Forwards Contracts vs. Futures Contracts
The Mechanics of Marking-to-Market
Term Structure of Forward Prices on Commodities
Returns on Forward Contracts

ECO-6004B Economics of Alternative Investments
Lecture 03: Future Pricing and Trading.

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$2019 - 2020$

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The Road-map of the module

- **Week 01:** An introduction to Alternative Investments.

- **Week 02:** Measures of Risk and Performance.

- **Weeks 03–04: Managed futures portfolio trading strategies.**

- **Weeks 05–06:** Real Estate.

- **Week 07:** Hedge Fund Investment Program.

- **Week 08:** Private Equity.

- **Week 09:** Investment in Structured Products.

- **Week 10:** Dynamic Portfolio Management.

- **Week 11:** Module Review.

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Readings for Lecture 03

- Alternative Investments - CAIA Level I.

    Chapter 11: Commodity Forward Pricing.

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Outline of Lecture 03

- Forwards Contracts vs. Futures Contracts.

- The Mechanics of Marking-to-Market.

- Term Structures of Forward Prices on Commodities.

- Returns on Forward Contracts.

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What is a derivative?

A derivative can be defined as a financial instrument whose value depends on (or derives from) the value of other **underlying variables**:
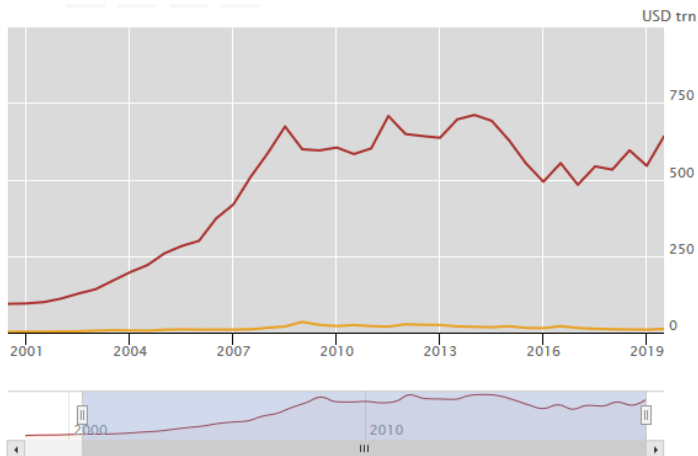
- The variables underlying derivatives are often the prices of traded assets.

- They are contracts which give the right and sometimes the obligation to buy or sell a quantity of the underlying asset.

The main types of derivatives are: forwards, futures, swaps and options.

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Hedging

- Financial derivatives allow investors to **hedge**, i.e. to reduce or eliminate risk.

- **Hedging risk** involves engaging in a financial transaction that offsets a long position by taking an additional short position, or offsets a short position by taking an additional long position.

  - Long position: when an institution has bought an asset.
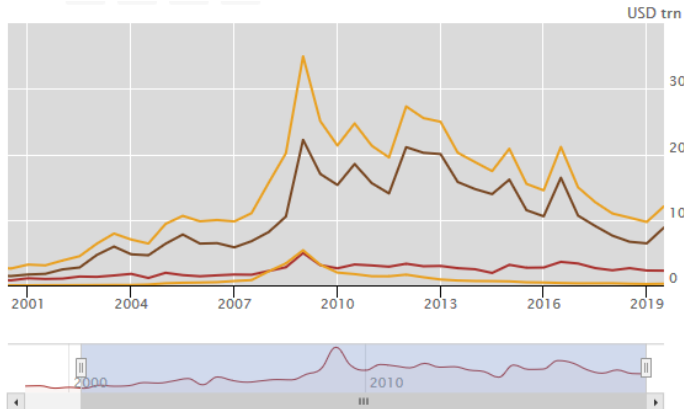
  - Short position: if it has sold an asset.

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Notional value of derivatives

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Market value of derivatives

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Forwards and Futures Contracts

- Both **forward** and **futures** contracts are **binding agreements** to buy or sell an asset for a certain price at a certain future date.

- Forward and future contracts:

- The price fixed now for future exchange is the **delivery price**.

- The buyer of the underlying is said to be "long" the forward (futures), the seller is said to be "short" the forward (futures).

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Forwards vs Futures Contracts

Forward

- trade in over-the-counter (OTC) markets;
- non-standardised;
- usually one specified delivery date;
- settled at the end of contract;
- usually delivery of the underlying asset takes place;
- some credit risk.

Future

- trade in exchanges;
- standardised;
- a range of delivery dates;
- gains/losses are settled daily (**marking-to-market**);
- usually the contract is reversed before the maturity date;
- Lower credit risk (guaranteed by the clearing house).

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Example

Suppose that the sterling exchange rate for a 90–day forward (and futures) contracts is 1.5000.

Trader A in the US is long £1 million in a 90–day forward contract and trader B is long £1 million in 90–day futures contracts. Each futures contract is for the purchase or sale of £62,500.

What is the difference between the gain and loss under the two contracts assuming that the spot exchange rate in 90 days is 1.7000?

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Trader A earns $200,000 on the 90th day.

Trader B makes the same gain, but spread out over 90–day period. On some days trader B may realise a loss, whereas on other days a gain.

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Another example

FX Rate Quotes for USD/GBP August 24, 2011.

	Bid	Offer
Spot	1.6398	1.6402
1–month forward	1.6392	1.6397
3–month forward	1.6382	1.6387
1–year forward	1.6328	1.6334

Forward

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The Mechanics of Marking-to-Market

Futures exchanges mark contracts to market at the end of each trading day.

- Net gains/losses on a contract are credited/debited to the trader's **margin account**.

- Movements on futures contracts are realised on a daily basis.

- Marking to market reduces the probability that participants may default.

Since forwards are not exchange traded, they are not marked to market each day.

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Example

Futures contracts on crude oil are often denominated in 1,000–barrel sizes.

At the delivery date of the futures contract, the short side is obligated to deliver to the long side 1,000 barrels of oil using stated delivery methods.

Assume that a trader establishes a long position of 5 contracts in crude oil futures at a futures price of \$100 per barrel. Both traders on the long side and the short side of the contract post collateral of, say, \$10 per barrel. This collateral is referred to as margin.

Suppose, at the end of the day, the price of the futures contract falls to \$99 per barrel. How much cash will each side of the contract have at the end of the day?

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Solution

The 5 contracts call for delivery of

$$5 \, \text{contracts} \cdot 1,000 \, \text{barrels} = 5,000 \, \text{barrels}$$

Each side of the contract initially posts margin of

$$\text{Initial margin} = 5,000 \, \text{barrels} \cdot \$10 \, \text{per barrel} = \$50,000$$

The long side of the contract loses \$5,000 as a result of the decline in price of \$1 per barrel, and the short side gains \$5,000.

Therefore, the long side has an updated collateral position of \$45,000. The short side has \$55,000.

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Initial Margin

Initial margin is the amount that must be deposited at the time the contract is entered.

The initial margin protects the trader with the winning position, who is exposed to the credit risk of being owed money from the losing position.

The investor is entitled to withdraw any balance in the margin account in excess of the maintenance margin.

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Maintenance Margin

To ensure that the balance in the margin account never becomes negative, a **maintenance margin** is set.

A maintenance margin is a minimum collateral requirement imposed on an ongoing basis until a position is closed.

If the balance in the margin account falls below the maintenance margin, the investor receives a **margin call** and is expected to top up the margin account to initial margin level by the end of the next day.

The extra funds deposited are known as a **variation margin**.

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Example

A trader enters a long position of 20 contracts with an initial futures price of $100 per barrel.

Each contract specifies 1,000 barrels for delivery.

Initial margin is $10,000 per contract.

Suppose that the maintenance margin is $5,000 per contract and the futures price drops by $6 per barrel.

Questions:

1) What is the total initial margin requirement?

2) What is the trader's margin balance after the price decline? Describe any margin call that this may trigger.

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Solution

The initial margin is equal to $20 \, \text{contracts} \cdot \$10,000 = \$200,000$.

The trader's total loss when price drops is

$$\$6 \cdot 1,000 \cdot 20 \, \text{contracts} = \$120,000$$

The trader's margin balance falls to

$$\$200,000 - \$120,000 = \$80,000$$

The maintenance margin requirement of the trader's position is

$$\$5,000 \cdot 20 \, \text{contracts} = \$100,000$$

Because the margin balance falls below the maintenance level, the trader will get a margin call to top up **$120,000** so that it is again at the level of the initial margin ($200,000).

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Another example

EAI Account establishes a **long position** in two gold futures contracts. The initial margin is $6,000 per contract, or $12,000 in total; the maintenance margin is $4,500 per contract, or $9,000 in total. The contract is entered into on Day 1 at $1,450 per ounce and closed out on Day 13 at $1,414.30. The contract size is 100 ounces.

Day	Trade price ($)	Settlement price ($)	Daily gain ($)	Cumulative gain ($)	Margin account balance ($)	Margin call ($)
1	1,450.00				12,000.00	
1		1,441.00	-1,800.00	-1,800.00	10,200.00	
2		1,438.30	-540.00	-2,340.00	9,660.00	
3		1,444.60	1,260.00	-1,080.00	10,920.00	
4		1,441.30	-660.00	-1,740.00	10,260.00	
5		1,440.10	-240.00	-1,980.00	10,020.00	
6		1,436.20	-780.00	-2,760.00	9,240.00	
7		1,429.90	-1,260.00	-4,020.00	7,980.00	4,020.00
8		1,430.80	180.00	-3,840.00	12.180.00	
9		1,425.40	-1,080.00	-4,920.00	11,100.00	
10		1,428.10	540.00	-4,380.00	11,640.00	
11		1,411.00	-3,420.00	-7,800.00	8,220.00	3,780.00
12		1,411.00	0.00	-7,800.00	12,000.00	
13	1,414.30		660.00	-7,140.00	12,660.00	

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Term Structure of Forward Prices on Commodities

The Term Structure of Forward Prices on Commodities is affected by:

- the costs of Carry for Commodity Contracts;

- the Arbitrage-Free Forward Pricing for Physical Assets;

- the Term Structure of Forward Price.

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Costs of Carry for Commodity Contracts

The costs of carry of a future contract is the difference between the futures price and the spot (underlying) price.

Spot Commodity Price + Carrying Costs = Forward Price

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Costs of Carry for Commodity Contracts

Table: Benefits and Costs of Direct Ownership.

	Real Assets	Financial Assets
Benefits	Convenience (y)	Dividends and Coupons (d)
Costs	Interest (r) + Storage (c)	Interest (r) + Custody (zero)

Convenience yield (y): the economic benefit of holding a real asset (rather than the future).

Gold is regarded as a safe asset in times of hyperinflation, so there is a benefit to holding the physical asset.

Energy products, food products and metals used in production process also generate a convenience yield for holding an excess inventory, to protect from supply disruption.

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Costs of Carry for Commodity Contracts

Storage costs (c): warehouse fees, insurance, transportation, spoilage.

Interest (r): the holder of future contract can invest his/her cash and earn risk–free rate. Equivalently, the holder of a physical asset can be thought of as borrowing at the risk–free rate to purchase the underlying asset.

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Arbitrage-Free Forward Pricing for Physical Assets

Expressing the storage costs and convenience yield as continuously compounded rates, the price of a forward contract on a physical asset is:

$$F(T) = e^{(r+c-y)T}S$$

where F is the forward price, S is the spot price, and T is the time to maturity of the forward contract.

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Example

Consider a six-month forward contract on a commodity that trades at a spot price of $50. The commodity has marketwide convenience yields of 3%, storage costs of 2%, and financing costs (interest rate) of 7%.

What is the price of six-month forward contract on the commodity?

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What is the price of six-month forward contract on the commodity?

$$F(T) = e^{(7\% + 2\% - 3\%)0.5} \cdot \$50 \approx \$51.52$$

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Arbitrage-Free Forward Pricing for Physical Assets

Two limitations to Arbitrage-Free Forward Pricing for Physical Assets are:

- A short position in the underlying physical asset may be difficult or expensive to obtain.

- The convenience yields and storage costs of market participants may differ and are unobservable.

The equation may be better viewed as an inequality:

$$F(T) \leq e^{(r+c-y)T} S$$

Long positions in the spot price can be used to perform arbitrage when forward price is too high, but short positions may not be available to perform arbitrage (without costs) when the forward price is too low.

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Example

Suppose that corn is trading at $9 per bushel because bad weather caused a decrease in supply. Market participants expect a copious harvest in about six months, which drives market prices down to $4 per bushel.

How could arbitrageurs attempt to profit from these prices?

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Arbitrage strategy:
  1) Borrow corn.
  2) Sell the corn for $9 per bushel in cash market.
  3) Take a long position in a forward contract with delivery in 6 months at $4.
  4) Get the delivery of corn in 6 months at $4 with a net profit of $5.

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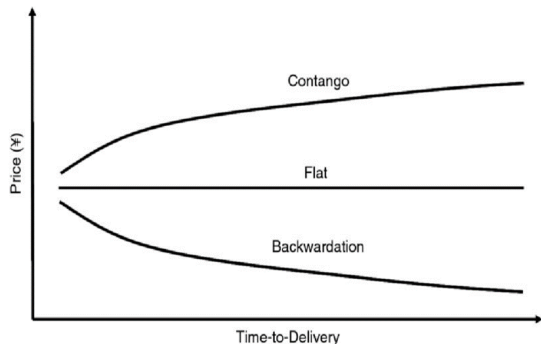How could arbitrageurs attempt to profit from these prices?

Arbitrage strategy:

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3) Take a long position in a forward contract with delivery in 6 months at \$4.
4) Get the delivery of corn in 6 months at \$4 with a net profit of \$5.

But arbitrageur would find that nobody would be willing to lend corn at little or no cost.

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Term Structure of Forward Prices

When the term structure of forward prices is upward sloping, the market is said to be in **contango**.

When the slope is negative, the market is in **backwardation**.

Back to the FX example

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Term Structure of Forward Prices

In **normal contango**, the forward price is believed to be <u>above</u> the expected spot price; and there is a positive expected return from the <u>short side</u> of futures contracts.

In **normal backwardation**, the forward price is believed to be <u>below</u> the expected spot price; and there is a positive expected return from the <u>long side</u> futures contracts.

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Returns on Forward Contracts

Futures and forward contracts may be used as beta drivers or alpha drivers.

Market participant who uses forward contract as **beta driver** is simply trying to obtain the risk and returns of the underlying commodity in the most cost–effective manner possible.

A portfolio manager wishing to diversify into Australian equities may establish a position in a forward contract on the S&P/ASX 200.

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Returns on Forward Contracts

Market participants, who use forward contracts as an **alpha drivers**, might be viewing the forward contracts on a commodity as mispriced relative to the underlying spot price or to other vehicle for obtaining commodity exposure.

Strategies for generating of alpha using futures contracts often focus on hedging futures contracts against spot prices (**basis**) or hedging futures contract against each other (**spread**).

Example: Amaranth Advisors, LLC (a hedge fund) speculated on the spread between price of natural gas contracts in the winter and summer delivery month.

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The Basis of a Forward Contract

The basis of a forward contract is the difference between the spot (or cash) price of the reference asset (S) and the price (F) of a forward contract with delivery at time T.

$$\textbf{Basis} = \boldsymbol{S - F(T)}$$

A trader hedging spot position against forward position analyse the basis and compares it with carrying cost to identify the mispricing.

The basis should approach 0 on the delivery date (e.g. the price of futures contract should equal spot price.

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Calendar Spread

The combination of a long position and a short position in forward contracts that have the same underlying commodity but differ by time is known as **calendar spread**.

$$\textbf{Calendar Spread } = F(T + t) - F(T)$$

where t is the length of time separating the settlement dates of the contracts.

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Calendar Spread

Investors seeking risk exposure through futures market have numerous choices with regard to settlement dates.

Calendar spread can be viewed as the difference between futures price on the same asset but different settlement dates.

The excess return on different futures contracts with different settlement dates vary because of calendar spreads change.

Calendar spreads trading is a speculation on changes in the shape and slope of term structure of forward prices.

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Example

Consider a calendar spread that is long the two-year forward contract and a short the 1-year contract on a physical commodity with a spot price of $100. The trader put the spread on in anticipation that storage cost c will rise.

Assume that $r = 2\%$, $c = 3\%$, and $y = 5\%$ (this is for the simplicity that $r + c - y = 0\%$ so that the forward prices equal the spot price).

What would be the profit or loss be to the trader if:
1) spot prices rose by $1?
2) the storage cost rose by one percentage point?

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Solution

1) The change in the spot price will not affect calendar spreads as long as the carrying costs change such that $r + c - y = 0$, since forward prices will continue to match the spot prices.

2) When the storage cost rose from 3% to 4%, $r + c - y$ will no longer be equal to 0, and forward prices will rise relative to spot prices.

$$F(2\,years) = 100 \cdot e^{0.01 \cdot 2} = \$102.02$$

$$F(1\,year) = 100 \cdot e^{0.01 \cdot 1} = \$101.01$$

This provides the trader with a profit equal to $1.01 ($2.02 − $1.01), as the trader is long the two–year forward contract that increased by $2.02 and short the one–year forward contract that increased by $1.01.