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Foundations · market mechanics from the ground up

Futures: what they are, who uses them for what and why their price is tied to the index

Chapter 4 of 10

A future is a standardised contract to fix a price today for later. This chapter explains contract size, margin and daily settlement using the E-mini on the S&P 500, shows with numbers how funds hedge with it and why leverage arises, derives the fair futures price from interest and dividends and explains basis, expiry, the roll and the link to index CFDs.

Field	Value
Series	Futures, options and who makes the price
Scope	Chapter 4 of 10
Type	Explanation with worked examples, not a measurement
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Contents

1. What a future is 2
2. Who uses futures and for what 3
3. Margin, leverage and daily settlement 3
4. The fair price: derivation from arbitrage 4
5. Basis and expiry 5
6. The roll 6
7. How index CFDs are tied to it 6
Common misconception 7
What you should understand now 7
Limits of this account 7

In one sentence: A future is a contract to buy an asset at a later date, whose price is fixed today such that nobody can earn from it without risk by instead buying the asset itself and holding it until that date.

What this chapter is: an explanation with worked examples. Contract data come from CME and Eurex. Index levels, interest rate, dividend yield and margin in the example are assumptions of a realistic order of magnitude and named as such. **Not a trading recommendation.**

Chapter 1 told why the future was invented. This one is about how exactly it works.

1. What a future is

A future is a contract between two parties:

- The **buyer** (he is "long") commits to taking a certain asset on a fixed day at a price agreed today.
- The **seller** (he is "short") commits to delivering at that price.

With a future on a stock index nothing is delivered at the end. Only the difference is settled in money. If the index is higher than the agreed price on expiry day, the buyer receives the difference from the seller. If it is lower, the buyer pays.

So every future has two sides. What one gains, the other loses. The number of contracts currently open is called **open interest**. It plays a large role in chapter 9.

The exchange fixes everything except the price, so that everyone trades the same contract:

Fixed	For the E-mini on the S&P 500
What it is written on (underlying)	S&P 500
Value of one index point (multiplier)	50 USD
Smallest price step (tick)	0.25 points, that is 12.50 USD
Expiry	third Friday in March, June, September and December
Trading hours	Sunday evening to Friday evening, almost continuously

Only the price is negotiated. If the future is at 7,000 points, one contract moves a notional value of

$$7{,}000 \times 50 \text{ USD} = 350{,}000 \text{ USD}$$

The most important index futures at a glance:

Future	Exchange	Value per point	Notional at index level
E-mini S&P 500 (ES)	CME	50 USD	350,000 USD at 7,000
Micro E-mini S&P 500 (MES)	CME	5 USD	35,000 USD at 7,000
E-mini Nasdaq 100 (NQ)	CME	20 USD	580,000 USD at 29,000
Micro E-mini Nasdaq 100 (MNQ)	CME	2 USD	58,000 USD at 29,000
DAX future (FDAX)	Eurex	25 EUR	625,000 EUR at 25,000
Mini-DAX future (FDXM)	Eurex	5 EUR	125,000 EUR at 25,000
Micro-DAX future (FDXS)	Eurex	1 EUR	25,000 EUR at 25,000

The index levels in the last column are round example values.

2. Who uses futures and for what

Hedging. A pension fund holds shares worth 35 million USD that move roughly like the S&P 500. It fears a decline but does not want to sell the shares. It sells futures:

$$\frac{35{,}000{,}000\ \text{USD}}{350{,}000\ \text{USD}} = 100\ \text{contracts}$$

If the market falls by 5 %, that is by 350 points, the shares lose 1.75 million USD. The 100 futures sold gain:

$$350 \times 50\ \text{USD} \times 100 = 1{,}750{,}000\ \text{USD}$$

The loss is offset. If the market rises by 5 % instead, the shares gain 1.75 million USD and the futures lose the same amount. The pension fund has given up its price risk for the duration of the hedge, for better and for worse. That is the difference from the option in chapter 5.

Investing quickly. A fund receives 35 million USD of new money. Buying 500 shares takes time and costs money. Buying 100 futures is a single trade. The fund is in the market immediately and later swaps the futures for shares bit by bit.

Taking a view on direction. Whoever expects rising prices buys futures. Whoever expects falling prices sells them. Selling a future is just as easy as buying one. With shares one would first have to borrow them.

Aligning prices. Arbitrageurs trade the future against the shares as soon as the two no longer fit together (section 4).

Offsetting options. Option dealers hedge their books with futures. That is the subject of chapter 8 and the reason this chapter comes before the options.

Why the future and not the shares themselves? One trade instead of five hundred, low costs, trading almost around the clock, selling without borrowing, and very little capital tied up. The last point needs a section of its own.

3. Margin, leverage and daily settlement

Whoever buys a future does not pay 350,000 USD. He only posts collateral, the **margin**. The exchange sets it and adjusts it when the market becomes more turbulent. For index futures it is a few per cent of the notional value. For the example we assume 21,000 USD per contract, which is 6 %.

From this the **leverage** arises:

$$\text{Leverage} = \frac{350{,}000\ \text{USD}}{21{,}000\ \text{USD}} \approx 16.7$$

If the index moves by 1 %, that is by 70 points, the value of the contract changes by 3,500 USD. That is 16.7 % of the collateral posted. Leverage is not a feature you add on. It results from posting only a small collateral for a large notional value.

So that nobody loses more than he has posted in such moves, the clearing house settles **every day**. Gains are credited, losses deducted, based on the official daily settlement price of the future. An example for one contract bought at 7,000:

Day	Settlement price	Change in points	Credit or debit	Margin account balance
Purchase	7,000			21,000 USD
1	6,950	−50	−2,500 USD	18,500 USD
2	7,020	+70	+3,500 USD	22,000 USD
3	6,980	−40	−2,000 USD	20,000 USD

After three days the future is 20 points below the purchase price. Exactly 20 times 50 USD, that is 1,000 USD, are missing from the account. The loss did not fall due only on expiry day but day by day.

If the account falls below a minimum level, the broker demands additional funds (margin call). If the money does not arrive, he closes the position. That is the protection against the default risk from chapter 1. For the trader it means: a position can be closed by force before the market recovers.

4. The fair price: derivation from arbitrage

Why is the future at 7,047 when the index is at 7,000? It is tempting to see an expectation in that: the market reckons with rising prices. That is wrong. The price follows from a calculation in which the expectation does not appear.

There are two ways of owning the index in 90 days:

- **Way A:** buy the future today. No money flows, in 90 days settlement takes place at the price F.
- **Way B:** buy the shares of the index today, with borrowed money, and hold them for 90 days.

Both ways lead to the same result, so they have to cost the same. What does way B cost?

The assumptions: index $S = 7{,}000$, interest rate $r = 4\,\%$ per year, dividend yield $q = 1.3\,\%$ per year, term $T = 90/365$ years.

Step 1: take out a loan and buy the shares. For 7,000 (per index unit).

Step 2: pay interest. After 90 days:

$$7{,}000 \times 0.04 \times \frac{90}{365} = 69.04$$

Step 3: collect dividends. The shares belong to the holder, so he receives the dividends:

$$7{,}000 \times 0.013 \times \frac{90}{365} = 22.44$$

Step 4: add up. In the end way B costs the purchase price plus interest minus dividends:

$$7{,}000 + 69.04 - 22.44 = 7{,}046.60$$

That has to be the price of the future. In general:

$$F = S \cdot \left(1 + (r - q) \cdot T\right)$$

The expression $(r - q)$ is called the **cost of carry**: the cost of holding, interest minus dividend. With continuous compounding the formula reads $F = S \cdot e^{(r-q)T}$ and gives 7,046.76 here. The difference is negligible for short terms.

What happens if the price deviates? Suppose the future is at 7,060. An arbitrageur sells the future and at the same time goes way B: he buys the shares on credit. In 90 days he economically delivers the shares against the future. His profit is already certain today:

$$7{,}060 - 7{,}046.60 = 13.40 \text{ points} = 670 \text{ USD per contract}$$

He carries no price risk in doing so, because what the shares lose, the future sold gains. Many do this at the same time. Their selling pushes the future down, their buying lifts the shares, until the gap is closed. If the future is too low, it runs the other way: buy the future, sell the shares.

In practice a narrow band remains around the fair price in which arbitrage does not pay because of trading costs. For the large index futures it is a few tenths of a point wide.

5. Basis and expiry

The distance between future and index is called the **basis**:

$$\text{Basis} = F - S = S \cdot (r - q) \cdot T$$

In the example that is 46.60 points at 90 days to expiry. The basis depends on the time to expiry T. It gets smaller with every day:

Time to expiry	Fair price of the future	Basis
90 days	7,046.60	46.60
60 days	7,031.07	31.07
30 days	7,015.53	15.53
0 days	7,000.00	0.00

On expiry day the basis is zero. Future and index meet. This is called **convergence**, and it is enforced: at the end the future is settled at the index level.

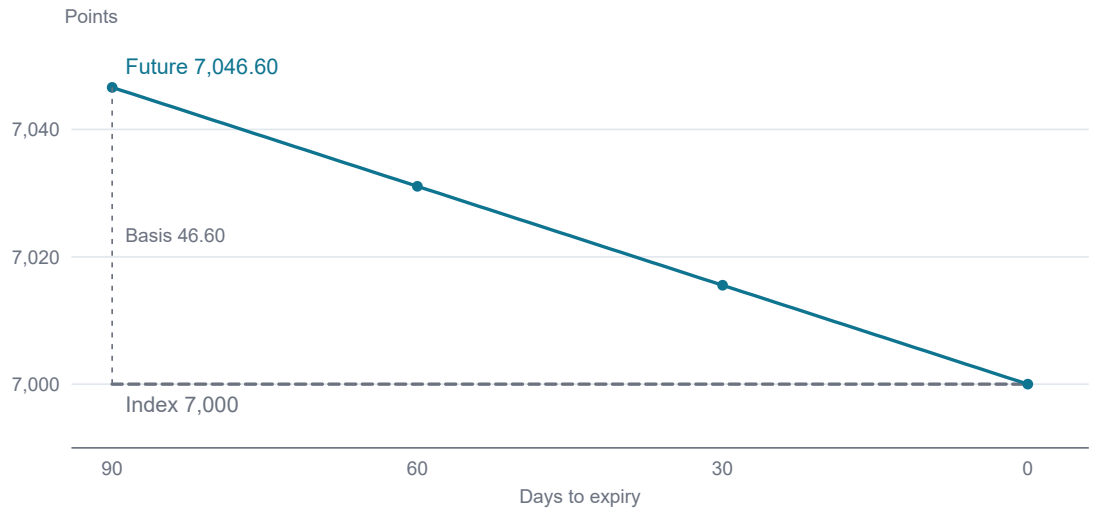


Fig. 1: Fair price of the future with the index unchanged at 7,000, an interest rate of 4 % and a dividend yield of 1.3 %. The basis melts away evenly and is zero on expiry day.

How settlement works. What matters is a single price on expiry day:

- **S&P 500 and Nasdaq 100:** settlement takes place on the third Friday of the expiry month at an index level computed from the opening prices of all index shares that morning.
- **DAX:** settlement takes place on the third Friday at the index level from the midday auction of Xetra trading at 13:00.

Whoever depends on that price trades in those auctions. That concentrates turnover there (chapter 3).

The DAX is a special case. The DAX counts dividends into the index level. So the holder of a DAX future does not miss a dividend, and in the formula $q = 0$. The basis is therefore larger than for a price index. An example from our own data: on 8 July 2026 the price with the highest volume in the DAX future was around 112 points above that of the CFD on the DAX (25,139 against 25,027), at 72 days to the September expiry. Annualised that is around 2.3 %, the order of magnitude of the euro money-market rate.

6. The roll

A future expires. Whoever wants to hold his position longer has to switch: close the expiring contract and open the next one. This is called the **roll**. For the large index futures turnover moves into the next contract about a week before expiry.

The next contract has three more months to expiry and is therefore higher, in the example by about 47 points. This difference is neither a gain nor a loss. It is the cost of carry for the additional three months, which would have been paid anyway.

Two practical consequences:

- **Continuous charts have jumps.** A chart that simply strings the contracts together shows a gap on roll day that never existed. For evaluations such series have to be adjusted.
- **Whoever is permanently long pays the carry continuously.** It sits in every new contract as a premium that melts away until expiry.

7. How index CFDs are tied to it

Many private investors trade indices not through futures but through CFDs (contracts for difference) with a broker. A CFD is not an exchange product. The broker is the counterparty and quotes his own prices. He derives them from the future, because that is where he hedges:

$$\text{CFD price} \approx \text{future} - \text{basis}$$

The CFD price therefore lies close to the index and keeps moving even when the stock exchange is closed and only the future trades.

The difference lies in the financing. In the future the cost of carry is in the price. With the CFD it is charged individually every night, as financing cost (swap), plus a mark-up by the broker. In our measurement, holding an index CFD overnight cost 1.5 to 2.1 basis points of swap, in addition to 2 basis points of spread. That was enough to consume the measurable overnight effect of the US indices completely (to the study).

For all further chapters this holds: when the future moves, the CFD moves. What option dealers do in the future arrives in the CFD price.

Common misconception

Common misconception: "The future is above the index, so the market expects rising prices." The basis is interest minus dividend times time to expiry. An expectation does not appear in the calculation. If the future were more expensive because of an expectation, anyone could earn from it without risk by selling it and buying the shares. The market's expectations are in the index level itself, not in the distance of the future from it.

What you should understand now

- A future is a standardised contract with two sides. With an index future only the difference is settled in money. One E-mini on the S&P 500 moves 50 USD per point.
- It is used for hedging, for investing quickly, for taking a view on direction, for arbitrage and for offsetting option books.
- Only a margin of a few per cent is posted. Leverage arises from that. Gains and losses are settled daily.
- The fair price is $F = S \cdot (1 + (r - q) \cdot T)$: index plus interest minus dividend. Arbitrage keeps the future at this price.
- The basis melts to zero by expiry. In the roll no additional costs are paid, only the carry for the next term. Index CFDs are derived from the future and charge the financing per night.

Limits of this account

- **Assumptions.** An interest rate of 4 %, a dividend yield of 1.3 %, a margin of 6 % and the index levels are example values. In reality dividends do not flow evenly but are bunched on certain dates. The basis then runs in steps.
- **Arbitrage is not free.** It needs capital, credit lines and the ability to sell shares one does not own. In crises the basis can therefore deviate from fair value for hours or days.
- **The DAX example** compares the highest-volume prices of two volume profiles, not two quotes made at the same moment, and is a single day.
- **Not covered:** futures on commodities, interest rates and currencies, in which storage costs and delivery play a role of their own, and tax treatment.

Continue with chapter 5: the option, the right without the obligation, and why call and put are linked by a simple equation.

An explanation of market mechanics with worked examples. Not investment advice and not a trading recommendation. Trading futures and options involves the risk of loss up to and beyond the capital employed.