

## LM01 Introduction to Commodity and Commodity Derivatives

### Characteristics of commodity sectors

The following table summarizes the characteristics of six important commodity sectors:

Sector	Description	Storage/ Transport	Supply	Demand
Energy	Crude oil, refined products, natural gas	Natural storage, pipes, ships	Political events, new technologies	Economic growth
Grains	Corn, wheat, rice, soy; seasons	Easy	Weather, disease, pests	Humans, animal feed, fuel
Industrial metals	Copper, aluminum, nickel, zinc, lead, tin, iron	Storage easy; transport can be expensive	Not impacted by weather	Industrial growth
Livestock	Poultry, sheep, cattle, hogs	Linked to grain costs	Grain costs, weather, disease	Emerging markets
Precious metals	Gold, silver, platinum	Easy	Not impacted by weather	Inflation, technology, jewelry
Softs (cash crops)	Cotton, coffee, sugar, cocoa	Difficult - freshness is important	Weather	Wealth, emerging markets

### Commodity sectors life cycle

The following table summarizes the life cycle for six important commodity sectors (Copper is used as an example for industrial metals; and coffee is used as an example for cash crops):

Commodity	Steps	Seasons	Considerations	Contracts
Crude oil	Input-output production life cycle: extraction, transportation, storage, trading, refining, transportation and trading	Extracted year round; seasonal demand based on weather.	Refineries and pipelines are very expensive to build but these costs are much lower than the cost of exploration.	Futures contracts and indexes which follow local grades and origins.

Natural gas	Straight-through consumption: extraction, transportation, storage, trading			
Copper	Input-output production life cycle: extract, grind, concentrate, roast, smelt, convert, refine, store and transport	Extracted year round.	Economies of scale; difficult to reduce supply when demand is low.	Futures contracts come due every month of the year.
Livestock	Time to maturity increases with size Cattle: birth, feeder cattle, live cattle, slaughter.	Growth is year-round; weight gain is influenced by weather and pastures.	Historically US livestock exports are low because of high risk of spoilage; now this risk is lower because of advances in cryogenics.	Ranchers and slaughterhouses trade futures to hedge exposure.
Grains	Planting, growth, pod/ear/head formation, harvest.	Well defined seasons and growth cycles. Demand is year-round.	Stored in silos and warehouses.	Farmers and consumers trade futures to hedge exposure.
Coffee	Harvested somewhere year-round. Cycle: Plant, three to four years to bear fruit (cherry), harvesting is done by hand in multiple sweeps, two to three weeks to dry, hulled, sorted and bagged for final market. Local buyer roasts and ships to retail location.		Two major varieties: robusta and arabica. Brazil produces both.	Two futures contracts: robusta in London and arabica in New York.

### Valuation of commodities

- Stocks and bonds are financial assets that represent claims against future cash flows. They are generally priced based on the present value of cash flows.
- On the other hand, commodities generally do not generate a stream of cash flows, therefore their valuation cannot be done on the basis of cash flows. Instead, the value of a commodity is the discounted value of a future price. The future price depends on

factors such as supply, demand and expected volatility.

- Investment in commodities is primarily done via derivative instruments such as futures contracts. The price of commodity futures contracts is based on the current spot price as well as the transportation and storage cost of holding a commodity.
- Future contracts can either be cash settled or require physical delivery. Market participants may not always have the ability to make or take physical delivery, and this factor can affect future prices.
- Hedgers can also impact futures prices as they regularly trade in order to hedge their commodity exposures.

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### Futures market participants

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Commodity market participants include:

- **Hedgers** – want to hedge their exposure to a commodity.
- **Traders and investors**
  - **Informed investors** – take advantage of mispricing due to a lack of information in the market place.
  - **Liquidity providers** - trade with hedgers and effectively provide insurance services.
  - **Arbitrageurs** – seek to profit from mispricing between the futures price and spot price.
- **Commodity exchanges** - determine contracts, rules and procedures for commodity trading and act to ensure that market participants fulfill obligations.
- **Commodity market analysts** - perform research and analysis on commodities and recommend investment positions.
- **Commodity regulators** – responsible for regulation of commodity markets.

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### Spot and futures pricing

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**Spot price** is the current price of a commodity for immediate delivery at a specific location. Spot prices vary across different regions based on quality and local supply demand factors.

**Futures price** is the price for future delivery of a commodity of a specific quality at a specific location.

The difference between the spot price and futures price is called '**basis**'.

- When spot price is higher than futures price, the market is in **backwardation** and basis is positive.
- When the spot price is lower than the futures price, the market is in **contango** and basis is negative.

The price difference between two contracts of different maturities is called the '**calendar**'

**spread'.**

- Calendar spread = Price of contract maturing earlier - Price of contract maturing later.
- Calendar spread is positive when the futures market is in backwardation and negative when the futures market is in contango.

Commodity futures contracts can be either cash settled or require physical delivery.

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### Theories explaining futures returns

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There are three theories of commodity futures returns:

1. **Insurance theory:** Commodity producers sell the commodity in futures market in order to make their revenues predictable. This implies that the futures price must be less than the spot price as a payment to the speculator for providing insurance to the producer.
2. **Hedging pressure hypothesis:** Producers and consumers sell and buy (respectively) in the futures market in order to remove price uncertainty. The number of sellers as against the number of buyers would determine whether the futures market would be in contango or backwardation.
3. **Theory of storage:** Commodity futures prices are affected by the costs of storage and convenience yield. Convenience yield is inversely related to general availability of the commodity. Futures price = Spot price + Direct Storage costs - Convenience yield

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### Components of futures returns

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The total return of a fully collateralized commodity futures contract is made up of:

1. **Price return** is produced by a change in spot prices.  

$$\text{Price return} = (\text{Current spot price} - \text{Previous spot price}) / \text{Previous spot price}$$

2. **Roll return** is produced by closing expiring contracts and reestablishing the position in far-dated contracts.

Roll return is sector dependent, it is positive when futures markets are in backwardation and negative when futures markets are in contango.

Roll return can be significant for a single period but is a small percentage of total return over multiple periods.

$$\text{Gross roll return} = (\text{Near-term contract closing price} - \text{Farther-term contract closing price}) / \text{Near-term futures contract closing price.}$$

$$\text{Net roll return} = \text{Gross roll return} \times \text{Percentage of the position in the futures contract being rolled.}$$

3. **Collateral return** is the yield on securities that the investor deposits as collateral to establish the futures position.

Collateral return = Risk free rate return

Total return = price return + roll return + collateral return.

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## Commodity swaps

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A commodity swap is a legal contract involving the exchange of payments over multiple dates as determined by specified reference prices or indexes relating to commodities. Swaps offer the participant greater customization relative to a futures contract. They also offer the advantage of providing the participant with a series of futures contracts without him having to actually manage multiple contracts.

### Types of swaps:

- **Excess return:** party pays a premium and receives excess return over a strike price.
- **Total return:** party receives total return on a commodity or index.
- **Basis:** payments are based on two related commodity reference prices.
- **Variance:** variance buyer benefits if actual variance is higher than stated variance and the direction of price move matters.
- **Volatility:** similar to variance swap except based on volatility and the direction of price moves does not matter.

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## Commodity indexes - Key characteristics

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Commodity indexes portray the aggregate movement of a basket of commodities. Key characteristics of a commodity index include:

- **Breadth of coverage** - Number of commodities and sectors included in the index.
- **Weights** - Relative weights assigned to each commodity and the methodology for determining these weights.
  - **Production weighted:** a commodity sector's weight is based on the level of production or economic value of that sector. There could be a cap or floor on the weight of a particular sector or commodity. In an upward trending market production value weighted indexes will outperform.
  - **Equal weighted:** all sectors have the same weight.
  - **Liquidity weighted:** liquidity can also be considered in allocating the weight of a sector.
- **Rolling methodology:** determining how contracts that are about to expire will be rolled over into future months.
  - A passive roll methodology typically involves owning 'front contracts'.
  - An active roll methodology would try to maximize roll yield.
- **Rebalancing methodology:** the methodology and frequency of rebalancing the weights of individual commodities, sectors and contracts in the index.
- **Governance:** The process by which above mentioned characteristics are

implemented.

In general, commodity indexes have a low correlation with traditional asset classes such as stocks and bonds. However, the correlation across different commodity indexes (or futures indexes) tends to be high.