is to be sold in the future and discount the tax liability to its present value using the after-tax risk-free rate.

Risk, as measured by standard deviation, must also be adjusted in the presence of tax. Capital gains tax reduces the gains realized on price appreciation, and the ability to use capital losses to offset those gains also reduces the losses realized from price declines. A post-tax standard deviation should therefore be used as an input into the asset allocation process.

EXAMPLE: After-tax standard deviation of return

A security has an expected pre-tax standard deviation of 12% and is under consideration for purchase by an investor who suffers capital gains tax at a rate of 20%. What is the after-tax standard deviation?

Answer:

after-tax standard deviation = 12%(1 − 0.2) = 9.6%

The use of both after-tax returns and after-tax risk can have significant impacts on the efficient frontier. Notably, allocations to tax inefficient assets such as high yield bonds will usually decrease. Such assets can, however, still play a part in the optimal allocation assuming they have low correlations with other assets in the portfolio.

Portfolio Rebalancing

To maintain the strategic asset allocation, all portfolios must periodically rebalance. Taxable asset owners will realize taxable gains at each rebalancing, so they must balance the need to maintain the strategic asset allocation with the desire to avoid taxable gains through frequent rebalancing.

Rebalancing should occur less frequently in taxable portfolios due to the reduction in volatility caused by taxation (while correlations remain unaltered). The acceptable rebalancing range after-tax can be calculated by first finding the allowable deviation from target: after-tax deviation = pre-tax deviation / (1 − t).

PROFESSOR'S NOTE

Be careful not to confuse the impact of taxes on after-tax standard deviation (of return) with the impact of taxes on allowable after-tax deviation from target weight for an asset class.

- Taxes cushion the pretax upside and downside of an asset's return and therefore **decrease** after-tax standard deviation of the asset (compared to its pretax standard deviation).

  $\sigma_{AT} = \sigma_{PT}(1 - t)$

- Because taxes lower return volatility, they **increase** the allowable deviation from target allocation weight (compared to pretax deviation).

  deviation from target weight$_{AT}$ = deviation from target weight$_{PT}$ / (1 – t)

EXAMPLE: Pretax vs. after-tax deviation from target allocation weight

A tax-exempt investor's strategic asset allocation calls for a 40% investment in fixed income, ±5% for a range of 35–45%. If fixed income returns are subject to a 30% tax rate, **calculate** the equivalent after-tax rebalancing range.

Answer:

pretax allowable deviation from target weight = 45% − 40% (or 40% − 35%) = 5%

post-tax deviation from target weight = 5% / (1 − 0.30) = 7.14% for a range of 32.86–47.14%

There are two strategies that can be employed to reduce the impact of taxation:

- Tax loss harvesting.
- Strategic asset location.

Tax loss harvesting involves deliberately realizing losses to offset gains elsewhere. Strategic asset location involves making the most efficient use of tax advantageous accounts. There are two types of accounts that offer tax advantages:

- Tax exempt accounts: assets in these accounts are not subject to taxation.
- Tax deferred accounts: assets can appreciate in these accounts tax free but are taxed upon distribution.

Assets placed in tax-exempt accounts need no adjustment to their market value before being included in the asset allocation process. However, the value of assets in tax-deferred and taxable accounts should be reduced by the tax burden.

The portfolio optimization process should consider both the asset classes available and the asset location. For example, if an investor has two accounts available: one taxable and one tax deferred—and two potential asset classes: fixed income and equities, the process should use four account types. It should use two for each asset class, depending on whether they are placed in the taxable or tax-deferred accounts.

The risk and return inputs for equities and fixed income assets to be located in the tax-deferred vehicle (which are allowed to grow tax-free) should be pre-tax. Risk and return inputs for each asset class to be located in the taxable vehicle should be after-tax.

Although liquidity needs for consumption should always be considered (e.g., assets allocated to pension accounts may not be accessible without incurring financial penalties), the following general rules should be applied when considering asset location:

- Assets subject to the lowest tax rates (typically equity) should be first allocated to taxable accounts.
- Assets subject to frequent trading and high tax rates should be allocated to tax-advantaged accounts.

MODULE QUIZ 14.1

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

1. An extremely large fund seeking to make a large allocation to an asset class will *most likely* face a liquidity constraint when investing in:
   A. hedge funds.
   B. global equity.

C. investment-grade bonds.

2. A fund manager oversees a tax-exempt fund and a taxable fund. The strategic asset allocation for both funds is 60% equity and 40% fixed income, with an after-tax rebalancing range of ±12.5%, assuming a tax rate of 20%. The current allocation in both funds is 71% equity and 29% fixed income. Which of the following statements is *most accurate*?
   A. Only the tax-exempt fund is outside its applicable rebalancing range.
   B. Both funds are outside their respective rebalancing ranges.
   C. Neither fund is outside its applicable rebalancing range.

MODULE 14.2: ADJUSTING THE STRATEGIC ASSET ALLOCATION

Video covering this content is available online.

LOS 14.c: Recommend and justify revisions to an asset allocation given change(s) in investment objectives and/or constraints.

CFA® Program Curriculum, Volume 3, page 192

It is unlikely that the initial optimal asset allocation will be applicable for the entire lifetime of any portfolio. In practice, it is common to reevaluate the allocation annually or if a change in goals, constraints, or beliefs suggests it is required.

Change in Goals

For (some) institutions, the business cycle may trigger changes in goals.

A downturn in business, for example, may necessitate increased cash flows from the portfolio. For instance, as airlines face competition from low-budget competitors, and because of uncertain revenue streams, they may reduce the level or risk exposure in their pension fund in order to smooth the volatility of contributions. Pension funds themselves have faced increasing deficits in recent years, which also triggers a reexamination of the asset allocation.

Changes in personal circumstances for the individual investor will also impact the allocation decision. Changes in employment status or starting a family, could both impact an investor's willingness and ability to take on risk.

Change in Constraints

A change in any of the constraints discussed earlier in this reading would also necessitate a review of the current allocation. Examples include:

- Government regulations requiring increased distributions to maintain tax-exempt status.
- Large unexpected cash flows to cover one-off events.
- Increased funding requirements for the beneficiary of an endowment.
- Forced early retirement of an investor due to illness.

Any change in constraint that leads to a requirement for increased cash outflows is likely to necessitate a shift to more liquid assets. Conversely, a large inflow (such as a donation to a foundation) is likely to give the portfolio more flexibility to take on risk.

Change in Beliefs

The investment activities of the asset owner are guided by a set of principles, or beliefs. Just as with goals and constraints, there is no guarantee that these beliefs will not change over time.

For a portfolio run by an investment committee, for example, a change in the makeup of that committee could change beliefs. New members are typically walked through an asset allocation study to make sure they understand the investing approach that had been adopted.

Changes in the economic environment are also likely to have a major impact on the optimization process.

The key inputs when optimizing the asset allocation are expected returns, volatility, and correlation of assets. If macroeconomic forecasts for any major asset class change, then the optimal allocation will likely change. An allocation exercise undertaken in the interest rate environment pre-2008 would have very different expectations for fixed income performance than one undertaken post-2008.

Asset allocations may also change at predetermined dates without the need for a detailed reexamination. Target-date mutual funds, for example, adjust allocations for individual investors depending on their age. Such funds use a *glide-path* and shift from equity to more conservative investments (nominal and inflation-protected bonds) as the target date of the fund approaches.

LOS 14.d: Discuss the use of short-term shifts in asset allocation.

CFA® Program Curriculum, Volume 3, page 198

The long-term asset allocation specified in an investment policy statement is known as the *strategic asset allocation (SAA)*. This represents the target asset weightings for the portfolio.

Short-term deviations, known as *tactical asset allocations (TAAs)*, are typically used to take advantage of cyclical conditions in the market or a perceived mispricing in a given asset class.

Objective

The objective of TAA is to increase risk-adjusted returns by exploiting these short-term opportunities. It should be noted that this strategy assumes short-term returns are predictable (rather than a random walk as for long-term returns), and its success is dependent on market or factor timing, not individual security selection.

The TAA will still take into account the risk constraint specified in the investment policy statement, but will not consider specific goals or liabilities.

Constraints

The success of the TAA should be judged against the benchmark of the SAA. The size of deviations may often be limited to a range around this allocation. There may also be an allowable range of predicted volatility or a tracking error budget versus the SAA.

Evaluation

There are several common methods of measuring the success of a TAA decision.

- Comparing the Sharpe ratios under the TAAs and the SAAs.
- Calculating the information ratio or t-stat of the excess realized returns relative to the SAA.
- Comparing the realized risk and return of the TAA to portfolios lying on the SAA's efficient frontier. It may be less optimal than other portfolios on that frontier.
- Perform attribution analysis on the excess return to identify the contribution of specific under- or over-weightings.

Drawbacks

The use of TAA incurs additional trading costs and taxation in the case of taxable investors. Overweighting an asset class also concentrates risk within the portfolio and reduces diversification benefits.

Approaches to Tactical Asset Allocation

Discretionary TAA relies on qualitative interpretation of macroeconomic variables. A skillful manager will aim to enhance returns in a rising market and hedge risks in falling markets by successfully forecasting short-term deviations from expected returns for an asset class. A manager may use a combination of macroeconomic data, fundamental data, and sentiment indicators to assist with forecasting.

Macroeconomic data will focus on bond yields and credit spreads, monetary policy, GDP growth, earnings and inflation predictions, and other leading economic indicators. Fundamental data such as the deviation of P/E, P/B ratios and dividend yield from their historic means may also be used. Economic sentiment can be gauged using a consumer confidence index.

Market sentiment can be assessed using:

1. Margin borrowing: Increasing purchases on margin drives up prices and indicates investors are bullish, although if the level of margin buying gets too high, it can be a bearish sign and indicates investors are overenthusiastic.
2. Short interest (aggregate amount of short selling): This is essentially the opposite. Increasing short interest drives down prices and indicates investors are bearish, although very high levels could indicate the market is at or near a low.
3. Volatility indices: These indicate the level of fear in the market. It can be calculated using the bid-ask spread on index options. It increases with more purchases of puts and decreases with more purchase of calls.

Although the range of data used in discretionary TAA is quantitative in nature, the individual manager decides which indicators to use and how to prioritize and interpret them.

A systematic approach takes a more quantitative view. It attempts to capture excess returns using strategies that have historically been predictable and persistent. Two of the main factors that may be exploited are value and momentum.

A value approach aims to exploit the excess return of value stocks over growth stocks. Value in equities is most commonly measured using dividend or cash flow yields. Shiller's earnings yield (E/P) uses a 10-year average inflation-adjusted earnings figure compared to market price. Value currencies may be identified using short-term interest rate differentials, and

commodities may be identified using roll yields. Commodity markets in backwardation will provide positive roll yields to the long, and those in contango negative. Yield spreads over risk free rates can be used to identify value in fixed income.

A momentum strategy assumes that trends will persist, which is why recent price movements are used to indicate whether to overweight or underweight an asset class. Indicators used include:

- Most recent 12-month trend: a momentum strategy assumes this trend will persist for the next 12 months.
- Moving-average crossover: shorter-term moving averages crossing above longer-term moving averages indicate an uptrend and vice versa.

MODULE 14.3: BEHAVIORAL ISSUES

Video covering this content is available online.

LOS 14.e: Identify behavioral biases that arise in asset allocation and recommend methods to overcome them.

CFA® Program Curriculum, Volume 3, page 203

Behavioral biases can cause problems during the asset allocation process. An awareness that behavioral bias exists is crucial to dealing with every bias.

Loss aversion is a bias in which investors dislike losses more than they like gains. This makes it difficult for investors to maintain discipline when returns are negative. There is a strong temptation to alter the asset allocation. Goals-based investing can help overcome the loss aversion bias. Goals are prioritized and subportfolios are used. High priority goals are funded with less risky assets, and riskier assets can be used in each subportfolio as the goal priority declines. Risk analysis typically focuses on downside measures such as shortfall risk.

Illusion of control is a tendency to overestimate the ability to control events. Combined with overconfidence, it typically leads to investors failing to diversify, trading too frequently, or both. Some common signs of this bias include:

- Frequent trading and tactical allocation shifts in an attempt at market timing. Investors who correctly call the reversal of a trend have too much confidence in their ability to repeat.
- Active security selection by institutional investors who believe the level of resources at their disposal gives them superior asset selection skills.
- Above average use of short selling and leverage.
- Shifting asset allocations despite a lack of consensus opinion as an individual trustee believes they know better than the market.
- Concentrated positions that expose the portfolio to diversifiable risk.
- Use of biased risk and return forecasts in the asset allocation framework that result in allocations that are inappropriately different from the market portfolio.

To counter the illusion of control, the market portfolio derived from the basic CAPM mean-variance framework should be used as the starting point for the allocation, and shifts in allocation away from this position should be subject to a formal review process.

Mental accounting involves separating assets and liabilities into different "buckets" based on **subjective criteria**. Mental accounting often leads to suboptimal asset allocations and less chance of meeting the goals. Individuals, for example, may spend their tax refund on luxury goods even when their savings are inadequate, or they may maintain low-interest savings accounts while paying high interest on large credit card balances. Entrepreneurs may form an emotional attachment to a company they founded and irrationally hold it in their high risk aspirational risk bucket, even when they no longer have any control at the company. Goals-based investing can help overcome mental accounting bias.

PROFESSOR'S NOTE

Notice that mental accounting is not the same thing as goals based even though goals-based investing has some elements of mental accounting in it. Goals-based investing is primarily a rational effort to differentiate the priority of goals and then use subportfolios in an effort to increase the chances of meeting the goals.

Representative bias, or *recency bias*, occurs when investors attach more importance to recent data than old data. The most common result is for an investor to shift allocations towards assets that have performed well recently. The popularity of purchasing and "flipping" (planning to sell it quickly at a profit) real estate property in the 1990s, can be traced back to a generation who had only experienced rising house prices. The problem was the past trend can and did change. Strong governance and objective asset allocation process are the best methods of defense against representative bias.

Framing bias occurs when the way information is presented affects the resulting decision. This is a common problem in asset allocation. If risk is presented as standard deviation, most investors prefer the lower risk. But downside risk measures may be more useful in specific situations. These include:

- VaR indicates amount of loss at some probability over a time.
- Conditional VaR quantifies the average loss within the VaR tail.
- Shortfall probability directly states the probability of some adverse outcome occurring.

The best way to overcome framing bias is to provide a full range of relevant information and not selectively frame only some pieces of the information.

Availability bias occurs when personally experienced or more easily recalled events disproportionately influence decisions. For example, an investor who suffered significant losses when the tech bubble burst won't buy tech or high P/B ratio stocks ever again. Investors make availability bias mistakes if they benchmark their portfolio performance to that of other investors, without regard to whether those other investors have comparable goals and constraints.

- *Familiarity bias* may be considered an offshoot of availability in that what is familiar or easy to recall is given too much importance in the decision process.
- *Home bias* can be considered another offshoot and is often seen in portfolios that over allocate to domestic securities, missing the opportunity to diversify with international securities.

Starting the allocation process with the global market portfolio can help to mitigate availability biases in the asset allocation process.

Investment Governance

Effective governance is essential to keeping behavioral bias under control. An effective framework should incorporate:

- Clearly stated long-term and short-term objectives.
- Logical allocation of responsibility for asset allocation decisions based on skills and workload.
- Documented processes for developing and approving the investment policy statement.
- Documented process for developing and approving the strategic asset allocation.
- Framework to monitor and report performance relative to specified goals and objectives.
- Periodic audits.

MODULE QUIZ 14.2, 14.3

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

1. A target date mutual fund being used by an individual with a goal of retiring at age 65 will *most likely*:
   A. increase the allocation to inflation-protected bonds later in the glide path.
   B. have a larger allocation to nominal bonds earlier in the glide path as opposed to later.
   C. allocate more of the portfolio to cash in the early phases of the glide path.
2. Which of the following statements regarding the relative success of a tactical asset allocation (TAA) against the strategic asset allocation (SAA) is *most likely* correct?
   A. The TAA is successful if it has a positive Sharpe ratio.
   B. The TAA is unsuccessful if the information ratio is negative.
   C. The TAA is successful if it has a lower standard deviation than that of the SAA.
3. Ellie Rotheram is a 42-year-old real estate broker. Through patient saving, she has accumulated a retirement portfolio worth $720,000. Her investment approach is very conservative, with 88% allocated to fixed income and 12% to equity. She does not want to take the higher risk of equity in this retirement portfolio.

   Recently, Rotheram inherited $500,000 and placed this in a separate portfolio. She realizes she has been very conservative in her retirement portfolio and plans to invest this portfolio more aggressively, in an effort to improve her lifestyle. So far, she has invested $225,000 in real estate investment trusts with holdings in her home state. She also invested $50,000 in the equity of a property development company, because she used to work there several years ago.

   Which of the following behavioral biases is Rotheram *most clearly* exhibiting?
   A. Mental accounting.
   B. Familiarity bias.
   C. Framing bias.

KEY CONCEPTS

LOS 14.a

Portfolios that are too small may be unable to invest in alternative investment vehicles that have minimum investment or qualification requirements.

Large portfolios have the skill, governance structure, and capital resources to invest in complex strategies and achieve diversification levels that smaller portfolios may be unable to achieve.

Portfolios that are too large may find it difficult to invest in niche strategies as the asset pool or managers available are quickly exhausted.

The asset owner's liquidity needs should be matched to the liquidity characteristics of an asset when optimizing asset allocation.

Investor behavior often changes during periods of negative returns, so any liquidity analysis should include an evaluation of liquidity requirements in times of market stress.

Longer time horizons typically allow for greater risk exposure due to the time diversification of risk.

Changes in goals, liabilities, and human capital as time passes mean the asset allocation process is a dynamic one that must be regularly revisited.

LOS 14.b

Investors subject to regulatory and tax requirements must factor those constraints into the asset allocation process.

Taxation reduces the risk and return of assets but leaves asset correlations unaltered.

Lower after-tax risk levels lead to wider rebalancing ranges for taxable investors. Frequent rebalancing leads to realized taxable gains.

Assets taxed at higher effective rates should be allocated first to tax advantaged accounts.

LOS 14.c

Asset allocations should be reviewed in the light of changing goals, beliefs, or other constraints.

Asset allocations may change automatically along a predetermined glide path in reaction to milestones or predictable events that change an investor's risk ability and willingness to take risk.

LOS 14.d

Short-term alterations to the long-term strategic asset allocation are known as tactical asset allocations (TAAs). The permitted size of alterations is likely to be dictated by the investment policy statement.

TAAs aim to enhance returns by altering asset classes, sectors, or risk-factor premium weightings.

The performance of TAAs can be measured by comparing realized portfolio results with TAA implemented to what would have happened under strategic asset allocation (SAA). Success is indicated by a better Sharpe ratio, information ratio, or t-stat of the excess returns. Actual TAA results that plot on the efficient frontier also indicate success.

TAAs can result in excessive trading and tax costs and in the concentration of risk in specific assets in the portfolio.

Systematic TAA uses quantitative signals to dictate shifts in weightings, whereas discretionary allocation relies on qualitative interpretation of data and manager skill in identifying shorter-term trends.

LOS 14.e

- Loss aversion occurs when a dislike of losses and preference for gains distorts rational decision making. Use goals-based investing to mitigate.
- Illusion of control is an overestimation of ability to control events. Start with the CAPM market portfolio and use sound corporate governance to mitigate.
- Mental accounting subjectively (not rationally) treats different pools of funds differently and often leads to suboptimal asset allocation. Use goals-based investing to mitigate.
- Representative (recency) bias overemphasizes the importance of the most recent events and can lead to trend following, assuming what is currently happening will continue. Use sound corporate governance to mitigate.
- Framing bias can result in suboptimal decisions when the way information is presented affects the decisions made. Start with a full range of relevant information to mitigate.
- Availability, familiarity, and home bias are closely related. What is easily recalled or available is given too much importance in the decision process. Start with the CAPM market portfolio to mitigate.

A strong governance process guards against most behavioral biases and should include clearly defined objectives (short and long term), responsibilities, and decision-making process along with a framework for monitoring, reviewing, and performing periodic internal audits.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 14.1

1. **A** Hedge funds are likely the smallest and least liquid class of the three choices. (LOS 14.a)

2. **A** The after-tax rebalancing deviation specified is 12.5% using a tax rate of 20%. The pretax deviation is therefore 12.5% × 0.8 = 10%. This means the tax-exempt portfolio is outside its applicable range. The range for the tax-exempt fund is 50% to 70% for equity and 30% to 50% for FI. The range for the taxable fund is 47.5% to 72.5% for equity and 27.5% to 52.5% for FI. Note that the effect of taxes on allowable deviation from target allocation weight was directly covered in our write up.

   $$\text{deviation from target weight}_{AT} = \text{deviation from target weight}_{PT} / (1 - t)$$

   In this case, you must work from deviation AT backwards to deviation PT, so the relationship is:

   $$\text{deviation from target weight}_{AT} (1 - t) = \text{deviation from target weight}_{PT}$$

   (LOS 14.b)

Module Quiz 14.2, 14.3

1. **A** Target date funds are intended for individuals who plan to retire on the fund's target date. The glide path ends on the target date. As the fund moves from early to late on the glide path, the asset allocation is shifted from equity towards more fixed income and cash. (Module 14.2, LOS 14.e)

2. **B** None of these are perfect answers in that we'd like to know how return to risk for the fund after TAA compares to what would have happened if the SAA (no TAA) had been followed. A negative IR certainly indicates failure as the goal of TAA is positive value added (the numerator of the IR ratio should be positive not negative). A positive Sharpe ratio alone says nothing about how SAA would have done, and lower risk with no idea of return earned provides little information. (Module 14.2, LOS 14.d)

3. **B** She exhibits familiarity bias when investing in equity of a company because she used to work there and a REIT because it has holdings in her home state. She is also using goals-based investing and while that has elements of mental accounting in it, the motivations are quite different. Using subportfolios to address different priority goals can be quite rational and is not by itself a bias. There is no indication that framing of information is a factor here. (Module 14.3, LOS 14.e)

TOPIC ASSESSMENT: ASSET ALLOCATION

Use the following information for Questions 1 through 6.

Tyler Robinson, CFA, a senior analyst at RNC Investments, is reviewing the investment policy statements (IPS) of two new RNC clients.

Bob Carlson, is a 45-year-old seasoned investor who prefers to take a strategic approach to allocating his assets. Carlson has just moved his account from Aggressive Investments (AI) to RNC because he was uncomfortable with the 12% return AI was promising its clients. Carlson knew that this return was only achievable with an increased level of risk-taking. Robinson interviews Carlson to determine his spending rate and his risk aversion score. They agree that a 3% after-tax return should cover his spending needs on an annual basis and that his risk aversion score is 8 out of 10.

Rick Olsen is a 22-year-old recent college graduate who believes in monitoring his portfolio on a daily basis and capitalizing on perceived mispricings. Olsen has just opened up his first investments account through RNC. RNC was recommended by one of his college finance professors who has a son working at RNC. Olsen would like to manage his own investments, but his new job requires him to work 60 hours a week, so he hired RNC. Robinson discusses the same two issues that he covered with Carlson. He concludes a 5% after-tax return is enough to cover Olsen's spending needs and that Olsen's risk aversion is much lower at a score of 2.

After gathering this client data, Robinson specifies the asset class data he will use for the strategic asset allocation. His initial plan is for a tradition mean variance optimization (MVO) that will allow the greatest possible diversification for each investor. To do so, he specifies that each asset class will:

1. Have similar attributes to the other asset classes from both a descriptive and statistical perspective.
2. Be specified in such a way that any single asset qualifies for inclusion in only one asset class.
3. Be liquid enough to allow transaction at reasonable cost.

Robinson later decides his initial approach is too data intensive and instead decides to limit the asset classes he will consider. He consults his firm's economist and gathers the following data on four asset classes. He notices he will need to adjust this data because the returns are given as percentages, but the risk is in decimal (not percentage) numbers:

Asset Class and Name	Expected Return	Expected Standard Deviation
A, U.S. Large-Cap	8.5%	0.15
B, U.S. Small-Cap	12.0%	0.20
C, U.S. Fixed Income	5.5%	0.03
D, Real Estate	7.0%	0.12

Using only this return and risk data plus a correlation matrix, Robinson then creates four portfolios. For the four portfolios, he calculates pre-tax expected returns, standard deviations, and Sharpe ratios.

Portfolio	Exp. Return	Exp. Std. Dev.	Sharpe Ratio	Asset Class Weights %			
				A	*B*	*C*	*D*
1	6.50%	5.95%	0.756	12	13	5	70
2	7.25%	8.30%	0.633	22	5	21	52
3	8.00%	11.15%	0.538	32	18	15	35
4	8.75%	14.25%	0.474	42	21	22	15

Robinson reviews his notes and verifies that Carlson and Olsen both have taxable and tax-exempt accounts where they can locate (hold) assets. Both clients are taxed at 25%. To assign rebalancing ranges, he analyzes the relevant variables and determines suitable ranges for their tax-exempt accounts. For example, if he determines that the allocation to an asset in Olsen's tax-exempt account is 32% with a deviation of 10%, the range would be 22 to 42%.

Robinson is also preparing for a round of client presentations. He prepares the following discussion points to use with his more sophisticated clients regarding issues associated with strategic asset allocation.

1. Allocating a portfolio between risk-free and the tangent portfolio on the efficient frontier is superior to selecting portfolios from the efficient frontier. It not only produces superior excess return to risk, it is simpler and the necessary risk-free assets are readily available.
2. Neither asset-only nor liability-relative asset allocation is necessarily superior. The choice depends on client circumstances. Foundations and endowments normally focus on asset only, but banks focus on liability-relative approaches.
3. Basic MVO has some practical problems. We can instead use Black-Litterman to solve for expected returns by asset class and then adjust those returns as we see appropriate. Or, we can use resampling to solve for a weighted average combination of asset classes that provides an efficient combination of risk and return.

1. Assuming Robinson recommended portfolio 1 to Carlson and portfolio 4 to Olsen, the utility-adjusted returns for both investors would be *closest* to:
   A. 6.72% for Olsen and 6.26% for Carlson.
   B. 5.08% for Carlson and 6.72% for Olsen.
   C. 6.26% for Carlson and 8.61% for Olsen.
2. Regarding Robinson's specification of asset class, which specification is *least accurate*?
   A. Specification 1.
   B. Specification 2.
   C. Specification 3.
3. What approach to asset allocation is Robinson *most likely* using?
   A. Black-Litterman.
   B. Resampled MVO.
   C. Mean-variance optimization (MVO).
4. If Carlson and Olsen hold assets in their tax-exempt accounts instead of taxable accounts:
   A. the after-tax return will exceed the pre-tax return.
   B. the same correlation data will apply to both accounts.

C. the rebalancing range in the taxable account may be skewed to allow less deviation above the target weight.

5. In the example about locating an asset in Olsen's tax-exempt account with a target weight of 32% and a deviation of 10%, the allowable rebalancing range if Olsen locates the asset in his taxable account will be *closest* to:
   A. 25 to 39%.
   B. 19 to 45%.
   C. 29 to 55%.

6. Which of Robinson's presentation points is *least accurate*?
   A. Point A.
   B. Point B.
   C. Point C.

TOPIC ASSESSMENT ANSWERS: ASSET ALLOCATION

1. **B** After adjusting the risk to percentages:

   Portfolio 1 has an expected return of 6.5% and an expected standard deviation of 5.95%. Given Carlson's risk aversion score of 8, his utility-adjusted return would be:

   $U_P = 6.5\% - 0.005(8)(5.95^2) = 5.08\%$

   Portfolio 4 has an expected return of 8.75% and an expected standard deviation of 14.25%. Given Olsen's risk aversion score of 2, his utility-adjusted return would be:

   $U_P = 8.75\% - 0.005(2)(14.25^2) = 6.72\%$

   (Study Session 5, Module 13.1, LOS 13.a)

2. **A** Asset classes have been appropriately specified if:
   - Assets in the class are similar from a descriptive as well as a statistical perspective (homogeneous). Robinson got this one wrong because he is saying the classes should be similar to each other. The classes should be different from each other as specified in the next point.
   - They are not highly correlated, so they provide the desired diversification.
   - Individual assets cannot be classified into more than one class (mutually exclusive). This is his second point.
   - They cover most possible investable assets.
   - They contain a sufficiently large percentage of liquid assets. This is his third point.

   Note that in the next question he consciously decides to limit the number of asset classes he considers. This is normal and he does it in a reasonable manner, including equity, fixed income, and an alternative investment. (Study Session 5, Module 12.4, LOS 12.e)

3. **C** He uses the basic inputs of MVO. The Black-Litterman would have used market asset class weights and solved for expected returns. Resampling would have used multiple sets of MVO inputs, not one set. (Study Session 5, Module 13.3, LOS 13.b, 13.i)

4. **B** Correlation data is a market-level issue and is not affected by the individual investor's tax situation; thus, the same correlation matrix applies to both tax locations. After-tax return will be less than pre-tax return, not more. The rebalancing range in the taxable account may be skewed to allow less deviation below (not above) the target weight to encourage realizing losses. Realizing losses can have tax benefits. (Study Session 5, Module 14.1, LOS 14.b)

5. **B** We are given Olson's tax rate, target weight, allowable deviation, and range for his tax exempt account. Because taxes reduce volatility and risk, ranges can be wider in the taxable portfolio.

   deviation after-tax = deviation pre-tax / (1 – t) = 10 / (1 – 0.25) = 13.33%

   With a target weight of 32% that makes the rebalancing range in the taxable account:

   32 +/– 13.33 = 18.67 to 45.33%

   (Study Session 5, Module 14.1, LOS 14.b)

6. **A** Point A is incorrect. It is describing a capital allocation line between the risk-free asset and efficient frontier. The error is in failing to understand what risk-free means in this context. Risk-free would mean an asset with zero volatility and zero correlation to all other asset classes. In most situations, no such asset exists. In practical terms, most portfolios are built using efficient frontier concepts and combinations of risky assets. Cash is mainly used to meet liquidity needs.

   Point B and C are consistent with the direct coverage and discussions in the text. (Study Session 5, Module 12.3, 12.6, LOS 12.c, 12.h, Module 13.3, LOS 13.b, 13.i)

The following is a review of the Derivatives and Currency Management principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #15.

READING 15: OPTION STRATEGIES

Study Session 6

EXAM FOCUS

The primary focus of this Study Session is on the ways in which derivative contracts (instruments whose values derive from the economic performance of underlying securities, currencies, or other instruments or factors) may be used to hedge, or change the degree of exposure to, existing positions (for example a holding of a stock, or the exposure to a foreign currency caused by the ownership of an asset or liability in that currency). We will also see how derivatives, particularly options, can be used to obtain exposures to instruments and factors that cannot be obtained directly from the instruments and factors themselves (strategies such as straddles and spreads, for instance).

Reading 15 deals with options, mainly focusing on options on individual stocks, although the principles apply equally well to options on any other instruments. Reading 16 looks at the principles and uses of futures and forward contracts, while Reading 17 is concerned with currency management, beginning with the various approaches to currency along the passive-active spectrum, moving on to active currency strategies (including volatility trading via options), before considering currency hedging using futures and forwards (mainly the latter), and options.

The sequence of topics in our coverage of Reading 15 differs from the LOS order. We start by looking at the payoffs and profits associated with holding option positions to expiration. Since value at expiration is purely reflective of intrinsic value, the calculations involved are simple (but highly examinable, so worth getting clear before the complicating issue of time value is addressed). Only then do we move on to the more theory-heavy areas associated with time value—the option "Greeks" and strategies derived from them.

MODULE 15.1: OPTIONS BASICS—VALUE AT EXPIRATION AND PROFIT AT EXPIRATION

Video covering this content is available online.

Options have already been met at the previous levels, of course, so the material in this first module is largely revision. However, we recommend that you don't skip it, since it is vital to everything that follows.

In particular, distinguishing between option value and profit (respectively pre- and post-initial premium), and the graphical representation of how they vary with differing values of the underlying price, is very helpful when we move on to analyze more complex strategies.

A Refresher on Options Terminology

- A **call** is a right to **buy**
- A **put** is a right to **sell**

Each option contract will specify the **underlying** to which the right relates.

- Underlyings include stocks and stock indices, bonds and bond futures, currencies, commodities, and more abstract factors such as stock volatility.

The contract will specify the **exercise** (**strike**) price at which the right can be exercised, and the **expiration** (**expiry**) date (and time) at which the right can be exercised (or not).

- **European-style options** may only be exercised at the point of expiration, while **American-style options** may be exercised on any trading day up to and including the point of expiration.
    - Note that European- and American-style are just labels for the two main styles of option, and are nothing to do with where the options are traded (there are other, more exotic, styles, such as Bermudan, but the details of such exotics are beyond the scope of the syllabus).

The buyer of an option pays a **premium** (the value of the option) to the seller.

- The **buyer** (who takes the **long** position in the option) has the right.
- The **seller** (taking the **short** position) receives the premium as payment for taking on the contingent liability associated with the buyer's right:
    - In the case of a **call** option, the short has undertaken to deliver the underlying if the buyer chooses to exercise (receiving the strike price in exchange).
    - In the case of a **put** option, the short has undertaken to take delivery of the underlying if the buyer chooses to exercise (paying the strike price).

Symbols and Formulas

We must minimize the use of formulas, where possible. The curriculum text does include some formulas and, if they help your understanding, by all means learn and use them, but our experience is that it is more reliable to focus on the underlying principles embedded in the formulas. None of the strategies tested are greatly complex, and in all cases answers can be determined from the basic principles of in/out the moneyness that follow in the next section.

When symbols are used we will follow the notation in the curriculum:

- X = the e**x**ercise (strike) price.
- S = the underlying (**s**tock) price.
- p and c = the prices (premiums) of the **p**ut and **c**all options.
- Subscripts on S, p, and c will stand for time, with 0 = the point at which the position is entered and T = option expiration.

Intrinsic Value and Time Value

At any point in time any given option will have a value. This is set, as are all values, by supply and demand but is likely to be determined by reference to one of the many option pricing models, of which the Black-Scholes-Merton (BSM) was the first (introduced in 1973), and is still widely used.

The key determinants of an option's value are:

- The strike price.

- The current level of the underlying (e.g., stock price, currency rate, etc.).
- The remaining time to expiration.
- The volatility of the underlying (the **expected** annualized standard deviation of the underlying over the period to option expiration).
- The annualized risk-free interest rate over the period to expiration.
- The annualized yield expected from the underlying (if any) over the period to expiration.
- Whether it is European- or American-style (in principle the latter might be worth more because they give the right to exercise before expiration, in addition to at expiration).

Market participants may not agree on what an option is worth—most likely because they disagree on the appropriate figure to use for volatility. However, note that all options that trade on exchanges will have a value, which is reflective of the consensus at that point in time. The current value of an option can be used to infer the consensus estimate of volatility for the underlying, known as **implied volatility**. This is done by working backwards through a pricing model, given the other factors can be directly observed.

Note that **implied volatility** is not the same as **historical (realized) volatility**, which is the square root of the **actual** realized variance of returns to date.

It is important to note that the volatility that is used to determine the option value is an estimate of the volatility **looking forward**, which is not the same as actual movement in the stock price. For example, the implied volatility for a stock option could well rise, even though the stock price is currently stable, if the consensus view changes on the potential for price moves during the period to expiration.

The value of an option can be decomposed into its intrinsic value and its time value, the total premium being the sum of these two.

- **Intrinsic value** is the value of immediate exercise[1]. It reflects the degree to which the option is in the money (ITM).
- **Time value** is the additional value reflective of *what might happen* between now and the point of expiration (i.e. over the option's remaining life).

An option is ITM if the long would derive a benefit from immediate exercise.

- **A call option is ITM if the current price of the underlying > strike price**, so the long has the right to pay less than the current market price for the underlying.

  The intrinsic value in such a case equals the underlying price minus the strike price (the extent to which the underlying price exceeds the strike price, which is the amount the long could gain by exercising their right, then immediately selling the underlying in the market). Note that here, and throughout, we will ignore transaction costs.
- **A put option is ITM if the current price of the underlying < strike price**, so the long has the right to receive more than the current market price for the underlying.

  The intrinsic value in such a case equals the strike price minus the underlying price (the extent to which the strike price exceeds the underlying price, which is the amount the long could gain by buying the underlying in the market, then immediately exercising their right to sell at the strike price).

Note that the intrinsic value is not the same as the profit to the long, which would have to factor in the premium that the long originally paid for the option. This means that it is perfectly possible for an option to be ITM, but for exercise to result in a loss to the long (if the intrinsic value < initial premium paid).

Note also that we are not saying that the long will *choose* to exercise, just that (ignoring premium paid) exercise would lead to a gain.

An option that is not ITM will have zero intrinsic value. It could be at the money (ATM), with the underlying = strike price, or out of the money (OTM):

- **A call option is OTM if current price of the underlying < strike price.**
- **A put option is OTM if current price of the underlying > strike price.**

At any point before expiration an option also has time value, which reflects what might happen over its remaining life. This is a much more complex concept, which explains why the first option pricing formula only appeared in 1973. Time to expiry, volatility, the risk-free rate, and the yield on the underlying all have a part to play, in addition to the underlying price and the strike price.

The details of pricing models are beyond the scope of the Level III curriculum—you will not be plugging figures into the BSM model, for example—but a couple of general principles are worth remembering, namely that with **all other factors held constant:**

- **Higher** volatility means **higher** option premiums (both for calls and puts).
- **Less** time to expiry means **lower** option premiums (both for calls and puts).

Data for Examples

For most of the examples in this reading we will use the following options on XYZ stock (current stock price = $52.14). The premiums are quoted as of "now" (assumed to be 20 March), and the April, May, and June expiration dates are respectively 31, 61, and 91 days in the future. The risk-free interest rate is 3%, and volatility has been assumed to be a constant 60% (we will see later that this is unrealistic, but this is not in itself a problem). The XYZ stock pays no dividends.

Each option contract is a right over 100 shares, but this table shows prices per share (in $), and we will work in per-share terms, unless otherwise stated:

Call Price			Strike	Put Price		
APR	**MAY**	**JUN**	**Price**	**APR**	**MAY**	**JUN**
4.80	6.26	7.40	**50**	2.53	3.87	4.88
3.53	5.05	6.22	**52.5**	3.75	5.14	6.19
2.52	4.02	5.20	**55**	5.24	6.61	7.65

We refer to the May expiry call with a strike price of 50 as the MAY 50 call, for instance.

We will initially be limiting ourselves to evaluating values and profits at expiration. This simplifies things since at expiration there will be no time value—only intrinsic value.

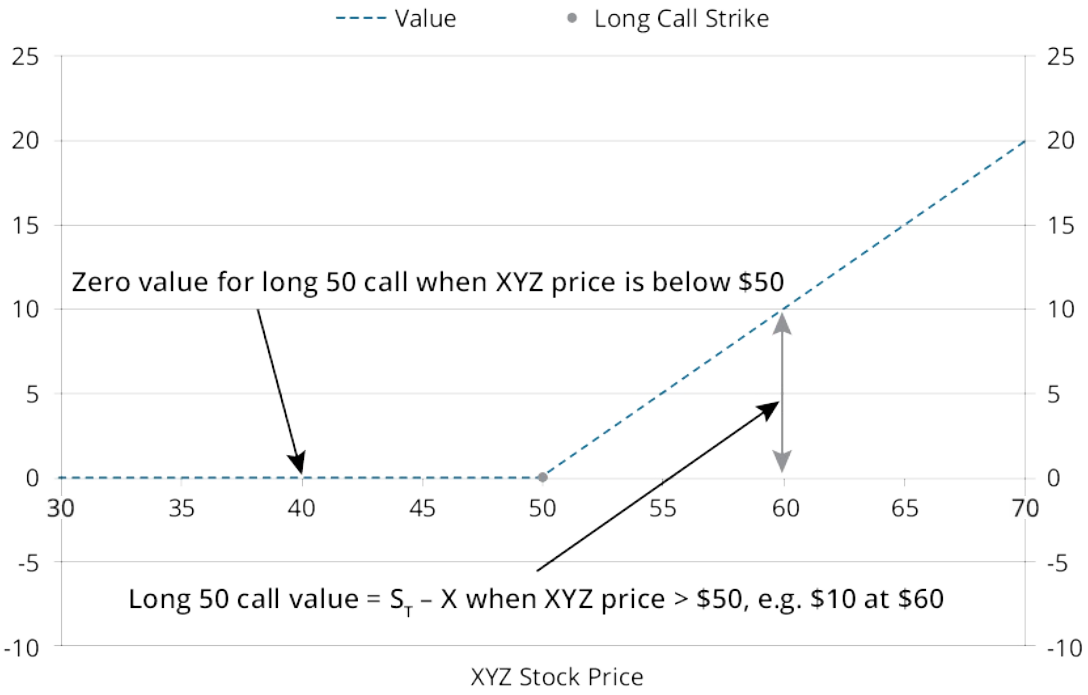
Basic At-Expiration Payoff Diagrams for Calls and Puts

Calls

Let us use the example of a long call to illustrate the way in which option values and profits can be depicted graphically.

Consider an investor who buys (goes long) an XYZ MAY 50 call, paying the $6.26 premium.

At the May expiration the option will either be ITM or OTM, dependent on whether the stock price then is above or below $50. Below $50 it will be OTM, with no (intrinsic) value, while above $50 the intrinsic value will equal stock price—$50:



In all such diagrams, the horizontal axis represents the value of the underlying, while the vertical axis represents the value or profit of the position [which it is will be clear from the labelling of the line(s)] corresponding to that underlying value.

For example, if the XYZ stock price at expiry is $40 then the 50 call will expire OTM, with zero value, while if the stock price at expiry is $60 then the 50 call will expire ITM, with a value of $60 – $50 = $10.

The initial cost of the option was $6.26 (per the table), so the profit at expiration will equal the value of the call minus $6.26, implying:

- If XYZ stock price = $40, profit = $0 – $6.26 = loss of $6.26.
- If XYZ stock price = $60, profit = $10 – $6.26 = $3.74.

Overall, the profit line will be the value line shifted downwards uniformly by the $6.26 initial premium.

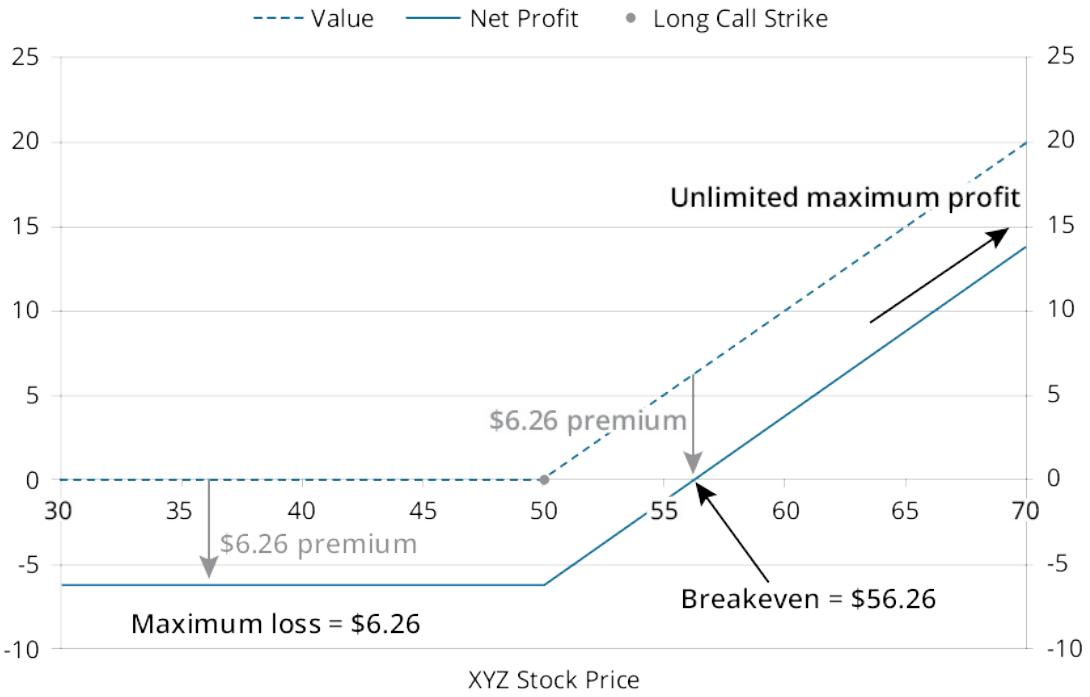
As a rule, for each and every strategy we consider, the profit line will be the value line shifted:

- **Downwards** by the amount of the (net) initial premium – if the (net) initial premium is an outflow (as here).

- **Upwards** by the amount of the (net) initial premium – if the (net) initial premium is an inflow.

This means that if we know the shape of the value line for a strategy, the profit line will have exactly the same shape.

For the long XYZ MAY 50 call:



It is clear that the maximum loss from a long call occurs when the option expires OTM with zero value, thus equals the premium paid.

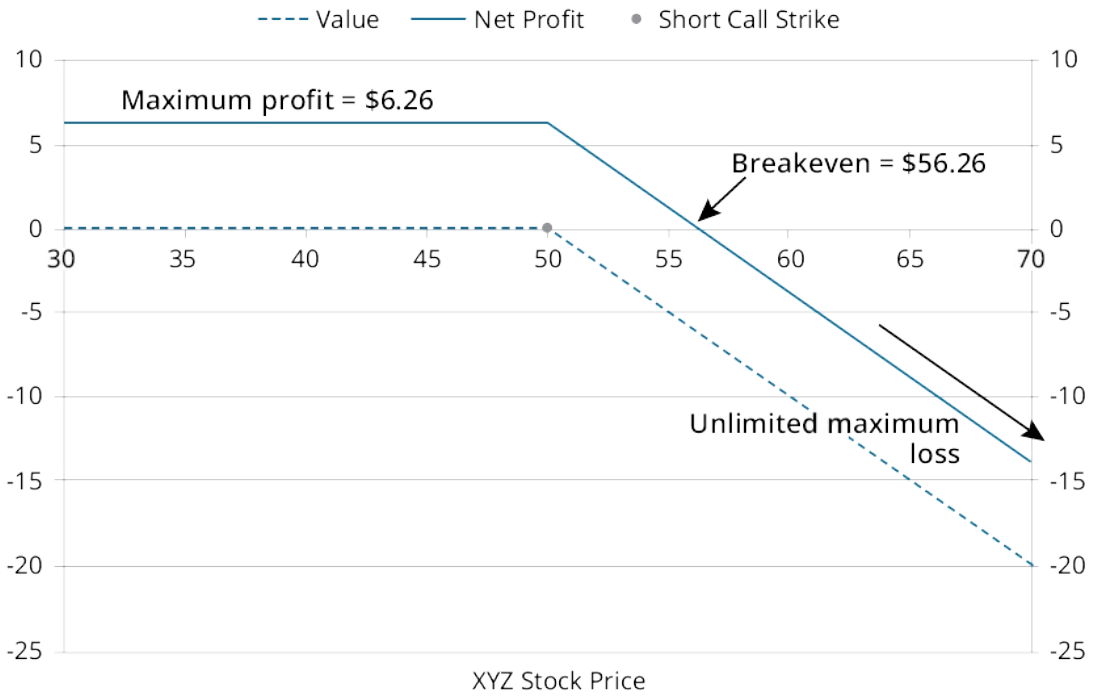
The long call position will break even at expiration if the value at expiration is exactly equal to the premium paid. This will happen when the stock price expires at the sum of the strike and the premium, $50 + $6.26 = $56.26 as shown on the previous diagram.

A long call has no maximum profit—the higher the stock price at expiry, the higher the profit on the call, with no upper limit.

The diagrams for a short call are identical, except that plus values, vertically, become minus, and vice-versa (since, in the absence of transaction costs, a positive result for the long is a negative result for the short, and vice-versa (in the jargon, it is a zero-sum game).

This means that equivalent long and short positions will have identical breakeven values for the underlying, while their maximum losses and profits will just swap around.

The short XYZ MAY 50 call has value and profit at expiration as here:



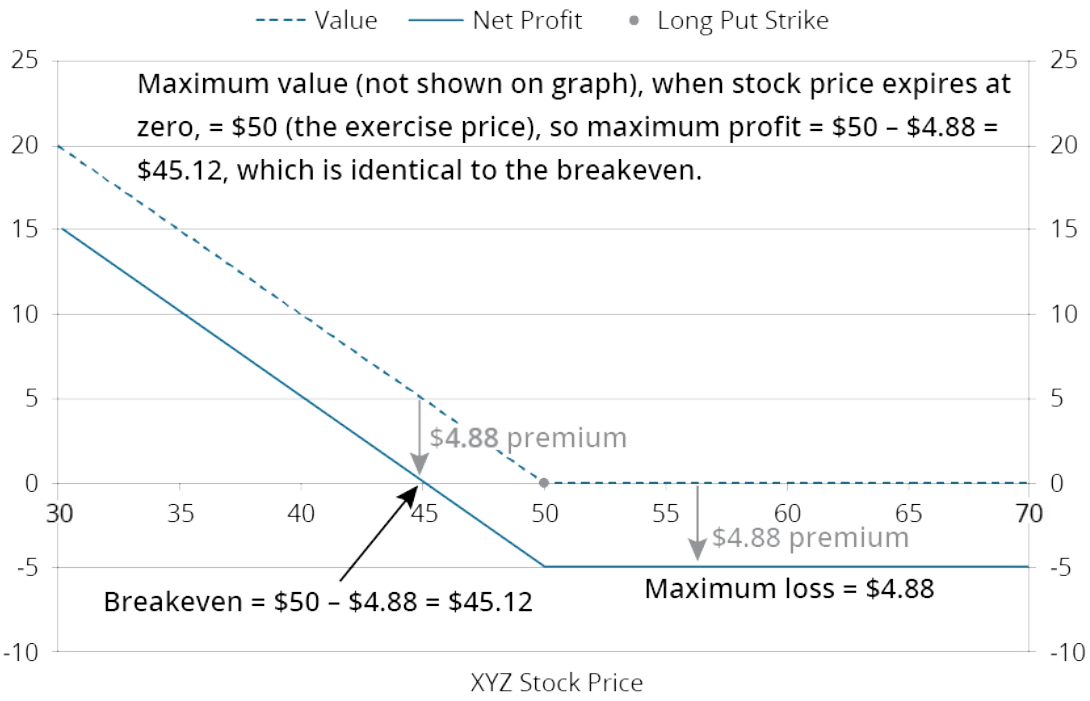
The basic motivation for buying a call is to profit from a rise in the underlying price, while limiting the downside.

When a call is sold (without any hedging position in place) then the position is described as a **naked** (uncovered) **call**, and limited upside from falls in the underlying price is balanced against unlimited potential losses from the underlying rising.

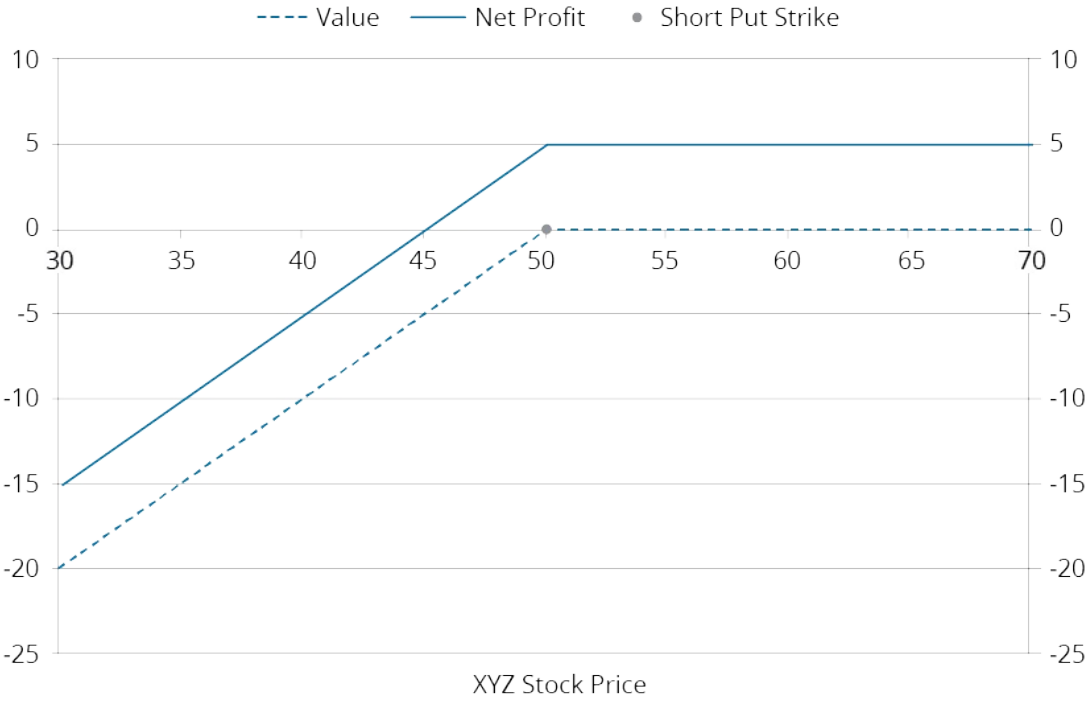
Puts

Puts are ITM on expiry when the underlying value ends below the strike price. This means that the graph for a put exposure will look like the call graph with left and right reversed.

For example, a long XYZ JUN 50 put (initial premium = $4.88) at expiration:



Here is the corresponding short XYZ JUN 50 put at expiration:



Confirm that you understand why the short XYZ JUN 50 put has maximum profit at expiration of $4.88, and breakeven = maximum loss = $45.12.

The basic motivation for buying a put is to profit from a fall in the underlying price, while limiting the downside.

When a put is **sold**[2] limited upside from rises in the underlying price is balanced against large (although limited) potential losses from the underlying falling.

MODULE 15.2: SYNTHETIC POSITIONS USING OPTIONS

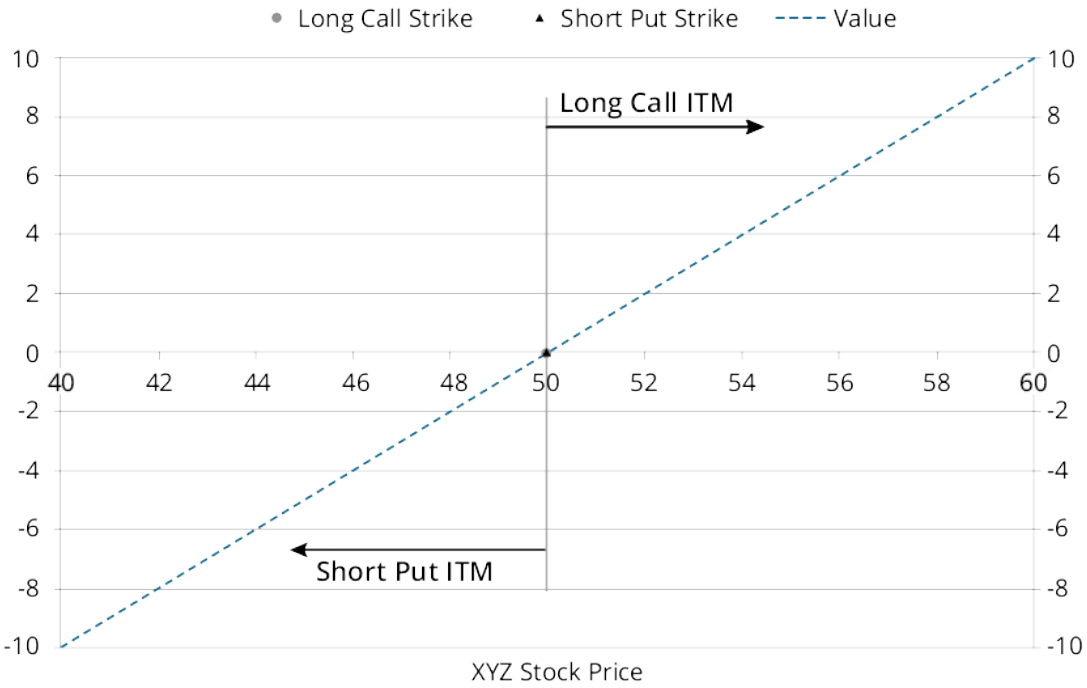
Video covering this content is available online.

LOS 15.a: Demonstrate how an asset's returns may be replicated by using options.

CFA® Program Curriculum, Volume 3, page 227

If we combine a long call with a short put (both on the same underlying, with the same strike price and expiration) then we create a synthetic long forward position.

For example, here are the values at expiration from being long an XYZ 50 call and short an XYZ 50 put:



For values of the underlying above 50 the long call expires ITM (while the put is OTM), giving positive value, while if the underlying is below 50 the short put expires ITM (the call is OTM), giving negative value (it is exercised by the counterparty). Whatever happens to the stock price this position gives the same payoff at expiration as does an identical-maturity long forward contract on XYZ at 50—both result in buying the stock for 50.

- In symbols the value at expiration = $S_T - X$.

Suppose both options were for May expiration, then the premium paid for the call would have been \$6.26, while the premium received on the put would have been \$3.87, for a net initial payment of \$6.26 – \$3.87 = \$2.39. The profit line would thus be \$2.39 below the value line. The breakeven at expiration for the position is \$50 + \$2.39 = \$52.39 (the call would be \$2.39 ITM at this stock price, just covering the net premium paid).

This profit calculation has ignored the time value of money, as we do throughout this topic review when we calculate net profits, but in this section let us be a bit more accurate. The premiums are paid "now" (assumed to be 20 March), whereas the value at expiration is in May, 61 days later, so we should not really just net them off.

As an alternative to buying the call and selling the put, consider buying the underlying XYZ stock in March (for $52.14) and holding it to the May expiration date. If we simultaneously borrow the PV of the strike price then at the May expiration date we will end up with a position with a net value exactly the same as the value of the long call + short put position we just examined: we will be able to sell the stock for the stock price at expiration and will have repay the borrowing (the amount to repay will be the strike price, since the amount borrowed was its present value), leaving us with $S_T - X$, as before.

Since these two positions end up with identical values, irrespective of the stock price at expiration, they must cost the same, so:

- Call premium (paid initially) – put premium (received initially) = initial stock price paid – PV(X) received
- In symbols, $\mathbf{c_0 - p_0 = S_0 - PV(X)}$, which can be rearranged to $\mathbf{S_0 + p_0 = c_0 + PV(X)}$.

This, of course, you will recognize as the **put-call parity** relationship. Note that this version of the put-call parity formula assumes that the underlying pays no yield (during the period to expiry).

In this case, we have $c_0 - p_0 = \$6.26 - \$3.87 = \$2.39$. The risk-free interest rate is 3%, so $PV(\$50) = \$50/(1.03)^{61/365} = \$49.75$, and the equation works, since $S_0 - PV(X) = \$52.14 - \$49.75 = \$2.39$.

Were PV(X) exactly equal to S_0 then put-call parity tells us that the call and put should have identical premiums (because $c_0 - p_0$ would equal zero). X in that situation would be the fair price for a forward contract.

Put-call forward parity substitutes $\mathbf{PV(F_0(T))}$ in place of S_0, where $F_0(T)$ is the forward price for a contract that matures at the same time as the options expire, giving $\mathbf{PV(F_0(T)) + p_0 = c_0 + PV(X)}$. Given that cash-and-carry arbitrage means that the fair forward price for an underlying that pays no yield equals $FV(S_0)$, and $PV(FV(S_0)) = S_0$, this is just a restatement of standard put-call parity.

EXAMPLE

Gavin Ennis is a dealer who has just sold a four-month forward contract on AlphaCo Stock to a client who will thereby purchase 1,000 shares of the stock for 179.59. AlphaCo's current share price is 179, and AlphaCo will not be paying a dividend during the next four months. The annualized interest rate is 1%, and AlphaCo 179.59 calls and puts are both currently trading at 16.34 per share.

Explain how Ennis could hedge his short forward position using a synthetic long forward position, and explain what happens at expiry if the AlphaCo share price is above or below 179.59.

Solution

Ennis should purchase a 179.59 call and sell a 179.59 put (both on 1,000 shares) with expiration matching the maturity of the forward contract. The net premium for these options will be zero.

At forward contract maturity, whatever happens, Ennis will have to sell the 1,000 shares to his client and receive 179.59 × 1,000. This is also the expiry point of the options.

If the share price is above 179.59 then Ennis will exercise the call, which is ITM, and purchase 1,000 shares, whereas if the share price is below 179.59 then the put counterparty will exercise the put (ITM) and sell 1,000 shares to Ennis. In either case Ennis buys 1,000 shares for 179.59 per share, which precisely offsets his obligation under the forward contract.

MODULE 15.3: COVERED CALLS

LOS 15.b: Discuss the investment objective(s), structure, payoff, risk(s), value at expiration, profit, maximum profit, maximum loss, and breakeven underlying price at expiration of a covered call position.

Video covering this content is available online.

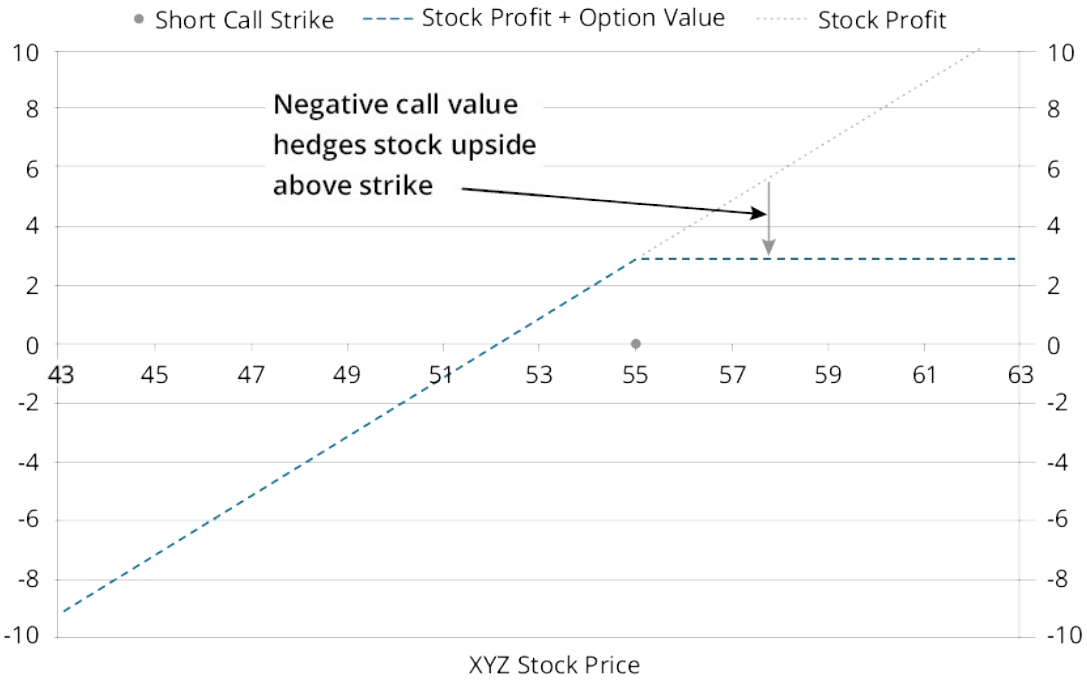
CFA® Program Curriculum, Volume 3, page 232

Covered Calls with Extra Yield the Main Focus

Suppose an investor has a long position in XYZ stock on 20 March. They think that the stock has limited upside over the next month, and are prepared to sell off upside above $55 ($2.86 above the 20 March stock price of $52.14).

The classic way of doing this is to sell a call (a **covered call**, because the risk of the short option position is hedged by ownership of the stock), in this case an XYZ APR 55 call. This will give premium income of $2.52 (per share) in March.

At expiration, if the XYZ stock price is above $55 then the call will be exercised by the counterparty and the investor will be obliged to sell the stock to them for $55. If the stock price is below $55 the call will expire OTM and unexercised, so the investor continues to hold the stock. Ignoring the call premium received, this means the gain/loss associated with holding the stock is capped for stock prices above $55:

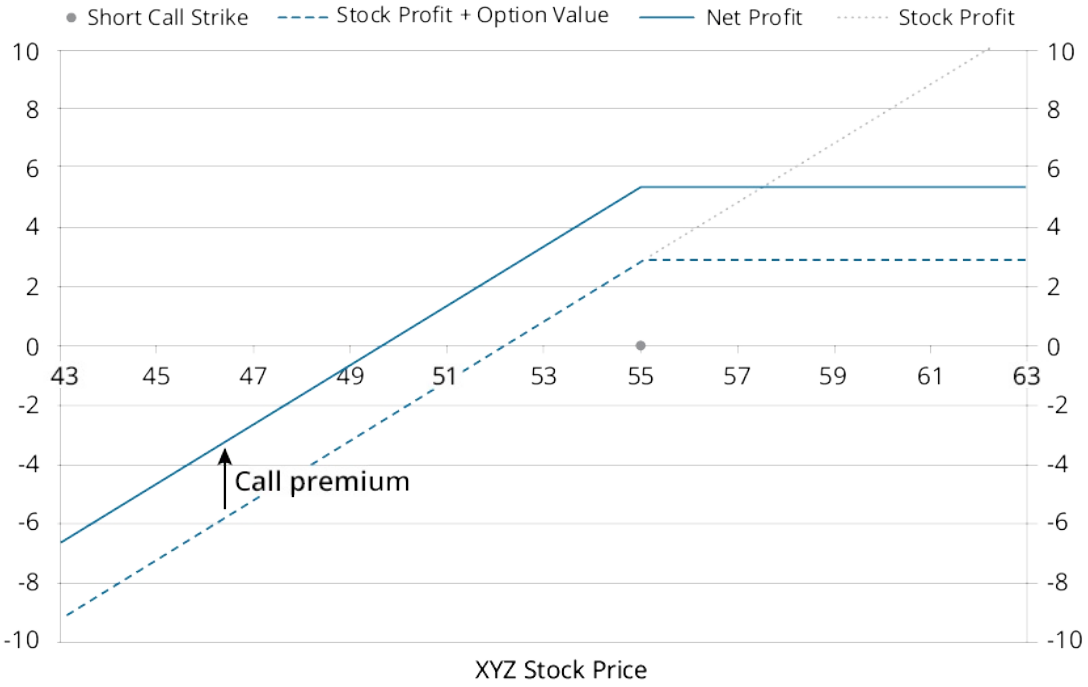


An equivalent way of thinking about it is that below $55 the call has zero intrinsic value, so adding this to the original stock gain/loss leaves us as we were, whereas above $55 the call's intrinsic value is the stock price minus the strike price (with a minus sign in front, since it is short), thus any gain on the stock above $55 is precisely offset by the increasing negative value of the short call.

At $55 the stock has risen by $2.86, and this is thus the maximum gain (ignoring the call premium). Note also that, ignoring the call premium, the breakeven point is the original stock

price of $52.14.

Taking account of the $2.52 call premium received takes us to the overall net profit/loss line:



The net profit line is the stock gain/loss (as modified by the call intrinsic value) shifted uniformly upwards by the call premium received.

The maximum profit equals $2.86 + $2.52 = $5.38, while the breakeven is $2.52 lower than it was without the premium received, which is at $52.14 – $2.52 = $49.62 (up to a $2.52 fall in the stock price is cushioned by the call premium).

Notice that the profit line has the same general shape as a short put and, as for a short put, the maximum loss is the same as the breakeven (since the loss increases one-for-one below breakeven, but the stock price cannot fall below zero). Thus maximum loss = $49.62.

Since the investor holding the stock believed the stock had limited upside over the month, they have turned upside potential (which they did not need) into cash in hand. They will only end up worse off if the stock price at expiry exceeds $55 + $2.52 = $57.52, which is the level at which the original stock gain/loss line cuts through the net profit line.

In general, for a covered call:

- maximum profit at expiry = $X - S_0 + c_0$
- breakeven stock price at expiry = maximum loss at expiry = $S_0 - c_0$

The motivation in the previous example of a covered call was earning extra yield (the focus was on the premium income).

There are two other likely motivations: reducing a position at a favorable price, and target price realization. Let us look at each in turn.

Reducing a Position at a Favorable Price

A second scenario where covered calls might be written is when an investor holds a position in a stock and intends to reduce that holding in the near future. For example Jenkins might hold 5,000 shares in XYZ on 20 March (share price = $52.14), but plans to dispose of 1,500 of these. She might simply sell 1,500 shares at $52.14, realizing $78,210, but instead could write 15 exchange-traded XYZ April 50 call contracts (on 1,500 shares), receiving a total premium of 1,500 × $4.80 = $7,200. Note that the options are currently ITM.

Provided the share price at the April expiry is no lower than $50, the options will get exercised, and Jenkins will be obliged to deliver 1,500 shares for 1,500 × $50 = $75,000. Adding the premium already received to this brings the total proceeds to $75,000 + $7,200 = $82,200, which exceeds the proceeds had she simply sold at the market price on 20 March.

However, there is a risk: if the XYZ price at expiration is lower than $50 then the calls will not be exercised and the shares will not be sold—the opportunity to sell at the current favorable price will have been missed.[3]

Target Price Realization

A third motivation is realizing a target price. In this case calls are written with a strike just above the current market price. The idea is that the investor believes the stock should be worth a bit more than its current price, and would be happy to sell it at that slightly-higher price. For example Perkins holds XYZ shares at $52.14 and writes APR 52.5 calls, receiving $3.53 per share. If the calls are exercised in April then the shares are sold at the $52.50 strike price, so a total per share of $52.50 + $3.53 = $56.03 has been realized.

The dangers are twofold. First, the stock price may rise substantially, in which case Perkins would regret having to sell at $52.50, rather than the higher market price. Second, the stock price might decline, and the opportunity to sell at the current level will have been missed.

Note that this use of covered calls is best seen as a hybrid of the previous two.

The observable difference between these three uses of covered calls is the value of the strike relative to the current stock price:

- For yield enhancement, the calls are OTM (possibly substantially so).
- For reducing a position at a favorable price, the calls are ITM.
- For target price realization, the calls are marginally OTM.

MODULE QUIZ 15.1, 15.2, 15.3

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

1. Which of the following trades would create a synthetic short exposure to PQR stock? The options expire in 6 months, and the risk-free interest rate is 2%.
   A. Borrow 99, buy a PQR 100 put and sell a PQR 100 call.
   B. Borrow 101, buy a PQR 100 put and buy a PQR 100 call.
   C. Buy a PQR 100 call and sell a PQR 100 put, simultaneously selling a six-month forward contract on PQR at 100.
2. An investor purchases a stock for $43 and sells a call for $2.10 with a strike price of $45. At expiration of the call:

   a) compute the maximum profit and loss and the breakeven price.

b) compute the profit or loss when the stock price is $0, $35, $40, $45, $50.

MODULE 15.4: PROTECTIVE PUTS

Video covering this content is available online.

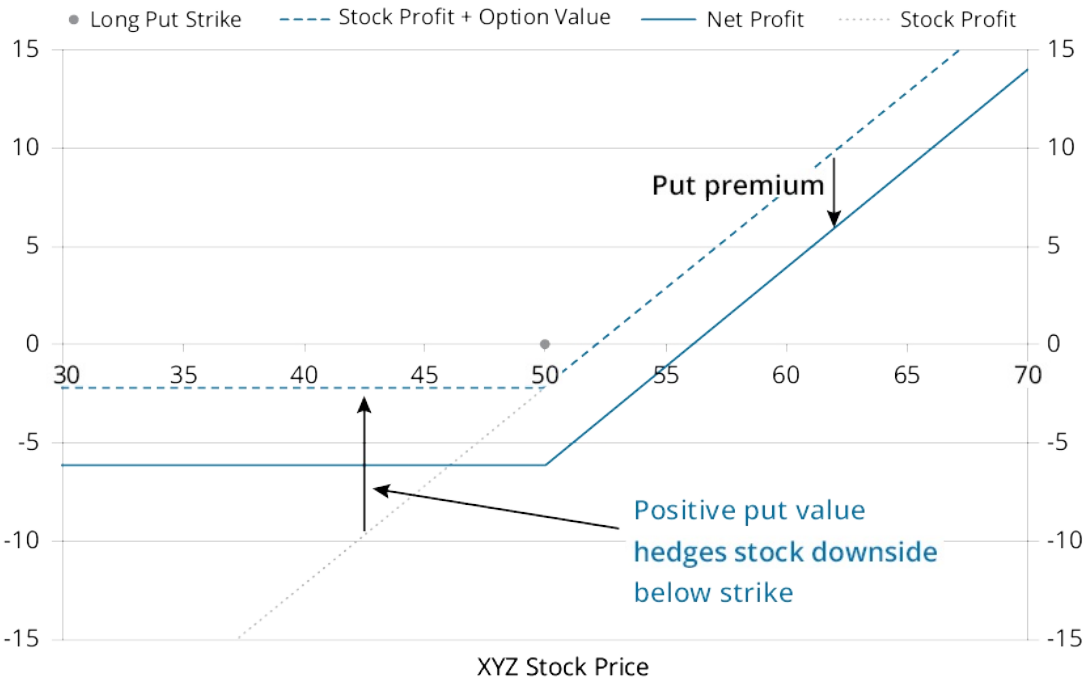
LOS 15.c: Discuss the investment objective(s), structure, payoff, risk(s), value at expiration, profit, maximum profit, maximum loss, and breakeven underlying price at expiration of a protective put position.

CFA® Program Curriculum, Volume 3, page 240

For an investor who has a long position in an underlying, the classic options-based hedge is the protective put – buying a put option to protect against the underlying falling in value, while retaining upside.

Suppose that an investor has a holding of XYZ stock on 20 March, and purchases XYZ May 50 puts on an equal number of shares as a hedge. The puts will cost $3.87 per share, and the share price is $52.14.

The position at May expiry is as shown on the next graph (in per-share terms, as always):



As with the covered call, when the initial option premium cost is ignored the breakeven is the same as for the unhedged stock, but this time we see that the stock loss is limited to the distance of the strike below the initial stock price ($52.14 – $50 = $2.14). Factoring in the initial premium, the net maximum loss is $2.14 + $3.87 = $6.01, while the breakeven is the premium added to the unhedged breakeven of $52.14, so $52.14 + $3.87 = $56.01. This breakeven can also be inferred from the fact that at 50 there is a loss of $6.01, so the underlying needs to expire $6.01 above that, at $56.01, to break even.

In general, for a protective put:

- Maximum loss at expiry = $S_0 - X + p_0$
- Breakeven stock price at expiry = $S_0 + p_0$
- Maximum profit = unlimited

MODULE 15.5: OPTIONS AS A HEDGE OF A SHORT POSITION

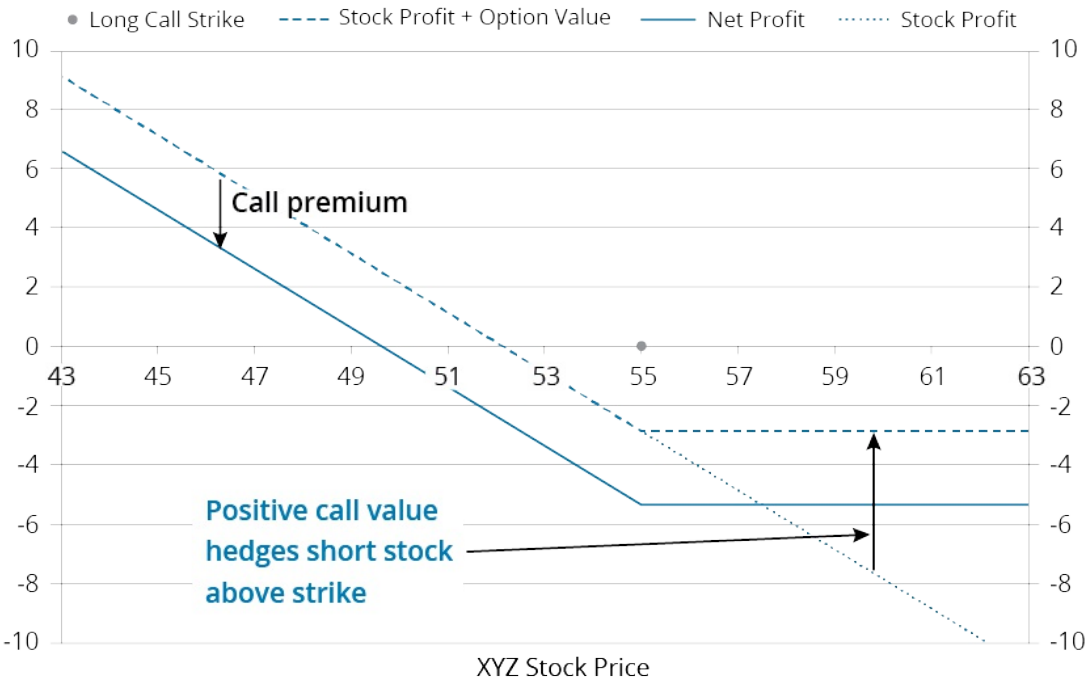
Video covering this content is available online.

LOS 15.e: Compare the effect of buying a call on a short underlying position with the effect of selling a put on a short underlying position.

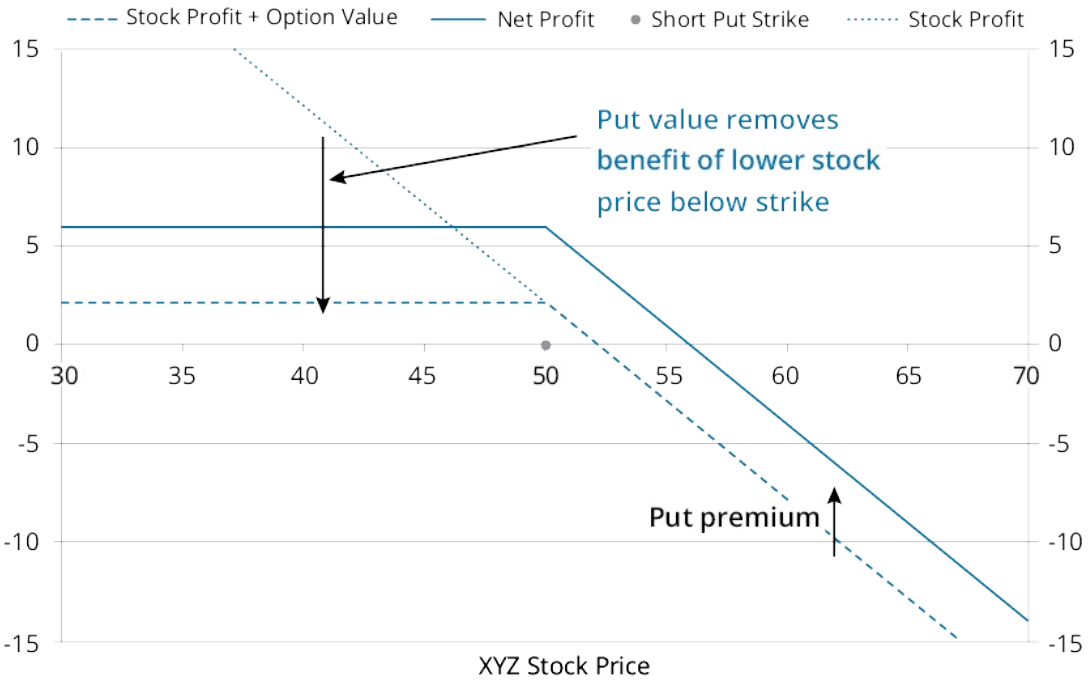
CFA® Program Curriculum, Volume 3, page 248

If an investor starts with a short position in the underlying, they will gain if the price falls and lose if the price rises.

Buying a call (probably above the current stock price) would provide a hedge against the stock rising. This is analogous to the way a protective *put* hedges a *long* stock position against a *fall* in the price:



Similarly, the sale of a put (probably below the current stock price) sells off (part of) the benefit of the stock falling, in the same way a **covered *call*** sells off the upside of a ***long* stock** position:



MODULE QUIZ 15.4, 15.5

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

1. An investor purchases a stock for $37.50 and buys a put for $1.40 with a strike price of $35. At expiration of the put:

   a) compute the maximum profit, maximum loss, and breakeven price.

b) compute the profit or loss for when the stock price is $30, $35, $40, and $50.

2. It is September, and Jones has a short position in Alphacorp stock. The share price is currently 220 and Jones anticipates little movement in the price over the next month, although his long-term view is bearish. To increase his yield from the holding Jones would *most likely* sell:
   A. October 240 calls.
   B. October 240 puts.
   C. October 200 puts.

MODULE 15.6: COLLARS

Video covering this content is available online.

LOS 15.f: Discuss the investment objective(s), structure, payoffs, risk(s), value at expiration, profit, maximum profit, maximum loss, and breakeven underlying price at expiration of the following option strategies: bull spread, bear spread, straddle, and collar.

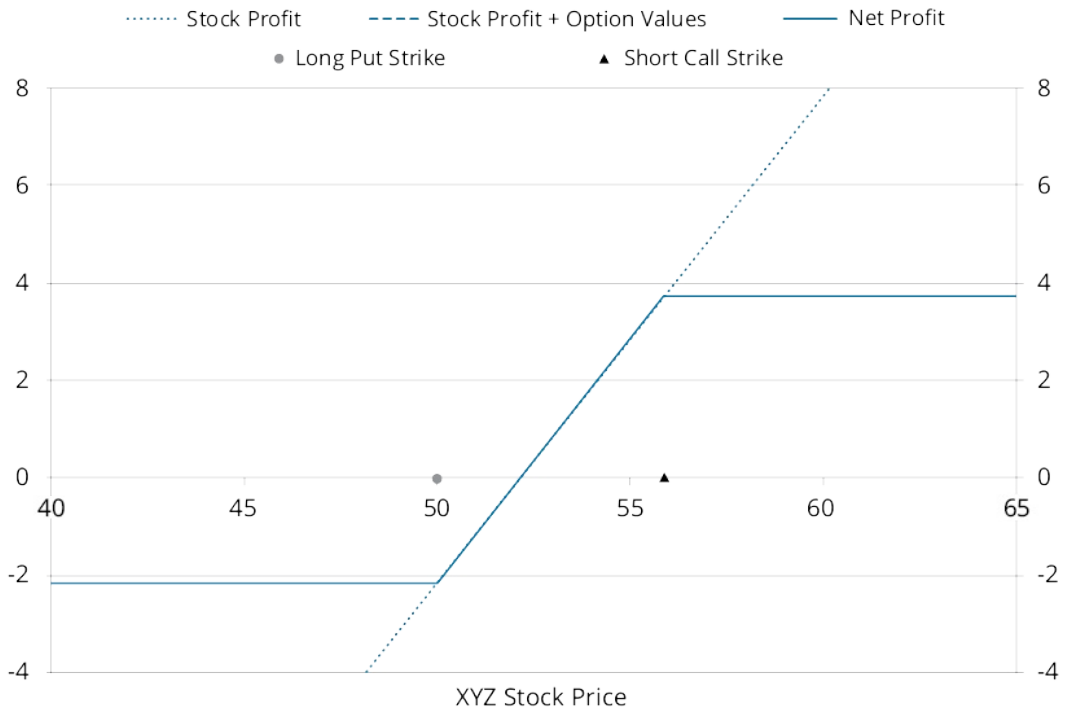
CFA® Program Curriculum, Volume 3, page 252

The **collar**[4] is probably best thought of as combination of protective put and covered call.

An investor who is long the underlying could buy a put (most likely OTM) to hedge the stock's downside, while at the same time selling a call (also most likely OTM) to sell off the upside and subsidize the cost of the call.

Usually the put strike is set, then an appropriate call strike is determined such that the call and put have the same premium. If the options are over-the-counter, rather than exchange-traded, this will be easy to do. In this case there will be no net inflow or outflow at initiation and the investor will have constructed a **zero-cost collar**.

For example, consider an investor with a holding of XYZ stock on 20 March (price = $52.14). They buy a June 50 put (premium = $4.88) and sell a June 55.87 call (premium = $4.88). At the June expiration:



Notice, in this case, that the line for stock profit + option values is the same as the net profit line because of the zero net initial premium.

The stock value is hedged beyond the strikes, with a maximum profit equal to the rise from the initial stock price up to the call strike ($55.87 – $52.14 = $3.73) and a maximum loss equal to the fall from the initial stock price down to the put strike ($52.14 – $50 = $2.14). The breakeven stock price is simply the initial stock price of $52.14, as when it was unhedged.

MODULE 15.7: STRADDLES

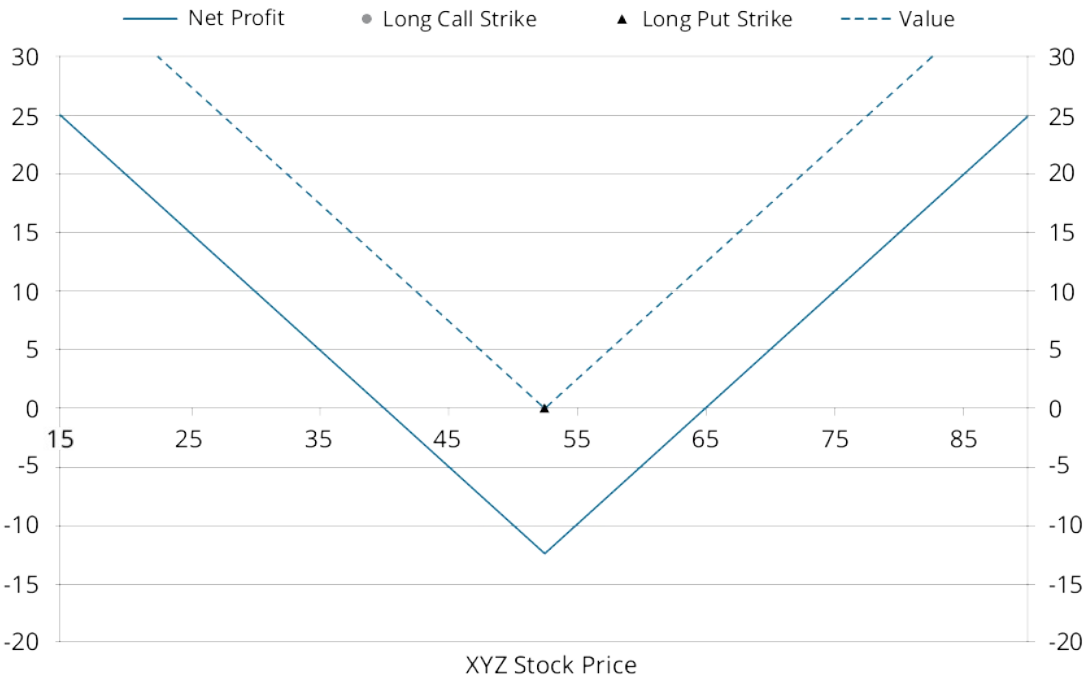
Video covering this content is available online.

The **straddle** is the classic volatility play. A **long straddle** involves the purchase of an equal number of calls and puts on a given underlying. The options all have the same expiry date and strike[5].

Notice that, unlike the strategies we have considered up to now, the straddle (and the spreads that follow) do not involve a position in the underlying—they just use options.

Keeping it simple, let us consider the purchase of a call and a put on one share of XYZ on 20 March. Typically the strike would be close to ATM, so given the stock price is $52.14, let us go long both the June 52.5 call and the June 52.5 put.

At expiration *either* the call *or* the put will be ITM, but not both. The call is ITM for stock prices above 52.50, while the put is ITM for stock prices below 52.50:



The value line for a long straddle is always V-shaped, centered on the strike, where both options expire worthless, so the total value is 0.

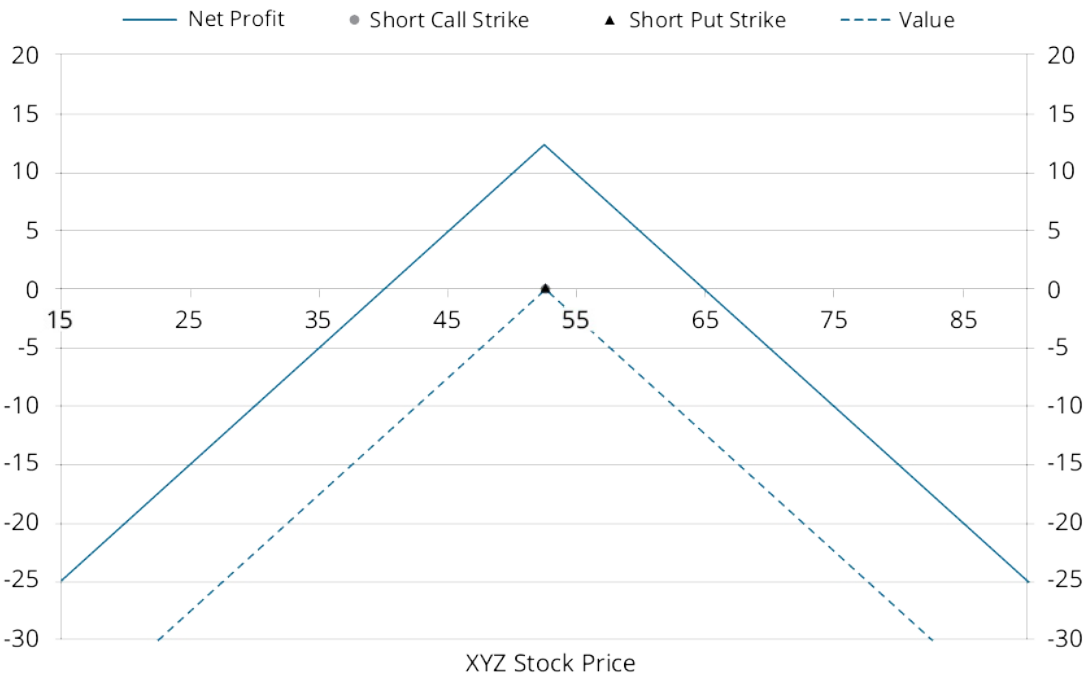
In this case, the premium for the call was $6.22, while the premium for the put was $6.19. Both were paid at initiation, so there was a total outlay of $6.22 + $6.19 = $12.41. This is thus the maximum loss (at the strike). The strategy breaks even at expiration when:

- either the call is $12.41 ITM at $52.50 + $12.41 = $64.91
- or the put is $12.41 ITM at $52.50 – $12.41 = $40.09

The strategy, if held to expiration, makes larger profits, the further from the strike the underlying ends up (i.e. the more the underlying moves, either way). There is no maximum profit.

A **short straddle** involves selling, instead of buying, and is a neutrality play. It makes more profit the closer to the strike the underlying ends up, with no limit on potential loss.

The at-expiration value and profit for the short XYZ June straddle is shown here:



MODULE QUIZ 15.6, 15.7

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

1. An investor purchases a stock for $29 and a put for $0.20 with a strike price of $27.50. The investor also sells a call with the same expiration date for $0.20 with a strike price of $30. At expiration of the options:

   a) Calculate the maximum profit and loss and the breakeven price.

   b) Calculate the profit or loss when the price is $20, $25, $28.50, $30, and $100.

2. An investor purchases a call on a stock, with an exercise price of $45 and premium of $3, and a put option with the same maturity that has an exercise price of $45 and premium of $2. At expiration of the options:

   a) Compute the maximum profit, maximum loss, and breakeven price.

   b) Compute the profit or loss when the price is $0, $35, $40, $45, $47, $55, and $100.

3. The EUR is trading at USD 1.035. A trader expects the EUR to become much more volatile than is reflected in current option prices. Puts and calls on the EUR are available. Puts with a strike of USD 0.98 are trading at USD 0.005 and with a strike of USD 1.04 are trading at USD 0.017. Calls with a strike of USD 0.98 are trading at USD 0.068 and with a strike of USD 1.04 are trading at USD 0.004. Compute the at-expiry breakeven price or prices of the correct option strategy.

MODULE 15.8: SPREADS

Video covering this content is available online.

Bull and bear spreads are positions that have equal numbers of long options on one strike and short options on a second strike. A spread will *either* be constructed using calls *or* using puts.

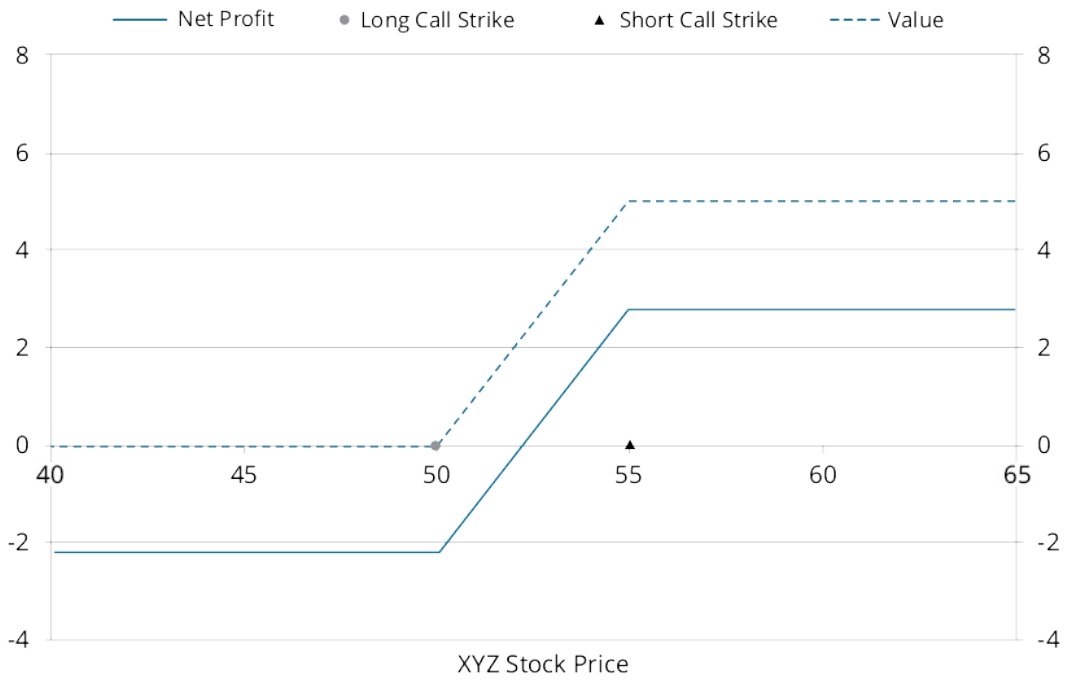
- **Bull** spreads use **long** options on the **lower** strike (**Bull** = **Buy L**ow) and **short** options on the **higher** strike.
- **Bear** spreads use **short** options on the **lower** strike and **long** options on the **higher** strike.

Bear spreads are just short bull spreads, in fact.

Bull Call Spread

Suppose that on 20 March an investor buys an XYZ June 50 call for $7.40 and sells an XYZ June 55 call for $5.20. This will involve a net outlay of $7.40 – $5.20 = $2.20.

The following diagram shows the value of the position, and the net profit, for a range of stock prices at expiration:



It is clear that the exposure is bullish, but limited, compared to just having a long call at 50.

We can think of the bull call spread as similar to a covered call, but with a long call taking the place of the stock.

Below the lower strike the position has zero value, since both options expire OTM.

Between the strikes only the long call expires ITM, so the value is equal to the difference between the stock price and the lower strike.

At 55 the value will equal 5, the difference between the strikes. This is also the maximum value, since any further upside to the long call is hedged away by the short call, which goes ITM above 55.

The maximum loss (when value = 0) is the net premium paid, $2.20.

Breakeven occurs when the value of the long call exactly compensates for the net premium paid. This will be $2.20 above the lower strike, at $50 + $2.20 = $52.20.

The maximum profit is the maximum value of $5 less the net premium, thus $5 – $2.20 = $2.80.

In general, for a bull call spread:

- Maximum loss = net premium paid
- Breakeven = lower strike + net premium paid
- Maximum profit = difference between strikes – net premium paid

The bull call spread is an example of a **debit spread** since it entails a net outlay: the bought call, with a lower strike, is more valuable than the sold call.

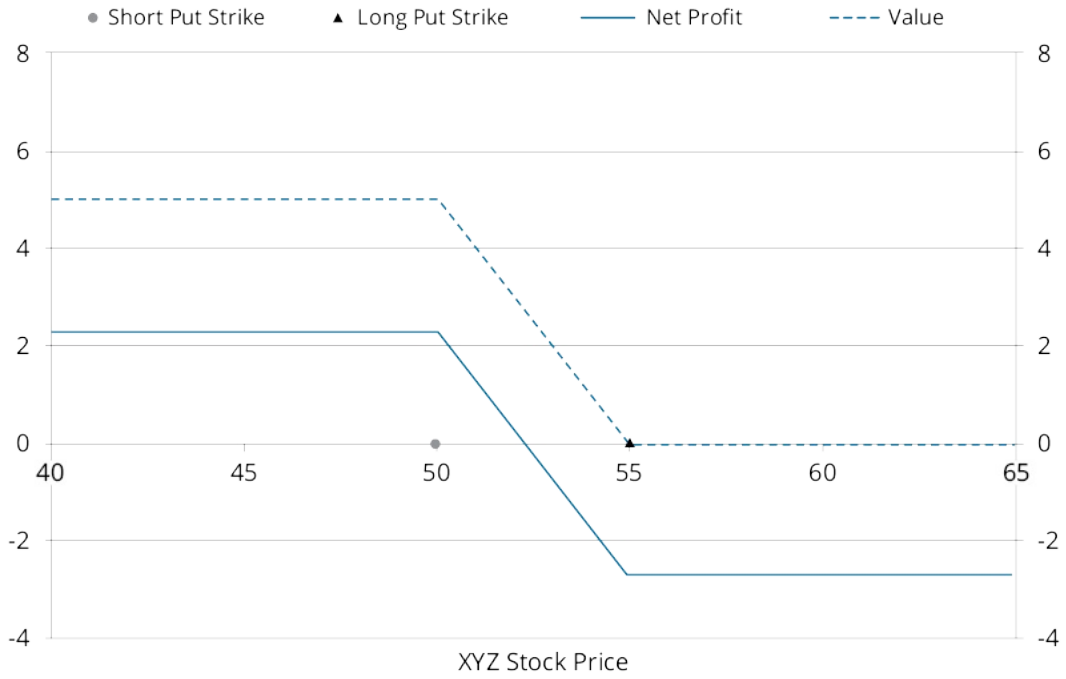
The other debit spread is the bear put spread.

Bear Put Spread

Here we sell a lower strike put and buy a higher strike put.

Suppose that on 20 March an investor buys an XYZ May 55 put for $6.61 and sells an XYZ May 50 put for $3.87. This will involve a net outlay of $6.61 – $3.87 = $2.74.

Value and profit at May expiration:



It is clear that the exposure is bearish, but limited, compared to just having a long put at 55.

Both options are OTM above the higher strike, for zero value.

Between the strikes the value reflects the moneyness of the long 55 put (how far the stock price is below the upper strike).

At the lower strike, the value is maximized and is hedged at that level for any lower stock price.

For a bear put spread:

- Maximum loss = net premium paid ($2.74 in this case)
- Breakeven = higher strike – net premium paid ($55 – $2.74 = $52.26)
- Maximum profit = difference between strikes – net premium paid ($5 – $2.74 = $2.26)

Bear Call and Bull Put Spreads

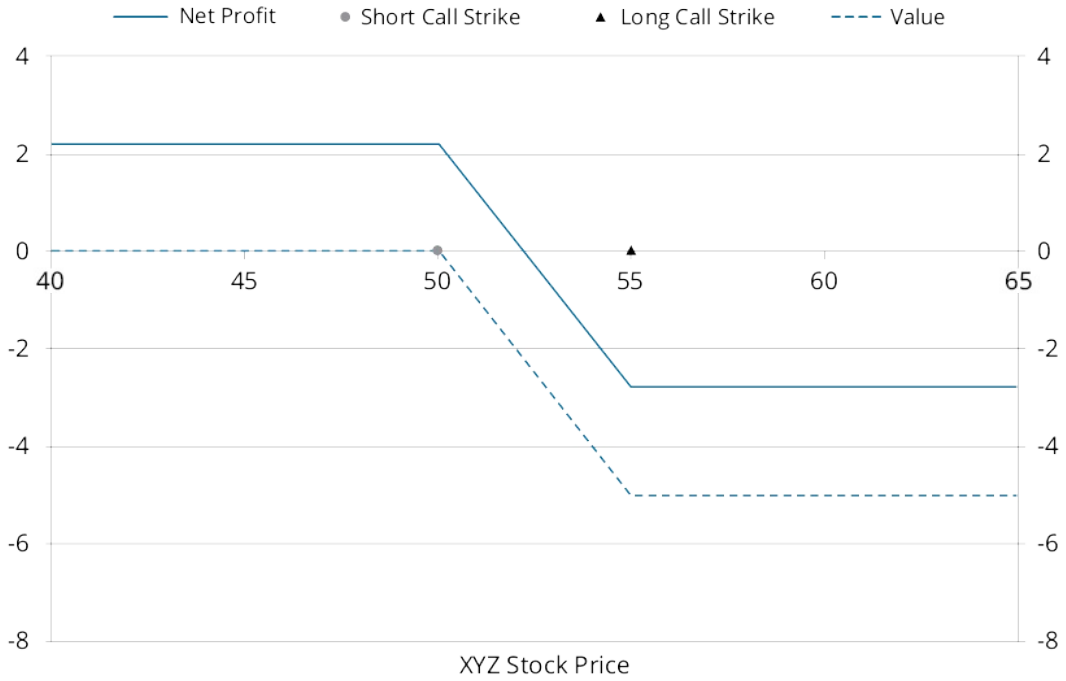
It is also possible, of course, to use calls to create a bear spread, or puts to create a bull spread. In both cases there would be a net inflow of premium (since the relatively more valuable option is sold) and they are referred to as **credit spreads**.

PROFESSOR'S NOTE

As a general rule, assume that a bull spread would be constructed using calls and that a bear spread would be constructed using puts (i.e. that debit spreads are to be preferred over credit spreads) unless a question states otherwise.

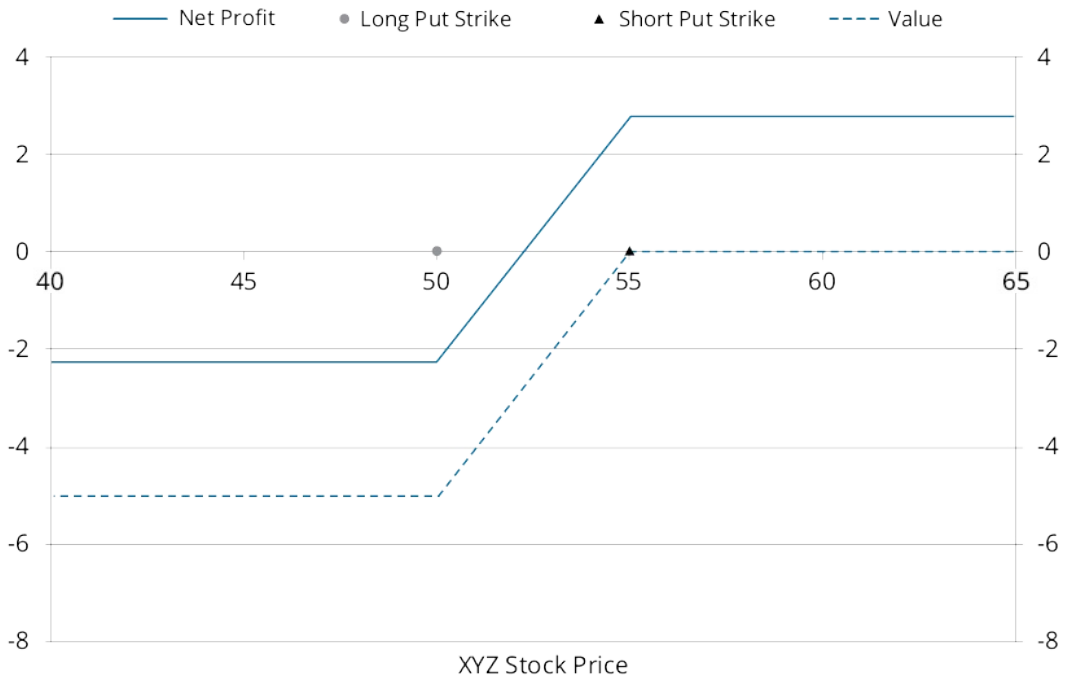
If you need to make calculations for a bear call spread then remember that it has the same profile as a bull call spread, but with profits and losses reversed.

For example, a short XYZ May 55 put ($6.61) plus a long XYZ May 50 put ($3.87). This will give an initial net inflow of $2.74, which will be the maximum profit at expiry:



- Maximum profit = net premium received
- Breakeven = lower strike + net premium received
- Maximum loss = difference between strikes – net premium received

Similarly, a **bull put spread** is the reverse of a bear put spread, in this case a long XYZ May 55 put ($6.61) and a short XYZ May 50 put ($3.87). At expiration:



- Maximum profit = net premium received
- Breakeven = higher strike – net premium received
- Maximum loss = difference between strikes – net premium received

Beware of credit spreads using American-style options, where there is the possibility of the short option going ITM, while the long option is still OTM, in which case the counterparty might choose to exercise early, which would disrupt the strategy.

Adding a Short Leg to a Long Position

Both legs of the spread do not necessarily have to be established at the same time, or held for the same length of time. For instance, a trader might have gone long an October 30 call in August, when the stock price was 28, and by September the stock may have risen to 38.5, so that he is already sitting on a potential profit. If at that point he thinks it unlikely that the stock price will rise further, he might sell an October 40 call, effectively cashing in the upside potential he does not think he needs. This is similar to the motivation behind a covered call.

Generalized At-Expiration Formulas for Spreads

In these formulas, net premium means the absolute value of the difference between the premiums.

For **debit spreads** (bull call and bear put):

- Maximum profit = net premium
- Maximum profit = difference between strikes – net premium

For **credit spreads** (bear call and bull put):

- Maximum profit = net premium
- Maximum profit = difference between strikes – net premium

For **Bull spreads**, breakeven = lower strike + net premium

For **Bear spreads**, breakeven = higher strike – net premium

MODULE QUIZ 15.8

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

1. An investor purchases a call for $2.10 with a strike price of $45 and sells a call for $0.50 with a strike price of $50. At expiration of the options:

   a) Compute the maximum profit and loss and the breakeven price.

   b) Compute the profit or loss when the price is $35, $45, $48, $50, and $55.

2. An investor purchases a put for $4.00 with a strike price of $25.00 and sells a put for $1.80 with a strike price of $20.00. At expiration of the puts:

   a) Compute the maximum profit and loss and the breakeven price.

b) Calculate the profit or loss when the price is $15, $20, $23.50, $25, and $30.

3. A stock trades at 51. Calls with strike prices of 47 and 53 are priced at 5.25 and 0.75, respectively. Compute the initial investment for a bear spread and the breakeven price or prices of the spread at options expiration.

MODULE 15.9: DELTA AND GAMMA

Video covering this content is available online.

So far, we have only considered values and profits at the point of option expiration; in so doing, we only had to worry about intrinsic value (thus simple one-for-one relationships).

During their lives, the way in which options respond to changes in the value of the underlying (and other factors) is more complicated, and we will now look at some aspects of this.

The Greeks

As you should recall, each is a ratio of absolute changes (in each case assuming only the named factor changes):

- **Delta** (Δ) = change in option **price** per +1 change in **stock price**.
  Delta is positive for (long) calls and negative for (long) puts.
- **Gamma** (Γ) = change in option **delta** per +1 change in **stock price.**
  Gamma is positive for (long) calls and for (long) puts.
- **Theta** (θ) = daily change in option **price** (effect of **time passing**).
  Theta is negative for (long) calls and (long) puts.
- **Vega** (ν) = change in option **price** per +1% change in **volatility.**

Vega is positive for (long) calls and for (long) puts.

Like option premiums, you will not be asked to calculate the values of the Greeks—if needed in a question they would be provided. What is important is an appreciation of the meaning and significance of each one. We will see they help us more fully understand some of the options strategies met in the last few sections.

Recall that **delta** measures the change in the price of an option for a +1 change in the price of the underlying (all other factors held constant).

Taking the XYZ stock options as an example, below is the table of option premiums on 20 March (when the stock price was $52.14) as seen before, together with a table of deltas at the same point in time:

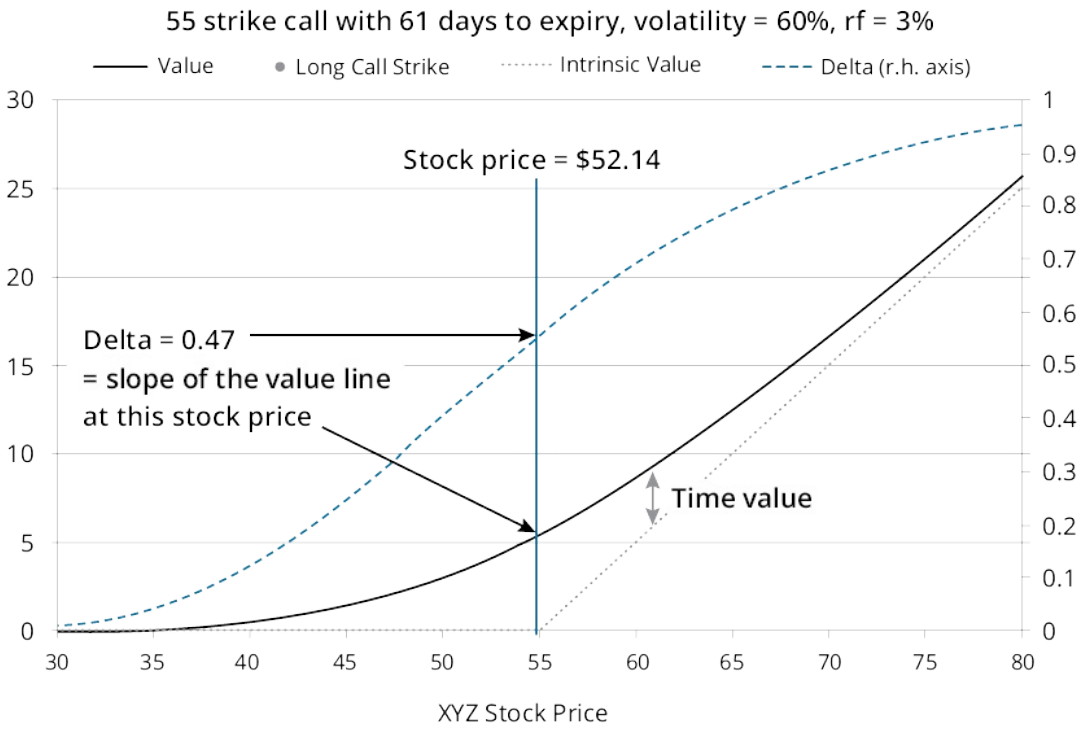
Call Price			Strike	Put Price		
APR	**MAY**	**JUN**	**Price**	**APR**	**MAY**	**JUN**
4.80	6.26	7.40	**50**	2.53	3.87	4.88
3.53	5.05	6.22	**52.5**	3.75	5.14	6.19
2.52	4.02	5.20	**55**	5.24	6.61	7.65

Call Delta			Strike	Put Delta		
APR	**MAY**	**JUN**	**Price**	**APR**	**MAY**	**JUN**
0.634	0.623	0.623	**50**	–0.366	–0.377	–0.377
0.525	0.546	0.560	**52.5**	–0.475	–0.454	–0.440
0.419	0.470	0.499	**55**	–0.581	–0.530	–0.501

For example, the MAY 55 call has a delta of 0.47, meaning that if the stock price rose by $1 to $53.14 then the MAY 55 call would rise, in principle, by $0.47, to $4.02 + $0.47 = $4.49. Note that all other factors are assumed held constant, in particular, time, so the change has to be *instantaneous*.

In fact, if we recompute the MAY 55 call premium for the $53.14 stock price, the pricing model gives us a figure of $4.51, slightly higher than the $4.49 predicted by delta. This is because the option price line is not a straight line (other than at expiration), with a curvature measured by **gamma**, so delta itself varies with the underlying.

The vertical distance between the (total) value line and the intrinsic value line corresponds to the time value, which is at its greatest around ATM, and diminishes the more the option is ITM or OTM[6]:



Here is the corresponding table for the option gammas on 20 March (at the original stock price of $52.14):

Call Gamma			Strike	Put Gamma		
APR	MAY	JUN	Price	APR	MAY	JUN
0.041	0.030	0.024	**50**	0.041	0.030	0.024
0.044	0.031	0.025	**52.5**	0.044	0.031	0.025
0.043	0.031	0.026	**55**	0.043	0.031	0.026

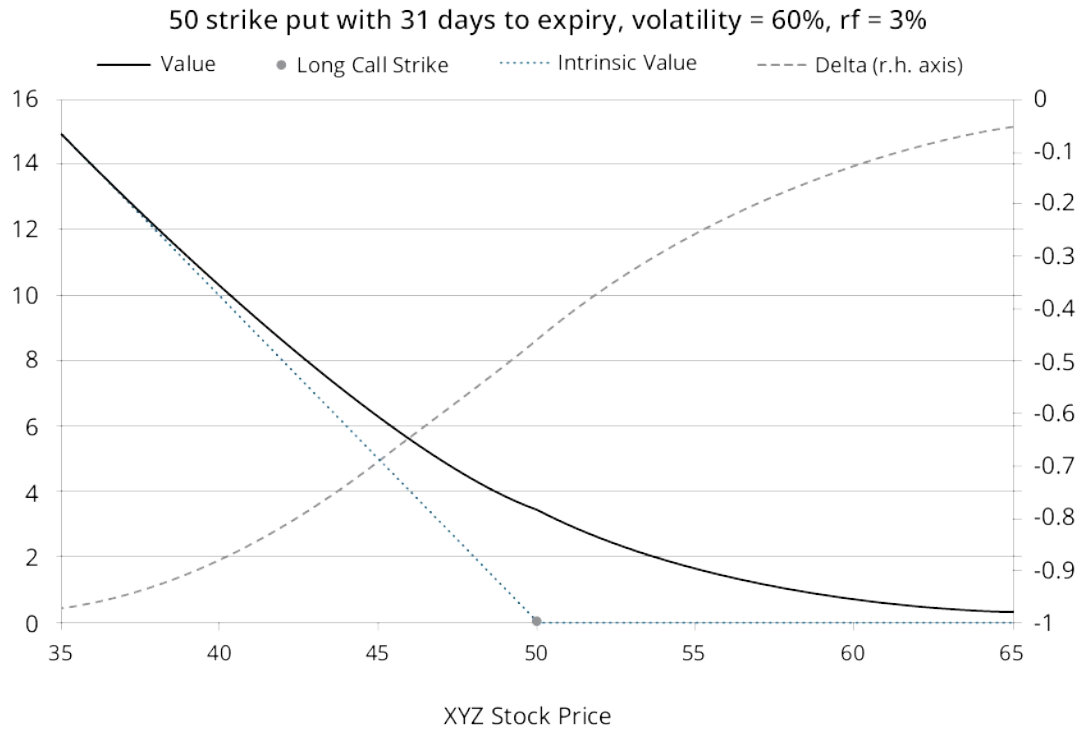
For example, the MAY 55 call has a gamma of 0.031, meaning if the share price were $1 higher, the call's delta would be 0.031 higher: 0.470 + 0.031 = 0.501.

PROFESSOR'S NOTE

The gamma adjustment is an approximation, in that same way that delta is. They are both only accurate for infinitesimal changes in the underlying price. Delta is the slope of the option price line at the current underlying price (think of it as the slope of the tangent to the line at that point)—as soon as the underlying moves at all, the delta changes. Similarly Gamma is the slope of the line representing delta, and this changes with the underlying, too.

Don't worry about having to do this calculation, but if Delta at the $52.14 stock price is 0.470, while it is 0.501 at the $53.14 price, then the average delta between those stock prices is (0.470 + 0.501)/2 = 0.486, so we could predict that the call value $1 above $52.14 would be $4.02 + $0.486 = $4.506, which is much closer than when we just used the initial value of delta.

The same principles apply to puts, of course. The following graph shows value and delta for the XYZ APR 50 (long) put (also on 20 March):

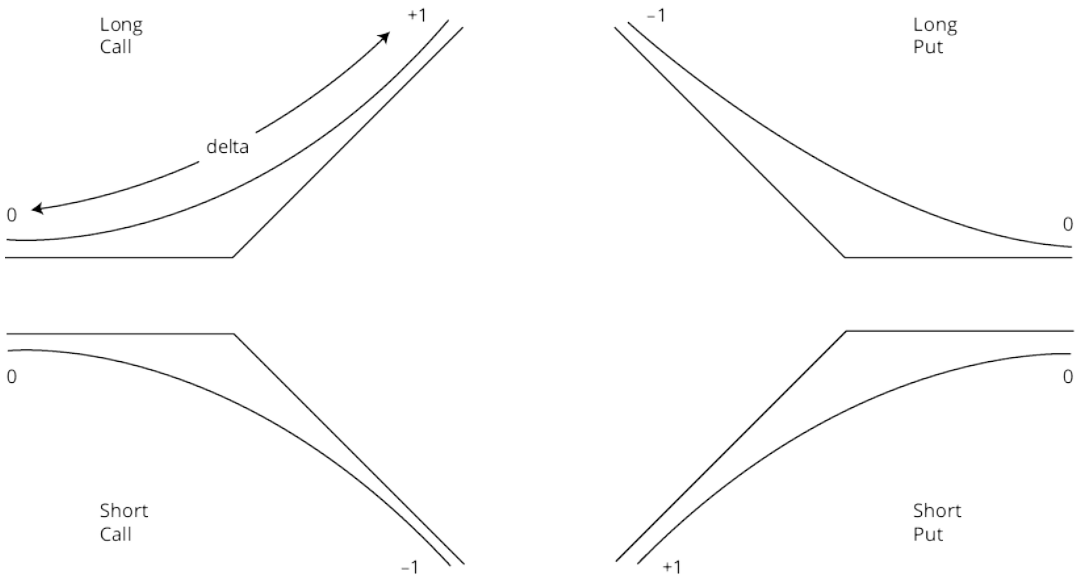


Puts (long) have negative delta, since the line slopes downwards, but there is a simple rule that applies to both calls and puts regarding the absolute size of delta (i.e. ignoring the sign):

All other factors held constant:

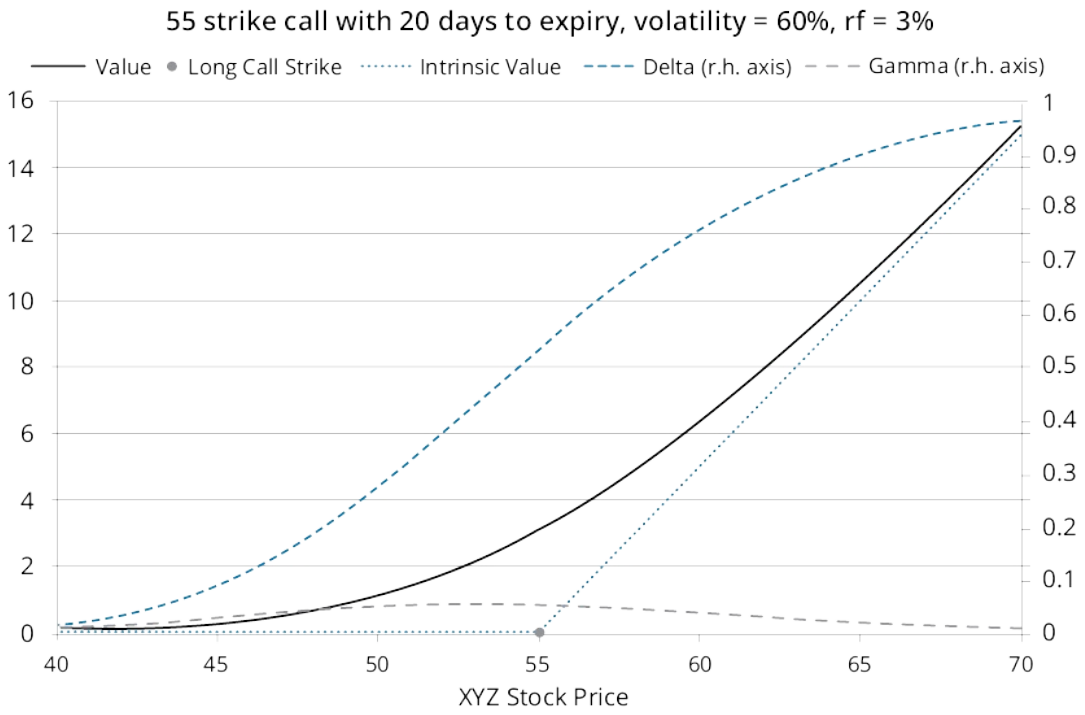
- The **more ITM** is an option, the **higher** is its (absolute) delta (closer to 1).
- The **more OTM** is an option, the **lower** is its (absolute) delta (closer to 0).

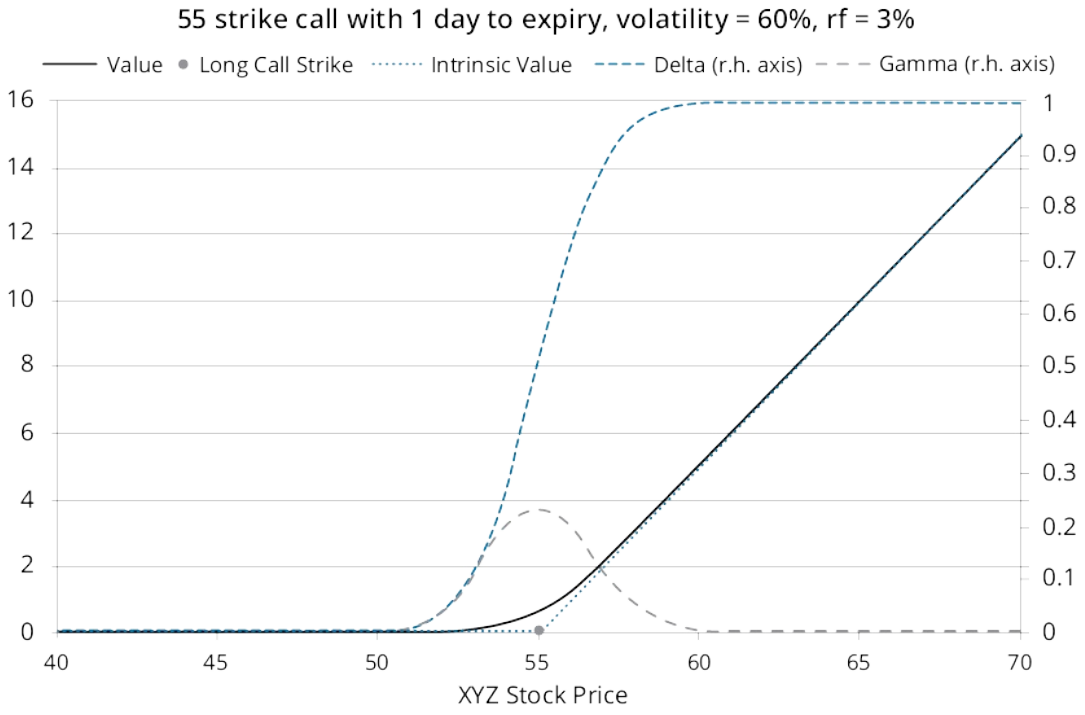
The following diagram summarizes the ranges of values of delta for long and short calls and puts:



Gamma is trickier to generalize, but it tends to be higher the closer to ATM an option, **and is at its greatest for ATM options that are close to expiration**. For instance, the following graphs illustrate the same call, first with 20 days to expiration and then with one day to

expiration when, with much less time remaining (so much less time value), the option premium line is crammed into a narrow range either side of the strike price, so gamma is highest over that range:





Deltas for the Underlying and for Futures and Forwards on the Underlying

It follows directly from the definition of delta that:

- The delta of a **long** position in one unit of the underlying is **+1**.

- The delta of a **short** position in one unit of the underlying is **–1**.

Futures and forwards on underlyings that pay no yield (e.g. nondividend paying stocks) are essentially proxies for the underlying, so they also have deltas of +1 (if long) and –1 (if short). All the examples we consider in this reading use underlyings of this sort.

Position Deltas

LOS 15.d: Compare the delta of covered call and protective put positions with the position of being long an asset and short a forward on the underlying asset.

CFA® Program Curriculum, Volume 3, pages 232 and 244

The overall (or portfolio) delta for a combination of options and positions in the underlying is computed by adding up the individual deltas (being careful with the signs).

For example, a holding of 100 shares in XYZ will have a delta of 100 × +1 = +100. That is, if the stock price rises $1 then the position value will rise by $100.

PROFESSOR'S NOTE

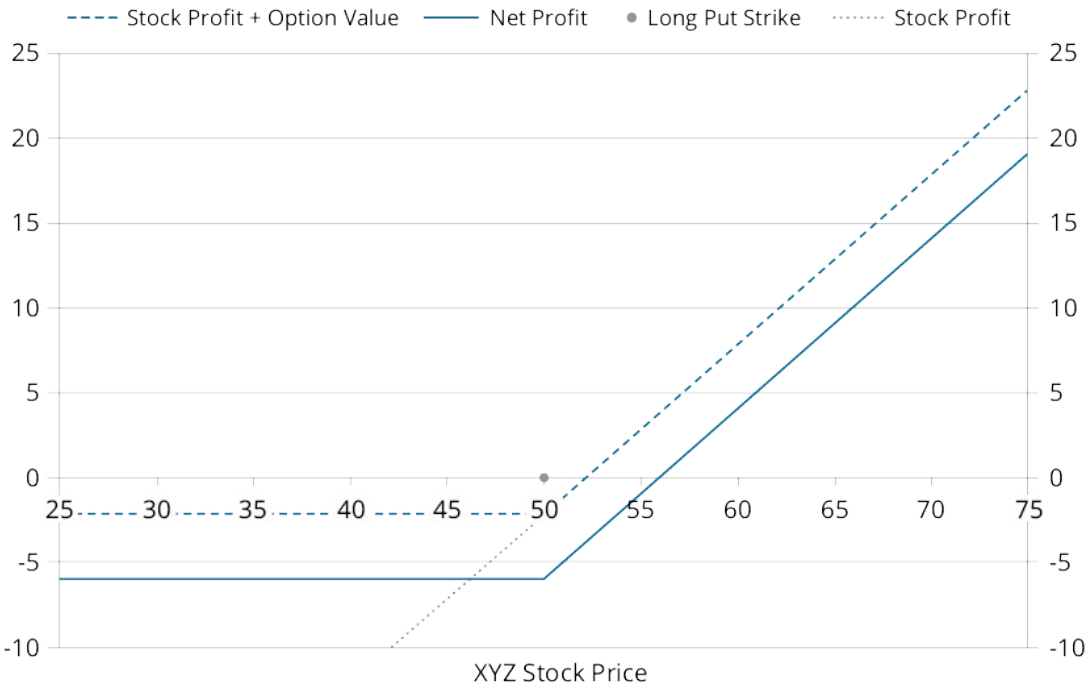
Unless told otherwise, assume that a traded stock option contract is a right over 100 shares. So a long position in an XYZ call option contract, where the option delta is +0.65, would have a position delta of 100 × +0.65 = +65.

A holding of 1,000 shares in XYZ, plus a long position in 10 XYZ put contracts (delta = –0.6), has a position delta of (1,000 × +1) + (10 × 100 × –0.6) = 1,000 – 600 = 400. Some of the stock's exposure is being offset by the negative exposure given by the puts.

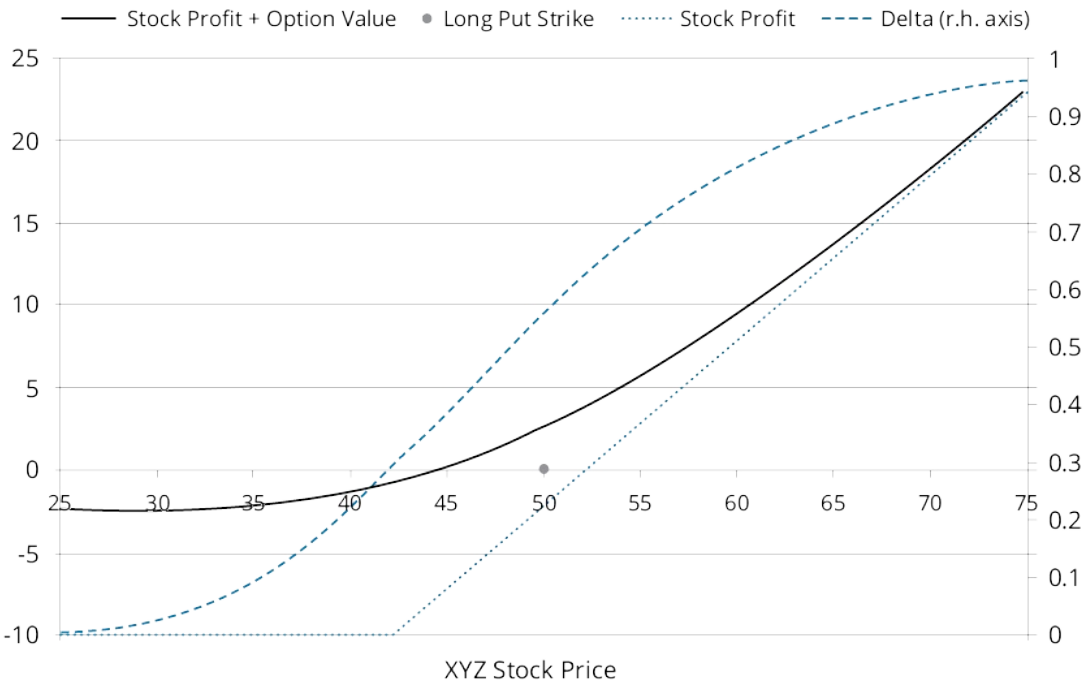
If the stock price falls $1, then the shares lose $1,000, but the net position value will only fall $400.

Protective Put Pre-Expiry

In the earlier section, where we concentrated on value at expiration, we thought of a protective put as a strategy that retains the full stock exposure above the strike price, but completely hedges below the strike price. For example a protective put on the XYZ stock, using the May 50 put (premium = $3.87), looks like this at expiration (assuming one share plus a long put on one share):



However, before expiration, the protective put is better thought of as modifying the delta of the long stock from its unhedged value of +1:

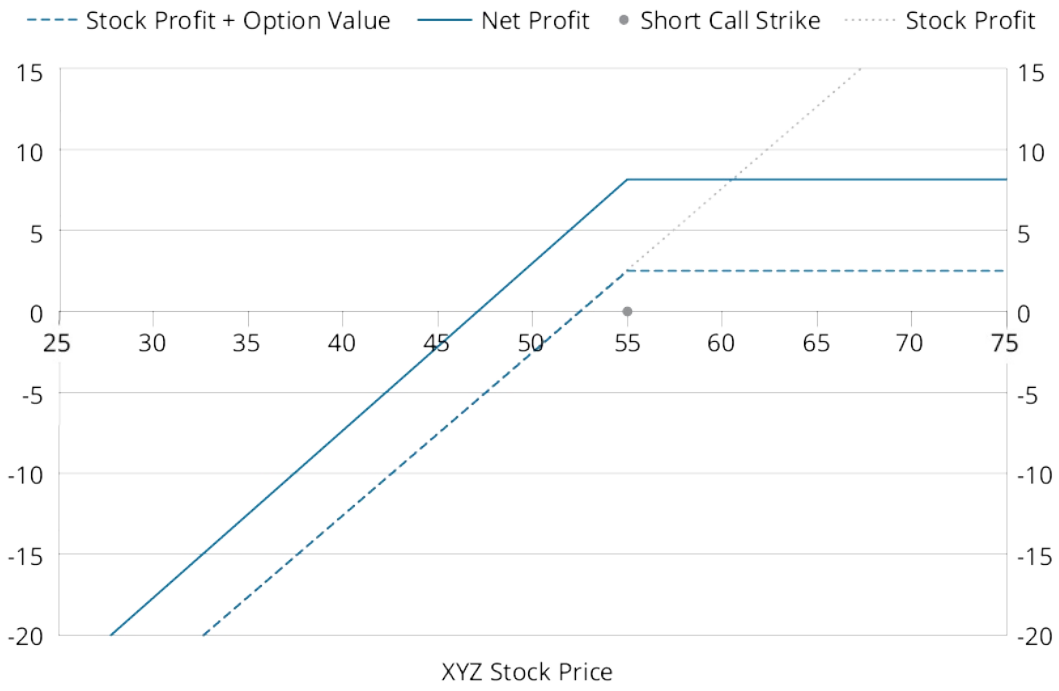


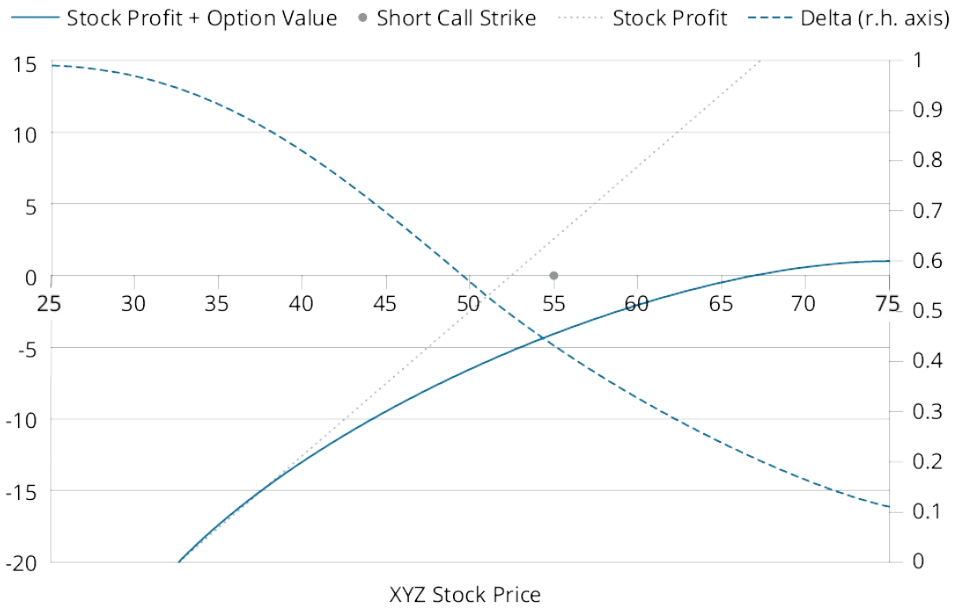
This graph shows the impact of the option value (ignoring the premium paid) on the gain/loss position for the stock at the point the option position was set up on 20 March. The net effect is that for large rises in the stock, the option moves substantially OTM, and the position delta tends towards +1 (so we have almost the same exposure as from the unhedged stock), whereas for large falls in the stock the option moves to being substantially ITM, and the delta tends towards 0 (protecting against the stock's downside). Notice that the stock plus the protective put has a net exposure equivalent to a long call.

Had we, instead, undertaken a forward contract-based hedge of the stock (selling forward against the long stock position) then, given that our forward position would be on exactly the same number of shares as we were holding, we would obtain a position delta of *number of shares × (delta of long stock + delta of short forward) = number of shares × (+1 + –1) = 0*, and would be completely hedged against price movements.

Covered Call Pre-Expiry

Similarly, we can compare a covered call (XYZ June 55) at expiration and earlier in the option's life:

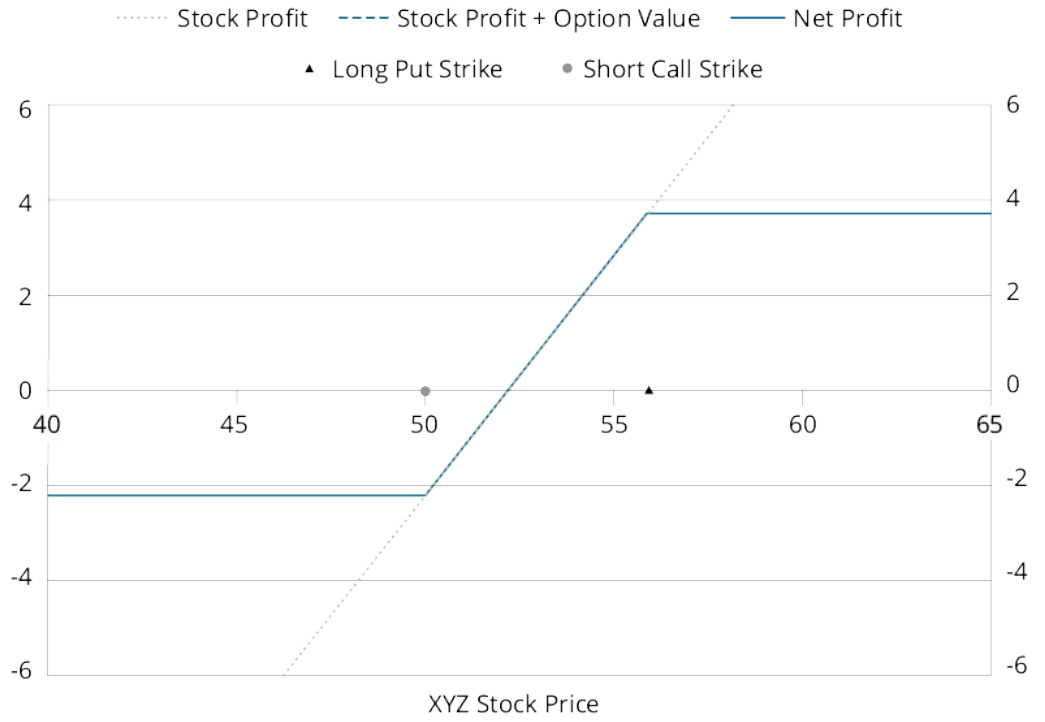


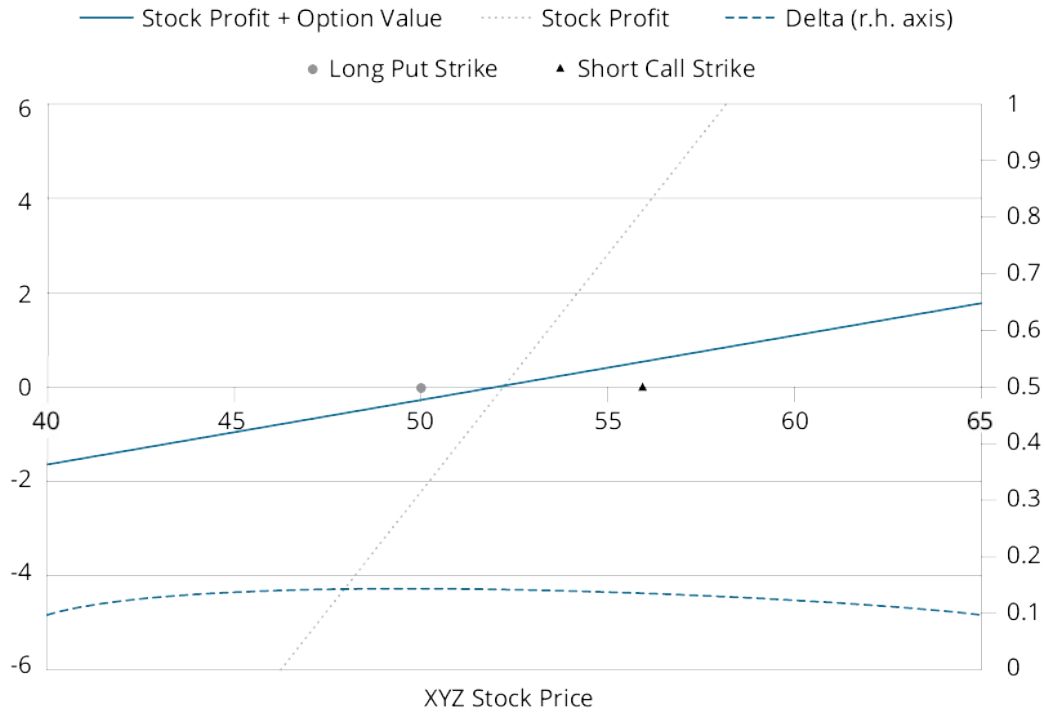


As with the protective put, the position delta varies from close to +1 (when the call is deeply OTM) to close to 0 (when the call is deeply ITM, and virtually all of the stock's upside is hedged away).

Collar Pre-Expiry

Here is a collar [XYZ stock, long June 50 put (premium = $4.88), short June 55.87 call (premium = $4.88)] shown in the same way, at expiration, and at initiation (91 days before expiration):

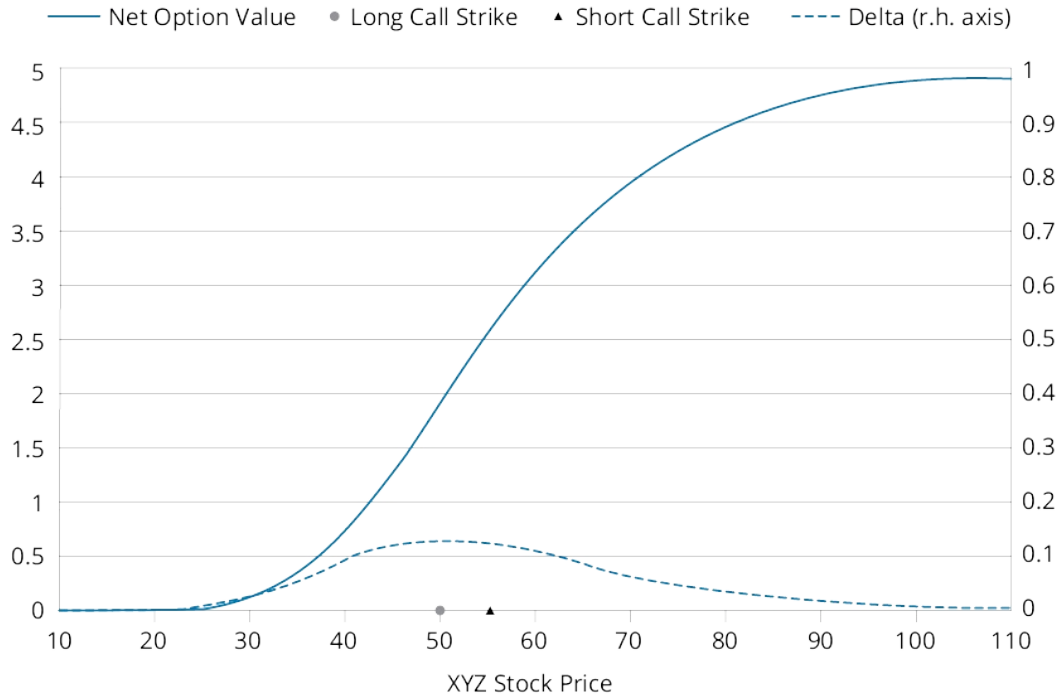




Pre-expiry the impact of the collar is to considerably dampen down the variability of the position (to about 15–20% of its unhedged level, in this case).

Bull Call Spread Pre-Expiry

Here is the value and delta for the XYZ bull call spread (long 50 call and short 55 call) at the point the strategy is initiated, 91 days pre-expiration:



It is still clear why it is bullish in outlook, but the exposure is highly muted, compared to the position at expiration (look at the values for delta). Notice the resemblance to the position for the collared stock. Something very similar would be seen for the other bull and bear spreads.

PROFESSOR'S NOTE

Detailed calculation questions are extremely unlikely for pre-expiry scenarios such as these, given how complex is the behavior of the options during their lives, in contrast to the relatively simple at-expiration scenarios.

MODULE QUIZ 15.9

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

1. Which of the following would most likely be possible deltas for covered call and protective put positions, just after they were established with three months to expiration?
   A. Both have deltas of zero.
   B. The covered call has a delta of 0.4, and the protective put has a delta of 0.45.
   C. The covered call has a delta of 0.35, while the protective put has a delta of –0.4.

MODULE 15.10: THETA AND VEGA

Theta

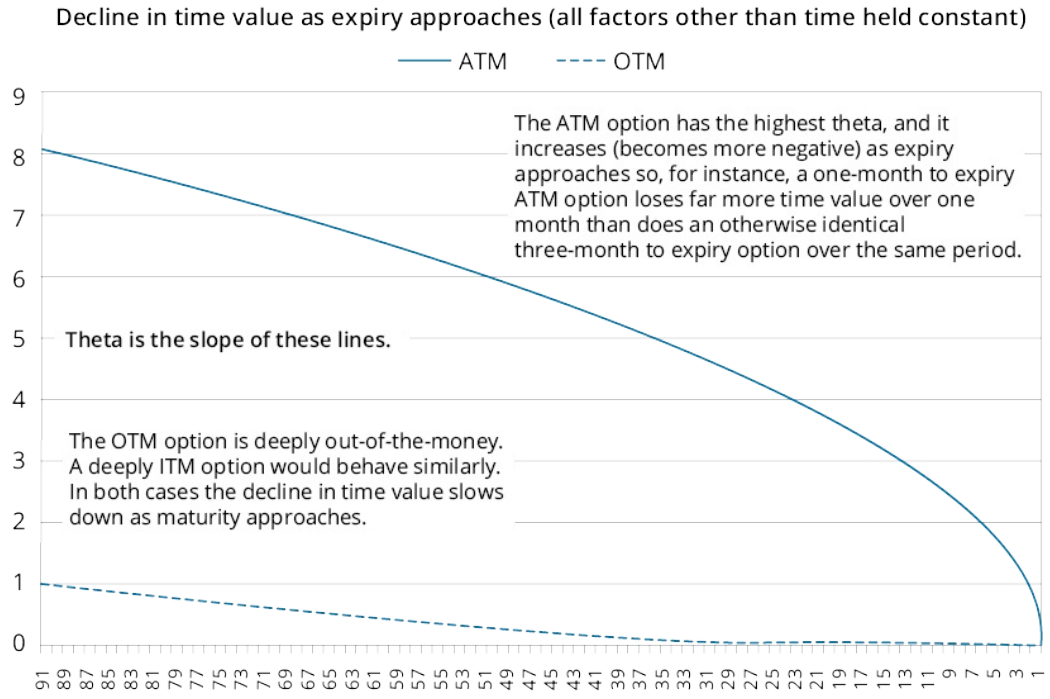
Theta measures how quickly an option loses value as time passes. For our old friends the XYZ stock options on 20 March the thetas are:

Call Theta			Strike	Put Theta		
APR	MAY	JUN	Price	APR	MAY	JUN
–0.058	–0.042	–0.035	**50**	–0.054	–0.038	–0.031
–0.061	–0.043	–0.036	**52.5**	–0.056	–0.039	–0.031

–0.059	–0.043	–0.036	**55**	–0.055	–0.039	–0.031

Notice that they are all negative: all other factors equal, less time to expiration means less time value.

Theta changes as the time passes. Options that are close to ATM have the highest thetas (in absolute terms), and these increase as expiration approaches (all other factors being held constant). In other words ATM options lose time value at an increasing rate as they mature. Here is an illustration, the horizontal axis is number of days to expiry, and the vertical axis is time value:



Calendar Spreads

LOS 15.g: Describe uses of calendar spreads.

CFA® Program Curriculum, Volume 3, page 265

In the spreads we have looked at so far, the options all expired at the same point (as well as being on the same underlying). **Calendar spreads** are the only examples we consider of option strategies where the options have different expirations.

The basic motivation with calendar spreads is to exploit the difference in **theta** between close-to-expiry and more-distant-from-expiry options.

For options that are near to ATM, the nearer-dated options will have a higher absolute value of theta (more negative) than longer-dated options.

A long calendar spread entails buying longer-dated options and selling shorter-dated options with the same strike and underlying. In principle the premium on the shorter-dated should fall faster than the premium on the longer-dated. Thus more value is gained on the short position than is lost on the long position, and a net profit is realized.

The options need to be close to ATM so the thetas are the right way around, and little movement should be anticipated in the underlying over the period to expiry of the nearer-dated option (large movement might undermine the profit from the strategy). Both options will either be calls or puts, and the choice between calls and puts will reflect the investor's view on the longer-term prospects for the stock (calls if bullish, puts if bearish).

> **EXAMPLE: Long calendar spread**
>
> Suppose that on 20 March, when the XYZ stock price is $52.14 Jenkins has a long-term bullish view on the XYZ stock price, but that over the next month he anticipates very little price movement.
>
> He buys 4 XYZ June 52.5 call contracts (on 100 shares) at 6.22, and sells 4 XYZ April 52.5 call contracts for $3.53. The net premium outlay is $2.69 × 4 × 100 = $1,076.
>
> If at the April call's expiry the stock price is still $52.14, both calls will be OTM and the April call will expire worthless. Assuming all other factors are unchanged, the June call will now be worth $5.00 (this is derived from the pricing model and, if needed, would be given in a question).
>
> Jenkins will now have a position worth $5 400 = $2,000, having paid only $1,076 a month earlier. The profit would be even higher if implied volatility rose, since that would drive the June call value higher.

A short calendar spread entails selling longer-dated options and buying shorter-dated options with the same strike and underlying. When options are sufficiently ITM or OTM the thetas are relatively higher for the longer-dated options, so this time the belief is that the longer-dated options will lose time value relatively more rapidly, thus the position as a whole should gain.

The short calendar spread strategy is vulnerable, however, to the underlying moving so the options end up ATM when the shorter-dated option expires (so the longer-dated option premiums rise, unless implied volatility also falls, and overall there is a loss since we are short). If the stock moves at all during the period of the strategy, it would be better for it to move a lot.

In both cases, the strategy is fundamentally the same: to sell the options that are expected to fall relatively faster as time passes.

In general:

- A long calendar spread will benefit from a stable market or an increase in implied volatility.
- A short calendar spread will benefit from a big move in the underlying market or a decrease in implied volatility.

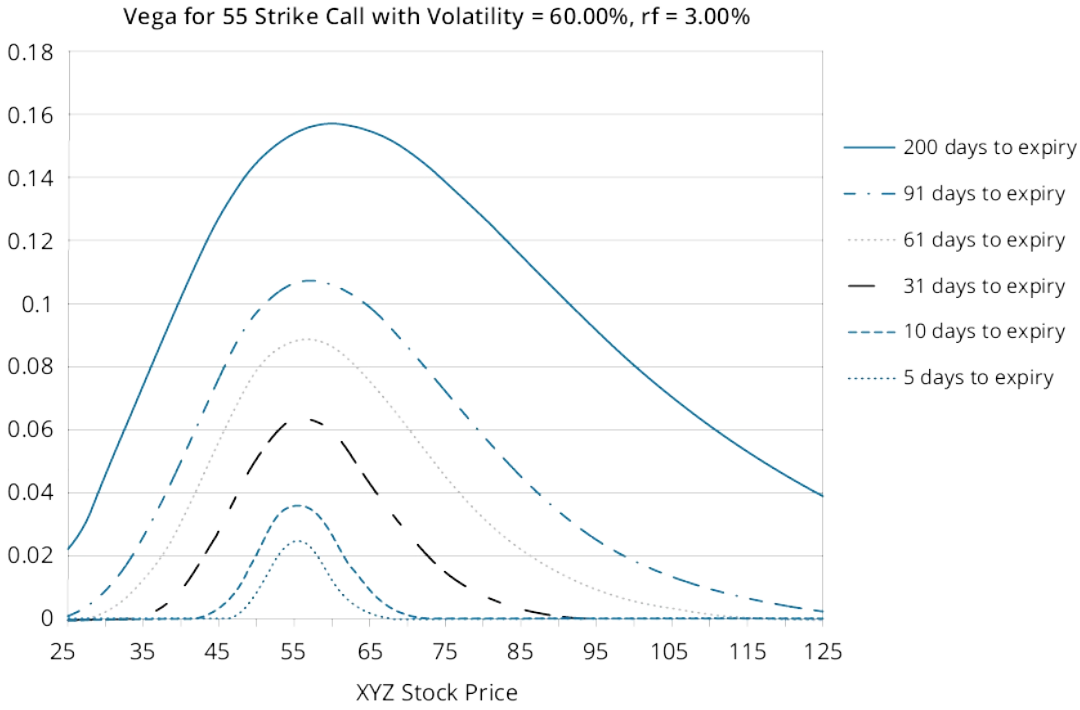
Vega

Vega measures the effect of a 1% increase in volatility on the value of the option. The vegas for the XYZ stock options on 20 March are:

Call Vega			Strike	Put Vega		
APR	**MAY**	**JUN**	**Price**	**APR**	**MAY**	**JUN**
0.057	0.081	0.098	**50**	0.057	0.081	0.098
0.060	0.084	0.102	**52.5**	0.060	0.084	0.102
0.059	0.084	0.103	**55**	0.059	0.084	0.103

Vegas are always positive: a more volatile underlying makes all the options on it more valuable (because there is more uncertainly about how things will turn out at expiration, thus more time value).

All other factors constant, vega is higher the more time there is to expiry, but it diminishes the further ITM or OTM the option is. For example:



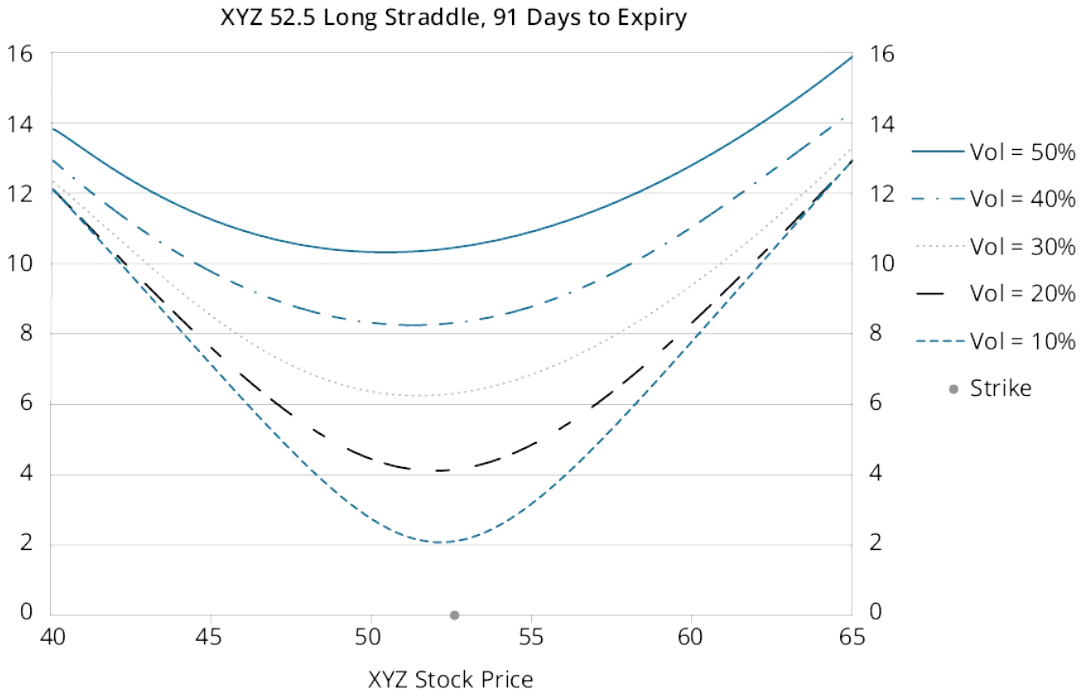
An Aside on Calculating Volatility

In converting between volatility (standard deviation) values for different time periods we multiply the volatility number by the **square root** of the ratio between the period lengths. For example, if we have used our pricing model to compute an annualized implied volatility of 57% from the value of an option expiring in one month (of, say, 42 trading days), then assuming a 252-day trading year we could derive an expected two-monthly volatility of $57\% \times \sqrt{\frac{42}{252}} = 23.27\%$.

Converting from monthly (21 days) to annual, on the other hand, would entail multiplying by $\sqrt{\frac{252}{21}}$.

Straddle Pre-Expiry

Earlier on we looked at the values and profits for long and short straddles at expiration. Let us now briefly look at the behavior of the value of a (long) straddle pre-expiration. We see that, at a given level of volatility the value varies with the underlying in a more subtle way than the V-shape we saw at expiry. It is still the case that value increases the further the underlying price is from the strike price, but the slope of the line (i.e., the delta) near the strike is close to zero, tending towards +1 as the underlying increases, and towards –1 as the underlying decreases. In particular note how, at a given point in the option's life, the level of volatility can have a dramatic effect on the value of the position:



In particular this means that if a straddle is bought, and then volatility increases, the position is likely to rise in value, even if nothing happens to the price of the underlying. This is the real reason why we refer to a long straddle as going long volatility.

Having both a call (with positive delta) and a put (with negative delta) means that we can have a position with a delta close to zero (**delta-neutral**, so we do not care what happens to the underlying price, within reason) but with positive vega.

Beware, however, that with two long options we will have negative theta, which means that the value will fall over time. The volatility must rise quickly enough to compensate for this.

Similarly, a short straddle, where both options are sold, can be delta-neutral but vega-negative, which would be a bet on falling volatility.

MODULE 15.11: VOLATILITY SKEW AND SMILE

Video covering this content is available online.

LOS 15.h: Discuss volatility skew and smile.

CFA® Program Curriculum, Volume 3, page 267

The option prices that we have been using for the XYZ options were calculated assuming a volatility of 30% for all the expirations and strike prices. This was for simplicity.

In practice, if implied volatility is computed for actual traded options on a particular underlying (e.g. a stock) the option prices for different expirations and strike prices are likely to imply differing values of volatility (and implied volatilities likely differ between calls and puts, too).

Holding expiration date constant, there are two often-observed patterns in the relationship between implied volatility and strike price:

- A **volatility smile** is where the further-from-ATM options have higher implied volatilities, so we would see a U-shaped (smiling) curve if implied volatility were

plotted against strike.

This is less common, however, than volatility skew.

- A **volatility skew** is where implied volatility increases for more OTM puts, and decreases for more OTM calls. This is explained by OTM puts being desirable as insurance against market declines (so their values are bid up by higher demand, and higher values imply higher volatility), while the demand for OTM calls is low.

Deviations in the skew from historical levels can be used to draw conclusions about market sentiment:

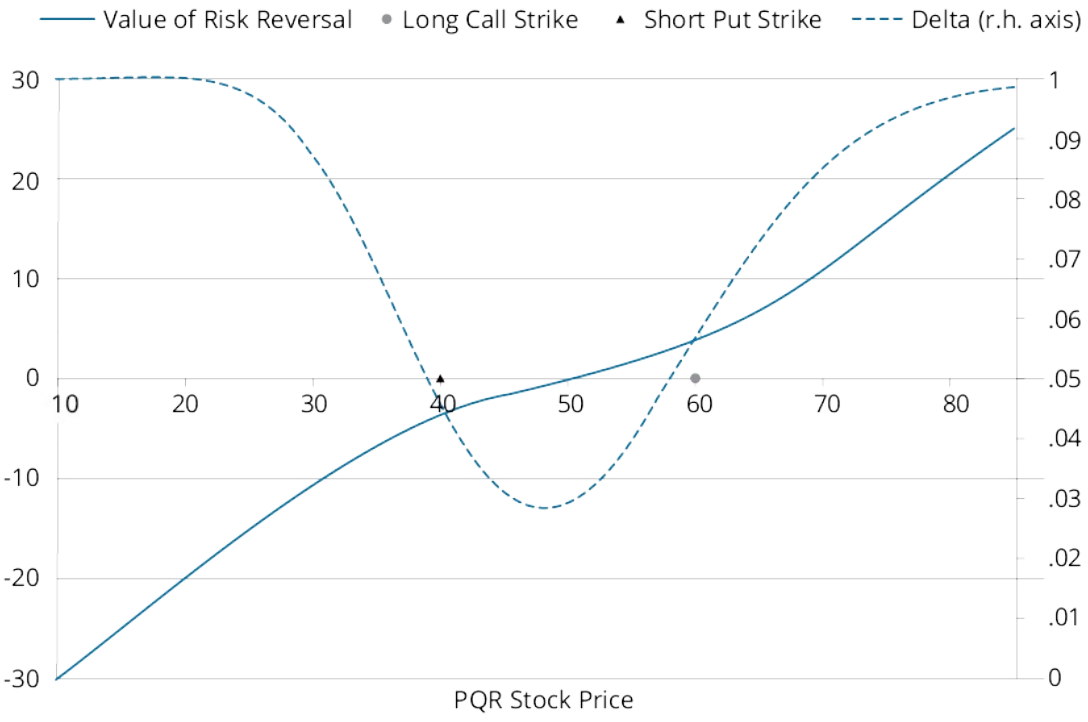
- A sharp increase in the level of the skew, plus a surge in the absolute level of implied volatility, is an indicator that market sentiment is turning bearish.
- Higher implied volatilities (relative to historical levels) for OTM calls indicate that investors are bullish, so the demand for OTM calls to take on upside exposure is strong.

Deviations that are expected to correct could form the basis of trading strategies, which might involve the use of risk reversals.

A long (short) **risk reversal** combines long (short) calls and short (long) puts on the same underlying.

For example, if a trader believes that put implied volatility is relatively too high, compared to that for calls, a long risk reversal could be created by buying the OTM call (seen as relatively underpriced) and selling the OTM put (seen as relatively overpriced) for the same expiration. This would create a broadly long exposure to the underlying, which could be problematic.

The following diagram shows values and deltas for a risk reversal on PQR stock. The PQR price is currently 50 and the call is bought at a strike of 60, while the put is sold at 40. The call's implied volatility is 50%, while the put's implied volatility is 70%. Suppose that this differential is substantially greater than we have seen in the past.



Do not worry about the precise details here, but notice that, at the current stock price of 50, the risk reversal has a delta considerably less than one. Suppose it equals 0.3, and the strategy involves 10 call contracts and 10 put contracts (each on 1,000 shares). For each $1 fall in the stock price the risk reversal will lose roughly $1 × 0.3 × 1,000 = $300.

The aim of the strategy is to make money if the anomalous relationship among the implied volatilities corrects (we went long the options that should gain value and short the options that should lose value if this happens). We were not aiming to bet on the stock price moving, but we have a net long exposure to the stock. To remove this exposure to the stock one further trade is necessary: the sale of 300 shares.

Why 300 shares? Because such a short position will experience equal and opposite gains/losses to the risk reversal, and will thus hedge the exposure to the stock price. This kind of hedge is called a **delta hedge** because the size of the position on one side of the hedge is adjusted to compensate for the delta of the position on the other side. 1,000 shares' worth of options with a delta of 0.3 are delta-hedged by 1,000 × 0.3 = 300 shares.

Note that the delta of the risk reversal will not stay constant (for example it changes as the stock price changes, and as time passes) and the size of the delta-hedge position will need to be adjusted (this is typical of delta hedges; they are **dynamic hedges** and require periodic rebalancing).

Finally, be aware of two further pieces of terminology:

- There is a **term structure of volatility**, where implied volatilities differ across option maturities (*contango* is quite common, with longer-dated options having higher implied volatilities).
- An **implied volatility surface** uses a three-dimensional graph, with implied volatility on the z-axis, to examine the joint influence of maturity (x-axis) and strike price (y-axis).

MODULE QUIZ 15.10, 15.11

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

1. An investor has a long-term bearish view on the Acme stock price, but over the next two months he anticipates very little price movement. An appropriate strategy to benefit from this view would be to:
   A. buy ATM calls on Acme with two months to expiry and simultaneously sell ATM calls on Acme with five months to expiry.
   B. sell ATM puts on Acme with two months to expiry and simultaneously buy ATM puts on Acme with five months to expiry.
   C. buy OTM calls on Acme with two months to expiry and sell OTM puts on Acme with two months to expiry.
2. Which of the following statements is *most correct*?
   A. A long straddle is a strategy based on the implied volatility smile, since the further the underlying moves from the strike by the expiration of the options, the greater the profit from the strategy.
   B. Volatility skew describes the empirical situation where implied volatility increases for more OTM calls, and decreases for more OTM puts.
   C. Volatility skew describes the empirical situation where implied volatility increases for more OTM puts, and decreases for more OTM calls.

MODULE 15.12: APPLICATIONS

LOS 15.i: Identify and evaluate appropriate option strategies consistent with given investment objectives.

Video covering this content is available online.

LOS 15.j: Demonstrate the use of options to achieve targeted equity risk exposures.

CFA® Program Curriculum, Volume 3, pages 272 and 284

PROFESSOR'S NOTE

In the final section of the curriculum reading a sequence of scenarios are described, each of which illustrates a use of a particular option strategy. The following outlines each scenario, and explains the choice of strategy, highlighting key issues in each case.

Covered Call

SCENARIO

A client needs cash. Within their portfolio is a stock (current price = 169) that they are considering selling in the near future and on which their advisor has a bearish outlook over the next six months. Information is provided on 44-day exchange-listed options (calls and put premiums and deltas, plus vegas).

Solution

Sell calls on the stock to generate premium income (provides the required cash) and reduce delta of stock holding (reduce exposure given bearish outlook).

Considerations

The premium on chosen option must be high enough to meet cash target (assumes 50 contracts sold to match 5,000 shares held): ITM call would generate the most cash, but there is a danger of shares being called away, so choose 170 calls (just OTM). More OTM calls raise too little cash.

Risks

Stock may rise. If it is above 170 at expiry then sell at 170 and lose further gain.

Stock may fall over period to expiry, giving loss on long stock position (but cushioned by premium).

Other points

Position delta is calculated for covered call at point options written, but otherwise the focus is on at-expiry outcomes. Vegas are ignored.

Put Writing

SCENARIO

Investor OQ wants to purchase shares, but considers them too expensive at 169. OQ is Prepared to pay no more than 165.

Solution

Write OTM puts (165 strike), and effectively gets paid to buy the stock.

If the stock is less than 165 at expiry then the put is exercised (by the counterparty) and OQ has to buy at 165.

Risks

Shares may fall below $X - p_0$ by expiry, in which case would have been better off buying them outright (cheaper than 165 by more than the premium).

The stock may rise to point where $S_T - 169 > p_0$. At that point it would have been better off buying shares at 169 since the rise in value since would exceed the premium received.

Long Straddle

SCENARIO

KH believes a stock price is about to rise or fall dramatically (at least ±10%), and considers a straddle.

Before KH makes the trade a news story breaks that increases volatility, making the same straddle more expensive.

Solution

The straddle is no longer worthwhile, since to reach new breakeven points stock needs to move > ±12%.

Other points

KH uses vega of the straddle before the news story broke to predict the effect of the story on the price of the straddle (sum of put and call premiums). The implied volatility is higher by 15 percentage points × initial vega of 0.468 (given) = 7.02 ($) increase in straddle value. This is very close to actual rise in price of straddle, given earlier in the solution.

Collar

SCENARIO

A client has a long position in a low cost basis stock, which means that selling is ruled out. Need to protect against a decline in price.

Solution

Use a zero-cost collar. Short calls sell off right tail of return distribution (potential large gains) and subsidize the purchase of puts that eliminate the left tail (potential large losses).

Calendar Spread

SCENARIO

ID expects little price movement in Euro Stoxx 50 index over next month from the current level of 3,500, but has a bearish long-term view. The consensus is for a flat market. ATM options are available.

Solution

Sell a three-month 3,500 put option and buy a six-month 3,500 put option (a **long** calendar spread, since they are long the options with more time to expiry).

This requires a net initial payment because the longer-dated put is more valuable (€173 – €119 = €54).

If ID's expectation is correct, and the stock index is unchanged at the expiry of the short (so the options are still ATM) then the following is true:

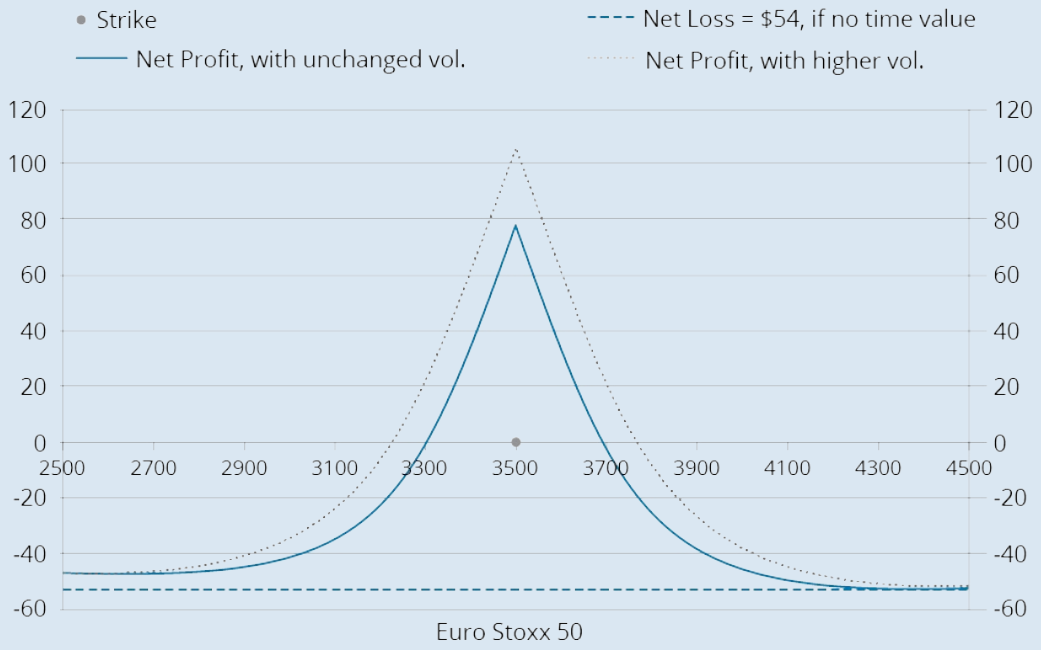
- The short put expires worthless. The long put (which now has three months to expiry) will be worth less than when it was bought (less time value),but its value will be higher than the net premium paid initially.
- This is because the three-month put had higher (more negative) theta, so it fell in value by more. ID was short this put and long the other, so makes a net profit.
- ID could either sell the long put at this point, realizing the net profit, or keep it as a bet on the index subsequently falling (having paid less, net, compared to solely going long).

Considerations

A calendar spread could use calls or puts, so why puts in this case? Because once the near-dated option expires ID wants to be left with a bearish exposure to the index – hence long puts.

Risks

At the short put's expiry it will only have intrinsic value, whereas the long put will have both intrinsic and time value. At any expiry level of the index the two options will have identical (absolute) intrinsic values (same strike), and these will cancel out, but the long put will also have time value, which is thus the net value of the position. Subtracting the net premium from the time value gives us the net profit:



A rise or fall in the index would reduce the (time) value of the long put, reducing the profit. A sufficiently large move, either way, could lead to a loss.

The worst outcome would be the entire net premium being lost.

A rise in implied volatility could increase profit/reduce loss, by pumping-up the long put's time value. Vice-versa a fall in implied volatility would decrease profit/increase loss.

Hedging an Expected Increase in Equity Market Volatility

SCENARIO

JW has a stock portfolio and fears the market is due a correction (a fall), which will be accompanied by a rise in short-term volatility. He wants to set up a position that will benefit from higher volatility, while lowering the cost of this hedge.

Solution

Buy an ATM call on volatility index (VIX) futures (futures which rise or fall with an index of market volatility). If volatility rises then the call will expire ITM and he will receive a payoff.

However, such a call could be expensive, so he simultaneously sells an OTM put on VIX futures—selling off the benefit of a fall in volatility.

Considerations

A regression of the portfolio's historic profits/losses versus changes in volatility could be used to determine what value of options to trade (to balance the hedge).

Buying VIX futures would be an alternative, less flexible, hedge.

Other points

Given the apparent negative correlation between volatility and the level of the market JW is in effect short volatility, and the hedge can be seen as equivalent to a collar, but against a short, rather than a long exposure.

Long Calls as a Proxy for the Underlying

SCENARIO

AS anticipates a rise in a share's price from £60 to £70 over the next three months, with no change in the implied volatility of the associated stock options. He wants to recommend the three-month (long) call that will maximize profits if this happens.

Solution

Choose the call which maximizes the ratio of expected profit to cost (assuming the stock rises to £70):

$$\frac{\text{profit at expiration if stock}=£70}{\text{premium}} = \frac{70-(X+c_0)}{c_0}$$

Note that we can automatically rule out any call where the breakeven ($X + c_0$) is above £70.

They also comment on delta, presumably because they are implicitly assuming that the position may not be held to call expiration, but could be closed out by selling the call once the rise in share price has happened. In that case the key issue is how the call value will change if the share price rises. The call that has the highest value for the profit to cost ratio has a lower (absolute) value of delta, suggesting that it is less responsive to rises in the underlying share price (bad), but it does have a higher gamma which, the answer claims, will more than compensate.

Risks

Not covered within the solution, but the obvious risk is that the share ends at a price other than £70, in which case a different call could have been preferable.

Protective Put

SCENARIO

EM holds shares that he expects will suffer a decline of up to 10% in one week. This would take the price down from €42 to €37.80. He wants to protect the position, while keeping the cost of the protection to a minimum. A range of one-month puts are presented.

Solution

Similarly to the previous example, they identify the put that maximizes the ratio of expected profit to cost (assuming the stock falls to €37.80):

$$\frac{\text{profit at expiration if stock}=€37.80}{\text{premium}} = \frac{(X-p_0)-37.8}{p_0}$$

Note that we can automatically rule out any put with breakeven ($X – p_0$) below €37.80.

Since the put will not be held to expiration this breakeven calculation (based on intrinsic value) is not definitive (although it could be seen as providing a worst-case estimate, ignoring time value). In practice the hedge will be closed out by selling the put once the period in which the decline is likely has passed, thus the hedge is really based on how the premium on the put will change over the holding period.

They thus go on to discuss delta, since the key issue is how the put value will change if the share price falls. The put that has the highest value for the profit to cost ratio has a lower (absolute) value of delta, suggesting that it is less responsive to falls in the underlying share price, but it does have a higher gamma which, the answer claims, will more than compensate.

For the following table, we suggest that you work out why the particular strategy is chosen in each case, given what you have read so far. Explanations are given below the exhibit on that same page if you want to check your conclusions:

Choosing Options Strategies Based on Direction and Volatility of the Underlying Asset

		Outlook on the Trend of Underlying Asset		
		Bearish	**Trading Range/Neutral View**	**Bullish**
Expected Move in Implied Volatility	Decrease	*Write calls*	*Write straddle*	*Write puts*
	Remain Unchanged	*Write calls and buy puts*	*Calendar spread*	*Buy calls and write puts*
	Increase	*Buy puts*	*Buy straddle*	*Buy calls*

*Reproduced from CFA Institute, page 273

MODULE QUIZ 15.12

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

Use the following information to answer Questions 1 and 2.

Dennis Austin works for O'Reilly Capital Management and manages endowments and trusts for large clients. The fund invests most of its portfolio in S&P 500 stocks, keeping some cash to facilitate purchases and withdrawals. The fund's performance has been quite volatile, losing over 20% last year but reporting gains ranging from 5% to 35% over the previous five years. O'Reilly's clients have many needs, goals, and objectives, and Austin is called upon to design investment strategies for their clients. Austin is convinced that the best way to deliver performance is to, whenever possible, combine the fund's stock portfolio with option positions on equity.

1. Given the following scenario:
   - Performance to date: Up 3%
   - Client objective: To maintain a positive stock position and retain upside potential
   - Austin's scenario: Expect low stock price volatility between now and the end of year.

   Which is the *best* option strategy to meet the client's objective?
   A. Bull call.
   B. Protective put.
   C. Long butterfly.
2. Given the following scenario:
   - Performance to date: Up 16%
   - Client objective: Earn at least 15%
   - Austin's scenario: Good chance of large gains or large losses between now and end of year.

   Which is the *best* option strategy to meet the client's objective?
   A. Long straddle.
   B. Long butterfly.
   C. Short straddle.
3. An investor believes that a stock they own will continue to oscillate in price and may trend downward in price. The *best* course of action for them to take would be to:
   A. sell call options on the stock.
   B. buy put options on the stock.
   C. enter into both a covered call and protective put strategy.
4. A short position in naked calls on an asset can be hedged by:
   A. buying a put.
   B. buying the underlying asset.
   C. shorting the underlying asset.

KEY CONCEPTS

LOS 15.a

Options can be used to replicate an asset's returns, or the returns from a forward contract.

- A long call plus a short put, with the same strikes and expiration, gives a synthetic long forward—equivalent to a long position in the underlying financed by borrowing at the risk-free rate.
- A short call plus a long put, same strikes and expiration, gives a synthetic short forward, which is equivalent to a short position in the underlying plus a long bond paying Rf.
- Put-call parity links all these positions together: $c_0 - p_0 = S_0 - PV(X)$ or $S_0 + p_0 = c_0 + PV(X)$.

LOS 15.b

An investor creates a covered call position by buying the underlying security and selling a call option.

- Covered call writing strategies can be used to generate additional portfolio income when the investor believes that the underlying stock price will remain unchanged over the short term. The calls are likely to be written OTM.
- ITM calls could be written when the investor aims to reduce a position at a favorable price.
- Marginally OTM calls could be used if the aim is to realize a target price.

LOS 15.c

A protective put is constructed by holding a long position in the underlying security and buying a put option (usually ATM, or somewhat OTM). You can use a protective put to limit the downside risk at the cost of the put premium.

- The purchase of the put provides a lower limit to the position at a cost of lowering the possible profit (i.e., the gain is reduced by the cost of the insurance). It is an ideal strategy for an investor who thinks the stock may go down in the near future, yet who wants to preserve upside potential.

LOS 15.d

The delta of a long (short) position in one unit of the underlying is +1 (–1). If a long position in an asset is hedged by a short forward then the delta will be reduced to zero, whereas both covered call and protective put positions have (positive) deltas that are different than zero.

- In other words, the effect of the covered call and protective put, during the option's life, is to reduce the asset's delta, but not eliminate it.

LOS 15.e

If an investor has a short position in the underlying then they could:

- Hedge their exposure to the underlying *rising* by buying a call (analogous to hedging a long position with a protective put).

- Sell off some of the benefit from the underlying *falling* by selling a put (analogous to a covered call).

LOS 15.f

There are many strategies that combine option positions, all on a single underlying, having the same expiration date:

- A bull call spread strategy comprises a long call and a short call. The short call has a higher exercise price, and its (lower) premium subsidizes the long call. A bull spread offers gains if the underlying asset's price goes up, but the upside is limited.
- A bear put spread strategy comprises a long put and a short put. The short put has a lower exercise price, and its (lower) premium subsidizes the long put. A bull spread offers gains if the underlying asset's price goes down, but the upside is limited.
- Both bull call and bear put spreads are known as *debit* spreads, because they involve an initial net premium payment. Particularly with American-style options, where early exercise is possible, they are the most common bull and bear spreads.
- Bull put and bear call spreads are also possible, however. These are *credit* spreads, and are the short versions of the other two spreads.
- Before expiration, bull (bear) spreads are best seen as positions giving long (short) exposure to the underlying, but with a reduced level of (absolute) delta.
- A long straddle is a long call plus long put with the same exercise price. The greater the move in the stock price, the greater the payoff from a straddle at expiration (with no upper limit on profit). Before expiration, the prime focus is on volatility increasing, since a long straddle will have positive vega (but low delta, when ATM).
- A short straddle is a short call plus short put with the same exercise price. The closer the stock price ends to the strike the greater is the payoff from a short straddle at expiration (this is limited to the sum of the premiums). Before expiration, as with a long straddle, the prime focus is on volatility, this time falling—a short straddle has negative vega (but low delta, when ATM).

The spreads and straddles only use options, whereas the collar combines options with the underlying:

- A collar strategy is simply a covered call and protective put combined to limit the downside and upside values of the position at expiration. Before expiration the collar can be seen as a way of reducing delta.

LOS 15.g

A long calendar spread involves the sale of a shorter-dated ATM (or near-ATM) call and the purchase of a longer-dated call with the same strike (or both could be puts). The basic motivation is to profit from the higher theta of the closer-to-expiry ATM option. At expiration the position will have a net value equal to the long put's time value. If the options are still ATM this will exceed the net premium paid initially.

- The danger is that the underlying could have moved away from its initial level, and the long put's time value is below the initial premium, although an increase in implied volatility could offset this.
- A short calendar spread buys the shorter-dated and sells the longer-dated options. The options are either ITM or OTM, and now a large move in the underlying (so it ends up

well away from the strike) is needed (and/or a decrease in implied volatility).

LOS 15.h

A volatility smile is where further-from-ATM options have higher implied volatilities.

The relatively more common situation is volatility skew, where implied volatility increases for more OTM puts, and decreases for more OTM calls.

- The skew is explained by OTM puts being desirable as insurance against market declines, while the demand for OTM calls is low.
- Deviations of the skew from historical levels could form the basis of trading strategies, e.g., a long (short) risk reversal combines long (short) OTM calls and short (long) OTM puts on the same underlying, delta-hedged using the underlying stock. A long risk reversal assumes the OTM calls are relatively underpriced (their implied volatility is relatively too low, compared to OTM puts).

LOS 15.i, LOS 15.j

See the examples towards the end of this reading for illustrations of the uses of the various strategies that have been covered in the reading.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 15.1, 15.2, 15.3

1. **A** Remember put-call parity: $\mathbf{c_0 - p_0 = S_0 - PV(X)}$, which can be rearranged to $\mathbf{-S_0 = p_0 - c_0 - PV(X)}$.

   This means that short stock equals long put plus short call plus borrowing at r_f.

   Given that X = 100, r_f = 2% and T = 0.5, we have $PV(X) = 100/(1.02)^{0.5} = 99.01 \approx 99$.

   The options position in B is a long straddle, whose profile is nothing like a short position in the stock.

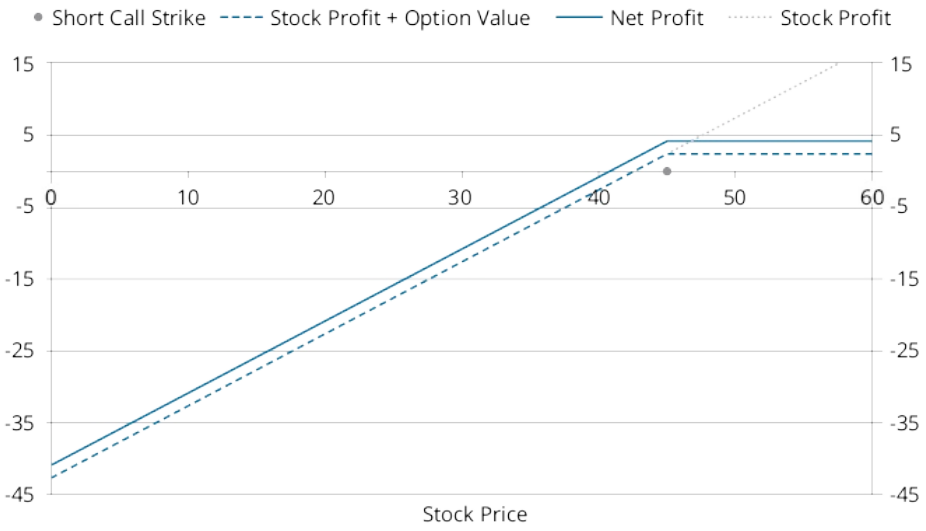
   The options in C would create a synthetic long forward. (Module 15.2, LOS 15.a)

2. a) **Maximum profit** occurs at the strike, and above.

   Rise in stock value at strike = \$45 – \$43 = \$2, plus the premium received of \$2.10 = \$4.10

   Breakeven price = premium below the initial stock price = $X - c_0$ = \$43 – \$2.10 = \$40.90

   Maximum loss = breakeven = \$40.90



   b) Given breakeven = \$40.90, while maximum profit = \$4.10 at the \$45 strike and above:

   - Profit at \$0 (\$40.90 below breakeven) = loss of \$40.90 (= maximum loss)
   - Profit at \$35 (\$40.90 – \$35 = \$5.90 below breakeven) = loss of \$5.90
   - Profit at \$40 (\$0.90 below breakeven) = loss of \$0.90
   - Profit at \$45 = Profit at \$50 = maximum profit = \$4.20

   (Module 15.3, LOS 15.b)

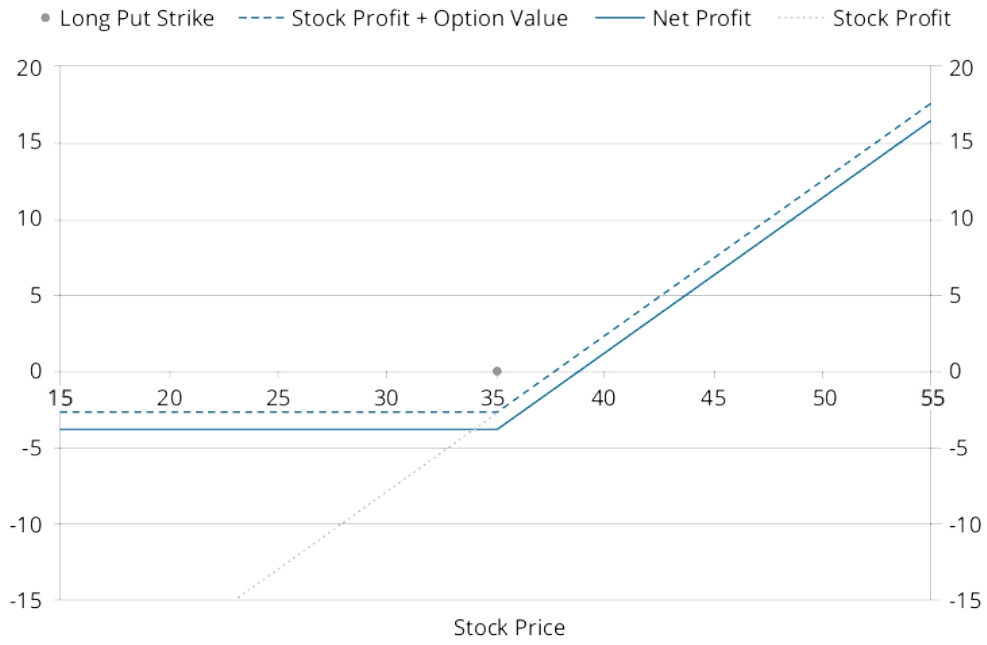
Module Quiz 15.4, 15.5

1. a) **Maximum profit** = unlimited.

   Maximum loss occurs at the strike, and below

   Fall in stock value to strike = $37.50 – $35 = $2.50, plus the premium paid of $1.40 = $3.90

   Breakeven price = premium above the initial stock price = X + p_0 = $37.50 + $1.40 = $38.90



   b) Given breakeven = $38.90, while maximum loss = $3.90 at the $35 strike and below:

   Profit at $30 = Profit at $35 = loss of $3.90

   Profit at $40 ($40 – $38.90 = $1.10 above breakeven) = $1.10

   Profit at $50 = $50 – $38.90 = $11.10

   (Module 15.4, LOS 15.c)

2. **C** Jones has a short exposure to Alphacorp. Selling an OTM put is the best choice to enhance yield.

   A is a covered call, which would only be appropriate were his exposure long. B is an ITM put, which would likely get exercised by the counterparty unless the share price rises, which Jones does not anticipate happening.

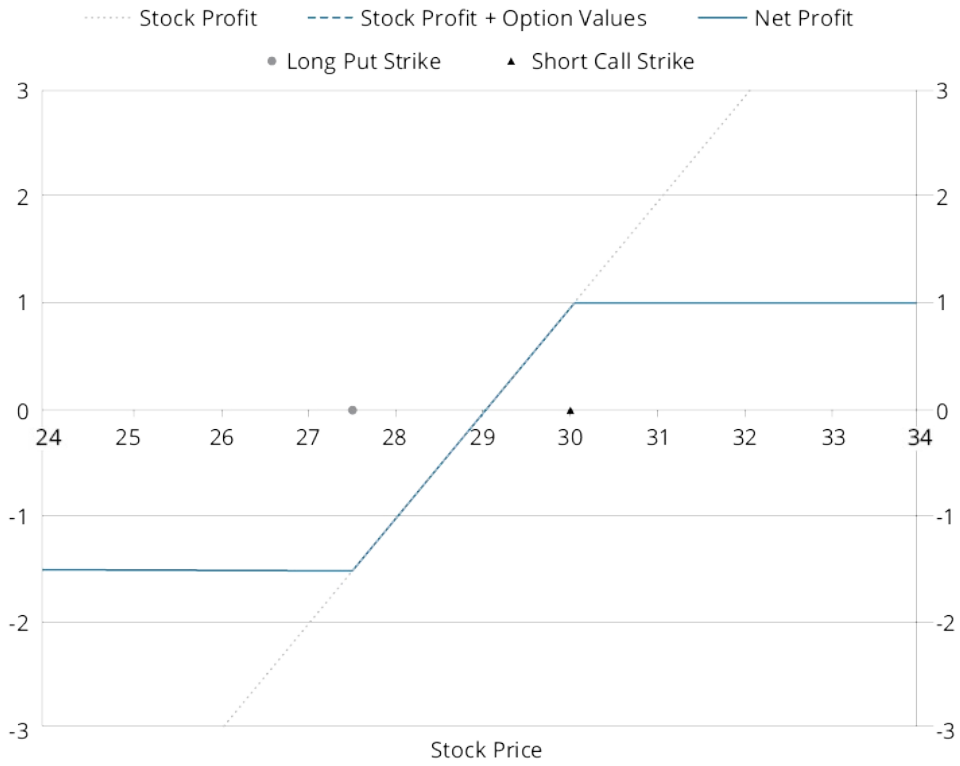
   (Module 15.5, LOS 15.e)

Module Quiz 15.6, 15.7

1. a) Call and put premiums are identical, so this is a **zero-cost collar**. Between strikes the profit/loss is the same as for the stock alone, and **breakeven** = initial stock price = $29

   Maximum profit at call strike = gain on stock at $30 = $30 – $29 = $1

   Maximum loss at put strike = loss on stock at $27.50 = $29 – $27.50 = $1.50



b) $20 and $25 are both below put strike, so profit at $20 = profit at $25 = loss of $1.50 (= maximum loss)

Profit at $28.50: between strikes, so the same as for stock alone. $0.50 below breakeven, so loss = $0.50

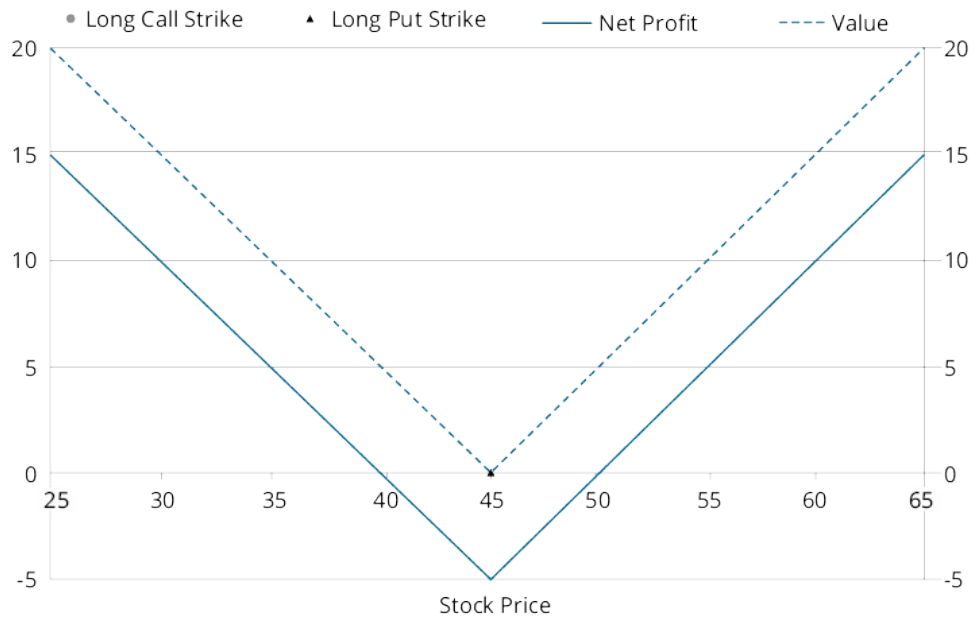
Profit at $30 = profit at $100 = $1 (= maximum profit)

(Module 15.6, LOS 15.f)

2. a) **Maximum profit** = unlimited.

Maximum loss occurs at the strike and equals the total premium paid = $3 + $2 = $5

Breakeven prices = total premium below and above the strike = $45 ± $5 = $40 and $50



b) Profit at $0: long put is $45 ITM, so profit = $45 – total premium = $45 – $5 = $40 (= lower b/even)

Profit at $35: long put is $45 – $35 = $10 ITM, so profit = $10 – $5 = $5

Profit at $40 = $0 (breakeven)

Profit at $45 = loss of $5 (maximum loss at strike)

Profit at $47: long call is $47 – $45 = $2 ITM, so profit = $2 – $5 = loss of $3

Profit at $55: long call is $55 – $45 = $10 ITM, so profit = $10 – $5 = $5

Profit at $100: long call is $100 – $45 = $55 ITM, so profit = $55 – $5 = $50

(Module 15.7, LOS 15.f)

3. Buy ATM puts and calls on the EUR. The 1.04 strike price is the closest to ATM. Buying the call and put will cost: 0.004 + 0.017 = 0.021. This is the max loss and occurs if the EUR closes at 1.04. For breakeven prices, the EUR must decrease or increase 0.021 to USD 1.019 or 1.061. (Module 15.7, LOS 15.f)

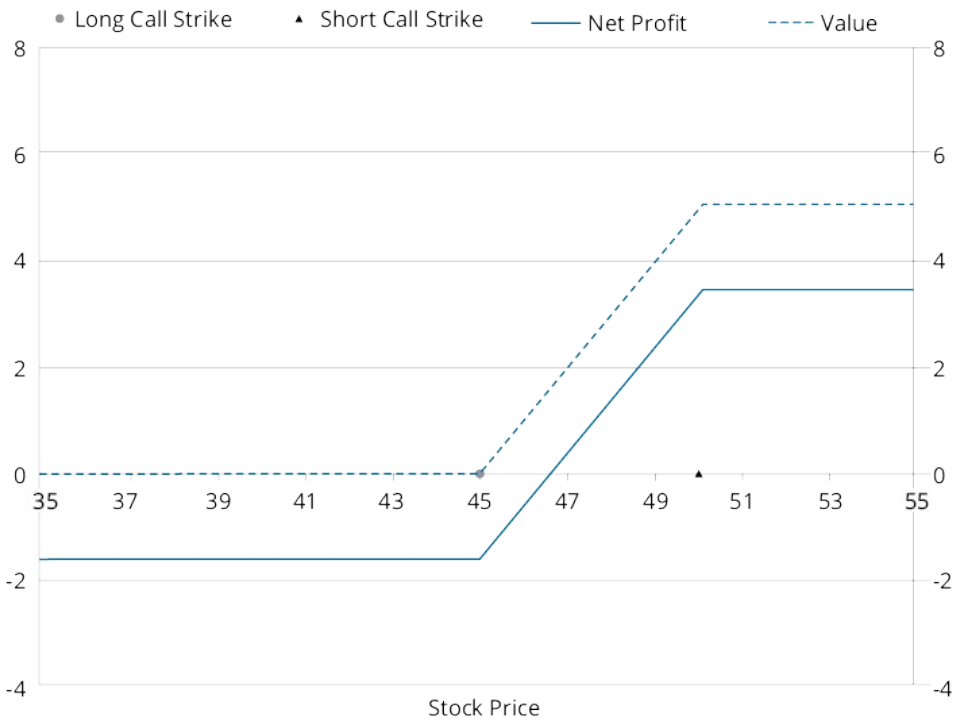
Module Quiz 15.8

1. a) This is a bull call spread, which is a debit spread (net initial outlay).

   For debit spreads the **maximum loss** = net premium paid = $2.10 – $0.50 = $1.60

   The difference between the maximum loss and the maximum profit is equal to the difference between the strikes, which is $50 – $45 = $5, so the **maximum profit** = $5 – $1.60 = $3.40

   Maximum loss occurs at lower strike (and below), so **breakeven price** = lower strike + net premium = $45 + $1.60 = $46.60



b) Given breakeven = $46.60, maximum loss = $1.60 at $45 and below, while maximum profit = $3.40 at $50 and above:

Profit at $35 = profit at $45 = loss of $1.60 (= maximum loss)

Profit at $48 ($48 – $46.60 = $1.40 above breakeven) = $1.40

Profit at $50 = profit at $55 = $3.40 (= maximum profit)

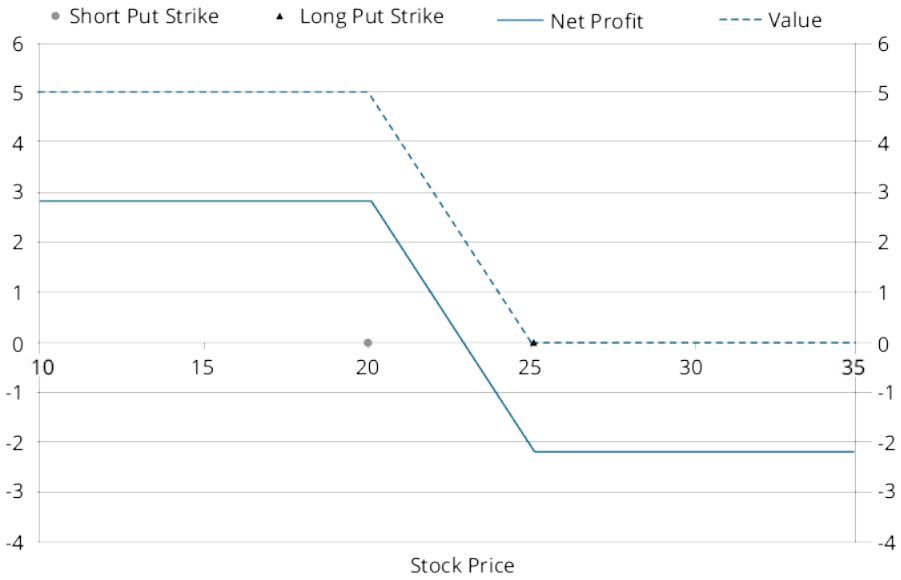
(LOS 15.f)

2. a) This is a bear put spread, which is a debit spread (net initial outlay).

For debit spreads the maximum loss = net premium paid = $4.00 – $1.80 = $2.20

The difference between the **maximum loss** and the maximum profit is equal to the difference between the strikes, which is $25 – $20 = $5, so the **maximum profit** = $5 – $2.20 = $2.80

Maximum loss occurs at upper strike (and above), so **breakeven price** = upper strike – net premium = $25 – $2.20 = $22.80



b) Given breakeven = $22.80, maximum loss = $2.20 at $25 and above, while maximum profit = $2.80 at $20 and below:

Profit at $15 = profit at $20 = $2.80 (= maximum profit)

Profit at $23.50 ($23.50 – $22.80 = $0.70 above breakeven) = loss of $0.70

Profit at $25 = profit at $35 = loss of $2.20 (= maximum loss)

(LOS 15.f)

3. In a bear spread the lower strike option is sold and the higher strike option is bought. Using calls this is a credit spread, since there is a net initial inflow of premium of 5.25 – 0.75 = 4.50.

   Initial investment = –4.50 (per share).

   The initial investment is also the maximum profit from the strategy. This occurs at and below the lower strike of 47, above which the profit falls one-for-one with rises in the underlying stock. Thus breakeven is 4.50 above the lower strike, at 47 + 4.50 = 51.50. (LOS 15.f)

Module Quiz 15.9

1. **B** Before expiration both covered calls and protective puts have positive deltas (short calls and long puts both have negative deltas, with absolute values less than 1, so they partially, but not fully, hedge the +1 delta of the long underlying). Neither fully eliminate the delta of the underlying.(LOS 15.d)

Module Quiz 15.10, 15.11

1. **B** An appropriate strategy in such a situation would be a long calendar spread, where close-to-ATM options with the same strikes but different expirations are traded. The longer-dated is bought and the shorter-dated is sold, to exploit the higher theta of the shorter-dated.

   A is a short calendar spread, whereas C is a risk reversal, which is a strategy to exploit implied volatility skews that differ from historical levels. (Module 15.10, LOS 15.g)

2. **C** A is incorrect because the straddle has little to do with the volatility smile, and B has calls and puts the wrong way around. (Module 15.11, LOS 15.g)

Module Quiz 15.12

1. **B** The client wants to stay positive on the stock and a protective put will retain the stock upside with limited down side risk. In addition volatility is low which will make option prices low. Both of the other strategies will compromise stock upside potential and involve selling options to reduce initial investment cost. Lowering initial investment was not a specific goal and it makes little sense to do so while option prices are low. (LOS 15.i)

2. **A** Long straddle produces gains if prices move up or down, and limited losses if prices do not move. Short straddle produces significant losses if prices move significantly up or down. Long Butterfly also produces losses should prices move either up or down. The condor is similar to the long butterfly, although the gains for no movement are not as great. (LOS 15.i)

3. **C** With a stock that is oscillating in price in which it is not trending upward, a covered call strategy is appropriate in which the investor owns the underlying asset and sells call options to enhance income. This strategy will work as long as the stock price does not go above the call strike price. In a downward trending market in which the investor believes the stock price will decrease, a protective put is appropriate in which they purchase a put on the underlying stock. The combination of the covered call and protective put is a collar. (LOS 15.i)

4. **B** Hedging a naked call can be accomplished by owning the underlying asset called a covered call strategy. (LOS 15.i)

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1. This can be computed for both European and American-style options, even though the former can only be exercised at expiration. It can be thought of as the base level for the option's value.

2. Writing a put option and simultaneously depositing the exercise price into a designated account is called writing a **cash-secured** put, thereby the long is assured that the put writer would be able to purchase the stock, if called on to do so. Simply writing a put without doing this is called a **naked** put.

3. If the strategy does work as intended, however, Jenkins will have captured the time value embedded in the option price (in this case $4.80 – ($52.14 – $50) = $2.66 per share, which corresponds to 1,500 × $2.66 = $3,990 (= $82,200 – $78,210).

4. Also known as a *fence* or a *hedge wrapper*.

5. **Strangles**, which we encounter in the currency reading, are like straddles, but the calls and puts have different strikes.

6. Time value is a reflection of the relative difficulty of hedging an option, and options are harder to hedge when it is unclear whether they are going to **expire** ITM or OTM. If they are already deeply ITM or OTM there is less uncertainty about this.

The following is a review of the Derivatives and Currency Management principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #16.

READING 16: SWAPS, FORWARDS, AND FUTURES STRATEGIES

Study Session 6

EXAM FOCUS

The primary focus here is understanding how to use derivatives to (1) change the beta of an equity portfolio, (2) change the duration of a bond portfolio, (3) change portfolio exposure to various asset classes, (4) create synthetic positions, and (5) lock in an interest rate for anticipated future borrowing or lending. Understand how the risks of various derivative contracts offset existing portfolio risks. This material may be tested with either a constructed response question on the morning exam or an item set on the afternoon exam.

MODULE 16.1: MANAGING INTEREST RATE RISK—INTEREST RATE SWAPS, FORWARD RATE AGREEMENT, AND INTEREST RATE FUTURES

Video covering this content is available online.

LOS 16.a: Demonstrate how interest rate swaps, forwards, and futures can be used to modify a portfolio's risk and return.

CFA® Program Curriculum, Volume 3, page 298

Interest rate swaps can be used to alter the duration of a fixed-income portfolio by changing a fixed-rate exposure to a floating-rate exposure, or vice versa.

Interest Rate Swaps

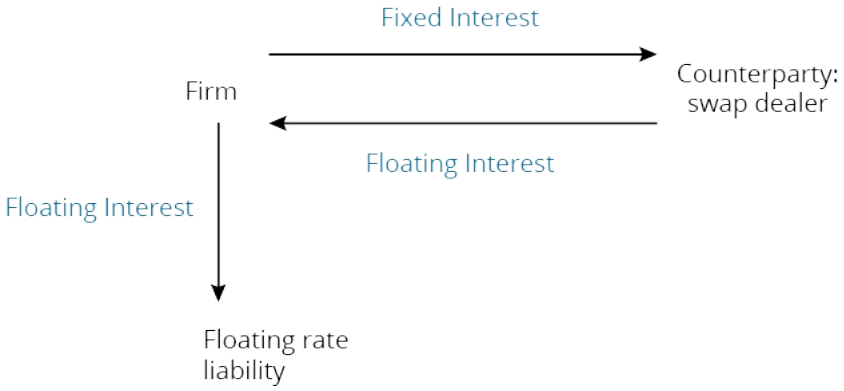
A *payer swap* is a contract to make a series of fixed-rate payments and receive a series of floating-rate payments, both based on a specified *notional principal* (amount). If future floating rates are higher than rates expected at the initiation of a swap, a payer swap will increase in value. A payer swap will decrease in value if future floating rates are less than expected. The counterparty to a payer swap has a *receiver swap* and will receive the fixed-rate payments and make the floating-rate payments. In practice, the payments from each party to a swap are netted (the party that owes the larger amount pays the difference) to reduce credit risk.

The floating-rate payment for the first *settlement date* is known at contract initiation, but the floating-rate payments for future settlement dates are not. A quarterly pay swap, for example, has quarterly settlement dates with floating-rate payments based on a quarterly reference rate such as 90-day LIBOR. The risk-return characteristics of a swap can be replicated with a capital market trade. For example, issuing a fixed-rate bond and buying an otherwise identical floating-rate bond would generate the same payments as a payer swap.

Converting a Floating-Rate Exposure to a Fixed-Rate Exposure

A company with a floating-rate exposure can use a payer swap (pay fixed, receive floating) to change it into a fixed-rate exposure. The swap must have settlement dates that match the payment dates on the floating-rate liability.

Figure 16.1: Converting Floating to Fixed Using a Payer Swap



Note that the firm's floating-rate payments from the swap will just offset its floating-rate payments on the liability, so the firm has only its fixed-rate liability from the swap.

Figure 16.2: Converting Fixed-Rate and Floating-Rate Exposures

Existing Exposure	Converting	Interest Rate Swap Required	Beneficial When
Floating-rate liability	Floating to fixed	Payer swap	Floating rates expected to rise
Fixed-rate liability	Fixed to floating	Receiver swap	Floating rates expected to fall
Floating-rate asset	Floating to fixed	Receiver swap	Floating rates expected to fall
Fixed-rate asset	Fixed to floating	Payer swap	Floating rates expected to rise

EXAMPLE: Converting a floating-rate liability to a fixed-rate liability

ABC, Inc., has issued $30 million four-year, semiannual-pay, floating-rate notes (FRNs) with coupons equal to 180-day LIBOR plus a 25 basis point margin. After one year, the firm expects interest rates to rise. ABC enters into a three-year payer swap with a fixed rate of 2%, semiannual payments, and a notional principal of $30 million. At initiation of the swap, 180-day LIBOR was 1.5%. The FRN and the swap have the same settlement dates.

Settlement date 1 (180 days after swap initiation):

Swap: fixed payment = $30 million × 2% × 180 / 360 = $300,000
floating payment = $30 million × 1.5% × 180 / 360 = $225,000
net cash flow = $225,000 – $300,000 = –$75,000
FRN: floating payment = $30 million × (1.5% + 0.25%) × 180 / 360 = $262,500

ABC, Inc.: total payment = $262,500 + $75,000 = $337,500

180-day LIBOR at settlement date 1 = 3%

Settlement date 2 (360 days after swap initiation):

Swap: fixed payment = $30 million × 2% × 180 / 360 = $300,000
floating payment = $30 million × 3% × 180 / 360 = $450,000
net cash flow = $450,000 − $300,000 = $150,000
FRN: floating payment = $30 million × (3% + 0.25%) × 180 / 360 = $487,500

ABC, Inc.: total payment = $487,500 − $150,000 = $337,500

Note that, regardless of realized LIBOR at the remaining settlement dates, the cash payments from ABC, Inc., will be $337,500—the fixed rate on the swap plus the margin above the reference rate on the FRN:

$30 million × (2% + 0.25%) × 180 / 360 = $337,500

The floating-rate payments of the FRN and the floating-rate payments from the payer swap just offset each other.

For the issuer of an FRN, the payer swap has converted the floating exposure to a fixed-rate exposure. This strategy eliminates both the downside and upside of exposure to floating rates.

Using Interest Rate Swaps to Alter Portfolio Duration

The cash flows on a payer swap can be replicated with two capital markets transactions: issuing a fixed-rate note and purchasing a floating-rate note (FRN). A receiver swap is equivalent to issuing an FRN and buying a fixed-rate note.

Because a fixed-rate note has a greater modified duration than an otherwise identical FRN, a payer swap has a negative duration (increasing in value when interest rates increase) and a receiver swap has a positive duration (decreasing in value when interest rates increase). Adding payer swap to a fixed-income portfolio will reduce portfolio duration, while adding a receiver swap to a fixed-income portfolio will increase portfolio duration.

PROFESSOR'S NOTE

The analysis presented here is based on modified duration, one of several available measures of price sensitivity to changes in interest rates. Using modified duration implicitly assumes that the yield curve is flat and shifts in the yield curve are parallel.

The notional principal of the interest rate swap to increase (or reduce) portfolio duration (target duration) can be calculated as follows:

$$NP_s = \left(\frac{MD_T - MD_P}{MD_s}\right)(MV_P)$$

where:

NP_S = notional swap principal

MD_T = target modified duration

MD_P = current portfolio modified duration

MD_S = modified duration of swap

MV_P = market value of portfolio

EXAMPLE: Using an interest rate swap to alter portfolio duration

A fund manager has a portfolio of £120 million fixed-rate U.K. bonds. The fund manager believes that interest rates will fall over the next three years and wishes to increase the portfolio's modified duration (exposure to changes in interest rates). She decides to increase portfolio duration from 4.5 to 6. A payer swap has a modified duration of –2 and a receiver swap has a modified duration of +2.

What type of swap will achieve the desired portfolio duration, and what is the required notional principal of the swap?

Answer:

The fund manager wishes to increase duration, so she should add a receiver swap with a notional principal of:

$$\text{NP}_s = \left(\frac{6-4.5}{2}\right) \times £120 \text{ million} = £90 \text{ million}$$

Interest Rate Forwards and Futures

Forward Rate Agreements (FRAs)

FRAs are typically used to hedge the uncertainty about a future short-term borrowing or lending rate. Consider a firm that anticipates borrowing a lump sum for 60 days, 30 days from now. The 60-day interest rate 30 days from now is uncertain. To hedge this uncertainty, the firm could take a long position in an FRA.

The long position in an FRA will receive a payment at settlement if the market rate of interest rate is higher than the (forward) rate specified in the FRA. Thus, if the 60-day rate 30 days from now is greater than the forward rate, the firm receives a payment from the FRA (with notional principal equal to the anticipated loan amount) that offsets the firm's higher borrowing costs. If the 60-day rate 30 days from now is less than the forward rate, the firm must make a payment to settle the FRA. This payment offsets the decrease in the firm's borrowing costs. Thus, the firm's borrowing costs in the future are essentially fixed by the FRA hedge. A firm that anticipates lending in the future could hedge the uncertainty about the market interest rate of the loan by taking a short position in an FRA. The key point is that long FRA positions will increase in value when future interest rates rise, and short positions will increase in value when interest rates fall.

Figure 16.3: FRA Diagram

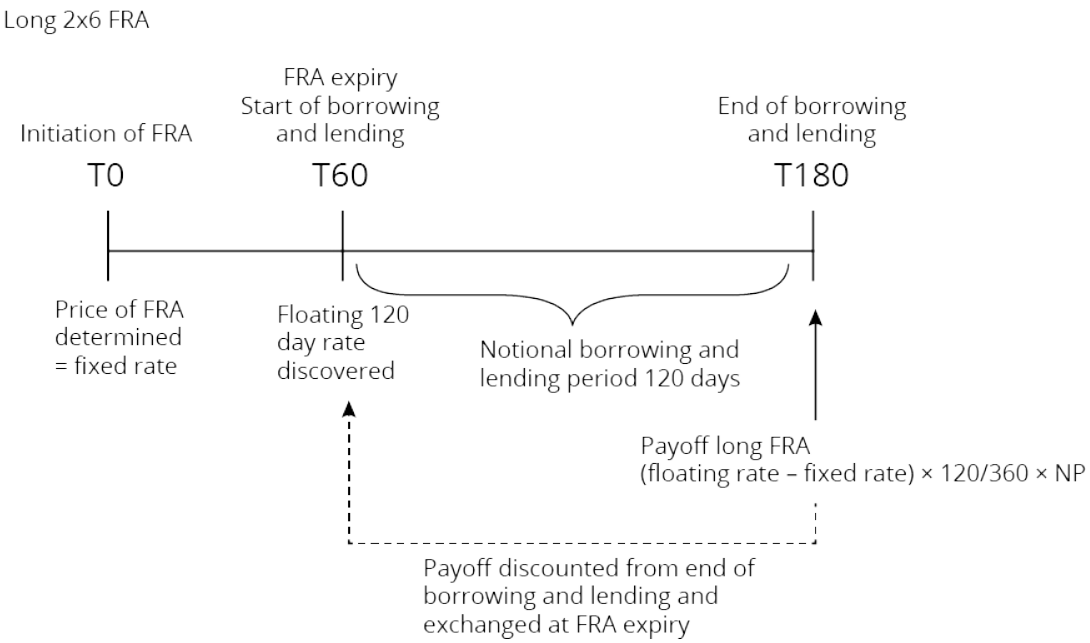


Figure 16.3 illustrates an FRA based on the future 120-day borrowing rate that settles 60 days from initiation. Note that the payment is made at the future borrowing or lending date and is equal to the present value of the difference in interest between a market-rate loan and a loan at the forward rate (rate specified in the FRA).

EXAMPLE: Using an FRA to hedge short-term future borrowing

Smithies Plc needs to borrow £1,000,000 for 180 days, 90 days from now, at LIBOR + 50 basis points (BP). The company is concerned that interest rates will rise over the 90-day period, increasing the cost of the 180-day loan. Smithies takes a long position in an FRA on 180-day LIBOR, 90 days in the future with a forward rate of 5% (annualized) and a notional principal of £1,000,000.

Calculate the firm's borrowing costs on the loan net of the FRA payment for realized 180-day LIBOR values, 90 days from now of 7% and 3%.

Answer:

LIBOR 7% at FRA expiry:

Cost of loan: (7% + 0.5%) × 180 / 360 × £1,000,000 = £37,500

Long FRA receipt: (7% – 5%) × 180 / 360 × £1,000,000 = £10,000*

Net cost: £37,500 – £10,000 = £27,500

LIBOR 3% at FRA expiry:

Cost of loan: (3% + 0.5%) × 180 / 360 × £1,000,000 = £17,500

Long FRA payment: (3% – 5%) × 180 / 360 × £1,000,000 = –£10,000*

Net cost: £17,500 + £10,000 = £27,500

The total cost is fixed at 5% + 50 BP regardless of the direction of interest rates:

5.5% × 180 / 360 × £1,000,000 = £27,500

*Note this is the payoff at the end of the borrowing and lending period; it is typically discounted and exchanged between FRA counterparties at settlement at day 90.

The firm has effectively hedged its future borrowing costs.

Short-Term Interest Rate (STIR) Futures

STIR futures are conceptually very similar to FRAs. The futures price is forward interest rate on deposits starting at the expiry of the future and lasting for 30 days. The standardization of futures means that contracts are only available on specific maturities (typically quarterly). Users that are hedging interest rate risk will often need to enter an offsetting transaction to close their futures position out when the hedge is no longer needed.

Eurodollar futures ($-based STIR futures) are based on deposits of $1 million and are priced using the IMM Index convention (i.e., 100 − annualized forward rate). The pricing convention means that futures prices will rise when forward rates fall. The forward interest rate is calculated from current spot LIBOR rates in the same way the forward price of an FRA is established. One basis point change in the forward rate will cause the contract's value to change by $25 ($1 million × 0.0001 × 90 / 360 = $25).

Using this pricing convention, a long Eurodollar futures position will increase in value as forward rates decrease and decrease in value as forward rates increase. Note that this differs from a long FRA position, which increases in value as forward rates increase and decreases in value as forward rates decrease.

EXAMPLE: Using Eurodollar futures to hedge short-term future investing

Allan Luard is expecting to receive a $20 million inheritance in 120 days. Allan intends to invest the $20 million in a 90-day deposit account at LIBOR –25 BP. Currently, Eurodollar futures expiring in 120 days are trading at 95. Allan is concerned that short-term rates may fall before he makes his deposit and would like to lock in a guaranteed interest rate today. He takes a long position in 20 Eurodollar futures contracts.

A. After 120 days, 90-day LIBOR is quoted at 3.5%. Allan closes out his future position and invests his inheritance in a 90-day deposit account at LIBOR – 25 BP. What is Allan's $ return from depositing his inheritance combined with his futures position?

Answer:

Interest received on deposit: $20 million × (3.5% − 0.25%) × 90 / 360 = $162,500

Number of futures contracts: $20 million / $1 million = 20

Futures price at settlement: 100 − 3.5 = 96.5

Profit on futures: 96.5 − 95 = 150 BP; 150 BP × $25 × 20 contracts = $75,000

Total return: $162,500 + $75,000 = $237,500

Allan has locked in the 90-day forward rate of 5% − 25 BP:

$20 million × (5% − 0.25%) × 90 / 360 = $237,500

B. If 3-month LIBOR is 6.5% in 120 days, what is Allan's $ return from depositing his inheritance combined with his futures position?

Answer:

Interest received on deposit: $20 million × (6.5% − 0.25%) × 90 / 360 = $312,500

Futures price: 100 − 6.5 = 93.5

Loss on futures: 93.5 − 95 = −150 BP; –150 BP × $25 × 20 contracts = −$75,000

Total return: $312,500 − $75,000 = $237,500

Both Eurodollar futures and FRA agreements allow lenders and borrowers to lock in rates for future borrowing and lending. While the pricing mechanisms are different, in both contracts, forward price is a forward rate of interest derived from current LIBOR rates. The FRA forward price (based on a 90-day loan period) should be the same as the forward reference rate used to price the Eurodollar futures in order to prevent arbitrage between futures and an equivalent FRA. The major differences between the two, besides their pricing conventions, are that futures are standardized, exchange traded, and require a margin deposit that is marked to market, while FRAs are customized contracts, created by dealers so that they are not liquid, and subject to counterparty risk.

Interest rate futures are available for many currencies. Euro interest rate futures, for example, are based on Euribor.

Fixed-Income Futures

Interest rate futures can be used to hedge the interest rate risk of short-maturity bonds (2–3 years), but this requires the estimation of the sensitivity of the value of each of the bond's cash flows to changes in the corresponding forward rate. Liquidity of interest rate futures decreases for forward rates further in the future. Longer-maturity bonds are most often hedged with fixed-income futures (bond futures), which have very good liquidity.

Treasury futures are available on T-bills, Treasury notes and Treasury bonds and are traded on the CBOT (Chicago Board of Trade) and CME (Chicago Mercantile Exchange). In Europe, government bond futures are traded on the Eurex and ICE exchanges and are available for bonds of various maturities.

Mechanics of Fixed-Income Futures

In practice, the majority of bond futures are closed out prior to settlement (the delivery date) by entering an offsetting trade. For futures held until settlement, bond futures include delivery

options for the short party. For example, with U.S. Treasury bond futures, the short party may deliver any U.S. Treasury bond with a maturity between 15 and 25 years at contract maturity. This practice ensures availability of government bonds for the short to deliver.

The price of Treasury bond futures is based on a notional government bond. The notional government bond is assumed to have a coupon rate of 6%. Each eligible bond that can be delivered by the short party is assigned a **conversion factor** (CF) to reflect its value relative to the notional bond in the contract.

CFs for eligible Treasury bonds are computed as the clean price of $1 face value of the eligible bond discounted at a yield to maturity of 6%. Note that bonds with a 6% coupon will automatically have a CF of one. Bonds with coupons higher than 6% will have CFs greater than one, and bonds with coupon rates less than 6% will have CFs less than one.

The short party will receive the principal invoice price on delivery:

$$\text{principal invoice price} = (\text{futures settlement price} / 100) \times \$100{,}000 \times \text{CF}$$

Settlement price is quoted with a par of $100. $100,000 is the face value of Treasury bond futures.

In practice, the bond delivered may be between coupon dates at the delivery date, so the short party will also receive any accrued interest on the bond delivered:

$$\text{total invoice amount} = \text{principal invoice price} + \text{accrued interest}$$

The process to compute the CF is imperfect largely because it assumes a flat interest rate term structure at 6%. The deliverable bonds have different coupons and maturities and, therefore, different durations. As a result, the shape of the term structure of interest rates does have an effect on the bond's value, which is ignored by the computation. If CFs were perfect, the short party would be indifferent between which of the eligible bonds to deliver. The bias in the computation of CFs means that one of the eligible bonds will generate the greatest gain (or smallest loss) to the short party at delivery. This bond is known as the **cheapest-to-deliver (CTD) bond**.

The cash-and-carry model is still used to price the future. The bond selected to price the future is the CTD. There are two methods to identify the CTD bond. The first method identifies the eligible bond that generates the highest return (implied repo rate) on a cash-and-carry trade. The second method is to find the eligible bond with the lowest basis. Basis is defined as the spot price minus the futures price.

The Treasury bond with the lowest basis will typically have the highest implied repo rate and be the cheapest to deliver.

PROFESSOR'S NOTE

Due to the mark-to-market feature in futures contracts, the short party does not receive the initial futures price at contract expiry. Daily futures settlement prices are used to compute the daily profit or loss on the futures contact with gains being added to the counterparties' margin accounts and losses being deducted. Daily profit or loss is calculated as $FP_t - FP_{t-1}$. To avoid double-counting profits and losses, the short party will receive the final settlement price multiplied by the CF at the maturity of the futures contract.

At delivery, the short party will deliver the CTD bond—with a value equal to the clean price plus accrued interest (the dirty or invoice price)—to the long party at the delivery date and

receive the settlement price multiplied by the CF plus accrued interest. The CTD bond will be the bond that generates the greatest profit or lowest loss on delivery.

$$\text{profit/(loss) on delivery} = [(\text{settlement price} \times \text{CF}) + \text{AI}_T] - (\text{CTD clean price} + \text{AI}_T)$$

EXAMPLE: Identifying the CTD bond at delivery

	Bond 1	Bond 2
Coupon	5.5%	5.75%
Time to maturity	20 years	19 years
Bond price	$141.13	$145.10
Accrued interest at delivery	$0	$0
CF	0.9422	0.9719
Futures settlement price	$148.75	$148.75

Answer:

	Bond 1	Bond 2
Settlement price × CF	$148.75 × 0.9422	$148.75 × 0.9719
= principal invoice amount	$140.15	$144.57
+ AI_T	$0	$0
= total invoice amount	$140.15	$144.57
Per $100,000 par	$140,150	$144,570
CTD clean price	$141.13	$145.10
+ AI_T	$0	$0
= CTD dirty price	$141.13	$145.10
Per $100,000	$141,130	$145,100
Delivery loss	–$980	–$530

Note that this example has assumed that delivery is immediately after a coupon payment and, therefore, accrued interest at delivery is zero. This is a simplifying assumption.

Bond 2 is the cheapest to deliver as it results in the smallest loss on delivery. Due to bias in the computation of CFs if yields are lower than 6%, there is a bias to short-duration (high coupon, low maturity) securities. If yields are greater than 6%, there is a bias to long-duration securities.

Hedging Interest Rate Risk Using Treasury Futures

To hedge the interest rate risk of a long bond portfolio, the fund manager will sell Treasury bond futures. As interest rates rise, bond prices fall and the futures price decreases, increasing the value of a short futures position. Futures contracts are typically used by portfolio managers to achieve a target duration. Short futures positions reduce portfolio duration, while long futures positions increase portfolio duration.

The starting point when hedging interest rate risk with Treasury futures is to identify the futures contract CTD security. Treasury futures prices will tend to correlate most closely with the CTD bond because the CTD has the lowest basis of any deliverable bond. The implication of this is that the change in the futures price will equal the change in the value of the CTD adjusted by its CF (i.e., the CTD and futures contract have the same duration).

$$\Delta \text{ futures price} = \frac{\Delta \text{CTD}}{\text{CF}}$$

To fully hedge (immunize) a portfolio's value against interest rate changes, the change in portfolio value must be offset by the change in the futures value:

$$\Delta P = HR \times \Delta \text{ futures price}$$

where:
ΔP = change in portfolio's value
HR = hedge ratio = Number of futures contracts

$$\Delta P = HR \times \frac{\Delta \text{CTD}}{\text{CF}}$$

$$HR = \frac{\Delta P}{\Delta \text{CTD}} \times \text{CF}$$

In practice, the CTD bond and the bonds in an investor's portfolio are unlikely to be perfect substitutes. The mismatch between the change in value of an asset or portfolio and the change in value of the derivative used to hedge it is referred to as basis risk or spread risk. The hedge ratio mentioned previously will be effective if the portfolio only contains the CTD bond. If the portfolio does not consist solely of the CTD bond, a duration-based hedge ratio (BPVHR) is calculated to determine the number of futures contracts required for a hedge:

$$\text{BPVHR} = \frac{-\text{BPV}_{\text{portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

Basis point value (BPV) is the expected change in value of a security or portfolio given a one basis point (0.01%) change in yield.

BPVHR = number of short futures

$\text{BPV}_{\text{portfolio}} = \text{MD}_{\text{portfolio}} \times 0.01\% \times \text{MV}_{\text{portfolio}}$

MD = modified duration

$\text{BPV}_{\text{CTD}} = \text{MD}_{\text{CTD}} \times 0.01\% \times \text{MV}_{\text{CTD}}$

MV_{CTD} = CTD price / 100 × \$100,000

To achieve a target duration, the formula can be amended to:

$$\text{BPVHR} = \frac{\text{BPV}_{\text{Target}} - \text{BPV}_{\text{Portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

$\text{BPV}_{\text{target}} = \text{MD}_{\text{target}} \times 0.0001 \times \text{MV}_{\text{portfolio}}$

The original formula is a special case where the $\text{BPV}_{\text{target}}$ equals zero.

EXAMPLE: Immunizing a bond portfolio from interest rate risk

A fixed-income portfolio manager is holding a portfolio with a market value of £60 million and wants to fully hedge the portfolio value against parallel movements in the yield curve. The portfolio has a modified duration of 10.75. The portfolio manager will sell U.K. Government Long Gilt futures to hedge the portfolio.

U.K. Government Long Gilt Futures Specifications	
Futures price	£130.21
Futures contract size	£100,000
CTD	4.75% coupon, 12 years to redemption
CTD price	£139.56

CTD CF	1.0709
CTD modified duration	9.7

1. **Compute** the number of U.K. Government Long Gilt futures to be sold to immunize the portfolio.
2. **Compute** the number of Gilt futures that need to be sold to achieve a target duration of 8.7.

Answer:

1. *Step 1*: Compute the BPV of the portfolio ($BPV_{portfolio}$):

$$BPV_{portfolio} = 10.75 \times 0.0001 \times £60 \text{ million} = £64,500$$

Step 2: Compute the BPV of the CTD (BPV_{CTD}):

$$BPV_{CTD} = 9.7 \times 0.0001 \times [(£139.56 / 100) \times £100,000]$$

$$= £135.37$$

Step 3: Compute the BPV hedge ratio:

$$BPVHR = \frac{-BPV_{Portfolio}}{BPV_{CTD}} \times CF = \frac{-£64,500}{135.37} \times 1.0709$$

$$= -476.47 \approx -476$$

The fund manager will need to sell 476 Long Gilt futures to fully hedge the portfolio.

2. $BPV_{target} = MD_{target} \times 0.0001 \times MV_{portfolio} = 8.7 \times 0.0001 \times £60 \text{ million}$

$= £52,200$

$$BPVHR = \frac{BPV_{Target} - BPV_{Portfolio}}{BPV_{CTD}} \times CF$$

$$= \frac{£52,200 - £64,500}{135.37} \times 1.0709 = -97.30 \approx -97$$

Selling 97 Long Gilt futures will achieve the portfolio's target modified duration of 8.7.

In practice, hedging results are not perfect due to three main factors:

1. The hedge was constructed using the CTD bond. If the level or slope of the term structure of interest rates changes significantly, the eligible bond, which is the CTD bond, may change. If the CTD bond changes, the duration of the Treasury bond future will also change.
2. Duration is not a perfect measure of how bond prices react to interest rate changes. Duration ignores the convexity of the bonds.
3. Modified duration only captures the impact of parallel movements in the term structure of interest rates. Shaping risk refers to nonparallel changes in the term structure, such as steepening, flattening, and changes in curvature.

MODULE QUIZ 16.1

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

1. Ben Root holds an interest rate swap with a tenor of one year and quarterly settlement dates. The variable reference rate is LIBOR. The variable payment/receipt on day 270 will be determined by:

A. 270-day LIBOR at initiation.
B. 90-day LIBOR at day 270.
C. 90-day LIBOR at day 180.

2. Virat Sharma, a high-net-worth individual, holds a four-year floating-rate note (FRN) with semiannual coupons at 180-day $LIBOR + 40 BP and a par value of $4 million. Sharma is concerned about falling interest rates and would like to hedge this risk.

   Four-year semiannual swaps are quoted at a swap rate of 4%; 180-day LIBOR at initiation is 3.5% and 180-day LIBOR at the first settlement date is 2.5%.

   What type of swap should Sharma use? **Compute** the net cash flow on the swap at the first and second dates. **Compute** the net return on Sharma's combined positions.

3. Adalene Bisset has agreed to purchase a new house for €8 million. Bisset expects to close the transaction in six months. She does not expect to close on the sale of her current house for nine months. Bisset needs to arrange three-month bridge financing €8 million for the commencing six months from now time and is concerned interest rates may have risen by then. She decides to sell three-month Euribor futures to hedge her risk.

Euribor Futures Contract Details	
Contract size	€1 million
Tick size 0.0001 × 90 / 360 × €1 million	€25
Futures price	98

   In six months, three-month interest rates are quoted at 2.5% and Bisset unwinds hedge the future is trading at 97.5. What is the effective interest rate on Bisset's loan?

   A. 0.5%.
   B. 2.0%.
   C. 2.5%.

4. Carlos Hendricks is a fixed-income fund manager. Hendricks is running a fund with a modified duration of 12 and a market value of $200 million. He is concerned that interest rates will increase and wants to reduce the duration of his portfolio to eight using U.S. Treasury futures.

U.S. Treasury Future	
Futures price	$164.20
Contract size	$100,000
CTD	4%, 20 years to maturity

CTD price	$126.39
CF	0.7689
CTD modified duration	14.54

What Treasury future position is required to achieve a portfolio duration of eight?

A. Sell 335 contracts.
B. Sell 435 contracts.
C. Sell 1,004 contracts.

MODULE 16.2: MANAGING CURRENCY EXPOSURE

Video covering this content is available online.

LOS 16.b: Demonstrate how currency swaps, forwards, and futures can be used to modify a portfolio's risk and return.

CFA® Program Curriculum, Volume 3, page 309

Many investors have assets and liabilities denominated in foreign currencies (not their domestic, or local, currency). When exchange rates change, the domestic-currency value of assets and liabilities denominated in a foreign currency will change. The exposure of foreign-currency denominated assets and liabilities to changes in exchange rates is termed currency risk.

Currency Swaps

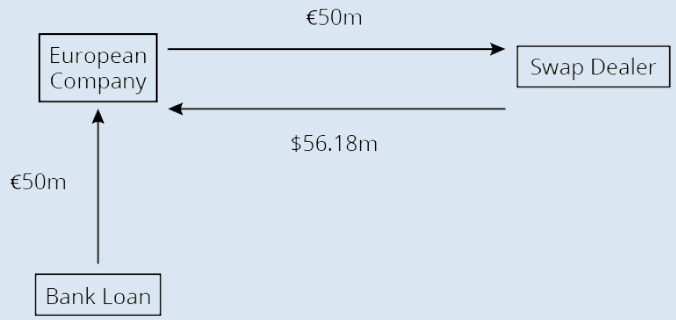
In a **currency swap**, one party agrees to make periodic interest rate payments on a notional amount in one currency, while the other party agrees to make period interest payments on a notional amount in another currency. The notional amounts are equivalent based on the exchange rate at the inception of the swap. Currency swaps allow borrowers requiring foreign currency to effectively borrow in a foreign currency. This may be advantageous to a company that will invest in a foreign asset that will generate foreign currency cash flows. The firm may not have good access to capital markets in the foreign country. A currency swap will allow the firm to hedge its currency risk from the foreign-currency cash flows. This is known as synthetic borrowing.

The parties to a currency swap may exchange only interest payments, but they may also exchange the notional amounts of each currency at the beginning and the end of the swap. This second case is known as a **cross-currency basis swap**. The periodic payments on a currency swap may be fixed or floating, but the typical swap is floating for floating.

EXAMPLE: Cross-currency basis swap

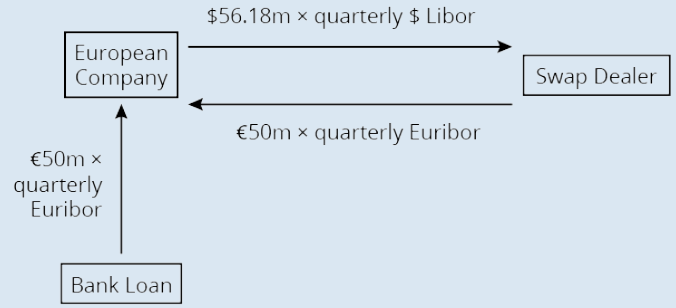
A euro-based company requires USD but does not have access to direct USD borrowing or finds it prohibitively expensive. The company decides to borrow in euros at 90-day Euribor and enter into a cross-currency basis swap to USD based on 90-day USD LIBOR (a floating-for-floating swap). The swap has a tenor of two years with quarterly settlement. The principal on the euro loan is €50 million and the $/€ exchange rate at initiation of the swap is $1.1236.

At initiation



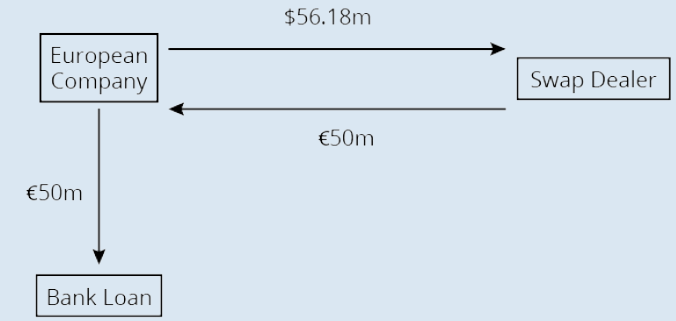
The euro-based company borrows €50 million and exchanges it for €50 million × 1.1236 = $56.18 million.

At quarterly settlement dates



Each counterparty pays variable interest for the currency they initially received. The euro-based company will be paying USD interest to the swap dealer. The swap dealer will be paying the euro interest to the company, which will then use it to service the interest on its loan with the bank.

At swap maturity (2 years)



At the swap's expiration, the notional principal amounts are exchanged. The amounts are the same as those exchanged initially; changes in the exchange rate over the life of the swap do not affect these amounts, so there is no uncertainty (exchange rate risk) on the principal flows. The European company receives the €50 million and uses it to repay its bank loan.

In this swap, the European company is described as the dollar payer and the swap dealer as the euro payer (i.e., the description relates to the interest flows and final principal payment, not the swap of initial principal).

Cross-Currency Basis

For the three decades leading up to the great financial crisis in 2008/2009, the **covered interest rate parity (CIRP)** relationship held quite well. When CIRP holds, borrowing directly in USD should have the same cost as borrowing in a foreign currency and hedging exchange rate risk with a currency swap.

When the CIRP relationship does not hold, arbitrage profits are theoretically possible, and exploitation of any arbitrage profits should result in zero basis over time. In a frictionless

market, cross-currency basis should not exist.

Since the financial crisis, basis has not been zero, indicating a failure of CIRP. The failure of CIRP to hold results from frictions in the arbitrage market. The introduction of stricter capital adequacy requirements and rules since the financial crash has resulted in much higher costs for covered interest rate arbitrage transactions. Another factor is high demand for USD loans. Since the financial crisis, USD lending via swaps has attracted a premium.

Cross-currency basis represents the additional cost of borrowing dollars synthetically with a currency swap relative to the cost of borrowing directly in the USD cash market. Typically, when describing basis we view it from the foreign-currency perspective rather than the USD perspective. If the cost of borrowing dollars synthetically via a swap is greater than the cost of direct USD borrowing, the foreign currency is said to be exhibiting negative basis. Most currencies have shown a negative basis against the dollar since the financial crisis. The implication is that the USD borrower must accept a lower interest rate on the foreign-currency interest payments it receives.

USD fixed-income investors can benefit when foreign currencies have a negative basis versus the USD by swapping USD for foreign currency and investing in foreign-currency denominated bonds and using a currency swap to convert the returns back to USD. Using this strategy, a USD investor can earn a higher return than by simply investing in the USD denominated bonds.

EXAMPLE: Cross-currency basis swap

Boivis Patisseries Sarl is a French chain of patisseries that has an extensive network of shops in continental Europe. As part of their expansion strategy, they are looking to set up shops in the United States. Boivis estimates that it will initially require $50 million to set up shops and cover working capital requirements. The finance directors at Boivis have looked at directly borrowing in USD but have found that costs would be $LIBOR + 100 BP. The decision is made to borrow for four years in euros at a rate of Euribor + 60 BP with interest paid quarterly and enter a currency swap to exchange euros for dollars. Basis on the Eurodollar swap is being quoted at –20 basis points (–20 BP). The swap pays variable interest on both legs on a quarterly settlement basis. The current $/€ exchange rate is $1.1815.

Three-month Euribor is 1.5% and $LIBOR is 2.0% at swap initiation. Three months later at the first settlement date, three-month Euribor is 1.6% and $LIBOR is 1.9%.

Compute the principal flows exchanged at the start and end of the swap's tenor. **Compute** the interest payments at the first and second settlement dates on the swap and the cost to Boivis for its synthetic dollar loan.

Answer:

Principal flows:

$50,000,000 / $1.1815 = €42,319,086

Boivis will need to borrow €42,319,086 and exchange it for $50,000,000. These amounts will be swapped back at the maturity of the swap.

Interest payment at first settlement date

Pays:

€ interest on the loan: €42,319,086 × (0.015 + 0.006) × 90 / 360 = €222,175

$ interest on the swap: $50,000,000 × 0.02 × 90 / 360 = $250,000

Receives:

€ interest on the swap: €42,319,086 × (0.015 − 0.002) × 90 / 360 = €137,537

Cost of $ financing:

Cost of borrowing $ direct: $50,000,000 × (0.02 + 0.01) × 90 / 360 = $375,000 (LIBOR + 100 BP)

Cost of synthetic $ borrowing: $50,000,000 × (0.02 + 0.006 + 0.002) × 90 / 360 = $350,000 (LIBOR + 80 BP)

Net benefit of swap: $375,000 − $350,000 = $25,000

Net benefit of swap: $50,000,000 (1% − 0.8%) × 90 / 360 = $25,000

Interest payment at second settlement date

Pays:

€ interest on the loan: €42,319,086 × (0.016 + 0.006) × 90 / 360 = €232,755

$ interest on the swap: $50,000,000 × 0.019 × 90 / 360 = $237,500

Receives:

€ interest on the swap: €42,319,086 × (0.016 − 0.002) × 90 / 360 = €148,117

Cost of $ financing:

Cost of borrowing $ direct: $50,000,000 × (0.019 + 0.01) × 90 / 360 = $362,500 (LIBOR + 100 BP)

Cost of synthetic $ borrowing: $50,000,000 × (0.019 + 0.006 + 0.002) × 90 / 360 = $337,500 (LIBOR + 80 BP)

Net benefit of swap: $362,500 − $337,500 = $25,000

Net benefit of swap: $50,000,000 (1% − 0.8%) × 90 / 360 = $25,000

Conclusion:

By borrowing in euros and entering a currency swap, Boivis has locked into a cost of $LIBOR + 80 BP for their USD borrowing, reflecting the 60 BP spread above Euribor on the loan and the –20 BP on the swap.

Currency Forwards and Futures

Currency forwards and futures allow users to exchange a specified amount of one currency for a specified amount of another currency on a future date. Forwards are customized, while futures are standardized contracts. Consider, for example, a U.K. company exporting goods to Canada that expects to receive a payment of 30 million Canadian dollars (CAD) in 90 days. The risk to the U.K. company is that the exchange rate may change over the next 90 days, so the amount received when converted to British pounds (GBP) is uncertain. A forward contract to purchase a specific number of GBP for 30 million CAD effectively guarantees the future exchange rate in 90 days. The customization of forward contracts allows the contract to be tailored to both the specific quantity of CAD to be received and the expected date of receipt.

Currency futures are standardized in terms of quantity of currency to be exchanged and delivery dates, so a futures hedge may not exactly match the requirements of a hedger. The range of currency pairs on which futures are available is limited, although they are available on most major currency pairs. The greater liquidity of currency futures is attractive to many investors and currency dealers.

The hedge ratio for futures can be calculated as:

$$\text{HR} = \frac{\text{amount of currency to be exchanged}}{\text{futures contract size}}$$

EXAMPLE: Hedging exchange rate risk using futures

A U.S. firm is due to receive €20 million in 90 days for goods they sold. The firm is seeking to hedge this risk by selling EUR futures contracts maturing closest to date the euros will be received. The EUR-USD FX future contract size is €125,000. The futures price is 1.3150 USD/EUR. The firm will sell futures contracts (promising to deliver euros at the rate of 1.3150 USD per EUR).

Calculate the number of futures contracts required to hedge the liability and the amount of USD to be received at contract settlement.

Answer:

$$\text{futures position HR} = \frac{€20{,}000{,}000}{€125{,}000} = 160 \text{ EUR-USD futures}$$

At contract settlement, the firm will deliver €20 million and receive 20 million × 1.3150 = $26,330,000.

If the settlement date of the futures does not match the date that euros will be received, the hedge will not be perfect. If the futures settlement is prior to the receipt of the euros, the firm will have exchange rate risk from the settlement date until the euros are received. If the futures settle after the euros are received, the futures position will be closed prior to the futures settlement. In this case, the futures price when the futures are purchased (to close out the short position) will likely not equal the spot price, so the firm has basis risk. This difference could lead to the receipt of either more or less USD than delivery at the settlement of the futures contract would.

MODULE QUIZ 16.2

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

1. The New Zealand dollar (NZD) is trading at a positive cross-currency basis against the U.S. dollar (USD). Sterling (GBP) is trading at a negative cross-currency basis to the USD. Which of the following strategies would generate the greatest return?
   A. Swapping USD for NZD and investing in New Zealand government securities.
   B. Swapping NZD for USD and investing in U.S. government securities.
   C. Swapping GBP for NZD and investing in New Zealand government securities.

2. Barney Wood imports goods to the U.K. from the Eurozone. He is due to make a payment in 30 days of €20 million. Wood is concerned that the pound will depreciate against the euro over this period and would like to hedge his currency risk with futures. The current spot rate is £/€ = 0.8929.

Cross-Currency EUR-GBP Future	
Futures price* £/€	0.8989
Contract size	€125,000

*Expires in 40 days

Calculate the futures position needed to hedge Wood's liability.

In 30 days, the exchange rate is £/€ = 0.9034 and the futures price is £/€ 0.9054. **Calculate** the cost to Wood if he leaves his euro liability unhedged and if he hedges the position using the future.

3. ABC Robotics, Inc., as a U.S. firm will borrow £30 million to set up a subsidiary in the U.K. ABC can borrow GBP directly at a cost of £LIBOR + 50 BP. ABC Robotics can borrow in USD at $LIBOR + 40 BP. A EUR-USD swap is quoted at −15 BP. The spot exchange rate at swap initiation is quoted as $/£ = £1.2000. The swap is a four-year semiannual swap where both the USD and GBP reference rates are based on six-month LIBOR. Six-month $LIBOR is 2.5% and £LIBOR is 1.5% at initiation of the swap. At the first settlement date, six-month $LIBOR is 2.25% and £LIBOR is 1%. **Calculate** the interest payments at the first and second settlement dates. How much better off is ABC Robotics from using the cross-currency swap rather than directly borrowing GBP?

MODULE 16.3: MANAGING EQUITY RISK

Video covering this content is available online.

LOS 16.c: Demonstrate how equity swaps, forwards, and futures can be used to modify a portfolio's risk and return.

CFA® Program Curriculum, Volume 3, page 313

Equity Swaps

Equity swaps can be used to create a synthetic exposure to physical stocks, allowing market participants to increase or decrease their exposure to equity returns. Equity swaps enable users to achieve the economic benefits of share ownership without the cost and expense of ownership.

The three main types of swaps include the following:

1. Pay fixed, receive equity return.
2. Pay floating, receive equity return.
3. Pay another equity return, receive equity return.

An example of paying another equity return and receiving an equity return would be paying the return on the Nasdaq Composite Index and receiving the return on the S&P 500.

The equity return may be based on:

- A single stock.
- A basket of equities.
- An equity index.

The equity return may be price return (typical) or total return (price + dividends).

A typical equity swap will involve a series of payments at periodic settlement dates over the tenor of the swap. Some equity swaps require each party to make a single payment at the end of the swap's life.

Figure 16.4: Equity Swap vs. Physical Stock

Advantages	Disadvantages
■ Gain exposure to equity when participation in physical market is restricted ■ Avoid tax on physical ownership (i.e., stamp duty) ■ Avoid custody fees on physical ownership ■ Avoid the cost of monitoring physical positons, which may increase due to corporate actions (i.e., dividend payments, stock splits, buy-backs, M&A, etc.)	■ Equity swaps typically require collateral ■ Swaps are illiquid ■ Swaps do not convey voting rights

EXAMPLE: Changing equity exposure using a swap

A German pension fund manager holds a €200 million portfolio of domestic stocks passively tracking the DAX 30 stock market index. The pension fund expects the index to rise in the next year and wishes to increase its exposure by 40%. The fund manager enters an equity swap with a notional principal of €80 million, agreeing to pay floating interest at Euribor + 30 BP and receive the return on the equity index. The swap has a tenor of one year and semiannual settlements. The DAX 30 at the time of swap initiation is 12,400 points.

Scenario 1:

The reference rate relating to the first settlement date is six-month Euribor = 6%.

The DAX 30 at the first settlement date = 13,020.

Scenario 2:

The reference rate relating to the first settlement date is six-month Euribor = 6%.

The DAX 30 at the second settlement date = 11,780.

Compute the gain or loss on the portfolio, the cash flows on the swap, and the net position for the fund manager in both scenarios.

Answer:

Scenario 1:

Return on DAX 30 = (13,020 / 12,400) − 1 = 5%

Increase in portfolio value = €200 million × 0.05 = €10 million

Equity leg of swap = €80 million × 0.05 = €4 million

Euribor leg of swap = €80 million × (0.06 + 0.003) × 180 / 360 = €2.52 million

Net cash flow on swap = €4 million − €2.52 million = €1.48 million

This is the synthetic equivalent to borrowing €80 million in the money markets at Euribor + 30 BP and investing €80 million in an index-tracking portfolio:

€80 million × [0.05 − (0.063 × 180 / 360)] = €1.48 million

Fund managers position = €10 million + €1.48 million = €11.48 million

Scenario 2:

Return on DAX 30 = (11,780 / 12,400) − 1 = −0.05

Decrease in portfolio value = €200 million × −0.05 = −€10 million

Equity leg of swap = €80 million × −0.05 = –€4 million

Floating leg of swap = €80 million × (0.06 + 0.003) × 180 / 360 = €2.52 million

Net cash flow on swap = −€4 million − €2.52 million = −€6.52 million

Note that the equity return receiver pays both the floating rate of interest and the negative return on the equity index.

This is the synthetic equivalent to borrowing €80 million in the money markets at Euribor + 30 BP and investing €80 million in an index-tracking portfolio:

€80 million × [−0.05 − (0.063 × 180 / 360)] = −€6.52 million

Fund managers net position = −€10 million − €6.52 million = −€16.52 million

To reduce the exposure to equity, the fund manager would enter a swap to pay the equity return and receive a floating (or fixed) rate of interest. This synthetically creates a position equivalent to selling equity and investing the proceeds in the money markets.

Equity Futures and Forwards

Equity futures are exchange traded, standardized, require margin, have low transaction costs, and are available on indexes and single stocks. They enable market participants to do the following:

- Implement tactical allocation decisions (alter the exposure to equity of a portfolio).
  - Selling futures (short position) reduces equity exposure.
  - Buying futures (long position) increases equity exposure.
- Achieve portfolio diversification.
- Gain exposure to international markets.
- Make directional bets on the direction of the market.

Forwards provide many of the same advantages but lack liquidity and are not subject to mark-to-market margin adjustments. Because there is no clearinghouse, the credit quality of the counterparties is a concern. The major advantage of forward contracts is they can be customized.

Index futures have a multiplier. The actual futures price is the quoted futures price (in points) × the multiplier. For S&P 500 Index futures, the multiplier is $250; for FTSE 100 Index futures, the multiplier is £10.

EXAMPLE: Using index futures to hedge equity market exposure

A fund manager holds a £200 million equity portfolio, which is passively tracking the FTSE 100 Index. The fund manager wishes to hedge 30% of the portfolio against equity market risk.

Contract Details for FTSE 100 Index Futures	
Quotation	Index points
Multiplier	£10 per point
Tick size	0.5 points
Delivery dates	March, June, September, December
Settlement price	FTSE 100 cash price on last day of trading
Futures price – September delivery	7,300

Compute the number of contracts required to hedge 30% of the portfolio's equity position. **Compute** the profit or loss if the FTSE 100 increases by 5% and the futures price is 7,665. **Compute** the profit or loss if the FTSE 100 falls by 5% and the futures price changes to 6,935.

Answer:

$$\text{number of futures contracts needed} = \frac{\text{monetary value of position to be hedged}}{\text{futures price} \times \text{multiplier}}$$

$$= \frac{-£60{,}000{,}000}{7{,}300 \times £10} = -821.9 = 822 \text{ short futures}$$

FTSE 100 @ 7,665 at delivery (5% increase)

Futures gain/(loss): 7,665 − 7,300 = 365 points ∴ 365 points × £10 × −822 = −£3,000,300

Portfolio value: (1 + 0.05) × £200,000,000 = £210,000,000

Net position: £210,000,000 − £3,000,300 = £206,999,700

Impact of hedge	£
Future position	−3,000,300
Portfolio £60,000,000 × 0.05	3,000,000
Net gain	−300

The imperfection in the hedge is the result of rounding the hedge ratio.

FTSE 100 @ 6,935 at delivery

Futures gain/(loss): 6,935 − 7,300 = −365 points ∴ −365 points × £10 × −822 = £3,000,300

Portfolio value: (1 − 0.05) × £200,000,000 = £190,000,000

Net position: £190,000,000 + £3,000,300 = £193,968,220

Impact of hedge	£
Future position	3,000,300
Portfolio £60,000,000 × −0.05	−3,000,000
Net gain	300

Achieving a Target Portfolio Beta

Short equity futures positions can be used to decrease the beta of a portfolio, and long positions can be used to increase the beta of a portfolio. A portfolio's beta is the weighted average of the betas of the portfolio stocks. The number of contracts required to change the beta of an existing portfolio can be calculated with the following formula:

$$\text{number of futures required} = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

where:

β_T = target portfolio beta

β_P = current portfolio beta

β_F = futures beta (beta of stock index)

MV_P = market value of portfolio

F = futures contract value = futures price × multiplier

Note that to fully hedge the portfolio from market risk, $\beta_T = 0$.

EXAMPLE: Achieving a target portfolio beta using index futures

A fund manager has a $60 million portfolio of aggressive stocks with a portfolio beta of 1.2 relative to the S&P 500. The fund manager believes the market will decline over the next six months and wishes to reduce the beta of the portfolio to 0.8 using S&P 500 futures. S&P 500 futures currently have a contract price of 2,984 and a multiplier of $250. At the end of the six-month period, the S&P 500 Index has decreased by 1.5%. By definition, beta of the S&P 500 Index equals 1.

Calculate the number of futures contracts and **determine** whether they should be bought or sold to achieve the target portfolio beta. **Compute** the effectiveness of the strategy at the end of the six-month period.

Answer:

$$\text{number of futures required} = \left(\frac{0.8-1.2}{1}\right)\left(\frac{\$60{,}000{,}000}{\$746{,}000}\right) = -32.17$$

$$= -32 \text{ futures contracts}$$

futures contract value = 2,984 × $250 = $746,000

Because the calculated value of the number of futures contracts is negative, the futures contracts should be sold.

Value of portfolio in six months:

$60,000,000 × [1 − (0.015 × 1.2)] = $58,920,000

Note that if the market falls by 1.5%, the portfolio will fall by more than 1.5% because its beta is greater than 1.

Profit on futures contract:

Futures contract value in six months: 2,984 × (1 − 0.015) = 2,939.24 = 2,939 (rounded to the nearest 0.5 index point)

Futures profit: (2,984 − 2,939) × $250 × 32 = $360,000

Net position: $58,920,000 + $360,000 = $59,280,000

$$\text{return} = \frac{\$59{,}280{,}000}{\$60{,}000{,}000} - 1 = -0.012, \textit{ or } -1.2\%$$

$$\text{beta of portfolio} = \frac{\%\text{ change in portfolio}}{\%\text{ change in index}} = \frac{-0.012}{-0.015} = 0.8$$

Cash Equitization

Holding cash balances will typically reduce the return on a portfolio because cash typically yields a lower rate of return than equity or fixed income. Holding cash balances will therefore increase the risk that the portfolios will underperform the benchmark. **Cash equitization** refers to purchasing index futures to replicate the returns that would have been earned by investing the cash in an index with risk and return characteristics similar to those of the portfolio. The major advantages of futures, in this application, are their liquidity and low transaction costs relative to direct investment in the equity markets. Cash equitization is also known as cash securitization or cash overlay.

An alternative to purchasing futures would be to buy call options and sell put options on the appropriate stock index with the same strike and expiry to create a synthetic forward position.

EXAMPLE: Cash equitization

A U.S. fund manager runs a passive fund, which tracks the S&P 500. Cash balances have built up in the portfolio and the fund manager is concerned that the cash drag will lead to portfolio underperformance relative to the S&P 500. The fund currently holds $8 million in cash. S&P 500 futures currently have a contract price of 2,780, a multiplier of $250, and a beta of 1.

Calculate the number of stock index futures needed to equitize the portfolio's excess cash.

Answer:

$$\text{number of futures required} = \left(\frac{\beta_{\text{T}}-\beta_{\text{P}}}{\beta_{\text{F}}}\right)\left(\frac{\text{MV}_{\text{P}}}{\text{F}}\right)$$

where:
β_{P} = current portfolio beta of cash position = 0 (note cash has a beta of 0)
MV_{P} = cash position

$$\text{number of futures required} = \left(\frac{\beta_T}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

where:
β_T = target portfolio beta (In this case, the target will be set to 1, as we want the beta of the synthetically invested cash to match the beta of the index.)

$$\text{number of futures required} = \left(\frac{1}{1}\right)\left(\frac{\$8{,}000{,}000}{\$695{,}000}\right) = 11.51$$
$$= 12 \text{ futures contracts}$$

F = 2,780 × $250 = $695,000

MODULE QUIZ 16.3

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

1. A U.K. fund manager has a defensive equity portfolio with a market value of £20 million and a beta equals 0.8 relative to the FTSE 100. The manager believes that U.K. equity will perform strongly over the next year and wishes to increase the portfolio beta to 1.4. FTSE 100 futures are currently trading at 7,425 points with a multiplier of £10. How many futures contracts are required to achieve the desired beta?
   A. 162 FTSE 100 futures.
   B. 377 FTSE 100 futures.
   C. 1,620 FTSE 100 futures.
2. Hideko Kobayashi is an active fund manager running an equity portfolio benchmarked against the Nikkei 225. The funds market value is ¥4,350,000,000. Due to recent sales, Hideko is worried that cash balances have built up to 5% of the fund's value. Hideko is worried about the cash drag affecting her performance fees and wishes to temporarily invest the surplus cash in the Nikkei 225. The Nikkei future she is considering has a price of 21,624 and a multiplier of ¥1,000. How many Nikkei 225 futures will she require for this cash overlay?
   A. 10 futures.
   B. 100 futures.
   C. 201 futures.

MODULE 16.4: DERIVATIVES ON VOLATILITY

Video covering this content is available online.

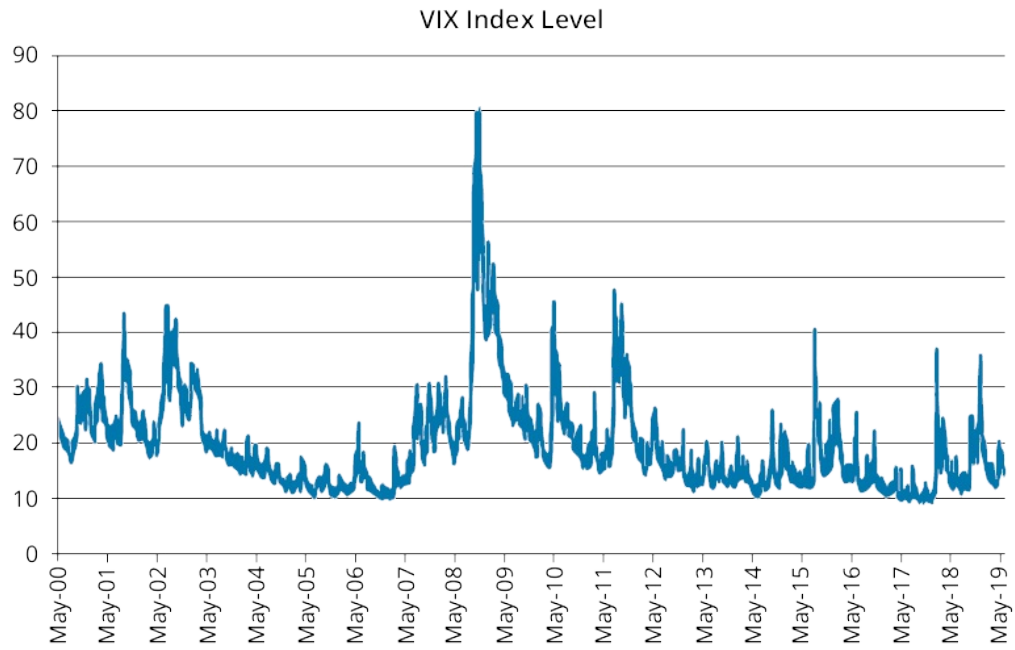
LOS 16.d: Demonstrate the use of volatility derivatives and variance swaps.

CFA® Program Curriculum, Volume 3, page 319

Volatility is a measure of the magnitude of price movements over a certain period of time. The best known measure of market volatility is the CBOE Volatility Index (more commonly known as VIX). The VIX Index measures implied volatility in the S&P 500 Index over a forward period of 30 days. VIX computes a weighted average of implied volatility inferred from S&P 500 traded options (calls and puts) with an average expiration of 30 days. It is important to note that VIX is not a measure of actual volatility but rather the expected volatility that is priced into options. VIX is also known as the fear index or fear gauge as we can directly view the market's expectations of future volatility.

Specifically, the VIX Index value is the annualized standard deviation of the expected +/− percentage moves in the S&P 500 Index over the following 30 days. For example, if the VIX was at 20, we could interpret it as telling us that the market expects that the S&P will stay

within a +/−20% range over one year with a 68% level of confidence. This implies a range +/− $\frac{20}{\sqrt{12}}$ = 5.77% over the next 30-day period.

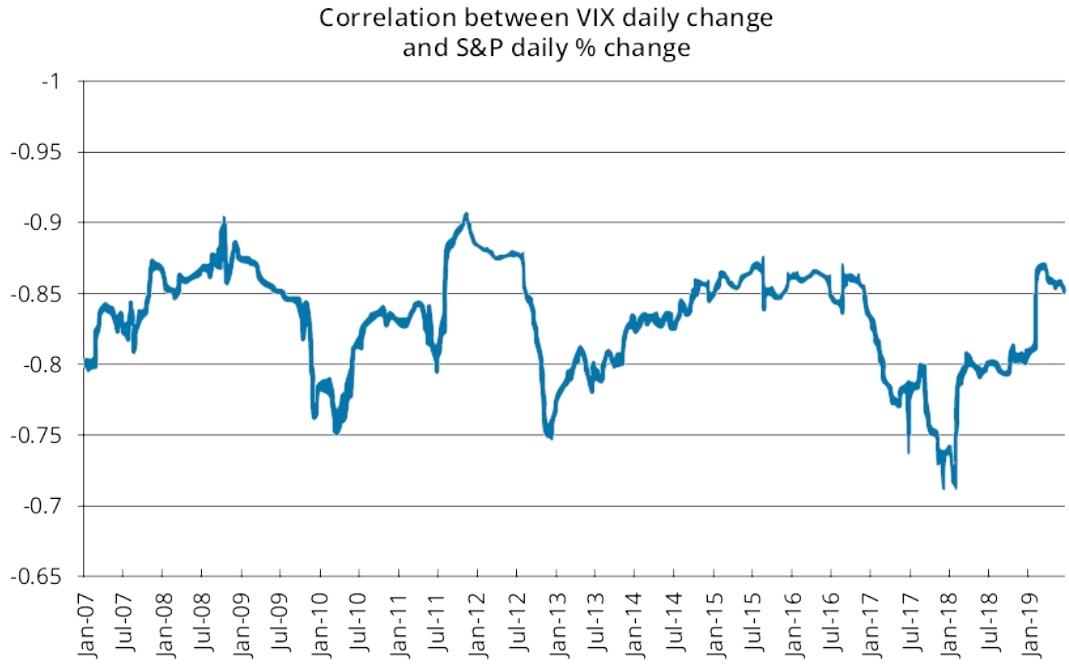


Source: CBOE

The graph of the VIX Index over the past 19 years shows large spikes in the index at times of great uncertainty—for example, in 2008 with the great financial crash, 2010 with the "flash crash" attributed to high-frequency traders, and 2011 with the S&P downgrade of U.S. sovereign debt. As a rule of thumb, a value lower than 20 represents a low-risk environment and values above 30 represent a high-risk environment. However, very low levels of the VIX Index can indicate an excessively bullish market, while very high levels can imply an excessively bearish market. The performance of VIX over this 19-year period also demonstrates the mean reversion of the index. Spikes in the index do not last, and the index reverts to more moderate levels soon after.

Importantly, empirical studies have shown a negative correlation between the VIX and stock returns, which becomes even more pronounced during downturns. This correlation allows derivatives based on the index to be used to offset the losses on an equity portfolio when volatility increases.

The following chart shows a rolling 252-day correlation between the VIX price and daily returns on the S&P 500.



Source: CBOE

While investors cannot directly invest in VIX, the CBOE introduced futures based on the VIX Index in 2004 and options in 2006. This has led to volatility being viewed as a separate asset class that can be bought and sold. VIX futures and options offer participants pure-play bets on market volatility.

VIX Futures

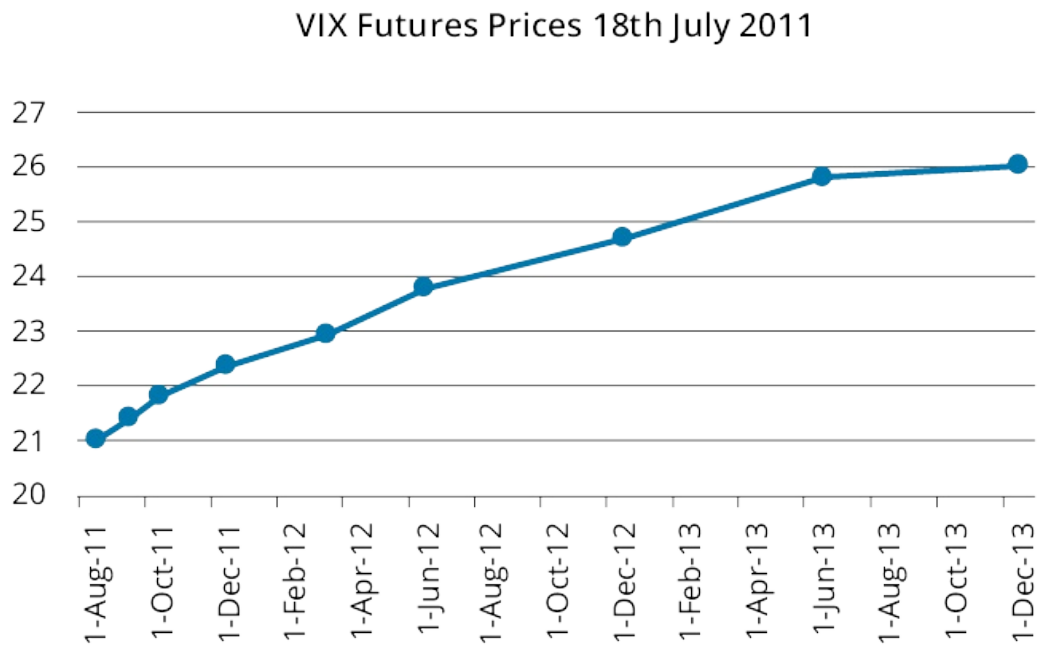
Unlike other futures contracts, the cost-of-carry model cannot be used to determine the fair value of the future because it is not possible to directly invest in spot VIX. The **VIX futures** price can be interpreted as the expected S&P 500 Index volatility in the 30-day period after the futures contract expiration date.

An equity holding can be protected from extreme downturns (tail risk) by buying VIX futures. Remember that VIX returns and equity returns are negatively correlated. If volatility increases, the equity portfolio will decline in value but VIX futures should increase in value. VIX futures will increase in value when the market's expectation of future volatility at contract maturity increases.

Selling VIX futures creates a short volatility position and captures the volatility risk premium embedded in S&P 500 options. Short volatility positions can result in large losses if expected volatility rises significantly.

The term structure of VIX futures can provide insights into the market's expectations of volatility over time. Contango and backwardation in the futures market are therefore driven by expected changes in volatility over time. The term structure of VIX futures is constantly changing, reflecting changes in expected 30-day volatility at future dates, current expected 30-day volatility, and VIX futures trading activity.

Contango Market

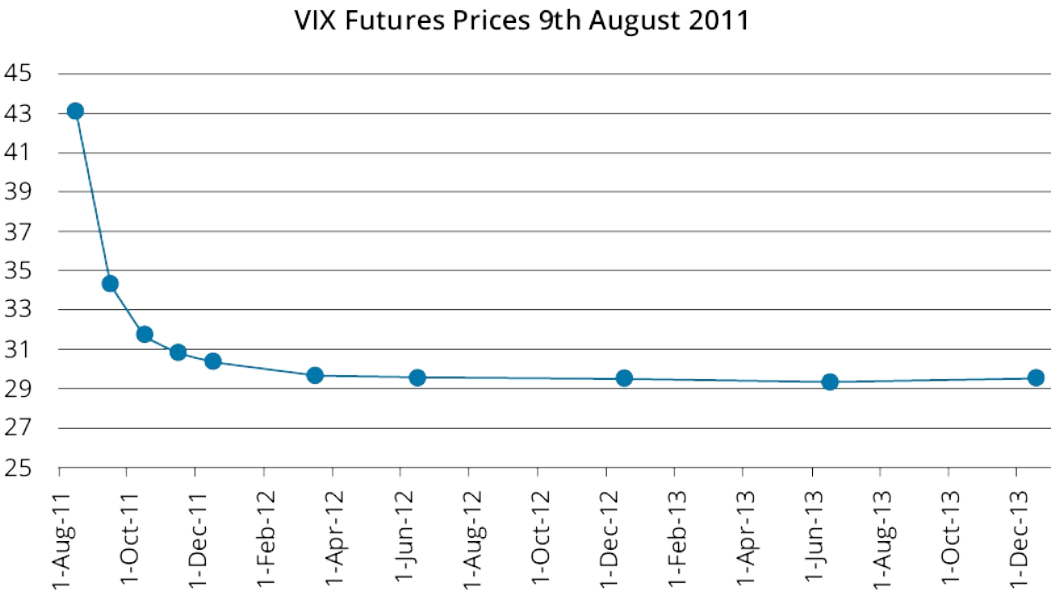


18 July, 2011; spot VIX = 20.95

Source: CBOE

The chart shows futures prices on the y-axis and futures expiration dates on the x-axis. Looking at the data on 18 July, 2011, the VIX futures market is in contango. Negative basis defines contango, where basis is computed as spot minus futures price. Longer-dated futures contracts have higher prices than short-dated futures contracts. We can interpret this as market participants expecting 30-day volatility to increase from August 2011 until December 2013. When levels of the VIX Index are low, it is common for the futures market to be in contango.

Backwardation



9 August, 2011; spot VIX = 35.06

Source: CBOE

Less than one month later, the term structure of VIX futures has completely changed and is now in backwardation. We can interpret this shape as the market expecting 30-day volatility to decrease over the period. The cause of the sudden change from contango to backwardation was a sudden increase in the VIX Index caused by the S&P downgrade of U.S. sovereign debt from AAA to AA+ on August 5, 2011.

VIX futures prices and the VIX Index will converge at contract maturity because VIX futures settle against spot VIX at expiration. For a participant who purchases long-dated VIX futures when the market is in contango (the typical situation), the difference between the spot and futures price will decline over time as the futures price moves toward spot VIX at expiration. If the market is in backwardation, the futures price should rise over time as it moves toward spot VIX. The profit or loss generated as the basis moves toward zero over the life of the futures contract is referred to as roll yield. When the short end of the VIX futures curve is steeper than the long end, the roll yield will be magnified.

Position	Term Structure	Roll Yield
Long futures position	Contango	Negative
Short futures position	Contango	Positive
Long futures position	Backwardation	Positive
Short futures position	Backwardation	Negative

VIX Options

VIX options are cash-settled European-style options. VIX options can only be exercised at contract maturity; therefore, the value of the option is determined by the expectations of VIX at the contract expiry. VIX call options will gain in value if expectations of volatility at maturity of the option increase, and put options will gain in value if expectations of volatility fall.

Other Volatility Indexes

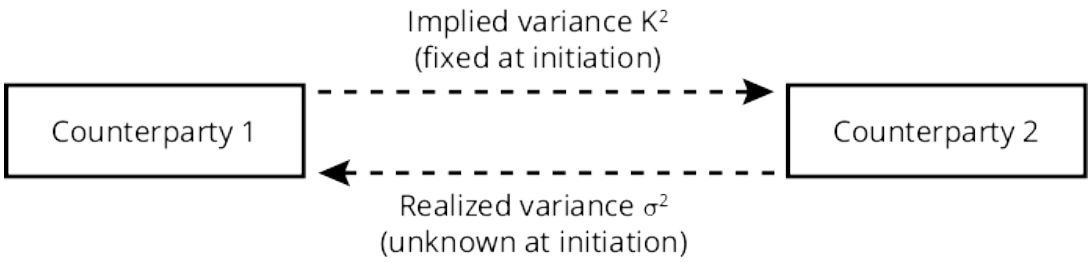
Volatility indexes are also available on other U.S. stock indexes, including the S&P 100, DJIA, Nasdaq, and Russell 2000.

Volatility indexes also exist on European stock market indexes. Using similar methodology to the VIX Index, VSTOXX is an implied volatility-based index based on the EURO STOXX 50 Index. VFTSE is a volatility index based on the FTSE 100, and VDAX-NEW is based on the DAX 30.

Variance Swaps

Variance swaps payoffs are based on variance rather than volatility (standard deviation). Variance is σ^2. These products are termed swaps as they have two counterparties, one making a fixed payment and the other making a variable payment. The fixed payment is typically based on implied volatility^2 (implied variance) over the period and is known at the initiation of the swap; this is referred to as the variance strike. The variable payment is unknown at swap initiation and is only known at swap maturity. It is the actual variance of the underlying asset over the life of the swap and is referred to as realized variance (σ^2).

The party receiving the variable payment (the purchaser) will gain on the contract when the realized variance is greater than the implied variance and will lose when the realized variance is less than the implied variance. A variance swap can, therefore, be viewed as a pure play on whether realized variance will be higher or lower than expected variance (implied variance) over the tenor of the swap.



There is no exchange of notional principal at the initiation of the swap. A variance swap also has no interim settlement periods. With a variance swap, there is a single payment at the expiration of the swap based on the difference between actual and implied variance over the life of the swap:

$$\text{settlement amount}_T = (\text{variance notional})(\text{realized variance} - \text{variance strike})$$

The value of the swap is zero at initiation because implied volatility is the best ex ante estimate of realized volatility.

Long (purchaser) describes the counterparty who receives the realized variance (actual) and pays the swap's variance strike (implied volatility).

Realized volatility > strike	Buyer (long) of swap makes a profit
Realized volatility < strike	Buyer (long) of swap makes a loss

Realized variance is calculated by taking the natural log of the daily price relatives, the closing price on day *t*, divided by the closing price on day *t* − *1*:

$$R_i = \ln(P_t / P_{t-1})$$

If we have *N* days of traded prices, we can compute *N* − *1* price relatives (R):

$$\text{daily varinace} = \left[\frac{\sum_{i=1}^{N-1} R_i^2}{(N-1)} \right]$$

annualized variance = daily variance × 252; 252 = assumed trading days in a year

PROFESSOR'S NOTE

This appears to be an unusual variance computation, as most computations we have seen deduct the mean from the numerator before squaring (i.e., $\frac{\sum_{i-1}^{N-1} (R_i - \bar{R})^2}{N-1}$). In this variance computation, the mean is not deducted. The logic is that we are calculating movement regardless of direction rather than movement around a mean. This has the advantage of making the variances perfectly additive (i.e., one-year variance can be split into two equal six-month periods). This concept will be used later for valuing variance swaps prior to maturity.

Variance swaps can be created for any underlying asset as long as it is traded and there is a record of daily prices.

The notional amount for a variance swap can be expressed as either variance notional (N_{VAR}) or vega notional (N_{VEGA}). Variance notional represents the profit or loss per point difference between implied variance (strike^2) and realized variance (σ^2). Variance notional can therefore be thought of as a multiplier that turns the point difference between σ^2 and K^2 into a monetary amount:

$$\text{profit/(loss)} = N_{VAR} \times (\sigma^2 - K^2)$$

where:
σ = realized volatility
K = strike volatility (implied volatility)

PROFESSOR'S NOTE

Both the actual (σ) and the implied volatility on the swap (K) are quoted in standard deviations but remember this is a variance swap and therefore we must square the volatility.

The market convention is to quote the notional on a swap as vega notional (N_{VEGA}) rather than variance notional (N_{VAR}). Recall that vega refers to the change in option premium per a 1% change in volatility, $\frac{\Delta Premium}{\Delta Volatility}$, a natural way to think about the return for volatility.

Given the relationship between N_{VAR} and N_{VEGA}, we can calculate the gains or losses on a variance swap with either of them. Using N_{VAR}, this calculation is more intuitive as it is multiplied by the difference between actual and implied variance:

$$\text{variance notional} = \frac{\text{vega notional}}{2 \times \text{strike price (K)}}, \text{ so profit}/\left(\text{loss}\right) = N_{VAR} \times \left(\sigma^2 - K^2\right)$$

$$= N_{VEGA} \times \left(\frac{\sigma^2 - K^2}{2K}\right)$$

Convexity

Because the payoffs on a variance swap are based on variance, while the strike price is expressed in terms of volatility, the payoffs for a variance swap are convex with respect to volatility. Compared to the payoffs on a volatility derivative with payoffs that are linear with respect to volatility, (1) when realized volatility is below the strike, the losses on the variance swap are smaller than the losses on the volatility derivative, and (2) when realized volatility is above the strike, the gains on the variance swap are greater than the gains on the volatility derivative. This convexity is similar in nature to the convexity of bond prices with respect to yield. With the variance swap, payoffs are increasing at an increasing rate when volatility rises and decreasing at a decreasing rate when volatility falls.

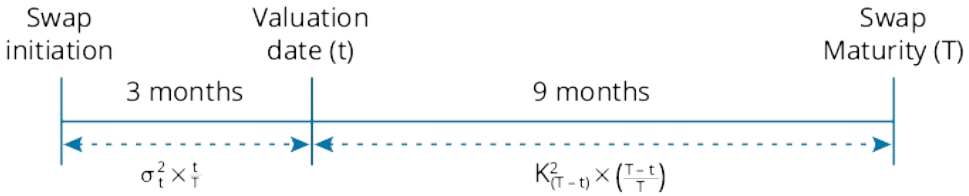
Convexity is an attractive feature to those who use variance swaps to hedge tail risk. When equity values fall sharply and volatility increases dramatically, decreases in portfolio value are offset by profits on a variance swap that increase at an accelerating rate.

Mark to Market

The value of a variance swap is zero at initiation, but over time, the swap will either gain or lose value as realized and implied volatility diverge. At any point, the expected variance at maturity is simply the time-weighted average of the variance realized over the time since swap inception and the implied variance over the remaining time to maturity.

Consider a one-year swap where three months have elapsed since inception:

Step 1: Compute expected variance at maturity (the time-weighted average of realized variance and implied variance over the remainder of the swap's life).



$$\text{expected variance to maturity} = \left(\sigma_t^2 \times \frac{t}{T}\right) + \left(K^2_{(T-t)} \times \frac{T-t}{T}\right)$$

where:
σ_t^2 = annualized realized volatility from initiation to valuation date squared
$K^2_{(T-t)}$ = annualized implied volatility from valuation date to swap maturity squared
$\frac{t}{T} = \frac{3}{12}$
$\frac{T-t}{T} = \frac{9}{12}$

Step 2: Compute expected payoff at swap maturity:

$$\text{payoff} = N_{VAR} \times (\text{expected variance to maturity} - \text{original strike}^2)$$

Step 3: Discount expected payoff at maturity back to the valuation date.

EXAMPLE: Valuing a variance swap during its life

Luke Amos, an equity fund manager, has purchased a one-year variance swap on the S&P 500 with vega notional of $100,000 and a strike of 20%.

Nine months have passed and the S&P has realized a volatility of 21%. The strike price for a three-month variance swap at this time is quoted at 22%, and the three-month interest rate is 2%.

Compute the current value of the swap.

Answer:

Step 1: Compute the expected variance at maturity:

$$\left(21^2 \times \frac{9}{12}\right) + \left(22^2 \times \frac{3}{12}\right) = 330.75 + 121 = 451.75$$

Step 2: Compute the expected payoff at maturity:

$$\text{variance notional} = \frac{\text{Vega notional}}{2 \times K} = \frac{\$100{,}000}{2 \times 20} = \$2{,}500$$

expected payoff at maturity = $(\sigma^2 - K^2) \times$ variance notional, where $K^2 = 20^2 = 400$

expected payoff at maturity = (451.75 − 400) × $2,500 = $129,375

Step 3: Discount expected payoff from maturity to the valuation date (3 months):

$$\text{unannualize the interest rate} = 2\% \times \frac{3}{12} = 0.5\%$$

$$\text{current value of swap} = \frac{\$129{,}375}{1.005} = \$128{,}731$$

This is a gain to the purchaser (long) and a loss to the seller (short).

MODULE QUIZ 16.4

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

1. Which of the following comments is *least* accurate regarding the VIX Index?
   A. Empirically, the VIX Index and equity returns are negatively correlated.
   B. VIX measures realized volatility over a 30-day period on the S&P 500.
   C. The VIX Index level is the annualized standard deviation of implied volatility on the S&P 500.
2. Which of the following comments is *most* accurate? The payoff on a variance swap can be calculated by multiplying the difference between actual variance and implied variance by:
   A. notional vega.
   B. notional variance.
   C. the expected return to volatility.
3. Quark Dealers sold a one-year FTSE MIB variance swap with a strike of 15 three months ago. Quark set the vega notional at €150,000. As part of their swap agreements, Quark requires the contract to be marked to market and subject to margining every three months.

   At the end of the first three-month period, realized volatility is 28. The strike on a nine-month variance swap is 32, and the nine-month interest rate is 0.6%.

   Compute the mark-to-market value of the swap.

MODULE 16.5: USES OF DERIVATIVES IN PORTFOLIO MANAGEMENT

Video covering this content is available online.

LOS 16.e: Demonstrate the use of derivatives to achieve targeted equity and interest rate risk exposures.

CFA® Program Curriculum, Volume 3, page 325

Using Equity Swaps

EXAMPLE: Using equity swaps to reduce equity exposure

Jennifer Seago has a concentrated holding of 80,000 shares in ABC Gmbh. Seago does not want to sell the shares—which she has held for many years—for tax reasons. ABC Gmbh is currently trading at €6.00 and she is concerned that the share price will decline over the next year as the company undergoes a restructuring. One-year Euribor is 0.95% and ABC is expected to pay an annual dividend of €0.05.

Suggest a swap strategy that will address Seago's concerns and constraint. **Evaluate** the results of this strategy for both an increase of 5% and a decrease of 5% in the price of ABC.

Consider the use of a one-year annual-pay total return swap. The reference rate for the interest leg of the swap is Euribor. The notional principal is 80,000 shares × €6.00 = €480,000.

Scenario 1:

The stock price falls by 5% and ABC pays a dividend of €0.05:

$$\text{total return on ABC} = \frac{€5.70 + €0.05}{€6.00} - 1 = -4.1667\%$$

€6.00 × (1 − 0.05) = €5.70

Seago receives interest and will pay positive returns on the stock and receive negative stock returns.

Seago receives:

[0.0095 − (−0.041667)] × €480,000 = €24,560

Scenario 2:

The stock price rises by 5% and ABC pays a dividend of €0.05:

$$\text{total return on ABC} = \frac{€6.30 + 0.05}{€6.00} - 1 = 5.8333\%$$

€6.00 × (1 + 0.05) = €6.30

Seago receives:

(0.0095 − 0.058333) × €480,000 = −€23,440 (i.e., pays €23,440)

Cash Equitization

EXAMPLE: Investing surplus cash using index futures

Yoann Barbet is the manager of an equities fund for which the investment universe is the FTSE 100. Currently, the fund holds £60 million in cash and £300 million in equities with a beta of 1.2 relative to the FTSE 100. The six-month rate earned on the cash will be 0.86% (annualized). Barbet does not want to commit the cash to specific equities over the next six months but is concerned about cash drag. If he wants to avoid cash drag and would like the beta of the portfolio to be 1.2, what strategy should be employed?

Barbet should gain exposure to equities with FTSE 100 futures over the next six months.

Six-month FTSE 100 futures are currently at 7,348.50 with a multiplier of £10. The beta of the FTSE 100 futures is 1. The tick size of the contract is 0.5 index points.

$$\text{number of futures to purchase} = \left(\frac{\beta_T}{\beta_F}\right)\left(\frac{\text{MV}_P}{F}\right)$$

$$\text{number of futures to purchase} = \left(\frac{1.2}{1}\right)\left(\frac{£60{,}000{,}000}{£73{,}485}\right)$$

$$= 979.79 \text{ (i.e., 980 contracts)}$$

Scenario:

The FTSE 100 gains 6% over the six-month period, six-month £LIBOR is 0.86%, and the futures price at the end of the period is 7,642.

value of funds invested in FTSE 100 futures = £300 million × 1.06 = £318 million

return on equity portfolio = £318 million − £300 million = £18 million

Receives:

interest on cash holding = £60 million × 0.0086 × 180 / 360 = £258,000

futures profit = (7,642 − 7,348.50) = 293.5 points; 293.5 points × £10 × 980 contracts = £2,876,300

total returns = £18,000,000 + £258,000 + £2,876,300 = £21,134,300

$$\text{return } \% = \frac{£21{,}134{,}300}{(£300{,}000{,}000 + £60{,}000{,}000)} = 5.87\%$$

Note that the underperformance of the portfolio relative to the 6% return on the index results from rounding in the number of contracts, rounding of the futures price to the nearest 0.5 index point, and a basis change on the FTSE forward contract.

Note the change in the FTSE 100 futures = $\frac{£7{,}642}{£7{,}348.50} - 1 = 3.99\%$; however, the FTSE 100 increased by 6%.

LOS 16.f: Demonstrate the use of derivatives in asset allocation, rebalancing, and inferring market expectations.

CFA® Program Curriculum, Volume 3, page 327

Asset Allocation Using Derivatives

EXAMPLE: Changing allocations between asset classes using futures

Mathieu Chausset is a French fund manager with €800 million assets under management. Currently, Mathieu has 80% allocated to equity and 20% allocated to French fixed-income securities. Mathieu currently splits his equity portfolio 50-50 between German and French stocks.

Mathieu wishes to alter his asset allocation for the next six months. Firstly, he wishes to increase the fixed-income proportion to 40% and reduce the equity proportion to 60%. Secondly, he wishes to reduce the proportion of his equity holdings in German securities to 30% and increase the proportion in French equity to 70%. Mathieu intends to achieve his new asset allocation by using index and government bond futures.

French government bonds = OATs

Mathieu's German stock portfolio has a beta of 1.2 relative to the DAX 30, and the French stock portfolio has a beta of 0.95 relative to the CAC 40. The French government bonds (OATs) portfolio has a modified duration of 8.5.

Futures Contract Details (Equity Index)		
Index name	French CAC 40	German DAX 30
Futures price	5,500	12,200
Multiplier	€10	€25
Beta	1	1
Tick size	0.5 points	0.5 points

Futures Contract Details (French OATs)	
Futures price	€163.84
Contract size	€100,000
CTD	€127.71
CF	0.7768
CTD modified duration	8.89

Determine how many long and short futures positions Mathieu will need to use to implement his desired asset allocation.

Answer:

	Original	New	Change in Exposure
Equity	€640 = 80%	€480 = 60%	
German stocks	€320 million = 50%	€144 million = 30%	Decrease €176 million
French stocks	€320 million = 50%	€336 = 70%	Increase €16 million
Fixed Income			
French OATs	€160 million = 20%	€320 million = 40%	Increase €160 million

German stocks: Alter exposure from €320 million to €144 million = decrease of €176 million

$$\text{number of futures required} = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

where:
β_T = target beta = 0 (the target beta is set to zero because we are reducing our exposure to German stock)
β_p = portfolio beta = 1.2
β_F = futures beta (i.e., beta of the index)
MV_P = reduction in portfolio exposure = €176 million
F = futures price × multiplier = 12,200 × €25 = €305,000

$$\text{number of futures required} = \left(\frac{0-1.2}{1}\right)\left(\frac{€176{,}000{,}000}{€305{,}000}\right) = -692.45$$

$$= -692 \text{ futures contracts}$$

Mathieu needs to sell 692 DAX futures.

French stocks: Alter exposure from €320 million to €336 million = increase of €16 million

β_T = target beta = 0.95 (we need to create an additional €16 million exposure with a beta of 0.95)
β_p = portfolio beta = 0
β_F = futures beta (i.e., beta of the index) = 1
MV_P = increase in portfolio size = €16 million
F = futures price × multiplier = 5,500 × €10 = €55,000

$$\text{number of futures required} = \left(\frac{0.95-0}{1}\right)\left(\frac{€16{,}000{,}000}{€55{,}000}\right) = 276.36$$

$$= 276 \text{ futures contracts}$$

Mathieu will need to purchase 276 futures on the CAC 40.

French OATs: Alter exposure from €160 million to €320 million = increase of €160 million

$$\text{BPVHR} = \frac{\text{BPV}_{\text{Target}} - \text{BPV}_{\text{Portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

$BPV_{target} = MD_{target} \times 0.0001 \times MV_{portfolio}$ = 8.5 × 0.0001 × €160 million = €136,000

$BPV_{CTD} = MD_{CTD}$ × 0.0001 × (price / 100 × contract size) = 8.89 × 0.0001 × [(€127.72 / 100) × €100,000] = €113.54

$$\text{BPVHR} = \frac{€136{,}000 - €0}{€113.54} \times 0.7768 = 930.46 = 930 \text{ futures contracts}$$

Mathieu will need to purchase 930 French OATs futures contracts.

Summary	Futures Positon	Number of Contracts

German stock	Short DAX 30 futures	692
French stock	Long CAC 40 futures	276
French bonds	Long OATs futures	930

Assume that over the next six months, the German stock portfolio decreases in value by 4% while the French portfolio increases in value by 2%; at the end of the six-month period, the CAC 40 futures price is 5,616 and the DAX 30 futures price is 11,793.5. What is the impact on Mathieu's portfolio after the asset allocation adjustments in the example have been made?

Answer:

German portfolio:

Original holding falls in value by €320 million × −0.04 = −€12,800,000

DAX futures gain = (11,793.5 − 12,200) × €25 × −692 = €7,032,450

net loss = −€12,800,000 + €7,032,450 = €5,767,550

If the portfolio had been reduced to €144,000,000 by physically selling stock, the loss would have been €144,000,000 × −0.04 = €5,760,000.

imperfection in hedge = €5,767,550 − €5,760,000 = €2,977 (caused by rounding in the hedge ratio and the basis change on futures position)

French portfolio:

Original holding increases in value by €320 million × 0.02 = €6,400,000

CAC futures gain = (5,616 − 5,500) × €10 × 276 = €320,160

net gain = €6,400,000 + €320,160 = €6,720,160

If the portfolio had been increased to €336 million by buying stock, the gain would have been €336,000,000 × 2% = €6,720,000.

imperfection in hedge = €6,720,160 − €6,720,000 = €160

Using the data from Mathieu's asset allocation example, assume that the French yield curve undergoes a parallel downward shift of 50 BP. What is the impact on Mathieu's portfolio after the asset allocation adjustments have been made?

Answer:

original holding gain = −8.5 × −0.005 × €160,000,000 = €6,800,000

bond futures gain/(loss) = BPV_F × change in yield × number of futures contracts

$BPV_F = BPV_{CTD} / CF$ = €113.54 / 0.7768 = €146.16

bond futures gain/(loss) = €146.16 × 50 × 930 = €6,796,440

net position = €6,800,000 + €6,796,440 = €13,596,440

If the portfolio had been increased to €320,000,000 by buying physical OATs, the gain would have been −8.5 × −0.005 × €320,000,000 = €13,600,000.

EXAMPLE: Rebalancing asset allocation using futures

Josh Birmingham is the fund manager for a portfolio that has a target asset allocation of 70% equity and 30% government bonds. The portfolio increased in value from $200 million to $210 million over the previous month. The following table shows the portfolio's current position and what is needed to maintain the target allocations:

Equity	Current	Target	Change in Exposure
U.S. large cap	$140 million (66.67%)	$147 million (70%)	+$7 million
Fixed Income			

U.S. Treasury bonds	$40 million (33.33%)	$63 million (30%)	–$7 million
Total	$210 million	$210 million	

Equity portfolio beta = 0.8
Fixed-income portfolio modified duration = 9.5

Josh intends to use the following futures contracts to hedge his position:

S&P 500 futures	S&P 500	Classic U.S. Treasury futures	
Futures price	2,930	Futures price	$135.00
Multiplier	$250	Contract size	$100,000
Beta	1	CTD	$110.25
Tick size	0.5 points	CF	0.8140
		CTD modified duration	8.5

Determine the futures positions Josh will need to use to rebalance the asset allocation.

Answer:

Equity portfolio:

Aim: increase exposure by $7 million

$$\text{Number of futures required} = \left(\frac{\beta_{\text{T}} - \beta_{\text{P}}}{\beta_{\text{F}}}\right)\left(\frac{\text{MV}_{\text{P}}}{\text{F}}\right)$$

$$\text{Number of futures required} = \left(\frac{0.8 - 0}{1}\right)\left(\frac{\$7{,}000{,}000}{\$732{,}500}\right) = 9.56$$

$$= 10 \text{ futures contracts}$$

F = 2,930 × $250 = $732,500

Josh will need to purchase 10 S&P 500 futures.

Fixed-income portfolio:

Aim: decrease exposure by $7 million

$$\text{BPVHR} = \frac{\text{BPV}_{\text{Target}} - \text{BPV}_{\text{Portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

$\text{BPV}_{\text{portfolio}} = \text{MD}_{\text{portfolio}} \times 0.0001 \times \text{MV}_{\text{portfolio}} = 9.5 \times 0.0001 \times \$7 \text{ million} = \$6{,}650$

$\text{BPV}_{\text{CTD}} = \text{MD}_{\text{CTD}} \times 0.0001 \times [\text{price} / 100 \times \text{contract size}] = 8.5 \times 0.0001 \times [(\$110.25 / 100) \times \$100{,}000] = \$93.71$

$$\text{BPVHR} = \frac{\$0 - \$6{,}650}{\$93.71} \times 0.8140 = -57.76 = -58 \text{ futures contracts}$$

Josh will need to sell 58 Treasury futures contracts.

Changing Allocations Between Asset Classes Using Swaps

EXAMPLE: Altering asset allocation using swaps

Akasuki Weber is a portfolio manager running the Cross Bright Helper fund. The fund has a current value of ¥21,580,000,000. The portfolio is currently invested in Japanese equity and bonds. Within the equity portion, the fund is split into exposures to both growth and value stocks. Within the fixed-income portion, the fund is split into exposures to government and corporate bonds.

Weber wants to alter the allocation between fixed income and equity and alter the allocation to the subfunds. The following table summarizes the changes she would like to make:

Stock	Current	Target	Change in Exposure
[illegible]	[illegible]	[illegible]	[illegible]

Value stock portfolio	¥9,063,600,000 (60%)	¥3,884,400,000 (30%)	−¥5,179,200,000
Growth stock portfolio	¥6,042,400,000 (40%)	¥9,063,600,000 (70%)	+¥3,021,200,000
Total equity	¥15,106,000,000 (70%)	¥12,948,000,000 (60%)	
Fixed income			
Government bonds	¥3,237,000,000 (50%)	¥5,179,200,000 (60%)	+¥1,942,200,000
Corporate bonds	¥3,237,000,000 (50%)	¥3,452,800,000 (40%)	+¥215,800,000
Total fixed income	¥6,474,000,000 (30%)	¥8,632,000,000 (40%)	
Total fund	¥21,580,000,000	¥21,580,000,000	

To avoid transaction costs involved in physical changes to the fund's asset allocation, Weber decides to use equity and fixed-income swaps. She has identified the following indexes, which have the closest characteristics with her existing subportfolios:

- MSCI Japan Value Index
- MSCI Japan Growth Index
- S&P Japanese Government Bond Index
- S&P Japanese Corporate Bond Index

Answer:

Swap 1: Pay return on MSCI Japan Value Index, receive floating reference rate (− dealers margin BP), based on a notional principal of ¥5,179,200,000

Swap 2: Pay reference rate (+ dealers margin BP), receive return on MSCI Japan Growth Index, based on a notional principal of ¥3,021,200,000

Swap 3: Pay reference rate (+ dealers margin BP), receive return on S&P Japanese Government Bond Index, based on a notional principal of ¥1,942,200,000

Swap 4: Pay reference rate (+ dealers margin BP), receive return on S&P Japanese Corporate Bond Index, based on a notional principal of ¥215,800,000

The equity and fixed-income indexes used in the swaps are unlikely to match the performance of Weber's subportfolios unless her subportfolios are passive trackers of these indexes. In addition, the index funds track total return (i.e., price and cash flow return on the index). Take swap 1 where Weber is paying the return on the MSCI Japan Value Index—Weber's value portfolio will not generate the price-change element of index return unless capital gains are realized by selling securities. Additionally, the dealer's margin on the floating rates will also need to be paid.

Inferring Market Expectations

Market expectations are current expectations derived from market prices. In the event of a market shock, market expectations can change rapidly.

Typical applications:

Application	Derivative
Inferring expectations of FOMC moves	Fed funds futures
Inferring expectations of inflation	CPI swaps
Inferring expectations of future volatility	VIX futures and options

Using Fed Funds Futures to Infer the Expected Average Federal Funds Rate

Market participants can use Fed funds futures to infer the expected probabilities of upcoming Fed interest rate changes. Some terms and definitions used in the analysis include the following:

- **Federal funds rate.** This is the interest rate that deposit institutions (banks and credit unions) charge other deposit institutions for loans in the overnight interbank markets. The federal funds effective (FFE) rate is the weighted average of interest rates charged on overnight interbank loans.
- **Federal funds target rate.** This is the rate set by governors of the Federal Reserve in Federal Open Market Committee (FOMC) meetings. The FOMC meets eight times a year to set the target rate based on current and forecasted macroeconomic variables. The most important considerations when setting the target rate are inflation rates and GDP growth rates. When market participants refer to the central bank (Fed) changing interest rates, it is typically this target rate they are referring to. The target rate is typically set as a range (e.g., 2.25%–2.50%).

Note that the Fed does not directly control the FFE rate, but it influences the rate through its monetary policy tools with the goal of keeping it within the target range. The monetary policy tools are open-market operations and the interest rate paid on bank reserves held at the Fed. Many central banks function in a similar fashion.

Fed fund futures are traded on the CME. The futures price reflects the market expectation of the FFE rate at the time of contract maturity. The Fed funds futures price will reflect market expectations about future changes in the Fed funds target rate. Fed fund futures can have monthly maturity dates as far out as 36 months.

To determine the probability of a change in the Fed funds target rate, use the following equation:

$$\text{percent probability of rate change} = \frac{\text{effective rate implied by futures} - \text{current Fed funds target rate}}{\text{Fed funds rate assuming a rate change} - \text{current Fed target funds rate}}$$

Note that this can be expressed as

$$\frac{\text{implied Fed funds effective rate} - \text{current target rate}}{\text{expected size of rate change}}$$

EXAMPLE: Determining the markets expectation of a target rate increase

Joe Stokes works at a bank where the interest received on loans made is linked to the FFE rate. Stokes has been asked to compute the likelihood that the FOMC will increase the rate by 25 BP at the next FOMC meeting.

Stokes has collected the following market data:

Fed funds future price*	98.1625
Current Fed funds target rate	1.50%–1.75%

*Nearest futures contract after the date of the next FOMC meeting

Calculate the following:

1. The expected average FFE rate at the futures contract maturity
2. The probability of a 25 BP increase in target rate at the next FOMC meeting

Answer:

1. Expected average FFE rate at contract expiration: 100 − 98.1625 = 1.8375%
2. Current target rate midpoint: $\frac{1.5\%+1.75\%}{2} = 1.625\%$

   Target rate assuming a 25 BP rise: 1.625% + 0.25% = 1.875%

$$\text{percent probability of rate change} = \frac{1.8375\% - 1.625\%}{1.875\% - 1.625\%}$$

$$= \frac{1.8375\% - 1.625\%}{0.25\%} = 0.85 = 85\%$$

MODULE QUIZ 16.5

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

1. Elise Schwarz manages a €400 million fund that invests in German and French equities and government bond futures. Currently, her portfolio has a 60% exposure to equity and a 40% exposure to government securities. Schwarz believes that the monetary policy of the ECB will provide a significant stimulus to European equity markets and would like to increase her equity exposure to 70% of the portfolio's value.

   Additionally, the current portfolio is 50% invested in Spanish stocks and 50% in German stocks. Schwarz would like to change the proportions to 60% Spanish stocks and 40% German stocks. She also wishes to change the asset allocation of her fixed-income portfolio —which is currently 50% invested in German Bunds and 50% in Spanish Obligaciones del Estado—to 70% German government debt and 30% Spanish government debt.

   Her current portfolios have the following details:

	Beta		Modified Duration
Spanish equity	β = 1.2	Spanish fixed income	7.34
German equity	β = 0.9	German fixed income	10.25

   Elise intends to use futures to achieve her new asset allocation, to avoid transaction costs involved with liquidating positions, and reinvesting.

   Elise has gathered the following futures information:

Equity Futures	German	Spanish
Index	DAX 30	IBEX 35
Futures price	12,500	9,200
Multiplier	€25	€10
Futures beta	1	1

Government Bond Futures	German Bund	Spanish Obligaciones del Estado
Contract size	€100,000	€100,000
CTD price	€105.44	€149.94
CTD CF	0.6095	0.9628
CTD modified duration	9.67	8.26

   Calculate and describe the future positions that would achieve Elise's new target asset allocation.

2. Stuart Zackaman has been announced as the new chair of the Federal Reserve. In his inaugural speech, he mentions that it is time that the United States stopped punishing savers to bail out irresponsible lenders.

   Joe Bear works at a bank where the interest paid on deposits is linked to the Fed funds rate. Bear observes that Zackaman's speech caused Fed funds futures prices to fall.

   Joe has collected the following market data:

Fed funds future price*	97.925
Current Fed funds target rate	1.75%–2.00%

   *Nearest futures contract after the date of the next FOMC meeting

   What is the probability of a 50 BP increase in target rate at the next FOMC meeting implied from the current Fed funds future price?

   A. 20%.
   B. 40%.
   C. 80%.

KEY CONCEPTS

LOS 16.a

- Interest rate swaps can be used to convert floating-rate assets (or liabilities) into fixed-rate assets (or liabilities).
- Interest rate swaps can be used to alter a fixed-income portfolio's duration.
  - Payer swaps (pay fixed) have negative durations.
  - Receiver swaps (receive fixed) have positive durations.
- To compute the notional principal of a swap to achieve a target duration, use the following equation:

  $$NP_S = \left(\frac{MD_T - MD_P}{MD_S}\right)(MV_P)$$

  where:

  NP_S = notional swap principal

  MD_T = target modified duration

  MD_P = current portfolio modified duration

  MD_S = modified duration of swap

  MV_P = market value of portfolio
- Forward rate agreements (FRAs) are OTC forward contracts that can be used to hedge short-term future floating lending or borrowing requirements (i.e., lock into a fixed interest rate). FRAs can also be used to speculate on the direction of interest rates.
  - Long FRA = pay fixed and receive floating, from FRA expiry to the end of a notional borrowing or lending period.
  - Short FRA = pay floating and receive fixed, from FRA expiry to the end of a notional borrowing or lending period.
  - The price of an FRA is a forward rate of interest determined from spot rates.
  - Long FRA increases in value when interest rates rise.
  - Short FRA increases in value when interest rates fall.
- Short-term interest rate (STIR) futures are exchange traded and, therefore, benefit from liquidity and no credit risk. Like FRAs, STIR futures can be used to hedge short-term future interest rate risk and speculate on interest rate direction.
  - STIR futures used IMM price convention = 100 − annualized interest rates.
  - Long STIR futures will increase in value when rates fall.
  - Short STIR futures will increase in value when rates rise.
  - The forward rate in the STIR future is the same forward rate in an FRA (assuming the same expiry and borrowing/lending periods).
  - STIRs are typically more liquid than bond futures.
  - Strips of STIRs are often used to hedge bonds with 2–3 years to maturity.
- Government bond futures are used to hedge fixed-income portfolios when the constituent bonds have more than 2–3 years to maturity.

- Treasury bond futures prices are based on a notional bond (typically with a 6% coupon).
- Short party to the contract can deliver a range of eligible government bonds.
- One of the government bonds will be cheapest to deliver (CTD).
- The CTD bond has the highest repo rate or lowest basis.
- Futures price is based on the CTD price divided by the CTD conversion factor (CF).
- Each eligible bond has a CF.
- Proceeds to short on delivery = (FP at settlement × CF of bond delivered) + AI_T.

- Hedging with Treasury futures is determined as follows:

$$\text{BPVHR} = \frac{\text{BPV}_{\text{Target}} - \text{BPV}_{\text{Portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

where:
BPV hedge ratio = BPVHR = number of futures required
BPV of target = $BPV_{Target} = MD_{Target} \times 0.0001 \times MV_{Portfolio}$
BPV of portfolio = $BPV_{Portfolio} = MD_{Portfolio} \times 0.01\% \times MV_{Portfolio}$
MD = modified duration
BPV of CTD = $BPV_{CTD} = MD_{CTD} \times 0.01\% \times MV_{CTD}$
market value of futures contract = MV_{CTD} = CTD price / 100 × $100,000

To fully hedge a portfolio against interest rate risk, set BPV_{target} to zero.

LOS 16.b

- Currency risk is the change in value of assets and liabilities denominated in overseas currencies when converted to the domestic currency and is caused by exchange rate fluctuations.
- Cross-currency swaps = synthetic overseas borrowing.
  - Borrow in cheap currency (often but not exclusively domestic).
  - Use a cross-currency swap to exchange domestic borrowing for overseas currency.
  - Principal exchanged using the spot rate at initiation at the start and end of the swap's life.
  - Counterparties pay the interest on the currency received at initiation.
  - The breakdown of covered interest rate parity means many currencies trade at a negative basis to the dollar.
  - Negative basis means the cost of synthetic $ borrowing > the cost of direct $ borrowing (i.e., lenders of the $ receive a premium).
  - Negative basis means that the $ lender will pay less than overseas LIBOR on their interest payments (i.e., overseas LIBOR – basis).
  - Negative basis allows U.S. fixed-income managers to lend dollars via a swap, invest the foreign currency in a foreign bond market, and generate a higher return (due to the basis) than if they invested domestically.
- Currency forwards allow a participant to lock in a guaranteed exchange rate for converting a fixed amount of one currency into another at a future delivery date.
- Currency futures are exchange-traded currency forwards:

$$\text{HR} = \frac{\text{value of risk exposure}}{\text{futures contract size}}$$

LOS 16.c

- Equity swaps can be used to create synthetic exposures to equity market return.
- There are three main types of equity swaps:
  - Pay fixed, receive equity return.
  - Pay floating, receive equity return.
  - Pay one equity return, receive another equity return.
- Equity return may be based on:
  - A stock index.
  - A basket of stock.
  - A single stock.

  Return may be computed as price return or total return (including dividends).
- The equity payer in an equity swap pays the return if positive and receives the return if negative.
- Equity futures are available for most major stock market indexes.
- Benefits of equity futures include:
  - Low transaction costs.
  - Implementing tactical asset allocation without transactions in the physical securities.
    - Selling futures: reduces equity exposure.
    - Buying futures: increases equity exposure.
  - Diversification of portfolios.
  - Gain exposure to a different equity market.
- To achieve a target beta, use the following:

  $$\text{number of futures required} = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

  where:

  β_T = target portfolio beta

  β_P = current portfolio beta

  β_F = futures beta (beta of stock index)

  MV_P = market value of portfolio

  F = futures contract value = futures price × multiplier
  - To reduce equity exposure $\beta_T = 0$ MV_P = market value of exposure to reduce
  - To equitize a cash position $\beta_P = 0$ MV_P = cash value to invest

LOS 16.d

- VIX = volatility index (CBOE Volatility Index):
  - Measures implied volatility of the S&P 500 over a forward period of 30 days.
  - Implied volatility computed from call and put options on the index.
  - Volatility mean reverts over time.
  - Market participants cannot directly invest in VIX.

- VIX level and equity returns are negatively correlated.
- VIX futures:
  - Term structure of futures allows us to view the market's expectation of volatility for different contract maturities.
  - Typically, the market is in contango when implied 30-day forward volatility is low.
  - VIX futures can be used to offset tail risk in equity portfolios.
- Variance swap payoff = $(\sigma^2 - K^2) \times N_{VAR}$
- Based on realized vs. implied volatility over the swap's life:
  - N_{VEGA} = profit or loss for a 1% change in volatility
  - N_{VAR} = multiplier that converts $(\sigma^2 - K^2)$ into a payoff
  - K = implied volatility over the swap period
  - σ = realized volatility over the swap period
  - variance notional = $\frac{\text{vega notional}}{2 \times \text{strike price (K)}}$
- Variance swaps have convex payoffs with respect to volatility.
- Volatility options and futures have linear payoffs with respect to volatility.
- Convexity makes variance swaps more attractive for hedging tail risk because, as volatility rises and equity returns fall, the payoffs on variance swaps increase at an increasing rate.
- Mark-to-market valuation of a variance swap:

  Step 1: Compute expected variance at maturity (the time-weighted average of realized variance and implied variance over the remainder of the swap's life):

  $$\text{expected variance to maturity} = \left(\sigma_t^2 \times \frac{t}{T}\right) + \left(K_{(T-t)}^2 \times \frac{T-t}{T}\right)$$

  Step 2: Compute expected payoff at maturity:

  $$\text{variance swap payoff} = (\text{expected variance} - K^2) \times N_{VAR}$$

  Step 3: Discount expected payoff from maturity back to the valuation date.

LOS 16.e

- Use an equity swap to reduce equity exposure by entering into a pay total return equity swap receive fixed.
- Invest surplus cash by purchasing equity index futures.

LOS 16.f

- Probability of FOMC rate changes can be inferred from Fed funds futures:

  $$\text{percent probability of rate change} = \frac{\text{effective rate implied by futures} - \text{current Fed funds target rate}}{\text{Fed funds rate assuming a rate change} - \text{current Fed target funds rate}}$$

  Note that this can be expressed as $\frac{\text{implied Fed funds effective rate} - \text{current target rate}}{\text{expected size of rate change}}$

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 16.1

1. **C** The variable leg cash flow on an interest rate swap is determined by the LIBOR rate determined at the previous settlement date. Remember, LIBOR is an add-on yield with payment in arrears. (LOS 16.a)

2. Type of swap:

   Schwarz is receiving variable LIBOR base cash flows on the FRN he holds. To hedge his interest rate risk, Schwarz will want to swap the floating rate he receives on the FRN for a fixed rate on a swap. Schwarz will use a receiver swap with a notional principal of $4 million, in order to pay floating and receive fixed.

   Swap cash flow at settlement date 1:

   Fixed leg = 4% × 180 / 360 × $4 million = $80,000

   Floating leg = 3.5% × 180 / 360 × $4 million = $70,000

   Net receipt = $80,000 – $70,000 = $10,000

   Swap cash flow at settlement date 2:

   Fixed leg = 4% × 180 / 360 × $4 million = $80,000

   Floating leg = 2.5% × 180 / 360 × $4 million = $50,000

   Net receipt = $80,000 – $50,000 = $30,000

   Net return settlement date 1:

   Interest received on FRN = (3.5% + 40 BP) × 180 / 360 × $4 million = $78,000

   Net receipt on swap = $10,000

   Total cash received = $78,000 + $10,000 = $88,000

   $ return = $88,000 / $4,000,000 = 2.2%, annualized = 4.4%

   Net return settlement date 2:

   Interest received on FRN = (2.5% + 40 BP) × 180 / 360 × $4 million = $58,000

   Net receipt on swap = $30,000

   Total cash received = $58,000 + $30,000 = $88,000

   $ return = $88,000 / $4,000,000 = 2.2%, annualized = 4.4%

   Schwarz's annualized return is 4.4%, equal to the 4% rate on the swap and the 40 BP cost on the FRN. (LOS 16.a)

3. **A** Cost of 3-month borrowing on bridging loan = 2.5%

   Profit on unwinding hedge = 98 − 97.5 = 50 BP

   Net cost = 2.5% − 50 BP = 2%

   Cost of loan = 0.025 × 90 / 360 × €8 million = €50,000

   Profit on futures = 50 BP × €25 × 8 contracts = €10,000

   Net cost = €50,000 − €10,000 = €40,000

   (€40,000 / €8 million) × 360 / 90 = 0.02, or 2% (LOS 16.a)

4. **A** BPV_{Target} = 8 × 0.0001 × $200 million = $160,000

   $BPV_{Portfolio}$ = 12 × 0.0001 × $200 million = $240,000

   BPV_{CTD} = 14.54 × 0.0001 × [($126.39 / 100) × $100,000] = $183.77

   $$\text{BPVHR} = \frac{BPV_{Target} - BPV_{Portfolio}}{BPV_{CTD}} \times \text{CF}$$

   $$= \frac{\$160{,}000 - \$240{,}000}{\$183.77} \times 0.7689 = -334.72 = -335$$

   (LOS 16.a)

Module Quiz 16.2

1. **B** If the NZD is trading at a positive cross-currency basis to the USD, New Zealand investors can earn superior returns by lending NZD via a currency swap and investing in U.S. government bonds. There is an additional return because the interest rate on lending NZD is higher than the rate suggested by covered interest rate parity (CIRP). Note that when the NZD has positive basis against the USD and the GBP has negative basis to the USD, then the GBP must have negative basis against the NZD. Most currencies trade at a negative cross-currency basis to the USD, due to high demand for USD funds versus a shortage of supply and a failure of CIRP. The positive basis on NZD and AUD (Australian dollar) has led organizations such as the World Bank to issue bonds in NZD and AUD and swap back to USD, reducing borrowing costs compared to borrowing directly in USD. (LOS 16.b)

2. $$\text{Number of contracts needed to hedge} = \frac{€20{,}000{,}000}{€125{,}000} = 160 \text{ contracts}$$

   Wood is converting from the price currency to the base currency and, therefore, will need to buy futures.

   Unhedged position:

   Cost at current exchange rate = €20,000,000 × 0.8929 = £17,858,000

   Unhedged position in 30 days = €20,000,000 × 0.9034 = £18,068,000

   Cost of euro strengthening = £18,068,000 – £17,858,000 = £210,000

   Hedged position:

   Cost of euro strengthening = £18,068,000 – £17,858,000 = £210,000

   Profit on hedge = (£0.9054 – £0.8989) × €20,000,000 = £130,000

   Note that when Barney enters the contract, he is agreeing to buy euros at £0.8989, and when he closes out, he is agreeing to sell euros at £0.9054.

   Net position = £130,000 – £210,000 = loss £80,000

   This loss on the hedge is the result of the change in basis:

	Spot	Future	Basis
At initiation £/€	0.8929	0.8989	0.006 or 60 pips
At close	0.9034	0.9054	0.002 or 20 pips

   Change in pips = 60 to 20 = −40

   −40 pips ÷ 10,000 × €20,000,000 = −€80,000 (LOS 16.b)

3. **Exchange of principal at initiation of swap:**

£30 million × $1.2 = $36 million

ABC Robotics, Inc., borrows $30 million domestically and uses the currency swap to exchange $36 million for £30 million.

At the first settlement date:

Pays:

£ interest on swap = £30 million × (1.5% − 0.15%) × 180 / 360 = £202,500

$ interest on loan = $36 million × (2.5% + 0.4%) × 180 / 360 = $522,000

Receives:

$ interest on swap = $36 million × 2.5% × 180 / 360 = $450,000

Total net payments:

£ interest on swap = £202,500

$ difference between the loan and swap = $522,000 − $450,000 = $72,000, which represents the 40 BP on the U.S. loan ($36 million × 0.4% × 180 / 360 = $72,000)

Direct £ borrowing cost = £30 million × (1.5% + 0.5%) × 180 / 360 = £300,000 (cost LIBOR + 50 BP)

Cost of synthetic borrowing = £30 million × (1.5% + 0.4% − 0.15%) × 180 / 360 = £262,500 (cost LIBOR + 25 BP)

Benefit of swap = £300,0000 − £262,500 = £37,500

Benefit of swap = (0.5% − 0.25%) × 180 / 360 = £37,500

At the second settlement date:

Pays:

£ interest on the swap = £30 million × (1% − 0.15%) × 180 / 360 = £127,500

$ interest on loan = $36 million × (2.25% + 0.4%) × 180 / 360 = $477,000

Receives:

$ interest on the swap = $36 million × 2.25% × 180 / 360 = $405,000

Total net payments:

£ interest on swap = £202,500

$ difference on loan and swap = $477,000 − $405,000 = $72,000, which represents the 40 BP on the U.S. loan ($36 million × 0.4% × 180 / 360 = $72,000)

Direct £ borrowing cost = £30 million × (1% + 0.5%) × 180 / 360 = £225,000 (cost LIBOR + 50 BP)

Cost of synthetic borrowing = £30 million × (1% + 0.4% − 0.15%) × 180 / 360 = £187,500 (cost LIBOR + 25 BP)

Benefit of swap = £225,000 − £187,500 = £37,500

Benefit of swap = (0.5% − 0.25%) × 180 / 360 = £37,500

Conclusion:

By borrowing in euros and entering a currency swap, ABC Robotics has locked into a cost of £LIBOR + 25 BP for their USD borrowing, reflecting the 40 BP spread above $LIBOR on the loan less the 15 BP received on the swap. (LOS 16.b)

Module Quiz 16.3

1. **A**

   $$\text{Number of futures required} = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

   $$\text{Number of futures required} = \left(\frac{1.4 - 0.8}{1}\right)\left(\frac{£20{,}000{,}000}{£74{,}250}\right) = 161.62$$

   $$= 162 \text{ futures contracts}$$

   Futures contract value = 7,425 × £10 = $74,250

   (LOS 16.c)

2. **A** Cash element of fund = ¥4,350,000,000 × 5% = ¥217,500,000

   $$\text{Number of futures required} = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

   $$\text{Number of futures required} = \left(\frac{1 - 0}{1}\right)\left(\frac{¥217{,}500{,}000}{¥21{,}264{,}000}\right) = 10.06$$

   $$= 10 \text{ futures contracts}$$

   β_T = 1 (the beta of the future equals the beta of the index)

   β_P = 0 (the beta of a cash position always equals zero)

   Futures contract value = 21,624 × ¥1,000 = ¥21,624,000

   (LOS 16.c)

Module Quiz 16.4

1. **B** VIX is a measure of expected volatility of the S&P 500 Index over the forthcoming 30 days. It is an annualized implied volatility calculation using an option-pricing model and the price of call and put options trading in the market. It suggests +/– range for the percentage change in the S&P 500, with a 68% level of confidence.

   Empirically, VIX and equity market performance is negatively correlated (i.e., when volatility spikes upwards, equity returns fall dramatically). The convexity of variance swaps relative to volatility makes their returns attractive when volatility is rising and equity markets are falling. (LOS 16.d)

2. **B** The payoff on a variance swap can be calculated as notional variance × ($\sigma^2 - K^2$). Using notional vega, we must additionally divide by 2 times the strike price (implied volatility), K:

   $$\text{payoff} = N_{VEGA} \times \left(\frac{\sigma^2 - K^2}{2K}\right)$$

   (LOS 16.d)

3. *Step 1*: Compute the expected variance at maturity as the time-weighted average of realized and implied volatility:

   $$\text{expected variance at maturity} = \left(\sigma_t^2 \times \frac{t}{T}\right) + \left(K_{(T-t)}^2 \times \frac{T-t}{T}\right)$$

   $$\text{expected variance at maturity} = \left(28^2 \times \frac{3}{12}\right) + \left(32^2 \times \frac{9}{12}\right) = 964$$

   Step 2: Compute the expected payoff at maturity:

   $$\text{variance notional} = \frac{\text{vega notional}}{2 \times K} = \frac{€150{,}000}{2 \times 15} = €5{,}000$$

   $K^2 = 15^2 = 225$

   expected payoff at maturity = ($\sigma^2 - K^2$) × variance notional

expected payoff at maturity = (784 − 225) × €5,000 = €2,795,000

Step 3: Discount expected payoff from maturity to valuation date (3 months):

$$\text{unannualize the interest rate} = 0.6\% \times \tfrac{9}{12} = 0.45\%$$

$$\text{current value of swap}\left(\text{purchaser}\right) = \tfrac{€2{,}795{,}000}{1.0045} = €2{,}782{,}479$$

This is the gain to the purchaser of the variance swap. Quark Dealers is a seller and, therefore, this is a loss. Note that this illustrates the risk of shorting variance. When volatility suddenly spikes upward, the losses increase at an accelerating rate. (LOS 16.d)

Module Quiz 16.5

1. *Step 1*: Set out current, target, and changes to asset allocations in percentages and monetary value.

Summary	Original	New	Change in Exposure
Equity	**€240 million (60%)**	**€280 million (70%)**	
German stocks	€120 million = 50%	€112 million = 40%	Decrease €8 million
Spanish stocks	€120 million = 50%	€168 million = 60%	Increase €48 million
Fixed Income	€160 million (40%)	€120 million (30%)	
German Bunds	€80 million = 50%	€84 million = 70%	Increase €4 million
Spanish Obligaciones del Estado	€80 million = 50%	€36 million = 30%	Decrease €44 million

Step 2: Compute each futures position.

German equity:

$$\text{Number of futures required} = \left(\frac{\beta_{\text{T}} - \beta_{\text{P}}}{\beta_{\text{F}}}\right)\left(\frac{\text{MV}_{\text{P}}}{\text{F}}\right)$$

β_T = target beta = 0 (the target beta is set to zero because we are reducing our exposure to German stock)

β_p = portfolio beta = 0.9

β_F = futures beta (i.e., beta of the index)

MV_P = reduction in portfolio size = €8 million

F = futures price × multiplier = 12,500 × €25 = €312,500

$$\text{Number of futures required} = \left(\frac{0 - 0.9}{1}\right)\left(\frac{€8{,}000{,}000}{€312{,}500}\right)$$

$$= -23.04 = -23 \text{ futures contracts}$$

Spanish equity:

β_T = target beta = 1.2 (the target beta is set to the beta of the existing portfolio)

β_p = portfolio beta = 0

β_F = futures beta (i.e., beta of the index)

MV_P = increase in portfolio size = €48 million

F = futures price × multiplier = 9,200 × €10 = €92,000

$$\text{Number of futures required} = \left(\frac{1.2-0}{1}\right)\left(\frac{€48{,}000{,}000}{€92{,}000}\right)$$

$$= 626.09 = 626 \text{ futures contracts}$$

German fixed income:

$$\text{BPVHR} = \frac{\text{BPV}_{\text{Target}} - \text{BPV}_{\text{Portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

$\text{BPV}_{\text{Target}} = \text{MD}_{\text{Portfolio}} \times 0.0001 \times \text{MV}_{\text{Portfolio}} = 10.25 \times 0.0001$

$\times$ €4,000,000 = €4,100

$\text{BPV}_{\text{CTD}} = \text{MD}_{\text{CTD}} \times 0.0001 \times [\text{price} / 100 \times \text{contract size}] = 9.67$

$\times 0.0001 \times [(€105.44 / 100) \times €100{,}000] = €101.96$

$$\text{BPVHR} = \frac{€4{,}100 - €0}{€101.96} \times 0.6095 = 24.51 = 25 \text{ futures contracts}$$

Spanish fixed income:

$$\text{BPVHR} = \frac{\text{BPV}_{\text{Target}} - \text{BPV}_{\text{Portfolio}}}{\text{BPV}_{\text{CTD}}} \times \text{CF}$$

$\text{BPV}_{\text{Portfolio}} = \text{MD}_{\text{Portfolio}} \times 0.0001 \times \text{MV}_{\text{Portfolio}} = 7.34 \times 0.0001$

$\times$ €44,000,000 = €32,296

$\text{BPV}_{\text{CTD}} = \text{MD}_{\text{CTD}} \times 0.0001 \times [\text{price} / 100 \times \text{contract size}] = 8.26$

$\times 0.0001 \times [(€149.94 / 100) \times €100{,}000] = €123.85$

$$\text{BPVHR} = \frac{€32{,}296}{€123.85} \times 0.9628 = -251.07 = -251 \text{ futures contracts}$$

Summary of Futures Positions	
German DAX 30 futures	Sell 23 futures
Spanish IBEX 35 futures	Buy 626 futures
German Bund futures	Buy 25 contracts
Spanish Obligaciones del Estado futures	Sell 251

(LOS 16.f)

2. **B** Expected average effective rate at contract expiration = 100 – 97.925 = 2.075%

Current target rate midpoint = $\frac{1.75\% + 2.00\%}{2}$ =1.875%

Target rate assuming a 50 BP rise = 1.875% + 0.50% =2.375%

Percent probability of a rate change = $\frac{2.075\% - 1.875\%}{2.375\% - 1.875\%} = \frac{2.075\% - 1.875\%}{0.50\%}$ = 0.4 = 40%

(LOS 16.f)

The following is a review of the Derivatives and Currency Management principles designed to address the learning outcome statements set forth by CFA Institute. Cross-Reference to CFA Institute Assigned Reading #17.

READING 17: CURRENCY MANAGEMENT: AN INTRODUCTION

Study Session 6

EXAM FOCUS

Globalization of financial markets is an important topic in portfolio management and for the CFA exam. This section reviews currency math and then discusses an extensive list of currency management tools and techniques.

MODULE 17.1: MANAGING CURRENCY EXPOSURE

Video covering this content is available online.

INTRODUCTION

PROFESSOR'S NOTE

Good technique always matters but particularly with currency. This material emphasizes (1) thinking of a currency quote as a base currency in the denominator and a pricing currency in the numerator, and (2) being prepared to interpret a currency quote from the perspective of either the base or pricing currency.

The Price and Base Currencies: The **base currency** is the denominator of the exchange rate and it is **priced** in terms of the numerator. Unless clearly identified otherwise, the terms "buy" and "sell" refer to the base currency. But remember, there are two currencies involved. For example, sell spot 1,000,000 at CAD/USD 0.9800 is assumed to mean sell for "immediate delivery" 1,000,000 U.S. dollars and buy 980,000 Canadian dollars. (The convention is settlement in two business days but this detail is ignored in most cases; the FX swap is an exception where the two business days are considered).

Buy 500,000 USD/CHF six months forward at 1.07 is assumed to mean buy 500,000 Swiss francs, settling in six months versus sell USD 535,000.

Bid/Asked Rules: Currencies are quoted with a **bid/offered** or **bid/asked price**. By convention, the smaller number is written first and the larger number is second. However, both the bid and the asked can be interpreted as the sale of one currency versus the purchase of the other currency. The difference is the dealer's profit margin to buy or sell the currencies. The customer pays the bid/ask spread, paying more and/or receiving less in the transaction. A quote of 0.9790/0.9810 CAD/USD has four interpretations.

Deliver more CAD can be phrased as:

- Buy 1.0000 USD and deliver (sell) 0.9810 CAD.
- Sell 0.9810 CAD and receive (buy) 1.0000 USD.

Receive less CAD can be phrased as:

- Sell 1.0000 USD and receive (buy) 0.9790 CAD.
- Buy 0.9790 CAD and deliver (sell) 1.0000 USD.

Spot Versus Forward: Spot exchange transactions are for immediate settlement and a **forward transaction** is a price agreed to on a transaction date for delayed (longer than spot) settlement. The forward quote can be given directly or in forward points (an adjustment from the spot quote).

Forward points are an adjustment to the spot price to determine the forward price. The points are interpreted based on the number of decimal places in which the spot price is quoted. The rule is to move the decimal in the points to the left by the same number of decimal places shown in the right for the spot price. For example:

Spot Quote	Forward Points	Points with Decimal Adjusted	Forward Price
1.33	1.1	1.1 / 100 = 0.011	1.33 + 0.011 = 1.341
2.554	–9.6	–9.6 / 1,000 = –0.0096	2.554 − 0.0096 = 2.5444
0.7654	13.67	13.67 / 10,000 = 0.001367	0.7654 + 0.001367 = 0.766767

There is a myth that the forward points are always divided by 10,000. That is only true if the spot quote is given to four decimal places. To continue the pattern, if the spot quote shows five decimals on the right, move the forward point decimal five places to the left (i.e., forward points / 100,000).

EXAMPLE: Spot and forward bid/asked quotes of the Australian dollar/euro

Maturity/Settlement	Spot Quote/Forward Points
Spot AUD/EUR	1.2571/ 1.2574
30 days	–1.0/–0.9
90 days	+11.7/+12.0

1. What is the 30 day forward bid/offered quote?
2. If a manager sells 1,000,000 AUD forward 90 days, **calculate** what the manager will deliver and receive. When will the exchange take place?

Answer:

1. The spot quote is given to four decimal places making the forward points for 30 days: –1.0 / 10,000 = –0.00010 and –0.9 / 10,000 = –0.00009, a four decimal place adjustment to match the spot quote. The 30-day forward bid/asked are: 1.2571 − 0.00010 = 1.25700 and 1.2574 − 0.00009 = 1.25731.
2. The exchange will be 90 days from the trade date, at contract expiration. The manager will deliver AUD 1,000,000.

   The 90-day forward quotes are 1.2571 + 0.00117 by 1.2574 + 0.00120, which is 1.25827/1.25860 for the AUD/EUR. The manager is delivering AUD and receiving EUR. The manager must deliver more AUD or receive fewer EUR. In this case, the bid/asked quotes are both for 1 EUR and the manager will deliver AUD.

   The manager must deliver at AUD/EUR 1.25860.The manager will receive EUR: AUD 1,000,000 / (1.25860 AUD/EUR) = EUR 794,533.61.

Offsetting Transactions and Mark to Market: While forward contracts do not require market to market cash flow exchanges prior to settlement, it is often desirable or required for regulatory purposes to mark the position to market value. The mark-to-market value is the

present value of any gain or loss that would be realized if the contract were closed early with an offsetting contract position.

EXAMPLE: Offsetting transactions

Based on the initial quotes given in the previous example, a different manager entered into a trade to sell (deliver) 90 days forward, EUR 10,000,000 at the "all-in" forward quote of AUD/EUR 1.25827. Thirty days have passed and exchange rates are now the following:

Maturity/Settlement	Spot Quote/Forward Points	LIBOR Rates AUD
Spot AUD/EUR	1.3189/1.3191	
30 days	+1.1/+1.2	1.10%
60 days	+10.3/+10.5	1.20%
90 days	+15.3/+16.1	1.25%

1. **Identify** the offsetting position the manager would take to close the initial transaction and **calculate** the resulting gain or loss. When will this gain or loss be settled?
2. **Calculate** the mark to market the manager would report on day 30 of the original trade if the trade were not closed out early.

Answers:

1. Thirty days have passed and the initial trade to sell EUR 10,000,000 forward has 60 days until expiration. The offsetting transaction is to buy 10,000,000 EUR 60 days forward. The solution is done in steps.

   Step 1: Thirty days have passed and the initial trade to sell EUR 10,000,000 forward has 60 days until expiration. The offsetting transaction is to buy 10,000,000 EUR 60 days forward. The solution is done in steps. Identify the forward exchange rate for the offsetting position. The manager must buy EUR 10,000,000 (which requires delivering AUD) 60 days forward at AUD/EUR 1.3191 + 0.00105, which is AUD/EUR 1.32015.

   Step 2: In 60 days, the manager will do the following:

   - On the original trade: sell EUR 10,000,000 and buy AUD at AUD/EUR 1.25827. The manager will receive AUD 12,582,700.
   - On the offsetting trade: buy EUR 10,000,000 and sell AUD at AUD/EUR 1.32015. The manager will pay AUD 13,201,500.

   The difference, a loss of AUD 618,800, will be settled and paid 90 days after the initial transaction and 60 days after the offsetting transaction.

   Alternatively, this can be solved directly. The base currency (euro) is sold at 1.25827 AUD and then bought at 1.32015 AUD for a loss of 1.32015 − 1.25827 = 0.06188 AUD per euro. On the trade of 10,000,000 euros, this is a loss of AUD 618,800.
2. The current mark to market is the present value of the gain or loss that would be locked in with an offsetting transaction. That offsetting loss was calculated in Solution 1 as AUD 618,800. The 60-day LIBOR rate on the AUD is 1.20%.

   Mark-to-market loss = AUD 618,800 / {1 + [0.012 (60 / 360)]} = AUD 617,564.87

An FX Swap: The FX swap is not a currency swap or even a swap as that term is otherwise used. The FX swap rolls over a maturing forward contract using a spot transaction into a new forward contract. An existing forward is "swapped" for another forward transaction.

EXAMPLE: An FX swap

A manager purchased 10,000,000 South African rand (ZAR) three months forward at ZAR/USD 9.4518.

Two days before contract expiration the manager decides to extend the transaction for another 30 days. **Explain** the FX swap used to implement this decision.

Answer:

The manager sells spot ZAR 10,000,000 to offset the maturing contract. Both the initial forward and offsetting spot transaction will settle in two business days. The manager enters a new 30-day forward contract to buy ZAR 10,000,000 versus the USD to rollover the trade.

Option Basics: A call option is a right to buy the underlying and gains value as the underlying rises above the strike price; its delta approaches 1.00 (a 100-delta). The call loses value as the underlying falls below the strike price and its delta approaches 0.00 (a 0-delta).

A put is the right to sell the underlying and gains value as the underlying falls below the strike price; its delta approaches –1.00 (this can also be referred to as a 100-delta, the negative sign is assumed and not written). The put loses value as the underlying rises above the strike price and the delta approaches 0.00 (a 0-delta).

For a call and a put with identical parameters (time to expiration, strike price, and price of the underlying), the sum of the absolute deltas is 1.00 or 100-delta.

Currency Option Basics: Currency options require two currencies and a call on one currency is a put on the other currency. Unless otherwise specified, the option is from the base currency perspective. For example, a call option to buy 10,000,000 at a strike price of ZAR/GBP 14.56 is the right to buy 10,000,000 British pounds and sell 145,600,000 South African rand. It is also a put option—the right to sell 145,600,000 South African rand and buy 10,000,000 British pounds.

A put option to sell 100,000 at MXN/EUR at 20.1 is the right to sell 100,000 euros and buy 2,010,000 Mexican pesos. It is also a call option to buy 2,010,000 Mexican pesos and sell 100,000 euros.

The important relationships can be summarized as follows:

As the Price of the Base Currency Increases:	The Call Option to Buy the Base Currency:	The Put Option to Sell the Base Currency:
From 0 to the strike price	Is out-of-the-money and rising in value. Delta is shifting from 0.0 toward 0.5 (from a 0-delta to a 50-delta).	Is in-the-money and falling in value. Delta is shifting from –1.0 toward –0.5 (from a 100-delta to a 50-delta).
To the strike price	Is at-the-money. Delta is approximately 0.5 (a 50-delta).	Is at-the-money. Delta is approximately –0.5 (a 50-delta).
From the strike price upward	Is in-the-money and rising in value. Delta is shifting from 0.5 toward 1.0 (from a 50-delta to a 100-delta).	Is out-of-the-money and falling in value. Delta is shifting from –0.5 toward 0.0 (from a 50-delta to a 0-delta).

EFFECTS OF CURRENCY ON PORTFOLIO RISK AND RETURN

Domestic currency or **home currency** is the currency of the investor (or the currency in which portfolio results are reported and analyzed).

Domestic asset is an asset denominated in the investor's domestic currency.

Foreign currency and **foreign asset** are a currency other that the investor's domestic currency and an asset denominated in that foreign currency. These are sometimes called the

local currency and local market, respectively.

Foreign-currency return (R_{FC}) is the return of the foreign asset measured in its local (foreign) currency. It can be called the local market return.

The **percentage change in value of the foreign currency** is denoted as R_{FX}. It can be called the local currency return.

Domestic-currency return (R_{DC}) is the return in domestic currency units considering both the **foreign-currency return** (R_{FC}) and the percentage change in value of the foreign currency (R_{FX}).

LOS 17.a: Analyze the effects of currency movements on portfolio risk and return.

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An investment in assets priced in a currency other than the investor's domestic currency (a *foreign asset* priced in a *foreign currency*) has two sources of risk and return: (1) the return on the assets in the foreign currency and (2) the return on the foreign currency from any change in its exchange rate with the investor's *domestic currency*. These returns are multiplicative and an investor's returns in domestic currency can be calculated as:

Equation 1: $R_{DC} = (1 + R_{FC})(1 + R_{FX}) - 1 = R_{FC} + R_{FX} + (R_{FC})(R_{FX})$

$R_{DC} \approx R_{FC} + R_{FX}$

PROFESSOR'S NOTE

There are three ways to calculate R_{DC} that you will see and are responsible for. The choice of approach is dictated by the case facts and question.

- $R_{DC} \approx R_{FC} + R_{FX}$: This approach is an approximation of the more accurate compounded calculation. It emphasizes the two sources of return, R_{FC} and R_{FX}. It is acceptable when precision is not needed, such as selecting between three quite different multiple choice answers or discussing the theoretical sources of return.
- $R_{DC} = (1 + R_{FC})(1 + R_{FX}) - 1 = R_{FC} + R_{FX} + (R_{FC})(R_{FX})$: This approach is precise if the precise R_{FX} is known. I would generally use this approach, unless given clear reasons to do something else.
- However, there are cases where determining R_{FX} is not simple. If the currency is hedged, then a precise currency hedge must short the ending number of foreign currency units; however, that ending number is not knowable for a risky asset. You will see a naïve hedge is normally used and the beginning number of foreign currency units are sold forward. In that case, a simple comparison of Fo and So will not be the true R_{FX}. In that case, you will see a different set of calculations made. You would directly calculate beginning and ending value of the portfolio in the investor's domestic currency units. Then R_{DC} is (EV – BV) / BV.

EXAMPLE: Calculating domestic currency returns

Consider a USD-based investor who invests in a portfolio of stocks that trade in euros. Over a one-year holding period, the value of the portfolio increases by 5% (in euros) and the euro-dollar exchange rate increases from 1.300 USD/EUR to 1.339 USD/EUR.

The EUR has appreciated with respect to the USD, so the investor has positive returns from foreign exchange of:

$R_{FX} = 1.339 / 1.300 - 1 = 0.03 = 3\%$.

The investor's return in domestic currency terms over the one-year holding period is:

$R_{DC} = (1.05 \times 1.03) - 1 = 0.05 + 0.03 + (0.05)(0.03) = 0.0815 = 8.15\%$

$R_{DC} \approx R_{FC} + R_{FX} = 5 + 3 = 8\%$

This example illustrates two important points. First, simply adding R_{FC} and R_{FX} (5% + 3% = 8%) yields an approximation of the domestic currency return. The approximation is closer to the actual return the smaller the values of the two sources of return.

Second, the exchange rate quotes must use the foreign currency (EUR) as the base currency (the denominator) to calculate the change in value of the currency (R_{FX}). To see why, consider what happens if the domestic currency (USD) had been the base currency.

FX Quotes	Foreign Currency as the Base Currency	1/X for Domestic Currency as the Base Currency
Beginning value	USD/EUR 1.300	EUR/USD 0.76923
Ending value	USD/EUR 1.339	EUR/USD 0.74683

0.74683/0.76923 − 1 = –0.02912 = –2.912%, which is depreciation of the USD relative to the EUR. The appreciation of the EUR is not simply the negative of the depreciation in the USD. R_{FX} is 3.000%, not 2.912%.

PROFESSOR'S NOTE

The message is to be careful when working with currency. Read the question and determine which is the foreign versus domestic currency. Label the numbers to determine if you are looking at domestic/foreign or foreign/domestic. Always use domestic/foreign (taking reciprocals if needed) and then solve as $EV / BV - 1 = R_{FX}$.

CALCULATING PORTFOLIO RETURN FOR MULTIPLE INVESTMENTS IN FOREIGN ASSETS

An investor may invest in multiple markets with different currencies. In that case, the domestic portfolio return is a weighted average of the domestic currency returns for each investment. Formally, we have the following.

$$\text{Equation 2: } R_{DC} = \sum_{i=1}^{n} w_i \left(R_{DC,i}\right)$$

where:

w_i = the proportion (in domestic currency terms) of the portfolio invested in assets traded in currency *i*

$R_{DC,i}$ = the domestic currency return for asset *i*

The following example illustrates this calculation.

EXAMPLE: Domestic currency returns on an investment in two foreign markets

A euro-based investor has a 75% position in GBP denominated assets and a 25% position in USD denominated assets. The results for the past year are the following.

R_{FC} for the GBP assets = 12%

R_{FC} for the USD assets = 5%

Beginning EUR/GBP exchange rate: 1.1666

Ending EUR/GBP exchange rate: 1.1437

Beginning USD/EUR exchange rate: 1.332

Ending USD/EUR exchange rate: 1.324

Calculate the investor's return over the period in domestic (EUR) currency terms.

Answer:

First, calculate the R_{DC} (in EUR) for each investment.

For the investment denominated in GBP, we have:

$R_{DC} = 1.12 \times (1.1437 / 1.1666) - 1 = (1.1200 \times 0.9804) - 1 = 9.80\%.$

The foreign currency (GBP) has depreciated approximately 2% relative to the euro. The negative currency return reduces the 12% return of the foreign market.

For the investment denominated in USD, the exchange rates were given with the foreign currency (USD) in the numerator. These can be inverted to make the investor's currency (the euro) the price currency and the foreign currency (USD) the base currency.

1 / 1.332 = 0.7508 EUR/USD
1 / 1.324 = 0.7553 EUR/USD

Allowing the investment denominated in USD R_{DC} (in EUR) to be calculated as:

$R_{DC} = [1.05 \times (0.7553 / 0.7508)] - 1 = (1.0500 \times 1.0060) - 1 = 5.63\%$

The foreign currency (USD) has appreciated approximately 0.6% relative to the euro. The positive currency return increases the 5% return of the foreign market.

The investor's total portfolio return is the weighted average of the R_{DC} for each market:

$(0.75 \times 9.80\%) + (0.25 \times 5.63\%) = 7.35 + 1.41 = 8.76\%$

RISK

An investor investing in a foreign denominated asset has two sources of risk: the fluctuation of the foreign currency and the fluctuation in foreign currency price of the foreign asset. Both will affect the standard deviation of R_{DC}.

The variance of R_{DC} can be calculated using a variation of the basic formula for variance of a two asset portfolio:

$$\sigma^2(R_{DC}) \approx w^2(R_{FC})\sigma^2(R_{FC}) + w^2(R_{FX})\sigma^2(R_{FX}) + 2w(R_{FC})w(R_{FX})\sigma(R_{FC})\sigma(R_{FX})\rho(R_{FC},R_{FX})$$

where:
ρ = the correlation between R_{FC} and R_{FX}

However, this basic two asset variance formula can be simplified when a domestic investor holds a single foreign currency denominated asset. The exposures (weights) to R_{FC} and R_{FX} are each 100% with the weights in the formula expressed as 1.0. The formula becomes:

Equation 3: $\sigma^2(R_{DC}) \approx \sigma^2(R_{FC}) + \sigma^2(R_{FX}) + 2\sigma(R_{FC})\sigma(R_{FX})\rho(R_{FC},R_{FX})$

The standard deviation of R_{DC} is the square root of this variance. Examining the equation indicates risk to our domestic investor:

- Depends on the standard deviation of R_{FC} and R_{FX}.
- May be higher for our domestic investor because standard deviation of R_{FX} is an additive term in the equation.
- However, correlation also matters. If the correlation between R_{FC} and R_{FX} is negative, the third component of the calculation becomes negative. The correlation measures the interaction of R_{FC} and R_{FX}.
  - If the correlation is positive, then R_{FC} returns are amplified by R_{FX} returns, increasing the volatility of return to our domestic investor.
  - If the correlation is negative, then R_{FC} returns are dampened by R_{FX} returns, decreasing the volatility of return to our domestic investor. (This is discussed further under this reading's topic of minimum variance hedge ratio).

PROFESSOR'S NOTE

The variance formula in Equation 3 is only an approximation but appropriate. It is based on the simple addition of R_{FC} and R_{FX} and ignores the cross product of $(R_{FC})(R_{FX})$. The use of an approximate variance formula relates to the number of correlations that would be required for true variance. Consider a portfolio of two foreign assets that has four variables, two foreign assets, and two foreign currencies resulting in six correlation pairs. With three foreign assets, there are six variables resulting in a total of 15 correlation pairs. A precise variance calculation would require accurately estimating all possible correlation pairs. That is considered unrealistic and the exact formula would create a false impression of precision. The approximation method is used for the CFA text. A special case is discussed in the following. Think of this special case as risk depends on end of period exposure to the foreign asset.

If RFC is a Risk-Free Return: In this case, its standard deviation and correlation with R_{FX} are zero. When R_{FX} is the only source of risk for the domestic investor in the foreign asset, a direct and precise calculation of the standard deviation of R_{DC} is practical.

Equation 4: $\sigma(R_{DC}) = \sigma(R_{FX})(1 + R_{FC})$

where:
R_{FC} = the return on a foreign currency denominated risk-free asset

PROFESSOR'S NOTE

Equation 4 is a special case when the foreign asset (R_{FC}) is a risk-free asset and cannot be derived from equation 3.

STRATEGIC DECISIONS

LOS 17.b: Discuss strategic choices in currency management.

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PROFESSOR'S NOTE

This is a lengthy discussion of factors to consider. The next LOS summarizes the conclusions.

Neither academic nor empirical analysis support firm conclusions on currency risk management. Opinions range from doing nothing to active management.

- Arguments made for not hedging currency risk include:
  - It is best to avoid the time and cost of hedging or trading currencies.
  - In the long-run, unhedged currency effects are a "zero-sum game"; if one currency appreciates, another must depreciate.
  - In the long-run, currencies revert to a theoretical fair value.
- The argument for active management of currency risk is that, in the short run, currency movement can be extreme, and inefficient pricing of currencies can be exploited to add to portfolio return. Many foreign exchange (FX) trades are dictated by international trade transactions or central bank policies. These are not motivated by consideration of fair value and may drive currency prices away from their fair value.

Currency management strategies for portfolios with exchange rate risk range from a passive approach of matching benchmark currency exposures to an active strategy that treats currency exposure independently of benchmark exposures and seeks to profit from (rather than hedge the risk of) currency exposures. Different approaches along this spectrum include:

Passive hedging is rule based and typically matches the portfolio's currency exposure to that of the benchmark used to evaluate the portfolio's performance. It will require periodic rebalancing to maintain the match. The goal is to eliminate currency risk relative to the benchmark.

Discretionary hedging allows the manager to deviate modestly from passive hedging by a specified percentage. An example is allowing 5% deviations from the hedge ratio that would match a currency's exposure to the benchmark exposure. The goal is to reduce currency risk while allowing the manager to pursue modest incremental currency returns relative to the benchmark.

Active currency management allows a manager to have greater deviations from benchmark currency exposures. This differs from discretionary hedging in the amount of discretion permitted and the manager is expected to generate positive incremental portfolio return from managing a portfolio's currency exposure. The goal is to create incremental return (alpha), not to reduce risk.

A **currency overlay** is a broad term covering the outsourcing of currency management. At the extreme, the overlay manager will treat currency as an asset class and may take positions independent of other portfolio assets. Seeking incremental return, an overlay manager who is bearish on the Swedish krona (SEK) for a portfolio with no exposure to the SEK would short the SEK. The manager is purely seeking currency alpha (incremental return), not risk reduction. Overlay managers can also be given a pure risk reduction mandate or restricted to risk reduction with modest return enhancement.

The IPS: The account's policy on whether to hedge or not to hedge currency risk should be recorded in the client's investment policy statement (IPS). Sections of the IPS that will be particularly relevant in reaching this strategic decision include investor objectives (including risk tolerance), time horizon, liquidity needs, and the benchmark to be used for analyzing portfolio results. The IPS should also specify:

- The target percentage of currency exposure that is to be hedged.

- Allowable discretion for the manager to vary around this target.
- Frequency of rebalancing the hedge.
- Benchmarks to use for evaluating the results of currency decisions.
- Allowable (or prohibited) hedging tools.

EXAMPLE: Choosing a hedging approach

A client with a USD based portfolio has little need for liquidity and is focused on short- term performance results. The client evaluates performance relative to a global equity index, which fully hedges currency exposure back to the USD and rebalances the hedge monthly.

1. **Discuss** how this information would affect the manager's views on hedging currency exposure in the portfolio.
2. **Explain** why rebalancing of currency exposure could be needed even if no changes are made to asset holdings.

Answers:

1. The client information leads to two possible strategies. (A) If the manager lacks currency expertise, the manager should also fully hedge currency risk and rebalance monthly, then focus on other areas such as asset selection to add value. (B) If the manager does have views on currency movement, the manager can instead increase exposure to currencies expected to appreciate and decrease exposure to currencies expected to depreciate.

   Given the client's focus on short-term results, the manager must consider the currency exposure of the index and either match it or deliberately deviate. A long-term assumption that "currency does not matter" is not appropriate. The lack of liquidity needs reduces the need for currency hedging as it reduces the likelihood of liquidations of foreign asset positions at depressed values.
2. Suppose both the U.S. client and the index allocate 10% to U.K. equities and sell the GBP forward to fully hedge the currency risk. Then over the course of the month, the U.K. stocks in the benchmark fall in value ($-R_{FC}$) while the U.K. stocks in the portfolio rise in value ($+R_{FC}$). The index will reduce the short GBP position to reflect the decreased GBP asset value. In contrast, the manager needs to increase the GBP short position to reflect increased GBP market value. Rebalancing the hedge must consider not only explicit transactions by the manager but also differentials in R_{FC} between the index and the portfolio.

Strategic Diversification Issues

- In the longer run, currency volatility has been lower than in the shorter run, reducing the need to hedge currency in portfolios with a long-term perspective.
- Positive correlation between returns of the asset measured in the foreign currency (R_{FC}) and returns from the foreign currency (R_{FX}) increase volatility of return to the investor (R_{DC}) and increase the need for currency hedging. Negative correlation dampens return volatility and decreases the need to hedge.
- Correlation tends to vary by time period, providing diversification in some periods and not in others, suggesting a varying hedge ratio is appropriate.
- Some investors assert that there is higher positive correlation between asset and currency returns in bond portfolios than in equity portfolios. If that is true, then there is more reason to hedge currency risk in bond portfolios than in equity portfolios. In a bond portfolio, the riskiness of the asset and currency are more likely to reinforce each other.
- The hedge ratio (the percentage of currency exposure to hedge) varies by manager preference.

Strategic Cost Issues: Hedging is not free and benefits must be weighted versus costs.

- The bid/asked transaction cost on a single currency trade is generally small, but repeated transaction costs add up. Full hedging and frequent rebalancing can be costly.
- Purchasing options to hedge involves an upfront option premium cost. If the option expires out-of-the-money, the premium is lost.
- Forward currency contracts are often shorter term than the hedging period, requiring contracts be rolled over as they mature (an FX swap). The hedge lowers return volatility but the rollover can create cash flow volatility with realized gains and losses on the maturing contracts. Financing cash outflows when interest rates are high can be costly as the interest that would have been earned on the funds is lost.
- Overhead costs can be high. A back office and trading infrastructure are needed for currency hedging. Cash accounts in multiple currencies may have to be maintained to support settlements and margin requirements.
- One hundred percent hedging has an opportunity cost with no possibility of favorable currency movement. Some managers elect to "split the difference" between 0 and 100% hedging and adopt a 50% strategic hedge ratio.
- Hedging every currency movement is costly and managers generally chose partial hedges. They may hedge and rebalance monthly rather than daily or accept some amount of negative currency return rather than zero.

LOS 17.c: Formulate an appropriate currency management program given financial market conditions and portfolio objectives and constraints.

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In conclusion, the factors that shift the strategic decision formulation toward a benchmark neutral or fully hedged strategy are:

- A short time horizon for portfolio objectives.
- High risk aversion.
- A client who is unconcerned with the opportunity costs of missing positive currency returns.
- High short-term income and liquidity needs.
- Significant foreign currency bond exposure.
- Low hedging costs.
- Clients who doubt the benefits of discretionary management.

MODULE QUIZ 17.1

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

Use the following information for Questions 1 and 2.

A Djiboutian (DJF) investor holds an international portfolio with beginning investments of USD 1,253,000 and EUR 2,347,800. Measured in the foreign currencies, these investments appreciate 5% and depreciate 7%, respectively.

Additional information:

Beginning Spot Exchange Rate	Beginning Forward Exchange Rate	Ending Spot Exchange Rate

DJF/USD 179.54	DJF/USD 185.67	DJF/USD 192.85
EUR/DJF 0.00416	EUR/DJF 0.00413	EUR/DJF 0.00421

1. The ending value of the USD investment is *closest* to:
   A. USD 1,150,000.
   B. DJF 236,200,000.
   C. DJF 253,700,000.
2. The unhedged return to the investor of the U.S. investment is *closest* to:
   A. –3%.
   B. +3%.
   C. +12%.
3. A European investor holds a diversified portfolio. From the euro perspective, the portfolio is weighted 60% and 40% in U.S. and U.K. investments.

Assets	Returns measured in foreign currency	Returns measured from investor's perspective	Standard deviation of asset's returns measured in foreign currency	Standard deviation of the foreign currency's returns
U.S.	5%	6%	4.5%	3.7%
U.K.	7%	8%	3.5%	4.7%

   The correlation between the foreign-currency asset's returns and returns on the foreign currency are 0.81 and 0.67, respectively, for the U.S. and English assets. **Compute** the standard deviation for the investor in the U.S. assets. **Show** your work.

4. The strategic decision to hedge currency risk will be *least* affected by the:
   A. manager's market views.
   B. correlation between asset and currency returns.
   C. investor's time horizon, risk aversion, and liquidity needs.
5. Which of the following clients would *most likely* allow a manager to implement discretionary currency hedging?
   A. One with a shorter time horizon and higher liquidity needs.
   B. One with more confidence in the portfolio manager and high income needs.
   C. One very concerned with minimizing regret and higher allocation to equity investments.
6. Jane Simms manages a German portfolio and has a 1,000,000 long position in South Korean won (KRW) through a forward contract that is about to come due. The current spot exchange rate is EUR/KRW 0.00067/0.00068. The forward points for a three-month forward contract are –1.2/–1.1. She expects the KRW to depreciate significantly and has the authority to increase or decrease the contract size by 10%. **Explain** whether she will increase or decrease the size of the forward contract and the forward exchange rate at which she will contract.

7. Jane Archer manages a Swiss-based (CHF) hedge fund. A portion of the fund is allocated 60% and 40%, respectively, to EUR and AUD investments. She has collected the following information.

Estimates	Euro zone	Australia
Asset return in foreign currency	2.0%	2.5%
Change in spot exchange rate versus the CHF	–1.0%	3.0%
Asset risk measured in foreign currency (σ)	15.0%	25.0%
Currency risk (σ)	7.0%	9.0%
Correlation of asset and currency return	+0.85	+0.65
Correlation of returns (CHF/EUR, CHF/AUD)	+0.70	

The following questions are from the portfolio perspective, measured in CHF.

a. **Calculate** the expected return of the portfolio.

b. **Calculate** the standard deviation of the portfolio.

c. **Calculate** the expected return to the portfolio if Archer takes a leveraged position with a 150% positive weight in Australia and a 150% negative weight in the euro zone.

d. **Calculate** the expected standard deviation of returns to the portfolio if Archer takes a leveraged position with a 150% positive weight in Australia and a 150% negative weight in the euro zone.

MODULE 17.2: ACTIVE STRATEGIES: FUNDAMENTALS AND TECHNICAL ANALYSIS

Video covering this content is

LOS 17.d: Compare active currency trading strategies based on economic fundamentals, technical analysis, carry-trade, and volatility trading.

available online.

CFA® Program Curriculum, Volume 3, page 368

The strategic decision sets the portfolio's normal currency hedging policy. If discretion is allowed, the manager can make active tactical decisions within defined boundaries, seeking to increase return. In all cases, active management requires that the manager have a view or a prediction of what will happen. Tactical decisions can be based on four broad approaches. Unfortunately, none of the approaches works consistently.

Economic Fundamentals

This approach assumes that, in the long term, currency value will converge to fair value. For example, a fundamental approach may assume purchasing power parity will determine long-run exchange rates. If the basket of goods and services produced in Country A costs 100 units of Country A's currency and that basket costs 200 units of Country B's currency in Country B, then the currency exchange rate of A to B is 100/200, a 0.50 A/B exchange rate.

Several factors will impact the eventual path of convergence over the short and intermediate terms. Increases in the value of a currency are associated with currencies:

- That are more undervalued relative to their fundamental value.
- That have the greatest rate of increase in their fundamental value.
- With higher real or nominal interest rates.
- With lower inflation relative to other countries.
- Of countries with decreasing risk premiums.

Opposite conditions are believed to be associated with declining currency values.

Technical Analysis

Technical analysis of currency is based on three principals:

1. Past price data can predict future price movement and because those prices reflect fundamental and other relevant information, there is no need to analyze such information.
2. Fallible human beings react to similar events in similar ways and therefore past price patterns tend to repeat.
3. It is unnecessary to know what the currency should be worth (based on fundamental value); it is only necessary to know where it will trade.

Technical analysis looks at past price and volume trading data. FX technical analysis focuses on price trends as volume data is generally less available. Technical analysis works best in markets with identifiable trends. Typical patterns that technicians seek to exploit are the following.

- An **overbought** (or **oversold**) market has gone up (or down) too far and the price is likely to reverse.

- A **support level** exists where there are substantial bids from customers to buy. A price that falls to that level is then likely to reverse and bounce higher as the purchases are executed.
- A **resistance level** exists where there are substantial offers from customers to sell. A price that rises to that level is then likely to reverse and bounce lower as the sales are executed.

At both support and resistance levels, the price becomes "sticky." However, if the market moves through the sticky resistance levels, it can then accelerate and continue in the same direction.

For example, assume technical traders have observed a support level for the GBP at 1.70 USD/GBP. The traders place limit orders to buy GBP at 1.70 USD/GBP. However, to limit their losses, the traders also enter stop loss orders to sell GBP at various prices between 1.70 and 1.69. If the GBP declines to the support level of 1.70, the buy orders are executed, supporting that price and explain the "sticky price behavior." However, if the GBP then declines lower, the stop loss sell orders are executed, driving the GBP lower as the GBP breaks its support level.

Moving averages of price are often used in technical analysis. A common rule is that if a shorter-term moving average crosses a longer-term moving average, it triggers a signal. The 50-day moving average rising above the 200-day moving average is a buy signal, falling below is a sell signal.

MODULE 17.3: ACTIVE STRATEGIES: CARRY AND VOLATILITY TRADING

Video covering this content is available online.

The Carry Trade

A **carry trade** refers to borrowing in a lower interest rate currency and investing the proceeds in a higher interest rate currency. Three issues are important to understand the carry trade.

1. **Covered interest rate parity** (CIRP) holds by arbitrage and establishes that the difference between spot (S_0) and forward (F_0) exchange rates equals the difference in the periodic interest rates of the two currencies.
    - The currency with the higher interest rate will trade at a **forward discount**, $F_0 < S_0$
    - The currency with the lower interest rate will trade at a **forward premium**, $F_0 > S_0$
2. The carry trade is based on a violation of **uncovered interest rate parity** (UCIRP). UCIRP is an international parity relationship asserting that the forward exchange rate calculated by CIRP is an unbiased estimate of the spot exchange rate that will exist in the future. If this were true:
    - The currency with the higher interest rate will decrease in value by the amount of the initial interest rate differential.
    - The currency with the lower interest rate will increase in value by the amount of the initial interest rate differential.

If these expectations were true, a carry trade would earn a zero return.

3. Because the carry trade exploits a violation of interest rate parity, it can be referred to as trading the forward rate bias. Historical evidence indicates that:
    - Generally, the higher interest rate currency has depreciated less than predicted by interest rate parity or even appreciated and a carry trade has earned a profit.
    - However, a small percentage of the time, the higher interest rate currency has depreciate substantially more than predicted by interest rate parity and a carry trade has generated large losses.

Generally, the carry trade is implemented by borrowing in the lower interest rate currencies of developed economies (**funding currencies**) and investing in the higher interest rate currencies of emerging economies (**investing currencies**). In periods of financial stress, the currencies of the higher risk emerging economies have depreciated sharply relative to the currencies of developed economies and such carry trades have generated significant losses. Given that periods of financial stress are associated with increasing exchange rate volatility, traders often exit their carry trade positions when exchange rate volatility increases significantly.

EXAMPLE: A carry trade

The spot exchange rate is BRL/USD 2.41. The interest rates in the two countries are 6% and 1%, respectively.

1. **Estimate** the one-year forward exchange rate for the Brazilian Real.
2. **State** the steps to initiate the carry trade and the theory on which it is based.
3. What is the profit on the trade if the spot exchange rate is unchanged and the trade is initiated by borrowing 100 currency units? **Show** your work.
4. What is the primary risk in this trade?

Answers:

1. The forward exchange rate for the Real should be approximately 5% below the current spot exchange rate to reflect the initial interest rate differential. The precise calculation is:

   $BRL/USD\ 2.41 \times (1.06 / 1.01)^1 = BRL/USD\ 2.529$

2.
    - Borrow USD at 1%.
    - Convert USD to BRL at the spot exchange rate of BRL/USD 2.41.
    - Invest the BRL at 6%.

   The carry trade is based on a violation of uncovered interest rate parity. It is profitable if the spot exchange rate of the higher interest rate currency declines less than predicted by the forward exchange rate.
3. It is 5%, reflecting the initial interest rate difference and unchanged spot exchange rate.
    - Borrow USD 100 creating a loan payable of USD 101.
    - Convert USD 100 to BRL 241 (= 100 × 2.41).
    - Invest the BRL 241 at 6% creating an ending value of BRL 255.46.
    - Convert the BRL 255.46 at the unchanged spot exchange rate back to USD 106.00 (= 255.46 / 2.41).
    - Pay off the USD loan for a profit of USD 5.00 on a USD 100 initial investment.
4. This is an unhedged trade and the profit or loss depends on the ending value of the BRL. If the BRL declines by more than 5%, the trade is unprofitable.

Figure 17.1: Summary of the Carry Trade

The Carry Trade:		
Is implemented by:	Borrowing and then selling in the spot market the lower yield currency.	To buy and invest in the higher yield currency.
Is trading the forward rate bias:	Selling in the spot market the currency trading at a forward premium.	And buying in the spot market the currency trading at a forward discount.

The carry trade is generally profitable under normal market conditions. But it can generate large losses in periods of financial distress and high volatility as investors flee high risk (yield) currencies.

PROFESSOR'S NOTE

You should notice this section does not support using the forward exchange rate as a prediction of how currency value will change, sometimes referred to as uncovered interest rate parity (UCIRP). Under IRP, the currency with the higher short-term interest rate will trade at a forward discount. UCIRP asserts that this calculated forward rate is a prediction of what will happen to the spot exchange rate and the higher rate currency will depreciate. This section has (1) noted that empirical evidence indicates the currency with the higher rate tends to appreciate, not depreciate, and (2) the carry trade is based on the higher rate currency appreciating or depreciating less than suggested by UCIRP. You should conclude that the Level III curriculum does not support using the forward exchange rate as a valid prediction of what will happen. The forward exchange rate can be and is used for hedging, but it just is not a good predictor of how the spot exchange rate will move, unless you want a very short career as a currency manager.

Volatility Trading

Volatility or "vol" trading allows a manager to profit from predicting changes in currency volatility. Recall from Level I and Level II that **delta** measures the change in value of an option's price for a change in value of the underlying and that **vega** measures change in value of the option for changes in volatility of the underlying. Vega is positive for both puts and calls because an increase in the expected volatility of the price of the underlying increases the value of both puts and calls.

Delta hedging entails creation of a **delta-neutral position**, which has a delta of zero. The delta-neutral position will not gain or lose value with small changes in the price of the underlying assets, but it will gain or lose value as the implied volatility reflected in the price of options changes. A manager can profit by correctly predicting changes in volatility.

A manager expecting volatility to increase should enter a **long straddle** by purchasing an at-the-money call and put. The manager is buying volatility. The two options will have equal but opposite deltas making the position delta neutral. If volatility increases, the options will rise in net value and the trade will be profitable.

A manager expecting volatility to decrease should enter a **short straddle** by selling both of these options. If volatility declines, the options will fall in net value. The options can be repurchased at lower prices for a profit.

PROFESSOR'S NOTE

Delta hedging will come up several times in the CFA curriculum. An important caveat is that the deltas will change and the positions must be continually rebalanced to maintain a delta-neutral position.

A **strangle** will provide similar but more moderate payoffs to a straddle. Out of-the-money calls and puts with the same absolute delta are purchased. The out-of-the-money options

require larger movement in the currency value to create intrinsic value but will cost less. Both the initial cost and the likely profit are lower than for the straddle.

MODULE QUIZ 17.2, 17.3

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

1. A currency overlay manager will *most likely* implement a carry trade when the yield of investing currencies is:
   A. lower and volatility is falling.
   B. higher and currency volatility is rising.
   C. higher and currency volatility is stable.
2. Which of the following statements about volatility and interest rates is *most likely* true?
   A. Falling currency volatility leads traders to exit a carry trade.
   B. Rising currency volatility will increase the cost of a collar more than the cost of a protective put.
   C. A delta neutral hedging strategy is more likely to tilt to a net long position in the euro when the euro zone is experiencing rising real interest rates.

MODULE 17.4: IMPLEMENTATION AND FORWARDS

Video covering this content is available online.

LOS 17.e: Describe how changes in factors underlying active trading strategies affect tactical trading decisions.

CFA® Program Curriculum, Volume 3, page 376

Active trading strategies are, by definition, risky. An active manager forms market expectations and implements shorter term tactical strategies seeking to add value. If the manager is wrong or does not cover the transaction costs, return is reduced. Manager expectations that trigger tactical trading decisions include the following.

Expectation:		**Action:**
Relative currency:	Appreciation	Reduce the hedge (short position) on **OR** increase the long position in the currency
	Depreciation	Increase the hedge on or decrease the long position in the currency
Volatility:	Rising	Long straddle (or strangle)
	Falling	Short straddle (or strangle)
Market conditions:	Stable	A carry trade
	Crisis	Discontinue the carry trade

Subtle variations on these actions include the following.

- A carry trade may involve a bundle of funding and investment currencies and positions need not be equally weighted. For example, if the manager expects a particular currency to show greater relative increase in value, the trade would be structured with increased long (or decrease short) positions in that currency.
- Delta neutral positions can be “tilted” to net positive or negative based on the manager’s view. A manager expecting a currency to appreciate (depreciate) could shift to a net positive (negative) delta.

CURRENCY MANAGEMENT TOOLS

PROFESSOR'S NOTE

We now examine a variety of hedging techniques and tools plus special considerations that may arise in some situations. The CFA text includes the warning "rote memorization" is not advised. Instead think of basic "building blocks" that allow an infinite number of combinations; focus on the basic concepts and terminology.

Some useful tips to sort through the material include the following. Some of these may be repeated from other sections.

1. What is the currency exposure that needs to be hedged? A typical situation is a portfolio exposed to fluctuation in value of a foreign currency.
2. It is easier to work with FX quotes when the foreign currency is the base currency. If quotes are given as B/P, take the reciprocal to make it P/B.
3. Assume any statements or directions refer to the base currency unless otherwise indicated in the case. But be explicit in your answers and state the currency you are referring to.
4. Decide whether the case requires buying or selling the base currency.
    - Buying forwards (and futures) or buying call options on the base currency increases exposure to the base currency.
    - Selling forwards (and futures) or buying put options on the base currency decreases exposure to the base currency.
    - Remember that:
        - A call on the base currency is a put on the pricing currency.
        - A put on the base currency is a call on the pricing currency.
5. Hedging is not free.
    - Hedges using forwards have no or minimal initial cost but high opportunity cost because the potential upside of the hedged currency is eliminated.
    - Purchasing options has high initial cost but retains the upside of the hedged currency (the protective put strategy).
    - Lowering the cost of the hedge will require some combination of less downside protection or upside potential. Cost can be lowered through some combination of:
        - Writing options to generate premium inflow.
        - Adjusting the option strike prices.
        - Adjusting the size (notional amount) of the options.
        - Adding exotic features to the options.
6. Discretionary hedging allows the manager to deviate from a policy neutral hedge position. Allowing the manager discretion can lower hedging costs and enhance return but also increases the risk of underperformance.
7. The IPS (or question specifics) should define the strategic, policy neutral hedge position. Generally this is a 100% hedge to match the currency exposure of the portfolio's benchmark.

LOS 17.f: Describe how forward contracts and FX (foreign exchange) swaps are used to adjust hedge ratios.

Typically, **forward contracts** are preferred for currency hedging because:

- They can be customized, while futures contracts are standardized.
- They are available for almost any currency pair, while futures trade in size for only a limited number of currencies.
- Futures contracts require margin which adds operational complexity and can require periodic cash flows.
- Trading volume of FX forwards and swaps dwarfs that of FX futures, providing better liquidity.

A hedge can be a **static hedge**, which is established and held until expiration, or a **dynamic hedge**, which is periodically rebalanced.

Consider a EUR-based manager who must hedge an initial CHF 10,000,000 of asset exposure. One month later, the asset has appreciated to CHF 11,000,000. Assume the manager can initially sell a one- or three-month contract.

1. Initially sell 10,000,000 CHF in the forward market with a one-month forward contract. At contract expiration, roll over the hedge. At rollover, the change in initial contract price will produce a realized gain or loss and cash flow settlement consequences. At the rollover, the size of the new contract can be adjusted to match the new value of the position to be hedged. Over the initial month, the hedge is static but can be dynamic at the rollover.

   If desired, the rollover can be done using an FX swap so that cash flows occur on the expiration date of the initial contract. For an FX swap, the manager would, two days prior to initial contract expiration, buy CHF 10 million in the spot market to cover the short position in the forward and sell forward CHF 11 million to roll over the hedge. This is termed a “mismatched” FX swap because the “near” spot leg and “far” forward leg are not of equal size.

   Both the initial short forward contract and the spot market purchase of CHF are for CHF 10,000,000 and settle in two business days. Any difference between the EUR/CHF rate of the initial forward contract and the current spot price will produce a (positive or negative) cash flow in EUR. For example, if the CHF declined by EUR 0.01, the initial hedge (short forward) will produce a cash gain of EUR 100,000 (= EUR 0.01 × 10,000,000).
2. Initially sell 10,000,000 CHF in the forward market with a three-month forward contract. One month later, the manager is underhedged with a CHF 10,000,000 short position versus an asset now worth CHF 11,000,000.
   a. With a static hedge, the manager would do nothing even though CHF exposure has increased.
   b. With a dynamic hedge, the manager would increase the hedge to cover the additional exposure by selling an additional CHF 1 million forward for two months to create a total short position of CHF 11 million. Because no contracts are being closed on the rebalancing date, all realized gain and losses and cash flows are deferred until the end of the three-month period. A dynamic hedging strategy will specify periodicity of rebalancing the hedge.

The choice of hedging approach should consider:

- Shorter term contracts or dynamic hedges with more frequent rebalancing tend to increase transaction costs but improve the hedge results.
- Higher risk aversion suggests more frequent rebalancing.
- Lower risk aversion and strong manager views suggest allowing the manager greater discretion around the strategic hedging policy.

ROLL YIELD

Hedging also exposes the portfolio to **roll yield** or **roll return**. Roll yield is a return from the movement of the forward price over time toward the spot price of an asset. It can be thought of as the profit or loss on a forward or futures contract if the spot price is unchanged at contract expiration. Determining whether the roll yield produces a profit or a loss will depend on two factors: (1) whether the currency is trading at a forward premium or discount and (2) whether is it purchased or sold. Roll yield for a contract held to expiration is determined by initial forward minus spot price divided by initial spot price.

For example, consider an investor who sells CHF 1 million six-month forward for USD 1.05 when the spot rate is 1.04. The forward price is at a premium so the roll yield on a short position will be positive. Think of it as the investor sells at a high price and the price rolls down for a gain. The investor can deliver CHF 1 million for 1.05 USD when its initial cost in the market (at spot) is 1.04 USD, for a gain of USD 10,000. The unannualized roll yield is 0.01/1.04 = 0.96%.

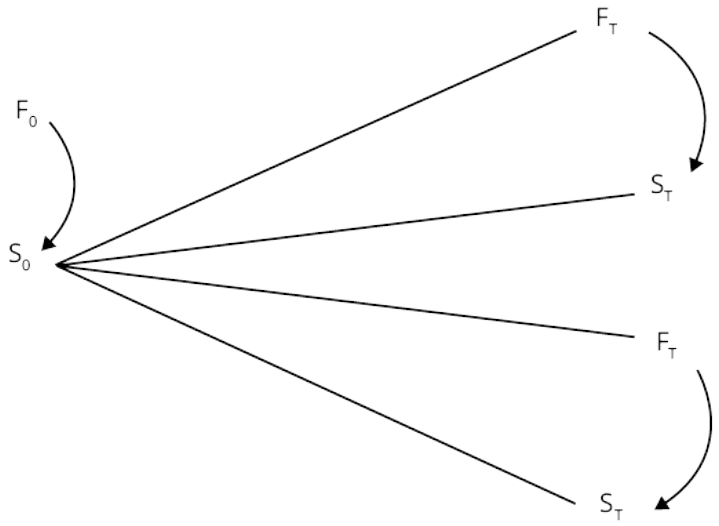
Roll yield will affect the cost/benefit analysis of whether to hedge the currency risk. It is a cost of hedging. Positive roll yield will shift the analysis toward hedging and negative roll yield will shift the analysis away from hedging. The relationships of forward premium or discount, initial difference in interest rates, positive or negative roll yield, and impact on hedging cost are summarized in Figure 17.2.

Figure 17.2: Forward Premiums or Discounts and Currency Hedging Costs

Current position of foreign asset in currency B	The hedge requires:	$F_{P/B} > S_{P/B}$, $i_B < i_P$ The forward price curve is upward-sloping.	$F_{P/B} < S_{P/B}$, $i_B > i_P$ The forward price curve is downward-sloping
Short the foreign asset	A long forward position in currency B, the hedge earns:	Negative roll yield, which increases hedging cost and discourages hedging.	Positive roll yield, which decreases hedging cost and encourages hedging.
Long the foreign asset	A short forward position in currency B the hedge earns:	Positive roll yield, which decreases hedging cost and encourages hedging.	Negative roll yield, which increases hedging cost and discourages hedging.

PROFESSOR'S NOTE

Suppose the initial forward price of the base currency is above its initial spot price. If the base currency is sold forward, F_T and S_T will converge at contract expiration and provide positive roll yield for the short position. The positive roll for the short position does not depend on whether the spot price increases or decreases. This is depicted in the following figure. It shows that the forward and spot price will converge at contract expiration regardless of whether the spot price increases or decreases. Suppose a manager sells the base currency forward when the initial forward price is above the spot price, $F_0 > S_0$. Convergence dictates that at contract expiration, $F_T = S_T$ and the roll return will be positive.



Note that the positive roll for the base currency short position is a negative roll for the long position. This discussion of roll and a contract on the base currency is equally true for contracts on any other assets such as stocks, bonds, and commodities.

Also note that the roll yield is not the total return from selling or buying the forward. The underlying spot price can increase or decrease. The forward price will converge to that unknown spot price at expiration of the forward. The total of the return to the forward position will be the change in price of the forward. That change in price of the forward has two components: 1) the unknown-in-advance change in the spot price, and 2) the known-in-advance roll yield.

EXAMPLE: Roll yield and interest rates

A USD-based investor has exposure to the South African rand (ZAR). The USD interest rate is 2.8% and the ZAR interest rate is 3.6%. **Determine** the roll yield for the investor if he hedges his ZAR exposure with a six-month forward.

Answer:

To hedge the long ZAR exposure, the investor sells the ZAR forward (buy the USD). IRP determines the premium or discount earned (roll yield) on the transaction. From IRP, the periodic risk-free rate of the currency purchased (USD) will be gained and the currency sold (ZAR) will be lost. Over a six-month period, this is approximately + 2.8% / 2 − 3.6% / 2 = –0.4%. The ZAR will trade at approximately a 0.4% forward discount.

A precise calculation of the discount requires first calculating the initial forward price using IRP:

$$F_{P/B} = S_{P/B}\left(\frac{1+i_P}{1+i_B}\right)$$

Then compare that forward price to the initial spot price to calculate the percentage roll yield (i.e., the forward premium or discount):

$$(F - S) / S$$

However by “assuming” an initial spot exchange rate between the two currencies of parity, a 1/1 exchange rate, this can be reduced to a single calculation:

$$\text{\% forward premium / discount} = \text{\% roll yield}$$

$$= (1.00)(1.028 / 1.036)^{0.5} - 1 = -0.387\%$$

Note that to analyze the ZAR, the ZAR is in the denominator of all terms.

PROFESSOR’S NOTE

The CFA text mentions but does not further apply a "similarity" between roll yield and trading the forward rate bias. Both depend on the initial interest rate differential between two currencies. In the previous example, the ZAR traded at a forward discount because it had an initially higher periodic interest rate.

- The forward rate bias trade (the carry trade) would buy the ZAR in the spot market to invest in and earn the higher interest rate.
- An investor who needs exposure to the ZAR would buy the ZAR in the forward market at a discount and earn positive roll yield.

The "similarity" is buying the higher yielding currency.

EXAMPLE: Hedging and roll yield

A portfolio's reporting currency is the Korean won (KRW) and the portfolio holds investments denominated in EUR, USD, and CHF. Current exchange rate information is provided below along with the manager's expectation for the spot rate in six months.

	Spot FX Rate	Six-Month Forward FX Rate	Manager's Forecast
KRW/EUR	1,483.99	1,499.23	1,450.87
KRW/USD	1,108.78	1,112.56	1,146.63
KRW/CHF	1,265.22	1,257.89	1,212.55

1. Which foreign currencies trade at a forward premium or discount?
2. Which foreign currency hedges would earn a positive roll yield?
3. Which foreign currencies would an active currency manager hedge?
4. **Comment** on how the roll yield affects the decision to hedge the EUR or USD.
5. **Calculate** the implied unannualized roll yield of a currency hedged for the portfolio's long exposure to CHF.

Answers:

1. The EUR and USD trade at a forward premium; forward price is above spot price.
2. The hedge will require a forward sale of the currency and sale at a forward premium will earn positive roll yield. Those are the EUR and USD.
3. An active manager will selectively hedge those currencies where the hedge is expected to improve return. The manager will compare expected unhedged with hedged returns. The manager is initially long each foreign currency so increases in the currency's value are a gain.

	Unhedged	Hedged
EUR	(1,450.87 / 1,483.99) –1 = –2.23%	(1,499.23 / 1,483.99) –1 = 1.03%
USD	(1,146.63 / 1,108.78) – 1 = 3.41%	(1,112.56 / 1,108.78) – 1 = 0.34%
CHF	(1,212.55 / 1,265.22) – 1 = –4.16%	(1,257.89 / 1,265.22) – 1 = –0.58%

   Comparing unhedged expected returns with hedged returns, the manager will hedge the EUR and CHF.
4. Selling forward the USD and EUR will result in positive roll yield which will reduce hedging costs. However, roll yield is only one factor to consider. The positive roll yield for selling the USD forward is not as attractive as the expected appreciation of leaving the USD unhedged.
5. The implied roll yield is the forward premium or discount. It is also the hedged currency return:

   $(F_0 – S_0) / S_0 = (F_0 / S_0) – 1 = (1{,}257.89 / 1{,}265.22) – 1 = –0.58\%$

This example demonstrates two issues involved with forward currency hedging. In essence, they are the same issue viewed from two different perspectives:

1. Positive (negative) roll yield will reduce (increase) hedging cost compared to the initial spot price.

2. Hedging locks in the forward price as an end of period exchange rate.

MODULE 17.5: IMPLEMENTATION AND OPTIONS

Video covering this content is available online.

LOS 17.g: Describe trading strategies used to reduce hedging costs and modify the risk–return characteristics of a foreign-currency portfolio.

CFA® Program Curriculum, Volume 3, page 388

The initial forward premium or discount is one cost factor to consider in analyzing the cost/benefit of a currency hedge. To reduce hedging cost, the manager can increase the size of trades that earn positive roll yield and reduce the size of trades that earn negative roll yield.

Forward hedging also incurs **opportunity cost**. Locking in a forward price to hedge currency risk will eliminate downside currency risk but also will eliminate any upside opportunity for gain from changes in exchange rates. Discretionary or option-based hedging strategies are designed to reduce opportunity cost.

Perfect hedging is expensive. If the manager wishes to insure against downside risk and retain upside potential, costs rise further. Reducing those hedging costs involves some form of less downside protection or less upside opportunity, moving the portfolio away from a 100% hedge ratio and/or toward more active decision making. The following discussion of strategies applies to a manager who wishes to hedge long exposure to the CHF (the base currency) and quotations are EUR/CHF.

1. **Over- or under-hedge with forward contracts** based on the manager's view. If the manager expects the CHF to appreciate, she can reduce the hedge ratio, hedging less than the full exposure to CHF risk. If the CHF is expected to depreciate, she can increase the hedge ratio, hedging more than the full exposure to CHF risk. If successful, this strategy creates "positive convexity"; gains will be increased and losses reduced. This is a relatively low cost strategy.

The rest of this discussion proceeds from roughly highest to lowest initial option cost.

2. **Buy at-the-money (ATM) put options** (also called **protective puts** or **portfolio insurance**). This strategy provides asymmetric protection, eliminating all downside risk and retaining all upside potential. But an at-the-money option is relatively expensive and has only time value (no intrinsic value). This strategy has the highest initial cost but no opportunity cost.
3. **Buy out-of-the-money (OTM) put options.** An ATM put would have a delta of approximately –0.50, called a 50-delta put because the sign of the delta is ignored with this terminology. Out-of-the-money puts have deltas that are smaller in magnitude than 0.50, so a 35-delta put is out of the money and a 25-delta put is further out of the money. Puts are less expensive the further they are out of the money, but also offer less downside protection. The manager will have downside CHF exposure down to the strike price of the puts. Compared to buying ATM protective puts, this strategy reduces the initial cost of the hedge but does not eliminate all downside risk.
4. **Collar**. The manager could buy the 35-delta puts on the CHF and sell 35-delta calls on the CHF. The OTM put provides some downside protection while costing less than an ATM put. The sale of the OTM call removes some upside potential (increasing

opportunity cost) but generates premium income to further reduce initial cost. This strategy further reduces initial cost but also limits upside potential compared to buying out-of-the money put options only.

A counterparty who buys the OTM call and sells the OTM put has taken on a risk reversal. The risk reversal profits if the underlying rises above the OTM call strike price and loses if the underlying falls below the OTM put strike price. The seller of the call and buyer of the put (used in the collar) can be described as short the risk reversal.

5. **Put spread**. Buy OTM puts on the CHF and sell puts that are further out of the money, (e.g., buy a 35-delta put and sell a 25-delta put). There is downside protection, which begins at the strike price of the purchased puts, but if the CHF falls below the lower strike price of the put sold, that downside protection is lost. This strategy reduces the initial cost and also reduces downside protection compared to buying out-of-the money put options only.
6. **Seagull spread**. This is a put spread combined with selling a call (e.g., buy a 35-delta put, sell a 25-delta put, and sell a 35-delta call). Compared to the put spread, only this hedge has less initial cost and the same down side protection, but limits upside potential.

Further alternatives include varying the degree of upside potential and downside protection. The manager can vary the notional amounts of the options. For example, a 1 × 2 put spread would buy 100 40-delta puts and sell 200 30-delta puts. The sale of additional puts increases premium income, reducing the initial cost of the hedge, but doubles the downside risk if the currency value falls below the strike price on the 30-delta puts.

All of these strategies are considered “plain vanilla” in that they are combinations of standard options. **Exotic options** introduce features not found in standard options.

1. A **knock-in option** is a plain vanilla option that only comes into existence if the underlying first reaches some prespecified level.
2. A **knock-out option** is a standard option that ceases to exist if the underlying reaches some prespecified level.
3. **Binary** or **digital options** pay a fixed amount that does not vary with the difference in price between the strike and underlying price.

PROFESSOR’S NOTE

Clearly there are any number of combinations and odd names for hedging strategies that use combinations of options positions. The important thing is to recognize how the above strategies affect the tradeoff between the cost of a hedge, its downside protection, and its upside potential.

The issues involved with selecting a hedge are summarized in the following steps.

1. Determine the base currency in the P/B quote. In a USD/CHF quote, the CHF is the base and if the quoted price increases (decreases), the CHF appreciates (depreciates).
2. Determine whether the base currency will be bought or sold. If bought and the quoted price increases (decreases), there is a gain (loss). If sold and the quoted price increases (decreases), there is a loss (gain).
3. If buying the base currency is required to hedge the existing risk, buying forwards or calls can be used. Buying OTM calls or writing options will reduce the hedge cost but also reduce downside protection or upside potential.
4. If selling the base currency is required to hedge the existing risk, forwards are sold or puts are purchased. Buying OTM puts or writing options will reduce the hedge cost but also reduce downside protection or upside potential.

5. The higher the client's risk tolerance and the stronger the manager's views, the less likely a simple 100% hedge will be used.
6. Various combinations of options, strike prices, and position sizes can reduce initial hedging costs, even to zero, but only by reducing downside protection or upside potential.

HEDGING MULTIPLE CURRENCIES

International portfolios will typically have exposure to more than one foreign currency. Generally, hedging each exposure individually is unnecessary, expensive, and time consuming. Consider a European investor who is underweight the AUD and overweight the NZD. The mechanical solution is a long position in AUD and a short position in NZD to reach neutral weights in both. Because the Australian and New Zealand economies are very similar, their currencies exhibit strong positive correlation. The two currencies are natural hedges for each other. If the initial over- and underweights were equal, there may be no need for any additional hedging.

MODULE 17.6: MORE ADVANCED IMPLEMENTATION ISSUES

Video covering this content is available online.

LOS 17.h: Describe the use of cross-hedges, macro-hedges, and minimum-variance-hedge ratios in portfolios exposed to multiple foreign currencies.

CFA® Program Curriculum, Volume 3, page 396

A **cross hedge** (sometimes called a **proxy hedge**) refers to hedging with an instrument that is not perfectly correlated with the exposure being hedged. Hedging the risk of a diversified U.S. equity portfolio with S&P futures contracts is a cross hedge when the portfolio is not identical to the S&P index portfolio. Cross hedges are generally not necessary in currency hedging because forward contracts for virtually all currency pairs are available but cross hedges may improve the efficiency of hedging.

Cross hedges also introduce additional risk to hedging. When the correlation of returns between the hedging instrument and the position being hedged is imperfect, the residual risk increases. The AUD and the NZD have a high positive correlation with each other so hedging an underweighting in the AUD with an overweighting in the NZD has little, but not zero, cross hedge risk.

The historical correlation is not a guarantee of the future. The future correlation may be different from historical correlation. If the correlation between two currencies moves toward zero, the (cross) hedge will not perform as expected. Portfolio performance could benefit or suffer from a change in correlation. The residual risk of the hedge is increased.

A **macro hedge** is a type of cross hedge that addresses portfolio-wide risk factors rather than the risk of individual portfolio assets. A bond portfolio might have interest rate risk, credit risk, and volatility risk exposures that the manager could hedge with bond futures (to hedge interest rate risk by modifying duration), credit derivatives (to hedge credit risk), and with volatility trading (to alter volatility risk).

One type of currency macro hedge uses a derivatives contract based on a fixed basket of currencies to modify currency exposure at a macro (portfolio) level. The currency basket in

the contract may not precisely match the currency exposures of the portfolio, but it can be less costly than hedging each currency exposure individually. The manager must make a choice between accepting higher residual currency risk versus lower cost.

The **minimum-variance hedge ratio** (MVHR) is a mathematical approach to determining the hedge ratio. When applied to currency hedging, it is a regression of the past changes in value of the portfolio (R_{DC}) to the past changes in value of the hedging instrument to minimize the value of the tracking error between these two variables. The hedge ratio is the beta (slope coefficient) of that regression. Because this hedge ratio is based on historical returns, if the correlation between the returns on the portfolio and the returns on the hedging instrument change, the hedge will not perform as well as expected.

The practical implications of this are as follows:

1. Our forward hedging examples up to now have been "direct" hedges. For example, a USD portfolio that is long CHF 1,000,000 sells CHF 1,000,000 forward to hedge the risk, a simple one-for-one hedge ratio of the notional exposure. In technical terms, the portfolio is long CHF, the hedging vehicle is a forward contract on the CHF, and the CHF and its forward have a virtually 1.00 correlation; therefore, no MVHR analysis is needed, sell CHF 1,000,000 forward.
2. Cross hedges or macro hedges are considered "indirect" hedges, the correlation between the currency exposure in the portfolio and a currency contract may not be 1.00 and the minimum-variance hedge ratio may not be one-for-one.
3. The MVHR can be used to jointly optimize over changes in value of R_{FX} and R_{FC} to minimize the volatility of R_{DC}.

   To illustrate this use of the MVHR, consider the case of a foreign country where the economy is heavily dependent on imported energy. Appreciation of the currency ($+R_{FX}$) would make imports less expensive, which is likely to decrease production costs, increasing profits and asset values ($+R_{FC}$). **Strong positive correlation between R_{FX} and R_{FC} increases the volatility of R_{DC}. A hedge ratio greater than 1.0 would reduce the volatility of R_{DC}.**

   Consider the case of a foreign country where the economy is heavily dependent on exports. Appreciation of the currency ($+R_{FX}$) would make its exports more expensive, likely reducing sales, profits, and asset values ($–R_{FC}$). **Strong negative correlation between R_{FX} and R_{FC} naturally decreases the volatility of R_{DC}. A hedge ratio less than 1.0 would reduce the volatility of R_{DC}.**

EXAMPLE: Determining and applying the MVHR

A U.S.-based portfolio is long EUR 2,000,000 of exposure. The portfolio manager decides to jointly hedge the risk of the asset returns measured in EUR and the risk of the currency return to minimize the volatility of the portfolio's returns measured in USD. The manager first adjusts all currency quotes to measure the value of the foreign currency by expressing the currency quotes as USD/EUR. He then calculates weekly percentage changes in value of the EUR (the R_{FX}) and unhedged percentage changes in value of the portfolio position measured in the portfolio's domestic currency (the R_{DC}). He performs a least squares regression analysis and determines based on the historical data that:

$$R_{DC} = 0.12 + 1.25(\%\Delta S_{USD/EUR}) + \varepsilon$$

With a correlation between R_{FX} and R_{FC} of 0.75

1. **Calculate** the size of and **state** the currency hedge to minimize expected volatility of the R_{DC}.
2. **Comment** on how effective the hedge is likely to be.

Answers:

1. EUR 2,000,000 × 1.25 = EUR 2,500,000; the manager will short EUR 2,500,000 to hedge a long EUR 2,000,000 exposure in the portfolio.
2. This is a cross hedge and is based on past correlation. The correlation can change and the hedge may perform better or worse than expected. In addition, a correlation of 0.75 is not perfect and there is random variation even in the past data.

MANAGING EMERGING MARKET CURRENCY

LOS 17.i: Discuss challenges for managing emerging market currency exposures.

CFA® Program Curriculum, Volume 3, page 406

The majority of investable asset value and FX transactions are in the six largest developed market currencies. Transactions in other currencies pose additional challenges because of: (1) higher transaction costs, "high markups" and (2) the increased probability of extreme events. Examples of these problems include the following.

- Low trading volume leads dealers to charge larger bid/asked spreads. The problem is compounded as the spreads tend to increase even further during periods of financial crisis.
- Liquidity can be lower and transaction costs higher to exit trades than to enter trades. Consider the carry trade that leads investors to gradually accumulate long positions in higher yield emerging market currencies. During periods of economic crises, the majority of those investors may attempt to exit a carry trade at the same time, driving the value of the emerging market currency down below its fundamental value and disrupting normal trading activity.
- Transactions between two emerging market currencies can be even more costly. Few dealers have the expertise to directly make a market between the currencies of smaller markets. A dealer may quote a transaction between the Malaysian ringgit (MYR) and Hungarian forint (HUF) but would, in fact, execute component transactions in EUR/MYR and EUR/HUF with other dealers who have the expertise to trade only one of the two currencies.
- Emerging market currencies return distributions are non-normal with higher probabilities of extreme events and negative skew of returns. Many trading strategies and risk measures assume a normal distribution and are, therefore, flawed.
- The higher yield of emerging market currencies will lead to large forward discounts. This produces negative roll yield for investors who need to sell such currencies forward.
- Contagion is common. During periods of financial crisis the correlations of emerging markets with each other and with their currencies tend to converge toward +1.0. Both emerging markets and their currencies have declined as a group. At the very time diversification is most needed, it tends to disappear.

- There is *tail risk*; the governments of emerging markets tend to actively intervene in the markets for their currencies, producing long periods of artificial price stability followed by sharp price movements when market forces overwhelm the government's capacity to intervene. The "tail risk" refers to these negative events occurring more frequently than would be assumed in the normal distribution.

Non-deliverable forwards (NDFs): Emerging market governments frequently restrict movement of their currency into or out of the country to settle normal derivative transactions. Such countries have included Brazil (BRL), China (CNY), and Russia (RUB). NDFs are an alternative to deliverable forwards and require a cash settlement of gains or losses in a developed market currency at settlement rather than a currency exchange.

A benefit of NDFs is lower credit risk because delivery of the notional amounts of both currencies is not required. Only the gains to one party are paid at settlement.

An additional point to consider with NDFs is that they exist because the emerging market government is restricting currency markets. Changes in government policy can lead to sharp movements in currency values (i.e., there is tail risk).

EXAMPLE: Calculating cash settlement values for an NDF

A trader buys EUR 1,000,000 six months forward at RUB/EUR 39. Six months later, the spot exchange rate is RUB/EUR 40. **Calculate** the cash flows that will occur at settlement.

Answer:

The trader has agreed to "sell" RUB 39,000,000 for EUR 1,000,000. At settlement, the market value of EUR 1,000,000 is RUB 40,000,000 so the investor has a gain of RUB 1,000,000.

However, NDF settlements are made in the developed market currency at the ending spot exchange rate so we must convert the gain of RUB 1,000,000 to EUR at RUB/EUR 40.The EUR value of RUB 1,000,000 at settlement is 1,000,000 / 40 = 25,000 euros and the trader will receive this payment from the counterparty. There is only a net exchange of gain.

MODULE QUIZ 17.4, 17.5, 17.6

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

1. Peter Perkins has a U.S.-based portfolio and decides to hedge his exposure to the Swiss franc (CHF) with a protective put strategy. However, he also decides he is willing to reduce the downside protection to lower the initial cost. Which of the following strategies will accomplish his objective?
   A. Buy 50-delta calls and puts on the CHF.
   B. Buy a 40-delta put and sell a 20-delta put on the CHF.
   C. Buy a 40-delta put and sell a 35-delta call on the CHF.
2. Jane Archer manages a Swiss-based (CHF) hedge fund. GBP 1,000,000 is currently invested in a diversified portfolio of U.K. stocks. Archer regresses the monthly returns of a diversified U.K. stock index (returns measured in CHF) versus the monthly change in value of the CHF/GBP. The regression coefficients are intercept = 0.11 and slope coefficient = 1.25. **Determine** the quantity of GBP Archer will short to implement a hedge of direct currency risk and a minimum-variance hedge.

	Direct currency hedge	Minimum-variance hedge
A.	GBP 1,000,000	GBP 1,000,000
B.	GBP 1,000,000	GBP 1,250,000
C.	GBP 1,250,000	GBP 1,250,000

3. A trader enters a short three-month non-deliverable forward on 2,000,000 CNY at CNY/USD 6.1155. At the end of the period, the spot exchange rate is USD/CNY 0.1612. The trader's

gain or loss is *closest* to:

A. USD 4,600 loss.
B. USD 4,700 loss.
C. USD 4,650 gain.

KEY CONCEPTS

LOS 17.a

An investment in assets priced in a currency other than the investor's domestic currency (a *foreign asset* priced in a *foreign currency*) has two sources of risk and return: (1) the return on the assets in the foreign currency and (2) the return on the foreign currency from any change in its exchange rate with the investor's *domestic currency*. These returns are multiplicative and an investor's returns in domestic currency can be calculated as:

Equation 1: $R_{DC} = (1 + R_{FC})(1 + R_{FX}) - 1 = R_{FC} + R_{FX} + (R_{FC})(R_{FX})$

$R_{DC} \approx R_{FC} + R_{FX}$

Equation 2: $R_{DC} = \sum_{i=1}^{n} w_i \left(R_{DC,i}\right)$

Equation 3: $\sigma^2(R_{DC}) \approx \sigma^2(R_{FC}) + \sigma^2(R_{FX}) + 2\sigma(R_{FC})\sigma(R_{FX})\rho(R_{FC},R_{FX})$

Equation 4: $\sigma(R_{DC}) = \sigma(R_{FX})(1 + R_{FC})$

where for Equation 4:
R_{FC} = the return on a foreign currency denominated risk-free asset

LOS 17.b

Passive hedging is rule-based and typically matches the portfolio's currency exposure to the portfolio's benchmark in order to eliminate currency risk relative to the benchmark.

Discretionary hedging allows the manager to deviate modestly from passive hedging. The primary goal is currency risk reduction while seeking some modest value added return.

Active currency management allows wider discretion to selectively hedge or not hedge and to deviate substantially from the benchmark. The goal is value added, not risk reduction. At the extreme, an active manager can treat currency as an asset class and take positions independent of the portfolio assets. For example, a manager who is bearish on the Swedish krona (SEK) can short the SEK even if no SEK assets are owned.

Currency overlay management is a broad term referring to the use of a separate currency manager. The asset manager first takes positions in the markets considered most attractive, without regard to the resulting currency exposures. The overlay manager then adjusts the currency exposures. The overlay manager's mandate can be passive, discretionary, or active.

Arguments made for not hedging currency risk include the following:

- Avoid the time and cost of hedging or trading currencies.
- Currency effects are a "zero-sum game"; if one currency appreciates, another must depreciate.
- In the long run, currencies revert to a theoretical fair value.

Arguments for active currency management include the following:

- In the short run, currency movement can be extreme.

- Inefficient pricing of currencies can be exploited to add to portfolio return. Inefficient pricing of currency can arise as many foreign exchange (FX) trades are dictated by international trade transactions or central bank policies.

LOS 17.c

Factors that favor a benchmark neutral or fully hedged currency strategy are:

- A short time horizon for portfolio objectives.
- High risk aversion.
- High short-term income and liquidity needs.
- Significant foreign currency bond exposure.
- Low hedging costs.
- Clients who doubt the benefits of discretionary management.
- A client who is unconcerned with the opportunity costs of missing positive currency returns.

LOS 17.d

1. Economic fundamentals assumes that purchasing power parity (PPP) determines exchange rates in the very long run. In the shorter run, currency appreciation is associated with:
    - Currencies that are undervalued relative to fundamental value (based on PPP).
    - Currencies with a faster rate of increase in fundamental value.
    - Countries with lower inflation.
    - Countries with higher real or nominal interest rates.
    - Countries with a decreasing country risk premium.
2. Technical analysis:
    - Overbought (or oversold) currencies reverse.
    - A currency that declines to its support level will reverse upward unless it pierces the support level, in which case, it can decline substantially.
    - A currency that increases to its resistance level will reverse downward unless it pierces the resistance level, in which case, it can increase substantially.
    - If a shorter term moving average crosses a longer term moving average, the price will continue moving in the direction of the shorter term moving average.
3. The carry trade exploits the forward rate bias (i.e., forward exchange rates are not a valid predictor of currency market movement).
    - Borrow the lower interest rate currency (often a developed market).
    - Convert it to the higher rate currency (often an emerging market) at the spot exchange rate.
    - Invest and earn the higher interest rate.

    This is a risky, not a hedged, trade. If the higher interest rate currency appreciates or depreciates less than “implied” by the forward rate, the trade will be profitable. In times of severe economic stress, the carry trade can be very unprofitable as the higher interest rate (and riskier) currency collapses.
4. Volatility trading profits from changes in volatility.

- If volatility is expected to increase, enter a straddle (purchase a call and put with the same strike price, typically using at-the-money options). A strangle (buy an out-of-the-money call and put) can also be used. The strangle will cost less but will have less upside if volatility increases.
- If volatility is expected to decline, enter a reverse straddle or strangle (i.e., sell the options).

LOS 17.e

Expectation:		Action:
Relative currency:	Appreciation	Reduce the hedge (short position) on **OR** increase the long position in the currency
	Depreciation	Increase the hedge on or decrease the long position in the currency
Volatility:	Rising	Long straddle (or strangle)
	Falling	Short straddle (or strangle)
Market conditions:	Stable	A carry trade
	Crisis	Discontinue the carry trade

LOS 17.f

Typically, forward contracts are preferred for currency hedging because:

- They can be customized, while futures contracts are standardized.
- They are available for almost any currency pair, while futures trade in size for only a limited number of currencies.
- Futures contracts require margin which adds operational complexity and can require periodic cash flows.
- Trading volume of FX forwards and swaps dwarfs that of FX futures, providing better liquidity.

A hedge can be a **static hedge**, which is established and held until expiration, or a **dynamic hedge**, which is periodically rebalanced.

The choice of hedging approach should consider:

- Shorter term contracts or dynamic hedges with more frequent rebalancing tend to increase transaction costs but improve the hedge results.
- Higher risk aversion suggests more frequent rebalancing.
- Lower risk aversion and strong manager views suggest allowing the manager greater discretion around the strategic hedging policy.

Hedging also exposes the portfolio to **roll yield** or **roll return**. Roll yield is a return from the movement of the forward price over time toward the spot price of an asset. It can be thought of as the profit or loss on a forward or futures contract if the spot price is unchanged at contract expiration.

Forward Premiums or Discounts and Currency Hedging Costs

Current position of foreign asset in currency B	The hedge requires:	$F_{P/B} > S_{P/B}$, $i_B < i_P$	$F_{P/B} < S_{P/B}$, $i_B > i_P$
		The forward price curve is upward-sloping.	The forward price curve is downward-sloping

Short the foreign asset	A long forward position in currency B, the hedge earns:	Negative roll yield, which increases hedging cost and discourages hedging.	Positive roll yield, which decreases hedging cost and encourages hedging.
Long the foreign asset	A short forward position in currency B the hedge earns:	Positive roll yield, which decreases hedging cost and encourages hedging.	Negative roll yield, which increases hedging cost and discourages hedging.

LOS 17.g

The cost of hedging a currency exposure:

- **Positive roll** will reduce and **negative roll** will increase hedging costs.
- Hedging with forward (or futures) has no explicit option premium cost, but it has **implicit cost**; it removes upside as well as downside.
- Active managers can selectively **over- or under-hedge**. Buy more or sell less of the currency expected to appreciate.
- An **at-the-money (ATM) put** (a **protective put** or **portfolio insurance**) is the most expensive (upfront premium cost) form of option hedging (e.g., buy a 50 delta put).

Option hedging costs can be reduced by decreasing upside potential or increasing downside risk. To hedge an existing currency exposure:

- **Buy an out-of-the-money (OTM) put.**
- **Use a collar; buy an OTM put and sell an OTM call.**
- **Use a put spread; buy an OTM put and sell a further OTM put.**
- **Use a seagull spread; buy an OTM put, sell a further OTM put and sell an OTM call.**
- **Use exotic options** that require addition conditions before they can be exercised or which can expire early.

LOS 17.h

A **cross hedge** (sometimes called a proxy hedge) uses a hedging vehicle that is different from, and not perfectly correlated with, the exposure being hedged.

A **macro hedge** is a type of cross hedge that addresses portfolio-wide risk factors rather than the risk of individual portfolio assets. One type of currency macro hedge uses a derivatives contract based on a fixed basket of currencies to modify currency exposure at a macro (portfolio) level.

The **minimum-variance hedge ratio** (MVHR) is a mathematical approach to determining the hedge ratio. Regress past changes in value of the portfolio (R_{DC}) to the past changes in value of the hedging instrument (the foreign currency) to find the hedge ratio that would have minimized standard deviation of R_{DC}. The hedge ratio is the beta (slope coefficient) of that regression.

- Positive correlation between R_{FX} and R_{FC}; MVHR > 1.
- Negative correlation between R_{FX} and R_{FC}; MVHR < 1.

LOS 17.i

Non-deliverable forwards (NDFs) settle the net gain or loss in a single currency (rather than exchanging currencies).

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 17.1

1. **C** The ending value in USD is: USD 1,253,000 × 1.05 = USD 1,315,650.The ending value in DJF is: USD 1,315,650 × DJF/USD 192.85 = DJF 253,723,103. (LOS 17.a)

2. **C** $(1 + R_{FC})(1 + R_{FX}) - 1$

   (1.05)(192.85 / 179.54) − 1 = 12.78% (LOS 17.a)

3. It depends on the standard deviation of the asset returns measured in the foreign currency, the standard deviation of the currency, and the correlation between these two sources of return.

   Variance = $(1.0^2)(4.5^2) + (1.0^2)(3.7^2) + 2(1.0)(1.0)(0.81)(4.5)(3.7) = 60.913$

   Standard deviation = 7.8%

   (LOS 17.a)

4. **A** The manager's market views affect tactical decisions to vary away from the strategic decision. The portfolio and market circumstances determine the strategic decision. (LOS 17.b)

5. **C** Any of the following will shift the portfolio toward active currency management allowing greater manager discretion:
   - A long time horizon for portfolio objectives.
   - Low risk aversion.
   - Concern with regret at missing opportunities to add value through discretionary currency management.
   - Low short-term income and liquidity needs.
   - Little foreign currency bond exposure.
   - High hedging costs.
   - Clients who believe in the benefits of discretionary management.

   (LOS 17.b)

6. The case states that Simms must hold a long position in the KRW and her long futures position is coming due. She must roll it over with another long position. She does have the authority to increase or decrease the long hedge position by 10%. Because she believes the KRW will depreciate, she should reduce the hedge size 10% and will buy only 900,000 KRW rather than the existing 1,000,000 when she rolls over the hedge. The quotes are given in EUR/KRW so she must transact at the higher price of 0.00068 reflecting she is paying more EUR per KRW. The spot quote is given in five decimal places so the forward points decimal must be moved five places to the left for a forward price of 0.00068 – (1.1 / 100,000) = 0.00068 – 0.000011 = 0.000669 EUR/KRW. (LOS 17.a)

7. a. The expected returns measured in the investor's domestic currency (CHF) are:

   EUR asset: (1.02)(0.99) – 1 = +0.98%

   AUD asset: (1.025)(1.03) – 1 = +5.58%

The weighted average return is: 0.6(0.98%) + 0.4(5.58%) = 2.82%

b. The standard deviations of asset returns measured in the investor's domestic currency are:

EUR asset: $[(15.0^2) + (7.0^2) + 2(15.0)(7.0)(0.85)]^{1/2} = 21.27\%$

AUD asset: $[(25.0^2) + (9.0^2) + 2(25.0)(9.0)(0.65)]^{1/2} = 31.60\%$

The standard deviation of portfolio returns is:

$[0.6^2(21.27^2) + 0.4^2(31.60^2) + 2(0.6)(0.4)(0.70)(21.27)(31.60)]^{1/2} = 23.42\%$

c. The expected returns measured in the investor's domestic currency (CHF) are:

EUR asset: (1.02)(0.99) – 1 = +0.98%

AUD asset: (1.025)(1.03) – 1 = +5.58%

The weighted average return is: –1.5(0.98%) + 1.5(5.58%) = 6.90%

d. The standard deviations of asset returns measured in the investor's domestic currency are:

EUR asset: $[(15.0^2) + (7.0^2) + 2(15.0)(7.0)(0.85)]^{1/2} = 21.27\%$

AUD asset: $[(25.0^2) + (9.0^2) + 2(25.0)(9.0)(0.65)]^{1/2} = 31.60\%$

The standard deviation of portfolio returns is:

$[(-1.5)^2(21.27^2) + (1.5)^2(31.60^2) + 2(-1.5)(1.5)(0.70)(21.27)(31.60)]^{1/2} = 33.87\%$

(LOS 17.a)

Module Quiz 17.2, 17.3

1. **C** A carry trade should be more profitable in periods of economic stability (low, stable currency volatility) with lower interest rates in the borrowing currencies and higher interest rates in the investing currencies. (Module 17.3, LOS 17.d)

2. **C** Rising real interest rates in the euro zone would attract capital and be associated with a rising currency value, leading a manager to tilt to a long position in the euro. The other two answers are incorrect. Low volatility is favorable to a carry trade. Rising volatility increases the price of both calls and puts. It is likely to have a greater impact on the cost of the protective put, which requires purchase of a put. In contrast, the collar cost is increased to purchase the put but offset by an increased receipt from selling the call. (Module 17.3, LOS 17.d)

Module Quiz 17.4, 17.5, 17.6

1. **B** This question requires you select the strategy that meets the objectives set by Perkins. He has three objectives and only one answer choice meets all three. He wants a protective put on the CHF; all three strategies buy a put on the CHF. He wants to lower the initial cost; one strategy buys a call, which will raise the cost, but it must be rejected. He is willing to reduce his downside protection in order to lower the initial cost; the only one strategy to do this is the buy a 40-delta put and sell a 20-delta put on the CHF. Note the strategy that sells an OTM call also lowers the initial cost but does so by limiting upside; this is not what Perkins specified. (Module 17.5, LOS 17.g)

2. **B** A direct currency hedge is a simple 1.0 hedge ratio; Archer will sell 1,000,000 GBP forward. A MVHR considers the correlation between returns of the foreign asset measured in the portfolio's domestic currency and change in value of the foreign currency. The hedge ratio is the beta (slope coefficient) of the regression. Archer will sell 1,250,000 GBP forward. (Module 17.6, LOS 17.h)

3. **C** An NDF settles in the developed market currency; however, the information is presented in a mixture of CNY/USD and USD/CNY which requires additional steps:

   Determine the size of the trade in USD at the forward exchange rate:

   CNY 2,000,000 / (CNY/USD 6.1155) = USD 327,037.85

   Determine the G/L on the USD position in CNY. The two exchange rates need to be in CNY/USD.

   Ending spot exchange rate USD/CNY 0.1612 is CNY/USD 6.20347.

   G/L = (CNY/USD 6.20347 − 6.1155) × 327,037.85 = CNY 28,769.52

   Determine the G/L in USD based on ending spot exchange rate is:

   G/L = CNY 28,769.52 × USD/CNY 0.1612 = USD 4,637.65

   The CNY was shorted at CNY/USD 6.1155 and declined in value to CNY/USD 6.20347 producing a gain on the trade of USD 4,637.65.

   (Module 17.6, LOS 17.i)

TOPIC ASSESSMENT: DERIVATIVES AND CURRENCY MANAGEMENT

Use the following information for Questions 1 through 4.

George Kaufman, portfolio manager and CEO of Kaufman Co., is extremely busy. He has a number of important issues that must be dealt with before the end of the week.

The portfolio Kaufman manages consists of $40 million in bonds and $60 million in equities. The modified duration of the bond portfolio is 6.3. The beta of the equity portfolio is 1.25. The holding period for each is one year. Kaufman also has the authority to borrow up to $25 million which may be invested on a short-term basis to earn the spread between the borrowing rate and the investing rate.

Kaufman is afraid that interest rates will raise 25 basis points in the near future and would like to decrease the duration of the bond portion of the portfolio to 5.0 for a short period. He prefers to use futures contracts to do this because it is a temporary change and he does not want to sell bonds in the portfolio. Kaufman is considering using a Treasury bond futures contract that has a modified duration of 4.2 and a price (including the multiplier) of $245,000.

The equity portion of the portfolio has performed extremely well over the recent past and Kaufman must decide on one of the following two strategies:

Equity Strategy 1: Kaufman could hold on to his current profits for the next six months which should make the reported annual return rank in the top one percentile of similar portfolios. Again, Kaufman prefers to use futures contracts instead of selling stocks to lock in the profits. The portfolio is composed of the same stocks and sector weightings as the S&P 500. The contract on the index is at 2000 (with a multiplier of 250), and it expires in six months. The risk free rate is 2% and the dividend yield on the index is 3%.

Equity Strategy 2: Kaufman believes there is a chance the market may move significantly over the next six months. To benefit from the expected move in the market, Kaufman could increase the equity portion of the portfolio from its current beta of 1.25 to 1.4 by using equity index futures. The appropriate equity index futures contract that Kaufman is considering using has a beta of 0.90 and a price (including the multiplier) of $335,000.

Finally, Kaufman Co. is expecting a $6 million cash inflow in four months and would like to pre-invest the funds to create the same exposure to the bond and stock market that is found in the original portfolio. The most appropriate stock index futures contract for accomplishing this has a total price (including the multiplier) of $315,650 and a beta of 1.10. The most appropriate bond index futures contract has a total price of $115,460 and an effective duration of 6.2.

1. The number of Treasury bond futures contracts that Kaufman would need to reduce the duration of the bonds in the portfolio is *closest* to:
   A. sell 51 contracts.
   B. sell 56 contracts.
   C. buy 269 contracts.

2. Kaufman is interested in increasing the beta of the equity portfolio to 1.4 for a brief period of time. Kaufman is expecting:
    A. an increase in the market; a long position in approximately 30 contracts will accomplish this target.
    B. an increase in the market; a long position in approximately 27 contracts will accomplish this target.
    C. a decrease in the market; a short position in approximately 72 contracts will accomplish this target.
3. The number of S&P index futures contracts Kaufman would need to buy or sell to eliminate all equity exposure for the next six months is *closest* to:
    A. buy approximately 121 contracts.
    B. sell approximately 121 contracts.
    C. sell approximately 400 contracts.
4. The *most appropriate* strategy to pre-invest the anticipated $6 million inflow would be to buy:
    A. 21 bond futures contracts and buy 13 stock futures contracts.
    B. 21 bond futures contracts and buy 35 stock futures contracts.
    C. 20 bond futures contracts and sell 13 stock futures contracts.

Use the following information for Questions 5 through 10.

Mary Freer is a portfolio manager for the Worldwide Investors Mutual Fund (Worldwide), a U.S. portfolio manager based in New York. Kate McLaughlin, a recent college graduate, is her assistant.

Freer is scheduled to give a presentation next week where she will discuss currency hedging issues. It will be a diverse group including more, as well as less, sophisticate investors. All the clients are based in the United States. Because the managers at Worldwide often use currency hedges and base the hedging decisions on a variety of factors, she asks McLaughlin to prepare summary statements that describe various client, as well as broad market and economic, factors that affect the decision to hedge. McLaughlin prepares two lists.

We are more likely to hedge to reduce currency risk in accounts:

1. With shorter time horizon and higher liquidity needs.
2. With greater allocation to foreign equity compared to accounts with larger foreign bond exposure.
3. Where the client is unsophisticated and does not understand why currency affects the rate of return.

In the second list, she states that we are more likely to expect appreciation in value of currencies that:

1. Trade at a forward premium (current forward price exceeds the spot price of the currency).
2. With higher relative interest rates.
3. With higher relative volatility.

She also asks McLaughlin to prepare a simple and complex example she can discuss at the presentation. McLaughlin provides the following:

Simple example: The foreign market will appreciate 6%, and the foreign currency will depreciate 3%. The foreign currency currently trades at a 2% forward discount.

Complex example: We hold a portfolio of European stocks, currently worth €300,000. The spot exchange rate is $1.10/€. We hedge the currency risk with a three-month futures contract on the euro at $1.15/€. A week later, the portfolio is worth €320,000, the spot exchange rate is $1.20/€, and the futures exchange rate is $1.23/€.

At the presentation, Freer is asked to discuss how Worldwide uses minimum-variance hedge ratio. She states:

- The minimum-variance hedge ratio is derived by regressing the unhedged return on the foreign stock in USD terms against the return on the currency futures contract.
- The advantage of this hedging approach is it captures the relationship between market and currency return. Suppose we invest in a foreign equity market and that currency depreciates. But this stimulates export sales, leading to increased profits and stock prices. That scenario would affect our hedge ratio. The MVHR will exceed a naïve hedge ratio 1.

She is also asked how basis risk can complicate hedging currency risk. She responds that:

1. Basis risk is unpredictable in the short run. But when we sell currencies at a forward premium, it will provide positive roll return over the long run.
2. We can reduce basis risk by assuring that the expiration of the contract is longer than our anticipated holding period.
3. Rolling over shorter-term contracts to reach our desired longer hedging period will improve the accuracy of our currency hedge, and by using forward contracts we avoid any cash flow issues until the end of the hedging period.

5. Regarding McLaughlin's first list, which client factor summary statement is *most likely* incorrect?
   A. 1.
   B. 2.
   C. 3.

6. Regarding McLaughlin's second list, which broad market factor summary statement is *most likely* correct?
   A. 1.
   B. 2.
   C. 3.

7. In McLaughlin's simple example and for an account that actively manages currency risk:
   A. the unhedged currency return of the investment is approximately 9%.
   B. the hedged currency return of the investment is approximately 6%.
   C. Freer would hedge the currency risk.

8. In McLaughlin's complex example and for an account that actively manages currency risk, the hedged currency return is *closest* to:
   A. 16.4%.
   B. 6.7%.
   C. 9.1%.

9. Regarding Freer's statements concerning the minimum-variance hedge ratio, she is:
    A. correct.
    B. incorrect regarding how to calculate a MVHR.
    C. incorrect in stating her example will lead to a MVHR > 1.0.
10. Regarding McLaughlin's statements concerning basis risk:
    A. all three are correct.
    B. only two of the statements are correct.
    C. only one of the statements is correct.

TOPIC ASSESSMENT ANSWERS: DERIVATIVES AND CURRENCY MANAGEMENT

1. **A** contracts = $[(MD_{Target} - MD_P) / MD_F][V_P / (P_f(multiplier))]$

   contracts = [(5 − 6.3) / 4.2] × ($40,000,000 / $245,000) = –50.53

   To reduce the duration of the portfolio, take a short position in the futures contract. Note that we must round the number of contracts up to 51 since partial contracts cannot be traded. (Study Session 6, Module 16.3, LOS 16.c)

2. **A** number of contracts = [(target beta – portfolio beta) / beta on futures]× value of the portfolio / (price of the futures × the multiplier)

   number of contracts = [(1.4 − 1.25) / 0.90] × ($60,000,000 / $335,000) = 29.85 contracts

   The positive sign indicates that we should take a long position in the futures to "leverage up" the position. If that is Kaufman's goal, he must be expecting an increase in the market. (Study Session 6, Module 16.3, LOS 16.c)

3. **B** $[\$60,000,000 \times (1.02)^{0.50}] / (2,000 \times \$250) = 121.19$ contracts

   Kaufman would need to sell the contracts to create a zero-beta position. (If he were converting cash to a synthetic equity position, he would instead *buy* contracts.) (Study Session 6, Module 16.5, LOS 16.e)

4. **A** Take the existing portfolio weights, 40% debt and 60% equity and apply them to the new money that is coming in. Also, "mirror" the duration and beta of the original portfolios.

   number of bond futures = [(6.3 − 0) / 6.2] × [(6,000,000 × 0.40) / 115,460] = 21.12 contracts

   number of stock futures = [(1.25 − 0) / 1.10] × [(6,000,000 × 0.60) / 315,650] = 12.96

   Kaufman Co. would take a long position in both the stock index and bond futures contracts because it is synthetically creating an existing portfolio until the actual $6 million is received and can be invested. (Study Session 6, Module 16.5, LOS 16.f)

5. **B** Because equity is a more volatile asset class than bonds, the added risk of currency in a foreign equity investment is relatively less significant than in a foreign bond investment. The statement got this backwards and is incorrect.

   The other two are true. Shorter time horizon and greater liquidity needs lower risk tolerance and therefore make hedging the currency risk more likely. An unsophisticated client who does not understand currency is likely to be more confused by the incremental variability of return it adds. Hedging the currency risk will make the investment somewhat more predictable. (Study Session 6, Module 17.1, LOS 17.b, 17.c)

6. **B** Currencies with higher relative interest rates tend to attract capital and appreciate in value.

   The other two are false. The forward premium is a direct reflection of the IRP currency arbitrage. A forward premium is caused by a relatively lower interest rate and that is

associated with currency depreciation. Note that a common misconception is that the forward currency exchange rate is a valid predictor of what will happen to the value of a currency. That is not supported by the CFA® material or by most empirical evidence. High volatility is a sign of distress, not of an undervalued currency. (Study Session 6, Module 17.3, LOS 17.d)

7. **C** The unhedged return is approximately 6 – 3 = 3%. The hedged currency return is approximately 6 – 2 = 4%. Therefore hedged is best. (Study Session 6, Module 17.4, LOS 17.f)

8. **C** Because this question involves specific beginning and ending amounts of an investment in a foreign denominated asset and G/L on currency contracts, we need to work through a variation of ending – beginning value in the investor's currency, the USD.

   G/L in USD on the unhedged investment is:

   (EUR320,000 × USD1.20/EUR) – (300,000 × 1.10) = (384,000 – 330,000) = USD54,000

   G/L on the contracts is:

   EUR300,000 × (USD1.15/EUR – 1.23) = –USD24,000

   This is a loss as the EUR was sold forward and contract price declined.

   The total gain versus BV in USD on the hedged investment is:

   USD30,000 / (EUR300,000 × USD1.10/EUR) = 9.09%

   There are various ways you can arrange this sequence of calculations, provided you come to the correct final result of 9.1%. If you simply solved for R_{FC} and R_{FX}, then added or compounded them together, that is not correct when a question involves specific beginning and ending amounts of an investment in a foreign denominated asset and G/L on currency contracts. (Study Session 6, Module 17.4, LOS 17.f)

9. **C** Freer is correct regarding how to calculate a MVHR. She is wrong regarding the numeric value of a MVHR. She describes a situation of negative correlation between R_{FC} (the stock market increases) and R_{FX} (the foreign currency depreciates). When there is negative correlation, one risk naturally tends to offset the other, lowering the MVHR. (Study Session 6, Module 17.6, LOS 17.h)

10. **C** She is correct that basis risk is unpredictable in the short. Basis is change in futures versus change in spot price, and those prices are determined by market conditions. But if a contract is held to expiration, F and S converge and the roll return is certain. It is the initial difference in F and S. She sold at a premium so that roll is positive.

    She is wrong about buying shorter or longer contracts. To reduce basis risk, she should buy contracts that match the hedging period. She is also wrong about cash flow. It is true forwards have no daily margin flow, but every time she rolls a contract there will be realized G/L to settle up with an exchange of funds. (Study Session 6, Module 17.4, LOS 17.f)

FORMULAS

Target interest rate using the neutral rate:

$$n_{target} = r_{neutral} + i_{target} + [0.5(GDP_{expected} - GDP_{trend}) + 0.5(i_{expected} - i_{target})]$$

Grinold-Kroner model:

$$E(Re) \approx D/P + (\%\Delta E - \%\Delta S) + \%\Delta P/E)$$

Singer-Terhaar model:

risk premium assuming full integration:

$$RP_i = \rho_{i,M}\sigma_i(\text{market Sharpe ratio})$$

risk premium assuming full segmentation:

$$RP_i = \sigma_i(\text{market Sharpe ratio})$$

weighted average risk premium:

RP_i = (degree of integration of *i*)(ERP assuming full integration) + (degree of segmentation of *i*)(ERP assuming full segmentation)

Capitalization rate (with infinite time period):

$$\text{cap rate} = E(R_{re}) - \text{NOI growth rate}$$

$$E(R_{re}) = \text{Cap rate} + \text{NOI growth rate}$$

Capitalization rate (with finite time period):

$$E(R_{re}) = \text{cap rate} + \text{NOI growth rate} - \%\Delta\text{cap rate}$$

Expected percentage change in the exchange rate:

$$E(\%\Delta S_{d/f}) = (r^d - r^f) + (Term^d - Term^f) + (Credit^d - Credit^f) + (Equity^d - Equity^f) + (Liquid^d - Liquid^f)$$

Return of the *i*th asset in a multifactor model:

$$r_i = \alpha_i + \sum_{k=1}^{K} \beta_{ik} F_k + \varepsilon_i$$

Variance of the *i*th asset:

$$\sigma_i^2 = \sum_{m=1}^{K} \sum_{n=1}^{K} \beta_{im}\beta_{in}\rho_{mn} + \nu_i^2$$

Covariance between the *i*th and *j*th asset:

$$\sigma_{ij} = \sum_{m=1}^{K} \sum_{n=1}^{K} \beta_{im}\beta_{jn}\rho_{mn}$$

Smoothed returns to estimate volatility is the weighted average of the current "true" returns and previously observed returns:

$R_t = (1-\lambda)r_1 + \lambda R_{t-1}$ where λ is a weight between 0 and 1

Portfolio variance = $\text{var}(r) = \left(\frac{1+\lambda}{1-\lambda}\right)\text{var}(R) > \text{var}(R)$

ARCH model:

$\sigma_t^2 = \gamma + \alpha\sigma_{t-1}^2 + \beta\eta_t^2 = \gamma + (\alpha + \beta)\sigma_{t-1}^2 + \beta\left(\eta_t^2 - \sigma_{t-1}^2\right)$

where α, β, and γ are nonnegative parameters and $(\alpha + \beta) < 1$, and η_t is a random variable indicating the unexpected return component.

Higher α + β terms indicate higher emphasis on past information, leading to volatility clustering.

$U_m = E(R_{s,m}) - 0.005 \times \lambda \times Var_{s,m}$

where:
$E(R_{s,m})$ = expected surplus return
$Var_{s,m}$ = variance of surplus return

After-tax *standard deviation* = pretax standard deviation (1 – t)

After-tax *deviation from midpoint of target asset allocation* = pretax deviation / (1 – t)

Put-call parity:

call premium (paid initially) – put premium (received initially) = initial stock price paid – PV(X) received

In symbols, $\mathbf{c_0 - p_0 = S_0 - PV(X)}$, which can be rearranged to $\mathbf{S_0 + p_0 = c_0 + PV(X)}$.

Notional principal of the interest rate swap:

$NP_s = \left(\frac{MD_T - MD_P}{MD_s}\right)(MV_P)$

where:
NP_S = notional swap principal
MD_T = target modified duration
MD_P = current portfolio modified duration
MD_S = modified duration of swap
MV_P = market value of portfolio

Identifying the CTD bond at delivery:

profit/(loss) on delivery = [(settlement price × CF) + AI_T] − (CTD clean price + AI_T)

To fully hedge (immunize) a portfolio's value against interest rate changes:

$\Delta P = HR \times \Delta$ futures price

where:
ΔP = change in portfolio's value

HR = hedge ratio = number of futures contracts

$$\Delta P = HR \times \frac{\Delta CTD}{CF}$$

$$HR = \frac{\Delta P}{\Delta CTD} \times CF$$

Duration-based hedge ratio (BPVHR):

$$BPVHR = \frac{-BPV_{portfolio}}{BPV_{CTD}} \times CF$$

BPVHR = number of short futures

$BPV_{portfolio} = MD_{portfolio} \times 0.01\% \times MV_{portfolio}$

MD = modified duration

$BPV_{CTD} = MD_{CTD} \times 0.01\% \times MV_{CTD}$

MV_{CTD} = CTD price / 100 × \$100,000

To achieve a target duration, the formula can be amended to:

$$BPVHR = \frac{BPV_{Target} - BPV_{Portfolio}}{BPV_{CTD}} \times CF$$

$BPV_{target} = MD_{target} \times 0.0001 \times MV_{portfolio}$

number of futures contracts needed

$$= \frac{\text{monetary value of position to be hedged}}{\text{futures price} \times \text{multiplier}}$$

The hedge ratio for futures can be calculated as:

$$HR = \frac{\text{amount of currency to be exchanged}}{\text{futures contract size}}$$

$$\text{number of futures required} = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right)$$

where:

β_T = target portfolio beta

β_P = current portfolio beta

β_F = futures beta (beta of stock index)

MV_P = market value of portfolio

F = futures contract value = futures price × multiplier

Variance over the life of the swap:

settlement $amount_T$ = (variance notional)(realized variance − variance strike)

Realized variance:

$R_i = \ln(P_t / P_{t-1})$

$$\text{daily varinace} = \left[\frac{\sum_{i=1}^{N-1} R_i^2}{(N-1)}\right]$$

annualized variance = daily variance × 252; 252 = assumed trading days in a year

Variance notional:

$$\text{variance notional} = \frac{\text{vega notional}}{2 \times \text{strike price (K)}}, \text{ so profit/ (loss)} = \text{N}_{\text{VAR}} \times \left(\sigma^2 - \text{K}^2\right)$$

$$= \text{N}_{\text{VEGA}} \times \left(\frac{\sigma^2 - \text{K}^2}{2\text{K}}\right)$$

$$\text{expected variance to maturity} = \left(\sigma_t^2 \times \frac{t}{T}\right) + \left(K_{(T-t)}^2 \times \frac{T-t}{T}\right)$$

where:
σ_t^2 = annualized realized volatility from initiation to valuation date squared
$K_{(T-t)}^2$ = annualized implied volatility from valuation date to swap maturity squared

Probability of a change in the Fed funds target rate:

$$\text{percent probability of rate change} = \frac{1.8375\% - 1.625\%}{1.875\% - 1.625\%}$$

$$= \frac{1.8375\% - 1.625\%}{0.25\%} = 0.85 = 85\%$$

Note that this can be expressed as

$$\frac{\text{implied Fed funds effective rate} - \text{current target rate}}{\text{expected size of rate change}}$$

Foreign Asset Return and Risk:

$$\text{R}_{\text{DC}} = (1 + \text{R}_{\text{FC}})(1 + \text{R}_{\text{FX}}) - 1 = \text{R}_{\text{FC}} + \text{R}_{\text{FX}} + (\text{R}_{\text{FC}})(\text{R}_{\text{FX}})$$

$$\text{R}_{\text{DC}} \approx \text{R}_{\text{FC}} + \text{R}_{\text{FX}}$$

$$\text{R}_{\text{DC}} = \sum_{\text{i}=1}^{\text{n}} \text{w}_\text{i}(\text{R}_{\text{DC,i}})$$

$$\sigma^2(\text{R}_{\text{DC}}) \approx \sigma^2(\text{R}_{\text{FC}}) + \sigma^2(\text{R}_{\text{FX}}) + 2\sigma(\text{R}_{\text{FC}})\sigma(\text{R}_{\text{FX}})\rho(\text{R}_{\text{FC}},\text{R}_{\text{FX}})$$

$$\sigma(\text{R}_{\text{DC}}) = \sigma(\text{R}_{\text{FX}})(1 + \text{R}_{\text{FC}})$$

where:
R_{FC} = the return on a foreign currency denominated risk-free asset

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