

Math 174E

Lecture 4

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Chapter 2: Futures Markets (and Central Counterparties)



Hull

Chapters 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.11

Background 1/4

Definition 2.1

A **futures contract** is an agreement between two parties to buy or sell an asset for a predetermined delivery price (**futures price**) at a predetermined future time (**maturity date**).

Two types of positions:

- ▶ **long** futures position: buying the underlying asset
- ▶ **short** futures position: selling the underlying asset

Purpose of trading futures:

- ▶ Hedging and speculation
- ▶ gaining *exposure* to the underlying asset without directly taking a position in the underlying asset (i.e., without buying and holding the asset)

Background 2/4

- ▶ futures (contracts) are traded actively all over the world on **exchanges** (Chicago Mercantile Exchange CME Group, Eurex, etc.)
- ▶ available on a wide range of **underlyings**
 - ▶ commodities, bonds (interest rate futures), currencies, stock indices, cryptocurrencies (Bitcoin, Ether), electricity, . . .
- ▶ prices quoted on the exchanges are **futures prices** for specific **delivery months**
- ▶ like spot prices, futures prices are determined by supply and demand (but also obey certain no-arbitrage principles) and continuously change over time
- ▶ exchange matches buyers and sellers (electronic trading via a limit order book)

Background 3/4

- ▶ specifications of a futures contract (made by the exchange)
 - ▶ underlying asset
 - ▶ contract size
 - ▶ delivery arrangements (location)
 - ▶ delivery month and delivery period
 - ▶ price quotes and tick size (dollars and cents; dollars and thirty-seconds of a dollar, i.e., $1/32 = 0.03125$)
 - ▶ price limits and position limits
- ▶ futures contracts are settled daily
- ▶ **daily settlement** against the *current futures price* (**settlement price**) is realized through **margin accounts**
- ▶ virtually **no credit risk** (contract defaults avoided through margin accounts)
- ▶ either **physical delivery** of the underlying asset at maturity (commodity) or **cash settlement** (index futures)

Background 4/4

- ▶ a futures contract can also be **closed out** prior to maturity by entering into the **opposite** trade/position
 - ▶ long position is closed out by taking a short position
 - ▶ short position is closed out with a long position
- ▶ total gain/loss is then determined by the change in the futures price, i.e., the futures price F_{t_1} when the contract was entered into (at time t_1) and the futures price F_{t_2} when contract is closed out (at time t_2)
 - ▶ P&L for **long position**: $F_{t_2} - F_{t_1}$
 - ▶ P&L for **short position**: $F_{t_1} - F_{t_2}$
- ▶ note that because of the daily settlement procedure gains and losses are actually computed and settled **daily**, not just at maturity or when the contract is closed out (see Example 2.2 below)

Margins & Daily Settlement

- ▶ a **margin** is a cash balance (or a marketable security) deposited by an investor with her broker in a **margin account**
- ▶ margins minimize the possibility of a loss through a default
- ▶ at the end of each trading day the margin account is adjusted to reflect gains and losses (**daily settlement** = “marking-to-market” with current **futures price**)
- ▶ types of margins
 - ▶ initial margin
 - ▶ maintenance margin
 - ▶ variation margin

*“in case the balance on the margin account falls below the maintenance margin, there is a **margin call** and the broker must deposit on behalf of her trader a variation margin to bring the balance back to the initial margin”*

- ▶ brokers need a margin account with the exchange's **clearinghouse** (broker acts as an intermediary)
- ▶ margin requirements are the same for long and short futures positions

Illustration

Example 2.2

On June 1 a trader instructs a broker to enter into a **long position** of **two December gold futures contracts**:

- ▶ current **futures price** \$1,250 per ounce
- ▶ contract size 100 ounce
- ▶ initial margin \$6,000 per contract (\$12,000 in total)
- ▶ maintenance margin \$4,500 per contract (\$9,000 in total)

That is, the trader has contracted to **buy** a total of 200 ounces of gold at \$1,250 per ounce in December (\$250,000).

However, after 16 days the trader decides to **close out** the contract by “selling” two December gold futures contracts (i.e., entering into the opposite short position). The December gold futures price on that day is \$1,226.90.

Trader's total loss:

$$200 \cdot 1,226.90 - 200 \cdot 1,250 = 245,380 - 250,000 = -4,620.$$

Daily Settlement

Operation of the **margin account** from Example 2.2:
(for a possible sequence of December gold futures prices = settlement price)

day	trade price (\$)	settlement price (\$)	daily gain (\$)	cumulative gain (\$)	margin account balance (\$)	margin call (\$)
1	1,250.00				12,000	
1		1,241.00	-1,800	-1,800	10,200	
2		1,238.30	-540	-2,340	9,660	
3		1,244.60	1,260	-1,080	10,920	
4		1,241.30	-660	-1,740	10,260	
5		1,240.10	-240	-1,980	10,020	
6		1,236.20	-780	-2,760	9,240	
7		1,229.90	-1,260	-4,020	7,980	4,020
8		1,230.80	180	-3,840	12,180	
9		1,225.40	-1,080	-4,920	11,100	
10		1,228.10	540	-4,380	11,640	
11		1,211.00	-3,420	-7,800	8,220	3,780
12		1,211.00	0	-7,800	12,000	
13		1,214.30	660	-7,140	12,660	
14		1,216.10	360	-6,780	13,020	
15		1,223.00	1,380	-5,400	14,400	
16	1,226.90		780	-4,620	15,180	

Trader's P&L: $15,180 - 12,000 - 4,020 - 3,780 = -4,620$

Source of table: Hull, Chapter 2.4, page 30.

Delivery

- ▶ **Closing out** (see Example 2.1)
 - ▶ avoidance of delivery
 - ▶ trader enters into **opposite type** of trade from the original one
 - ▶ trader's gain or loss is determined by the change in the futures prices
 - ▶ vast majority of contracts are closed out
- ▶ **Physical delivery**
 - ▶ if contract is not closed out before maturity
 - ▶ short position chooses in case there are alternatives
 - ▶ short position must issue a "notice of intention to deliver" to the exchange clearing house
- ▶ **Cash settlement**
 - ▶ necessary if delivery is inconvenient or impossible (e.g., stock index futures like futures on the S&P 500)
 - ▶ outstanding contract is declared closed on a predetermined day
 - ▶ final settlement price is set equal to the spot price of the underlying asset on that day (open or close price)

Properties of Futures Prices 1/2

Convergence of futures price to spot price:

- ▶ as the delivery period for a futures contract is approached, the futures price converges to the spot price of the underlying asset
- ▶ when the delivery period is reached, the futures price equals – or is very close – to the spot price
 - ▶ futures price $>$ spot price: buy the asset, sell (short) a futures contract, make delivery (“arbitrage opportunity”)
 - ▶ futures price $<$ spot price: companies interested in acquiring the asset enter into a long futures contract instead of buying it in the spot market
- ▶ prior to the delivery period: futures price can be above or below the spot price (the relation between spot and futures prices is discussed in **Chapter 5**)

Properties of Futures Prices 2/2

Patterns of futures prices with respect to maturity:

- ▶ **contango** (normal market): futures price is an *increasing* function of the maturity of the contract (time-to-maturity)
- ▶ **backwardation** (inverted market): futures price is a *decreasing* function of the maturity of the contract (time-to-maturity)

Forward vs. Futures Contracts

Both contracts are agreements to buy or sell an asset for a certain price at a certain future time.

Forward	Future
private contract between two parties	traded on an exchange
not standardized	standardized contract
usually one specified delivery date	range of delivery dates
settled at end of contract	settled daily
delivery or final cash settlement	usually closed out prior to maturity
some credit risk	virtually no credit risk

Source of table: Hull, Chapter 2.11, page 43.

Chapter 3: Hedging Strategies Using Futures



Hull

Chapters 3.1, (3.2)

Basic Principles

What is hedging?

- ▶ a hedge is an investment that is implemented solely to reduce or cancel out the financial risk in another investment
 - ▶ typical risk factors are fluctuations in prices, exchange rates, interest rates etc.
- ▶ a perfect hedge eliminates the entire risk
 - ▶ in general, perfect hedges are hard to realize in practice
- ▶ a hedge tries to reduce undesired risk by matching cash flows (neutralization)

Hedging with futures contracts:

- ▶ offset risk from price changes by **locking in** a specific price
- ▶ static hedging (“hedge-and-forget”)
- ▶ futures contracts are closed out before maturity (no delivery!)

Types of static hedges with futures 1/2

Idea: Take a position in a futures contract that **neutralizes** or **offsets** the price risk

Short hedges:

- ▶ short position in a futures contract
- ▶ suitable if hedger wants to **fix the price** of an asset she wants to **sell** at some time in the future at the then prevailing market price (to some third party)
- ▶ *Examples:* Copper mine fixes future copper prices, U.S. exporter receiving euros in three months locks in the USD per EUR exchange rate
- ▶ realized selling price \approx futures price

Important: In general, the hedger's intention is **not** necessarily to sell the asset through the short position in the futures contract and make delivery!

Types of static hedges with futures 2/2

Long hedges:

- ▶ long position in a futures contract
- ▶ suitable if hedger wants to **fix the price** of an asset she wants to **buy** at some time in the future at the then prevailing market price (from some third party)
- ▶ *Examples:* Car producer fixes the price of aluminium, U.S. importeur paying euros in three months locks in the USD per EUR exchange rate
- ▶ realized buying price \approx futures price

Important: In general, the hedger's intention is **not** necessarily to buy the asset through the long position in the futures contract and take delivery!

For a discussion of arguments for and against hedging, see Hull 3.2.

Examples 1/2

Example 3.1 (Short hedge)

Today on May 15 an oil producer has negotiated a contract to **sell** 1 million barrels of crude oil on August 15 with some client. It has been agreed that the price that will apply in the contract is the market price on August 15.

The company can hedge its exposure to changes in the crude oil spot price by **shorting** futures contracts (with delivery month August) and close out its position on August 15.

See Notes Lecture 5 for a numerical discussion.

Examples 2/2

Example 3.2 (Long hedge)

Today on January 15 a copper fabricator knows it will **require** 100,000 pounds of copper on May 15 to meet a certain contract.

The fabricator can hedge its position by taking a **long position** in futures contracts (with delivery month May) and closing its position on May 15.

See Notes Lecture 5 for a numerical discussion.