CFA Institute®
CFA Program

ALTERNATIVE INVESTMENTS

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How to Use the CFA Program Curriculum

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

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- Topic area weights that indicate the relative exam weightings of the top-level topic areas (www.cfainstitute.org/en/programs/cfa/curriculum)
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- The CFA Program curriculum that candidates receive access to upon exam registration

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Alternative Investments

LEARNING MODULE

1

Introduction to Commodities and Commodity Derivatives

by David Burkart, CFA, and James Alan Finnegan, CAIA, RMA, CFA.

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LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	compare characteristics of commodity sectors
☐	compare the life cycle of commodity sectors from production through trading or consumption
☐	contrast the valuation of commodities with the valuation of equities and bonds
☐	describe types of participants in commodity futures markets
☐	analyze the relationship between spot prices and futures prices in markets in contango and markets in backwardation
☐	compare theories of commodity futures returns
☐	describe, calculate, and interpret the components of total return for a fully collateralized commodity futures contract
☐	contrast roll return in markets in contango and markets in backwardation
☐	describe how commodity swaps are used to obtain or modify exposure to commodities
☐	describe how the construction of commodity indexes affects index returns

INTRODUCTION

In the upcoming sections, we present the characteristics and valuation of commodities and commodity derivatives. Given that investment in commodities is conducted primarily through futures markets, the concepts and theories behind commodity

futures is a primary focus of the reading. In particular, the relationship between spot and futures prices, as well as the underlying components of futures returns, are key analytical considerations.

What do we mean when we talk about investing in commodities? A basic economic definition is that a commodity is a physical good attributable to a natural resource that is tradable and supplied without substantial differentiation by the general public.

Commodities trade in physical (spot) markets and in futures and forward markets. Spot markets involve the physical transfer of goods between buyers and sellers; prices in these markets reflect current (or very near term) supply and demand conditions. Global commodity futures markets constitute financial exchanges of standardized futures contracts in which a price is established in the market today for the sale of some defined quantity and quality of a commodity at a future date of delivery; completion of the contract may permit cash settlement or require physical delivery.

Commodity futures exchanges allow for risk transfer and provide a valuable price discovery mechanism that reflects the collective views of all market participants with regard to the future supply and demand prospects of a commodity. Given the financial (versus physical) nature of their contract execution, commodity exchanges allow important parties beyond traditional suppliers and buyers—speculators, arbitrageurs, private equity, endowments, and other institutional investors—to participate in these price discovery and risk transfer processes. Standardized contracts and organized exchanges also offer liquidity (i.e., trading volumes) to facilitate closing, reducing, expanding, or opening new hedges or exposures as circumstances change on a daily basis.

Forward markets exist alongside futures markets in certain commodities for use by entities that require customization in contract terms. Forwards are largely outside the scope of this reading and are discussed only briefly. Exposure to commodities is also traded in the swap markets for both speculative and hedging purposes. Investment managers may want to establish swap positions to match certain portfolio needs, whereas producers may want to more precisely adjust their commodity risk (e.g., the origin of their cattle or the chemical specifications of their crude oil).

Commodities offer the potential for diversification benefits in a multi-asset class portfolio because of historically low average return correlation with stocks and bonds. In addition, certain academic studies (e.g., Gorton and Rouwenhorst 2006; Erb and Harvey 2006) demonstrate that some commodities have historically had inflation hedging qualities.

Our coverage of the commodities topic is organized as follows: We provide an overview of physical commodity markets, including the major sectors, their life cycles, and their valuation. We then describe futures market participants, commodity futures pricing, and the analysis of commodity returns, including the concepts of contango and backwardation. The subsequent section reviews the use of swap instruments rather than futures to gain exposure to commodities. We then review the various commodity indexes given their importance as benchmarks for the asset class and investment vehicles. Finally, we conclude with a summary of the major points.

2 COMMODITY SECTORS

☐ compare characteristics of commodity sectors

Commodities are an asset class inherently different from traditional financial assets, such as equities and bonds. These latter assets are securities that are claims on productive capital assets and/or financial assets and thus are expected to generate cash flows for their owners. The intrinsic value of these securities is the present discounted value of their expected future cash flows. Commodities are valued differently. Commodities' value derives from either their use as consumables or as inputs to the production of goods and services. Because a number of commodities need to be processed or have a limited life before spoiling or decaying, an astute analyst will take into account the growth and extraction patterns of the various commodities as well as the logistics associated with transporting these physical goods. Therefore, commodities, while seemingly familiar from everyday life, offer distinct sets of risk exposures for investors.

Fundamental analysis of commodities relies on analyzing supply and demand for each of the products as well as estimating the reaction to the inevitable shocks to their equilibrium or underlying direction. For example, a growing world population demands more crude oil or related products as transportation of goods and people increases. However, technological improvements (e.g., shale drilling or electric vehicles) can disrupt that trend and in the case of armed conflict or adverse weather, for example, may alter it on very short notice! This means that the quantitative analysis of commodities is often imperfect because of high degrees of non-normalcy and shifting correlations. Furthermore, the coefficients to underlying variables are often non-stationary; for example, much corn today is genetically modified to resist heat, rendering drought impact estimates derived from history less predictive. Much of the raw data are held off market by private firms engaged in the commodity industry (such as oil or agricultural companies), which also hinders a purely quantitative approach. Therefore, the framework offered here will be at a high level. We will later provide a breakdown of individual areas for the investor to apply discretionary or quantitative techniques, as circumstances allow. Because the framework can be applied to both supply and demand, we shall set that distinction aside until we focus on individual sectors and commodities. The tools and considerations in fundamental analysis are as follows:

a. Direct announcements: Various government agencies and private companies broadcast production and inventory data that can be used to infer demand, which is often unobservable. Possible public sources include the USDA (US Department of Agriculture), OPEC (Organization of the Petroleum Exporting Countries), the NBS (National Bureau of Statistics of China), and the IEA (International Energy Agency). Setting aside questions of reliability, sometimes estimating current conditions is as straightforward as monitoring official announcements, even with a lag.

b. Component analysis: The more diligent analyst will attempt to break down high-level supply and demand into various components. Applying a stock and flow approach is a logical method. The stock or potential production or demand attempts to set boundaries around what is actually produced or wanted. This can be as general as the amount of arable land in all of Europe or as specific as the current capacity of the Ghawar oil field in Saudi Arabia. The flow considers the utilization of that stock of raw material. Examples include understanding the oil tanker traffic heading to China, estimating the historical yields of US cotton (the amount of fiber per unit of land) in various weather conditions, and estimating the number of piglets per mother hog in Canada.

These examples lend themselves to historical quantitative or conditional analysis. However, care needs to be taken regarding the qualitative aspects of supply and demand; a new policy such as stricter emissions standards

can affect both supply (higher standards often strand lower-quality materials) and demand (not all consumers may be properly equipped to utilize a changing standard). Political unrest may not touch an isolated farm but may disrupt consumption.

c. Timing considerations: Stocks and flows from (b) can be further affected by timing issues—such as seasonality and logistics—and, therefore, price reaction. A shock, by definition, is a sudden timing switch; an earthquake that destroys a pipeline does not affect the stock, but it does halt the flow. A more common consideration is seasonality, such as the growing period for crops and people's demand for winter heat generated from natural gas. This last aspect in particular feeds into the shape of the commodity futures curve, as discussed later.

d. Money flow: Short-term and long-term prices can be affected by sentiment and macro monetary conditions, such as inflation. If investor risk tolerance is particularly high or low, then expecting exaggerated price movements would be rational as fundamental conditions are hyped up or beaten down. Alternatively, capital availability from low interest rates can help trigger the building of new mines and affect future supply. Government subsidies of substitute technologies can limit commodity price appreciation (e.g., available funds for electric cars indirectly affect the price of gasoline).

In summary, although the casual investor can perhaps focus solely on public summary statements, the engaged researcher will apply a framework of examining the stock and flow components and their related timing to better understand and weigh the pressures leading to higher or lower prices.

Commodity Sectors

The world of commodities is relatively broad but can be defined and separated in a reasonable manner. Although there are several ways to segment the asset class by sector, here we use the approach that is the basis for the Bloomberg Commodity Index: energy, grains, industrial (base) metals, livestock, precious metals, and softs (cash crops). This segmentation is more granular than some other indexes but is reasonably consistent with the breakdown in the specialties of most market participants. As noted previously, each sector has a number of individual characteristics that are important in determining the supply and demand for each commodity. A key concept is how easily and cost-effectively the commodity can be produced and stored, as well as such related issues as frequency/timing of consumption, spoilage, insurance, and ease of transportation to consumers. Note that many commodities, such as uranium or water, are traded only in thin, private markets. They are really just individual transactions, as opposed to the markets we are discussing. For the purposes of our coverage, we have to constrain ourselves to primary commodities, recognizing that there are many others that may offer investment opportunities or require hedging. Exhibit 1 reviews each sector and its main characteristics and influences.

Exhibit 1: A Description of Commodity Sectors and Factors

	Energy: Fuel transportation, industrial production, and electrical generation. Primary commodities include crude oil, natural gas, coal, and refined products, such as gasoline and heating oil.	
Primary Influences	Stocks: Discovery and depletion of new fields, economic and political costs/certainty of access to those fields, refinery technology and maintenance, power plant type and construction, economic (GDP) size	Flows: Pipeline and tanker reliability, seasonality (summer/winter), adverse weather (cold, hurricanes), automobile/truck sales, geopolitical instability, environmental requirements, economic (GDP) growth
	Grains: Provide human and animal sustenance but also can be distilled into fuel (e.g., ethanol). Primary commodities include corn, soy, wheat, and rice.	
Primary Influences	Stocks: Arable farmland, storage/port facilities (infrastructure), human and animal population size	Flows: Weather (moisture, temperature), disease, consumer preferences, genetic modification, biofuel substitution, population growth
	Industrial/Base Metals: Materials for durable consumer goods, industry, and construction. Primary commodities include copper, aluminum, nickel, zinc, lead, tin, and iron.	
Primary Influences	Stocks: Mined acreage, smelter capacity, economic (GDP) stage of industrial/consumer development	Flows: Government industrial and environmental policies, economic (GDP) growth, automobile/truck sales, infrastructure investment
	Livestock: Animals raised for human consumption. Primary commodities include hogs, cattle, sheep, and poultry.	
Primary Influences	Stocks: Herd size, processing plant capacity, consumer preferences, feed availability/cost	Flows: Speed of maturation to slaughter weight, economic (GDP) growth/consumer income, disease, adverse weather
	Precious Metals: Certain metals that act as monetary stores of value (as well as industrial uses). Primary commodities include gold, silver, and platinum.	
Primary Influences	Stocks: Mined acreage, smelter capacity, fiat money supply/banking development	Flows: Central bank monetary policy, geopolitics, economic (GDP) growth
	Softs (Cash Crops): Crops sold for income—as opposed to consumed for subsistence—and often originally seen as luxuries. Primary commodities include cotton, cocoa, sugar, and coffee.	
Primary Influences	Stocks: Arable farmland, storage/port facilities (infrastructure), economic (GDP) size	Flows: Weather (moisture, temperature), disease, consumer preferences, biofuel substitution, economic (GDP) growth/consumer income

As noted in this section, each commodity sector is unique in its fundamental drivers but with the overlapping context of economic and monetary data. With this context in mind, we will now examine the life cycle of the sectors from production to consumption—and their interaction—in more detail.

EXAMPLE 1

Commodity Sector Demand

1. Industrial activity *most likely* affects the demand for which of the following commodities?

   A. Copper

   B. Natural gas

   C. Softs (e.g., cotton, coffee, sugar and cocoa)

Solution:

A is correct. Copper is used for construction, infrastructure development, and the manufacture of durable goods, all of which are economically sensitive. B is incorrect because demand for natural gas is driven primarily by weather conditions (heating or cooling) and only secondarily by industrial activity. C is incorrect because demand for softs is driven primarily by global income.

EXAMPLE 2

Commodity Sector Risks

1. Which of the following commodity sectors are *least* affected in the short term by weather-related risks?

   A. Energy

   B. Livestock

   C. Precious metals

Solution:

C is correct. Weather has very little impact on the availability of precious metals given their ease of storage. Inflation expectations, fund flows, and industrial production are more important factors. A is incorrect because energy demand is strongly influenced by weather (e.g., heating demand in the winter or transportation demand in the summer). B is incorrect because the health of livestock is vulnerable to unfavorable weather conditions increasing the risks of death and disease by extreme cold, wet, and heat.

3 LIFE CYCLE OF COMMODITIES

☐ compare the life cycle of commodity sectors from production through trading or consumption

The life cycle of commodities varies considerably depending on the economic, technical, and structural (i.e., industry, value chain) profile of each commodity, as well as the sector. Conceptually, the commodity production life cycle reflects and amplifies the changes in storage, weather, and political/economic events that shift supply and

demand. Recall from the earlier discussion that timing/seasonality is, in effect, an overlay on top of the underlying supply/demand factors. A short life cycle allows for relatively rapid adjustment to outside events, whereas a long life cycle generally limits the ability of supply or demand to react to new conditions. These shifts, in turn, feed into the economics for the valuation and shape of the commodity supply and demand curves, plus their respective price elasticities of demand and supply. Understanding the life cycle builds understanding of, and ideally ability to forecast, what drives market actions and commodity returns.

Among the food commodities, agriculture and livestock have well-defined seasons and growth cycles that are specific to geographic regions. For example, by March of each year, corn planting may be finished in the southern United States but not yet started in Canada. Meanwhile, the corn harvest may be underway in Brazil and Argentina given their reverse seasonal cycle in the Southern Hemisphere. Each geographic location also represents local markets that have different domestic and export demand. These differences affect the nature (level and reliability) of demand and the power of buyers to extend or contract the life cycle.

In comparison, commodities in the energy and metals sectors are extracted all year round. Their life cycle changes are generally at the margin of a continuous process, as opposed to being centered at a discrete time or season. But the products from crude oil and metal ore have seasonal demands depending on weather (e.g., gasoline demand in the summer and heating oil demand in the winter) that affect the life cycle and usage of the underlying commodity. And with all the differences between the varieties even within the same sector, the life cycles depicted have to be representative and selective. The life cycles of several key commodity sectors are as follows.

Energy

For an example of the differences within a sector, one need look no further than energy. Natural gas can be consumed almost immediately after extraction from the ground. Crude oil, in contrast, has to be transformed into something else; crude is useless in its innate form. The refined products (e.g., gasoline and heating oil), in turn, have a number of potential processing steps depending on the quality of crude oil input and the relative demand for the various products. The steps for the energy complex can be summarized as shown in Exhibit 2.

Exhibit 2: Steps for the Energy Complex

Step	Title	Description
1.	Extraction	A drilling location is selected after surveys, and the well is dug. Enough underground pressure for the hydrocarbons to come out naturally may exist, or water or other tools may be required to create such pressure. Water is also used for the fracturing process known as "fracking," which breaks up shale formations to allow for oil or gas to be extracted.
2.	Storage	After extraction, crude oil is commercially stored for a few months on average in the United States, Singapore, and northern Europe and is strategically stored by many countries. In addition, oil may temporarily be stored on tanker ships. Natural gas may be delivered directly to the end consumer. Summer-extracted natural gas is often injected into storage for the winter months.
3.	Consumption Stage	Only natural gas is consumed at this stage because it does not need to be refined. Crude oil requires further processing.

Step	Title	Description
4.	Refining	Crude oil is distilled into its component parts via a process called "cracking." Heat is used to successively boil off the components that are, in turn, cooled down and collected (e.g., gasoline, kerosene), until only the remnants (e.g., asphalt) are left.
5.	Consumption Stage	The distilled products are separated and shipped to their various locations—by ship, pipe, train, or truck—for use by the end consumer.

Sources: Based on information from www.eia.gov/energyexplained/index.php?page=oil_refining#tab1, https://en.wikipedia.org/wiki/Petroleum_refining_processes (accessed 23 April 2019), and authors' research.

Refineries are extraordinarily expensive to build—typically costing several billion US dollars—depending on the processes required to purify and distill the oil. Part of the cost depends on the expected specifications of the crude oil input. Generally speaking, a low-grade, high sulfur source would require more investment than one with an assured lighter, "sweeter" source. Pipelines are also very costly: For example, the Keystone XL pipeline expansion between Canada and the United States was originally estimated to cost $5 billion in 2010, but the estimate was doubled to $10 billion in 2014. Even in countries dealing with violent insurrections (e.g., Libya, Iraq, Nigeria), damage to refineries has been generally modest because of their value to all parties. Pipelines, however, are often destroyed or cut off. Although these costs may appear staggering, they actually pale in comparison with the costs (and risks) of oil exploration, especially in deep offshore locations or geographically remote (or geopolitically risky) regions.

The crude oil market has a number of futures contracts and indexes that follow local grades and origins, but the two most commonly traded set of contracts follow the US-based crude oil (West Texas Intermediate, or WTI, crude oil) and the UK-located Brent crude oil from the North Sea. Likewise, there are futures for natural gas, gasoil, gasoline, and heating oil. Each has different delivery locations and standards, but the WTI and Brent contracts represent a high-quality refinery input that exploration and production companies can use as a hedging device.

EXAMPLE 3

Energy Life Cycle

1. Which of the following is a primary difference in the production life cycle between crude oil and natural gas?

   A. Only crude oil needs to be stored.

   B. European companies are the only ones that store crude oil.

   C. Natural gas requires very little additional processing after extraction compared with crude oil.

Solution:

C is correct. Natural gas can be used after it is extracted from the ground upon delivery, but crude oil must first be processed for later use. A is incorrect because both oil and natural gas are stored before usage. B is incorrect because many countries around the world store crude oil, both commercially and strategically.

Industrial/Precious Metals

The life cycle of both precious and industrial metals is probably the most flexible because the ore, as well as the finished products, can be stored for months (if not years) given the relative resistance to spoilage of metals (assuming proper storage). Otherwise, the life cycle parallels the energy one outlined previously, as shown in Exhibit 3.

Exhibit 3: Copper Purification Process

	Step Name	Description
1.	Extracting and Preparing	Ore (raw earth with ~2% metal content) is removed via a mine or open pit. Ore is then ground into powder and concentrated to roughly 25% purity.
2.	Smelting	The purified ore is heated, and more impurities are removed as slag, increasing the metal content to 60%. Further processes increase the concentration to 99.99%.
3.	Storage/Logistics	The purified metal is held typically in a bonded warehouse until it is shipped to an end user.

Sources: Based on information from http://resources.schoolscience.co.uk/CDA/14-16/cumining/copch2pg1.html (accessed 23 April 2019), www.madehow.com/Volume-4/Copper.html (accessed 23 April 2019), and authors' research.

Similar to refining crude oil, creating the economies of scale involved in the smelter and ore processing plants is critical. These are huge facilities for which marginal costs (i.e., the cost to convert the last pound or kilogram of processed ore into a useful metal) decline substantially with both the scale of the facility and its utilization (output as a percentage of capacity). As a result, when supply exceeds demand for a given industrial metal, it is difficult for suppliers to either cut back production or halt it entirely. Overproduction often continues until smaller or financially weaker competitors are forced to shut down. Because demand for industrial metals fluctuates with overall economic growth, as was discussed previously, there are substantial incentives for metals producers to invest in new capacity when their utilization (and profit) is high but huge economic and financial penalties for operating these facilities when demand falls off during an economic downturn. Ironically, given the typical economic cycle and the time lag involved after deciding to expand capacity, new supply often arrives just as demand is declining—which exacerbates pricing and profit declines.

With the lack of annual seasonality in the production of metals and ease of storage without spoilage, much of time variability comes from the demand side of the equation (e.g., construction and economic growth).

EXAMPLE 4

Industrial Metals Life Cycle

1. Because of large economies of scale for processing industrial metals, producers:
   - **A.** immediately shut down new capacity when supply exceeds demand.
   - **B.** have an incentive to maintain maximum operating production levels when demand declines.
   - **C.** find it difficult to cut back production or capacity even when supply exceeds demand or demand slows.

Solution:

C is correct. Given the sizable facilities in which metals are produced and their capital requirements, reducing capacity is difficult when demand slows. A is incorrect because of the time lag involved in responding to reduced demand conditions. B is incorrect because producers would face financial losses if they maintained maximum production levels when there is a decline in demand.

Livestock

Livestock grows year round, but good weather and access to high-quality pasture and feed accelerate weight gain. As a result, there is fluctuation in the availability of animals ready for slaughter. The timing to maturity typically increases with size, with poultry maturing in a matter of weeks, hogs in months, and cattle in a few years. Taking the example of a hog, the life cycle begins with a sow (female hog) giving birth. Normally it takes about six months to raise a piglet to slaughter weight, and during that time it can be fed almost anything to get it up to proper bulk. In mass-scale production, soymeal and cornmeal are the most common foods. In contrast, cattle take longer to raise. For mass-scale breeding, the first one to two years are spent as "feeder cattle," first eating a grass diet in pasture. The next phase covers an additional 6–12 months whereby cattle are in a feed lot being fattened to slaughter weight, generally on a corn-based diet. Note that the various types of feed for these animals are other traded commodities.

The livestock industry in the United States has historically been among the least export-oriented of all the commodities because of the high risk of spoilage once an animal is slaughtered. However, advances in cryogenics (freezing) technologies with regard to chicken, beef, and pork mean that increasingly these products are moving from one part of the world to another in response to differences in production costs and demand. And as emerging and frontier market countries develop middle class consumers capable of purchasing meat protein as a regular part of their diet, there has been increased investment in the livestock and meatpacking industries in such countries as the United States and Brazil. These industries combine low-cost sources of animal feed, large grazing acreage, and strong domestic demand (leading to facilities with substantial economies of scale) as key export points to supply global demand.

Ranchers and slaughterhouses trade hog and cattle futures to hedge against their commitments. Ranchers can hedge both young cattle that are still in pasture (called feeder cattle) and animals being fattened for butchering (called live cattle).

EXAMPLE 5

Livestock Life Cycle

1. The US livestock sector has been among the least export-oriented commodity sectors because of:
   - **A.** low technological innovation in the sector.
   - **B.** high risk of spoilage once animals are slaughtered.
   - **C.** little or no demand for US livestock from outside the United States.

Solution:

B is correct. Livestock incur a high risk of spoilage once they are slaughtered unless the meat is frozen. A is incorrect because advances in cryogenics have improved the ability to export from the United States. C is incorrect because demand for US livestock has expanded internationally, particularly in emerging market countries that are experiencing economic growth.

Grains

Grains in the Northern Hemisphere follow a similar growth cycle, with an analogous but opposite growth cycle in the Southern Hemisphere. Plants mature according to the following steps: (1) planting (placing the seeds in the ground after preparation/fertilization work); (2) growth (the emerging of the seedling to full height); (3) pod/ear/head formation (the food grain is created by the plant); and (4) harvest (the collection of the grain by the farmer). The timing in North America is shown in Exhibit 4 to illustrate the time it takes to grow each crop.

Exhibit 4: Timing for Grain Production in North America

	Corn	Soybeans	Wheat*
Planting	April–May	May–June	Sep.–Oct.
Growth	June–Aug.	July–Aug.	Nov.–March
Pod/Ear/Head Formation	Aug.–Sep.	Sep.	April–May
Harvest	Sep.–Nov.	Sep.–Oct.	June–July

** The hard winter wheat variety, which has a higher protein content, is used here.*
Source: Authors' research.

Because demand for grains is year round, they are regularly stored in silos and warehouses globally. Some countries have a central purchasing bureau, and others depend on local or international trading companies to maintain stockpiles. Poor hygienic standards and logistics can result in a substantial loss of value to grains due to mold or insect/animal infestation. Monitoring the purchasing patterns of these government tenders can assist a research analyst in determining grain demand.

Farmers and consumers can trade futures to hedge their exposure to the crop in question, and the contract delivery months reflect the different times of the growing cycle outlined earlier. Ranchers also can use grain futures to hedge against the cost of feeding an animal.

Softs

Coffee, cocoa, cotton, and sugar are very different soft commodities in this sector, so we will focus on one that is grown and enjoyed broadly—coffee. Coffee is harvested somewhere all year round in the various countries that circle the Equator. After the coffee cherries are picked (still often by hand, to ensure that only ripe ones are taken), the husk and fruit are removed and the remaining bean dried. More than half of coffee uses the dry method in which the harvested cherries are laid out in the sun for two to three weeks. The wet method uses fresh water to soak the cherries, the soft pulp is removed, the bean is fermented for 12–48 hours, and then the bean is dried. The "green" beans are then hulled, sorted, and bagged for their final markets. With most of the consumption in faraway foreign markets, ships are commonly used to

transport the beans to their buyer, which may store them in a bonded warehouse. The local buyer roasts the beans and ships them to the retail location (e.g., coffee house or supermarket) for purchase or brewing.

Coffee comes in two main varieties, robusta and arabica, although there are many others. Generally speaking, robusta beans are lower quality with less flavor than the arabica. There are two futures contracts associated with coffee: The robusta variety is traded in London, and the arabica variety is traded in New York. Note that the contracts are for the unroasted or "green" beans. The physical delivery aspect of these contracts allows for sellers to deliver the beans to an authorized bonded warehouse as fulfillment of the contract at expiration. Therefore, farmers and distributors can sell futures contracts to hedge the sales price of production, and coffee roasters can buy futures contracts to hedge coffee bean purchase costs; contract maturities can be selected by each to match their product delivery schedules.

4 VALUATION OF COMMODITIES

☐ contrast the valuation of commodities with the valuation of equities and bonds

The valuation of commodities compared with that of equities and bonds can be summarized by the fact that stocks and bonds represent financial assets and are claims on the economic output of a business, a government, or an individual. Commodities, however, are almost always physical assets. We say "almost always" because some newer classes of commodities, such as electricity or weather, are not physical assets in the sense that you can touch or store them.

Commodities are typically tangible items with an intrinsic (but variable) economic value (e.g., a nugget of gold, a pile of coal, a bushel of corn). They do not generate future cash flows beyond what can be realized through their purchase and sale. In addition, the standard financial instruments that are based on commodities are not financial assets (like a stock or bond) but are derivative contracts with finite lifetimes, such as futures contracts. As with other types of derivatives, commodity derivative contracts can and do have value, but they are contingent on some other factors, such as the price of the underlying commodity. Hence, the valuation of commodities is based not on the estimation of future profitability and cash flows but on a discounted forecast of future possible prices based on such factors as the supply and demand of the physical item or the expected volatility of future prices. On the one hand, this forecast may be quite formal and elaborately estimated by a producer or consumer. One can imagine the detailed inputs available to an oil company based on the labor and capital expenses needed to extract oil, refine it, and transport it to final sale as gasoline in your automobile. On the other hand, this forecast may be instinctively made by a floor trader with little fundamental analysis but instead with professional judgment based on years of experience and perhaps some technical analysis.

As opposed to a stock or bond that receives periodic income, owning a commodity incurs transportation and storage costs. These ongoing expenditures affect the shape of the forward price curve of the commodity derivative contracts with different expiration dates. If storage and transportation costs are substantial, the prices for a commodity futures contract will likely be incrementally higher as one looks farther into the future. However, sometimes the current demand for the commodity can move the spot price higher than the futures price. The spot price reflects the fact that, instead of going long a futures contract, one could buy the commodity today and store it until a future

date for use. The expenditure would be the outlay/investment at today's spot price for the commodity along with (or net of) the future costs one would incur to store and hold it. This time element of commodity storage and supply and demand can generate "roll return" and affect investment returns. These and other factors figure into the assessment of futures pricing, which we will cover later.

Some commodity contracts require actual delivery of the physical commodity at the end of the contract versus settlement in a cash payment (based on the difference between the contract futures price and the spot price prevailing at the time of contract expiration). The force of arbitrage—which reflects the law of one price—may not be entirely enforced by arbitrageurs because some participants do not have the ability to make or take delivery of the physical commodity. In these situations, the relationships that link spot and futures prices are not an equality but are a range that only indicates the limit or boundary of value differences that can occur.

There is an important additional consideration concerning the link between spot and futures prices in commodities. Some of the largest users of commodity futures are businesses seeking to hedge price risk when that price is a critical source of either revenue or cost in their business operations. For example, the airline industry is very dependent on the cost of jet fuel for operating planes. The highly competitive nature of the industry results in tremendous price pressure on airfares, with a need for airlines to fill each flight with as many passengers as possible. The futures and swap markets for jet fuel allow airlines to lower the risk of higher fuel costs by hedging the price of future fuel purchases (particularly against surprise shocks in oil prices).

In addition, the price discovery process of the commodity futures markets provides airlines with insights about future fuel prices that help determine what prices to offer their customers for future flights while still making a profit. In fact, airline ticket sales are—in effect—selling a contract at a price set today for future delivery of a service—namely, a plane flight. In this case, the airlines will typically hedge their price risk and uncertainty about future fuel costs by purchasing ("going long") energy futures contracts.

EXAMPLE 6

Commodities versus Stocks and Bonds

1. In contrast to financial assets, such as stocks and bonds:

   A. commodities are always physical goods.

   B. commodities generate periodic cash flows.

   C. commodity investment is primarily via derivatives.

Solution:

C is correct. The most common way to invest in commodities is via derivatives. A is incorrect because although most commodities are physical goods, certain newer classes, such as electricity or weather, are not tangible. B is incorrect because commodities may incur, rather than generate, periodic cash flow through transportation and storage costs (when the commodities are physically owned).

EXAMPLE 7

Spot Commodity Valuation

1. What is a key distinction between the valuation of commodities compared with the valuation of stocks and bonds?

   A. Valuation of commodities cannot be conducted using technical analysis.

   B. Valuation of commodities focuses on supply and demand, whereas valuation of stocks and bonds focuses on discounted cash flows.

   C. Valuation of stocks and bonds focuses on future supply and demand, whereas commodity valuation focuses on future profit margins and cash flow.

Solution:

B is correct. The valuation of commodities is based on a forecast of future prices based on supply and demand factors, as well as expected price volatility. In contrast, the valuation of stocks and bonds is based on estimating future profitability and/or cash flow. A is incorrect because technical analysis is sometimes applied to valuing commodities. C is incorrect for the reasons stated for choice B.

5 COMMODITIES FUTURES MARKETS: PARTICIPANTS

☐ describe types of participants in commodity futures markets

Public commodity markets are structured as futures markets—that is, as a central exchange where participants trade standardized contracts to make and take delivery at a specified place at a specified future time. As mentioned, futures contracts are derivatives because the value of the contract is derived from another asset. Both futures and forward contracts are binding agreements that establish a price today for delivery of a commodity in the future (or settlement of the contract in cash at expiration). As mentioned at the beginning of the reading, the focus of this reading is on futures, with forwards discussed only briefly.

Futures Market Participants

The key differences between futures and forward contracts is that futures contracts are standardized agreements traded on public exchanges, such as the Chicago Mercantile Exchange (CME), Intercontinental Exchange (ICE), and the Shanghai Futures Exchange (SHFE), and gains/losses are marked to market every day. Standardization allows a participant to enter into a contract without ever knowing who the counterparty is. In addition, the exchange oversees trading and margin requirements and provides some degree of self-imposed regulatory oversight. In contrast, forward contracts are commonly bilateral agreements between a known party that wants to go long and one that wants to go short. Because of their bilateral nature, forwards are considered to be OTC (over the counter) contracts with less regulatory oversight and much more customization to the specific needs of the hedging (or speculating) party. Often, the

counterparty for a forward contract is a financial institution that is providing liquidity or customization in exchange for a fee. Although futures markets require that daily cash movements in the futures price be paid from the losing positions to the winning positions, forward contracts are usually only settled upon expiration or with some custom frequency dictated by the contract.

Early commodity exchanges operated as forward markets, but too often participants would go bankrupt when unrealized losses became realized at the end of the contract. The futures process was introduced to minimize this risk, with the exchange acting as payment guarantor. The first modern organized futures exchange was the Dojima Rice Exchange in Osaka, Japan, which was founded in 1710, although futures contracts were traded in England during the 16th century. The structure of futures markets is important to understand as a way of understanding the goals and roles of the various participants. When we consider any commodity, for every producer of that commodity there is a consumer. Thus, for participants who are long the physical commodity and want to sell it, there are also participants who are short the physical commodity and want to buy it. Therefore, for fairness between the two sets of participants, longs and shorts need to operate on an equal basis. As a coincident observation, the commodity markets are net zero in terms of aggregate futures positions (futures contract longs equal futures contract shorts). In contrast, in markets for stocks and bonds, there is a net long position because the issued stocks' and bonds' market values are equal to the net aggregate positions at the end of each day. Shorting an equity is constrained by the short seller's need to locate shares to short, the requirement to reimburse dividends on borrowed shares, and requirements to post and pay interest on margin that generally exceeds the margin required for long equity positions (as in the United States under Regulation T). In contrast, shorting commodity futures is much simpler, with short investors selling to long investors directly, and thus short investors post the same margin required of long investors.

There are a number of participants in commodity futures markets. First are *hedgers*, who trade in the markets to hedge their exposures related to the commodity. The second are long-term and short-term *traders* and *investors* (including index investors), who speculate on market direction or volatility and provide liquidity and price discovery for the markets in exchange for the expectation of making a profit. Third are the *exchanges* (or clearing houses), which set trading rules and provide the infrastructure of transmitting prices and payments. Fourth are *analysts*, who use the exchange information for non-trading purposes, such as evaluating commodity businesses, creating products that are based on commodity futures (e.g., exchange-traded funds, swaps, and notes), and making public policy decisions. Analysts also include brokers and other financial intermediaries who participate in the markets but do not take a position. Finally, *regulators* of both the exchange and traders exist to monitor and police the markets, investigate malfeasance, and provide a venue for complaints.

Commodity Hedgers

Hedgers tend to be knowledgeable market participants: One would expect that a company that drills for oil knows something about the supply and demand for oil and related forms of energy (at least in the long run). However, hedgers may not be accurate predictors of the future supply and demand for their product. Consider a baker who buys wheat for future delivery and benefits from a surprise drought (has locked in a low price in a supply-constrained market). However, the baker is hurt if the weather is beneficial (has effectively overpaid during a bumper crop). Given that a hedger can make delivery (if short the futures contract) or take delivery (if long the futures contract), he or she is generally motivated by risk mitigation with regard to cash flow, so the risk is more of an opportunity cost than an actual one.