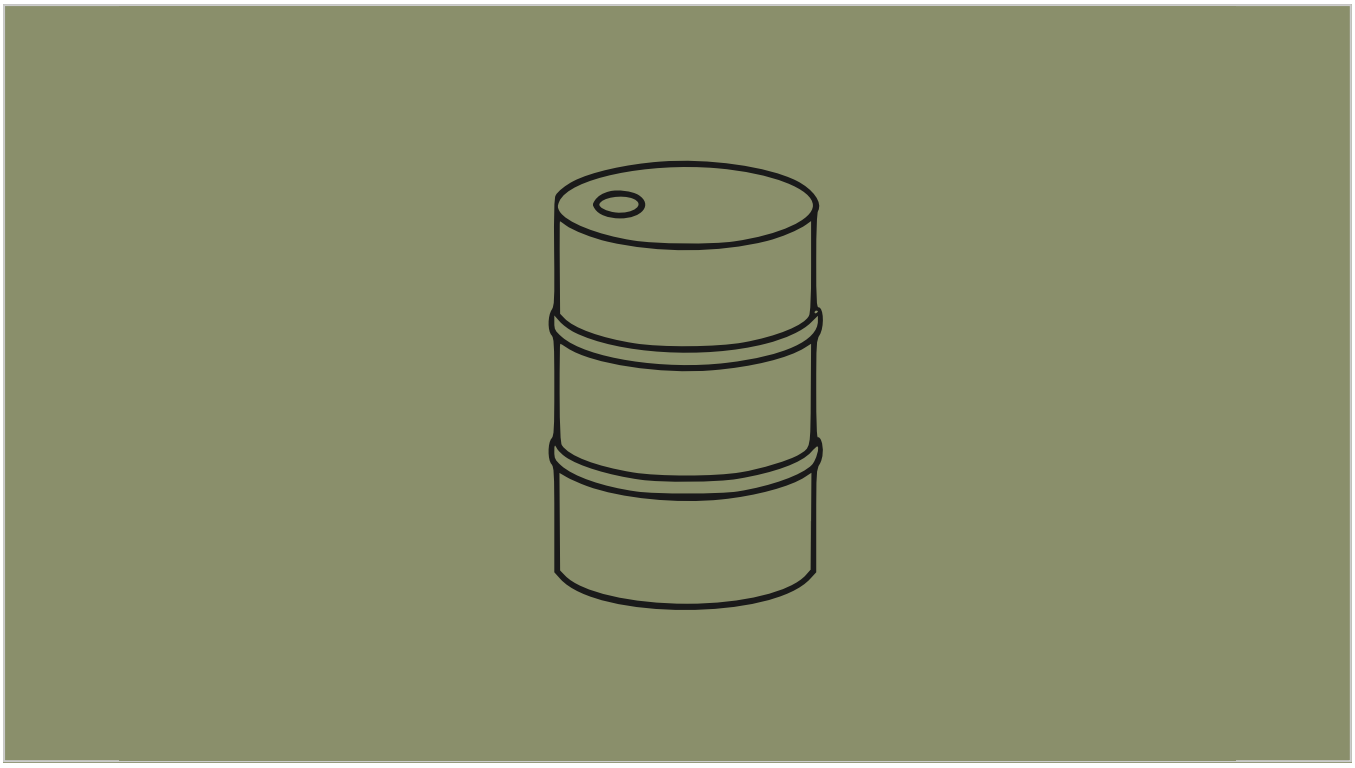
Finance

# A Primer on Oil Markets: Futures Markets

Oil futures allow market participants to hedge volatility in crude oil markets and speculate on future oil prices. In part two of a three-part series on how markets for trading crude oil work, we explore oil futures markets.



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## What are oil futures markets?

An oil futures market is a public marketplace where participants trade legal agreements to buy or sell crude oil at a predetermined, locked-in price on a set date in the future. Those agreements, known as *oil futures contracts*, allow market participants to lock in prices for weeks or months in advance to protect themselves from unexpected market swings.

Unlike spot and forward markets, where oil trades occur privately and directly between counterparties over the counter (OTC), futures markets require buyers and sellers to transact on public, highly regulated, and centralized exchange platforms. Examples include the New York Mercantile Exchange, the Intercontinental Exchange (ICE), the Dubai Mercantile Exchange (DME), and the Shanghai International Energy Exchange (INE).

The exchange matches buyers with sellers and mitigates counterparty risk by taking on clearing duties. As the clearinghouse, the exchange acts as a central counterparty to both buyers and sellers trading oil futures contracts. To put it another way, the exchange is the buyer to every seller and the seller to every buyer.[1]

Buying an oil futures contract creates a long position in the exchange's order book, while selling one creates a short position. A trader enters a long position if they expect the future price of oil will go *up*, and a short position if they expect the price to go *down*. The difference between the locked-in price and the market price of oil at the end of the contract's term determines the financial outcome for a trader's position. If the market price of oil is higher than the locked-in price, the long position makes a profit and the short position makes a loss; if the market price is lower than the locked-in price, the short position profits and the long position loses money.

To enter the market and create a position, traders are required to deposit a specific amount, usually a fixed percentage of the total value of oil being traded, into a dedicated trading account that the exchange has access to. This deposit, known as the *initial margin*, acts as a good-faith financial guarantee that the trader will perform their obligations over the lifespan of the contract: specifically, the obligation to cover any financial losses incurred on their positions from day to day.[2]

The initial margin requirement is usually set anywhere between 3% and 12% of the total value of oil (a.k.a., *notional value*) controlled by a single oil futures contract. Importantly, the initial margin is not a payment for opening a futures position. Opening a short or long futures position is technically free, but the position must be collateralized to remain open. The initial margin functions as a trader's collateral; the exchange is allowed to liquidate the collateral and use it cover a trader's debt if they fail to keep enough cash in their margin account to settle daily losses.

## Oil futures vs. oil forwards

Oil futures contracts are similar to oil forward contracts. Selling an oil futures contract creates a legal obligation to sell oil to the contract buyer at a specific price in the future. Buying an oil futures contracts creates a corresponding legal obligation to take delivery of oil from the contract seller at a specific price also in the future. These agreements are legally binding, meaning participants cannot simply exit them and may face legal consequences if they fail to fulfill obligations written into the contract.

Oil futures contracts, however, differ from oil forward contracts on **settlement** and **standardization**. While forward contracts are typically designed for physical delivery, some futures markets permit both physical delivery and cash settlement of oil contracts. In physical delivery, the seller transfers real oil to the buyer to settle the transaction; in cash settlement, traders settle the cash difference between the futures contract's original purchase price and the current market price of oil on the futures market.

Forward trading allows buyers and sellers to customize contract terms, including how much oil is delivered, the type of crude oil, and when and where the delivery happens. However, in futures trading, all contracts are standardized and share the same set of rules around crude oil volume, quality, and delivery terms.[3] Standardization makes oil futures contracts *fungible*, i.e., they can be exchanged at 1:1 value because every oil futures contract is identical, unlike oil forwards that often have bespoke terms.[4]

Oil futures are also easier to trade than oil forwards because trades are cleared by the exchange. Suppose Bob buys a WTI futures contract from Eve and later sells the same contract to Alice. Because the exchange is the clearinghouse, Bob can exit the agreement entirely, leaving both Alice and Eve holding independent contracts directly with the exchange; if Eve defaults, the exchange must execute her side of the contract and deliver the oil to Alice. Alice can buy the futures contract from Bob without worrying about whether Eve will honor the agreement because the exchange takes on the counterparty risk.

Conversely, oil forwards are non-fungible because trades are not cleared by an exchange. If Bob buys a forward contract from Eve, he cannot sell the same forward to Alice and exit the agreement. Bob has to sign a new, separate oil forward contract with Alice. If Eve later defaults on her forward contract with Bob, Bob has to find oil elsewhere to honor the agreement he has with Alice, or he will have to default as well. This is the "daisy-chain collapse" mentioned in the previous article on oil forward markets and contributes to the difficulty of trading oil forwards on secondary markets.

## Daily settlement in oil futures markets

Although oil futures contract are not settled immediately, buyers and sellers start to accumulate paper profits and losses on their open positions as the market price of oil moves away from the contract's original price. A *paper profit* occurs when the market price increases above the purchase price, while a *paper loss* occurs when the market price drops below the purchase price. These profits and losses are *unrealized*, existing only in each trader's financial records (i.e., "on paper"), because the oil has not been sold yet. They become realized when the oil in question is delivered to the buyer below or above the current market price.

If a trader with an open futures position accumulates significant paper losses, the probability of a default may increase. For instance, say Alice sells a one-month WTI futures contract for 1,000 barrels of oil (valuing a barrel at $70) to Bob on Monday. If the futures price of oil climbs to $75 on Tuesday, Alice has made a paper loss of $5,000 ($5 x 1,000 barrels). The loss is unrealized because Bob doesn't pay immediately, and the delivery happens much later. However, if Alice continues to accumulate paper losses, Bob may worry about the possibility of Alice defaulting on the contract.

It's easy to see why Bob would be worried. If Alice owns physical oil, she can still deliver the oil, even if it requires writing off the realized loss. However, if she must buy oil on the open market instead, her capacity to deliver the oil will depend on how much money she budgeted originally, whether she has

enough to buy oil at the market rate, and how much extra liquidity she can access if the cost of oil exceeds her budget. Should something goes wrong with Alice's financial budgeting, Bob will not get the oil at the price he agreed with Alice when the contract expires and the delivery window arrives, unless the exchange steps in and executes Alice's part of the contract.

This example shows that paper losses accumulated by participants in oil futures markets can have real financial consequences. Since the exchange clears the trade and bears counterparty risk, Bob is protected if Alice defaults. The exchange will have to cover the default and deliver oil to Bob using its own money for the market to remain intact.[5]

The exchange is not a charity, however; it assumes counterparty risk on behalf of market participants because doing so makes it easier for a market for trading oil futures to scale. Ideally, the exchange wants to maintain a balanced order book and have zero financial obligations. A balanced order book means that every long position has a corresponding short position, following the rule of double-entry bookkeeping. When the number of short positions and long positions are perfectly matched, the exchange never has to buy or sell oil to keep the market running because the obligations cancel each other out (a buyer exists for every seller).

To balance the books and eliminate counterparty risk, the exchange marks open futures positions to market and settles profits and losses incurred on those positions daily instead of waiting until contracts expire. Mark to market (MTM) is a daily process where the exchange revalues an open futures position to match the current market price. To mark a position to market, the exchange calculates the difference between the trader's entry price (i.e., the price they locked in when they opened a position) and the price of oil on the futures market at the close of trading for that day.

The outcome of comparing a position's entry price and the final market price determines if the position made or lost money. The final price is also called the *settlement price*, as it determines the profits and losses that the exchange must settle at the close of business. The settlement price is posted by the exchange and derived from the volume-weighted average price (VWAP) of oil futures traded in the closing minutes of the daily trading window. For example, CME Group calculates the daily settlement price for NYMEX Light Sweet Crude Oil (WTI) futures using the volume-weighted average price of trades executed in a designated window between 1.28 pm and 1.30 pm Central Time. Similarly, the Intercontinental Exchange (ICE) calculates the settlement price for ICE Brent Crude futures based on the VWAP of trades executed between 7.28 pm and 7.30 pm London time.[6]

Two sets of outcomes are possible for traders with open positions in the oil futures market after each daily settlement:

- **Long positions (futures buyers)**: If the settlement price is higher than the trader's entry price, the position makes a profit. If the settlement price is lower, the position makes a loss.
- **Short positions (futures sellers)**: If the settlement price is lower than the trader's entry price, the position makes a profit. If the settlement price is higher, the position makes a loss.

The exchange settles profits and losses using the initial margin deposited by traders with open futures positions. If the short position in an oil futures contract is in loss, and the long position is in profit, the exchange deducts the amount lost by the short trader from their margin balance and adds it to the long trader's margin balance. The opposite happens if the long position loses and the short position profits: money is deducted from the long trader's margin account and credited to the short trader's margin account.

After marking positions to market, the exchange updates each trader's entry price to the last settlement price and resets their daily financial obligations are reset to zero. The process repeats at the close of trading the next day until the contract ends, or the trader exits their positions. In the earlier example, Alice loses $5,000 and Bob makes $5,000 on the first day of trading. If the margin requirement was 10%, Alice and Bob would be required to deposit $7,000 individually to open short and long positions in the exchange's order book. The exchange would deduct $5,000 from Alice's margin balance to pay Bob for the profit made on his short futures position for that day.

## Why daily settlement is inadequate

The exchange doesn't have financial exposure when Alice makes her first loss because her margin balance is enough to cover the payment to Bob. But if Bob makes another profit of $5,000 the following day, the exchange would be left severely exposed. As the clearinghouse, it has to cover the difference between Alice's margin ($2,000) and Bob's daily profit ($5,000) and pay Bob $3,000 out of its own pocket.

The exchange's financial exposure doesn't end there. Because a clearinghouse guarantees all trades, the exchange has to keep paying Bob his daily profits if Alice doesn't increase her margin. If Bob hypothetically makes a profit of $5,000 every day until the contract's term ends, the exchange will have to put up $350,000 ($5,000 x 30 days) from its clearinghouse reserves to cover the daily settlement and keep the market intact.

The problem here is simple: while all the open short positions in the orderbook are adequately collateralized, at least one long position (Alice's long position) is undercollateralized. Here, the profits on open short position cannot be offset by losses on open short positions because one of the long traders (Alice) has an inadequate margin balance. The daily settlement mechanism is designed to settle profits and losses between open futures positions by moving balances between the long and short sides of the orderbook; if one or more undercollateralized positions exist on one side, the bookkeeping math breaks down and the market becomes insolvent (i.e., unable to settle outstanding liabilities).

To keep the market solvent without having to use its own money, the exchange must have a perfect 1:1 ratio of collateralized short and long positions and zero out liabilities by offsetting total profits with total losses on open positions. Alice skews the ration by letting her margin balance fall below what is

required to cover the daily loss on her position. Hence, the exchange must find a new buyer to replace Alice in the market: the trader's new collateralized long position replaces Alice's underwater position, with their margin balance used to cover daily losses as well as profits on Bob's short position.

### Novation: How exchanges replace defaulting traders

For a trader to open a long oil futures position, someone else has to take the opposite side of the trade and open a short oil futures position. Replacing Alice thus requires the exchange to sell a replacement contract and open a short position, while the new buyer opens a collateralized long position that restores balance in the orderbook. This trade offsets the effect of Alice's default and protect the market's integrity by ensuring that every collateralized short position is matched by a collateralized long position.

Crucially, the exchange's short position does not actually show up in the orderbook, or else the market would have more short positions than long positions. The exchange is instead exploiting a special legal mechanism called *novation* to balance the books. Novation allows an exchange, acting as a clearinghouse, to replace a contract between two traders with separate contracts between each trader and the exchange. The original transaction is "novated" by the exchange becoming the counterparty to both sides; consequently, the two parties no longer have obligations to each other and instead have obligations to and from the exchange.

Novation in this context means Bob's oil futures contract is with the exchange, not Alice. Likewise, when a trader, let's call him Charlie, enters the market by buying an oil futures contract, his counterparty is the exchange. That said, the exchange becoming everyone's counterparty doesn't give it any financial obligations, at least if all open positions are adequately collateralized. When collateralized open positions and collateralized open short positions are cleanly matched, the exchange is a neutral party with zero liabilities and only works to manage the flow of balances between the two sides of the order book.

To understand why the exchange doesn't have obligations despite acting as the central counterparty, let's go back to the original example. When Bob made a profit on his short position, the exchange credited his account with funds taken from Alice's margin balance; similarly, it covered Alice's profit using cash deducted from Bob's initial margin. Although Alice and Bob each had separate contracts with the exchange, their positions were mathematically matched and canceled each other out. The exchange never had to settle profits and losses using its own money because each time a trader's long oil futures position profited, another trader's short oil futures position lost: the exchange simply had to cover each loss on a short position with the profit on each long position.

The exchange's orderbook become balanced after it sells the replacement contract to Charlie. Charlie and Bob are counterparties with the exchange, not each other, but they are both mathematically matched in the financial ledger. Each time Bob's short position is in profit, Charlie records a loss on his long position and his margin is used to pay Bob. Conversely, whenever Charlie's long position is in

profit, Bob makes a loss on his short position and his margin balance is used to settle Charlie's profit. As long as Charlie maintains a healthy margin balance, and never lets his position become undercollateralized, the exchange never has to step in to keep the market afloat.

One problem still exists, though. The exchange is not exempt from the rule requiring anyone opening a futures position to put up margin and has to deposit the same amount that Charlie deposits as initial margin ($7,000). The exchange is legally allowed to use Alice's margin to open the new short position (collateral becomes forfeit if a default occurs), but Alice only has $2,000 left. For the trade with Charlie to clear, the exchange has to put up an additional $5,000 to complete the margin requirement.

The problem here is that the futures price of oil can crash so hard during the day and drop a trader's margin balance below the amount required to place an offsetting trade if it becomes necessary to balance the books. To mitigate this problem, exchanges complement daily settlement with *intraday settlement*. Using intraday settlement allows exchanges to detect, in real time, when a trader starts accumulating significant losses and automatically place an offsetting trade while their margin balance is still within the ideal threshold.

## Intraday settlement in oil futures markets

In daily settlement, the exchange revalues oil futures positions (i.e., marks them to market) and settles profits and losses at the close of trading. In intraday settlement, the exchange revalues open positions throughout the day, deploying algorithms to monitor millisecond-level changes in live prices and apply real-time updates to traders' unrealized profits and losses. For each open position, the exchange's system asks: "If we closed trading at this moment and had to settle the accumulated losses (if they exist) with the trader's margin, would the account's value drop below the safety threshold?"

The safety threshold is often described as the *maintenance margin* and is different from the initial margin. The initial margin is the minimum deposit required to collateralize an oil futures position and enter the market; the maintenance margin is the minimum cash balance a trade must have in their margin account to keep that position open. Most exchanges set the maintenance margin slightly lower than the initial margin, treating the initial margin as the performance bond and the maintenance margin as the safety threshold below which a trader's position has to be liquidated and offset by an opposite trade to protect the market and keep the books balanced.

An exchange may set the maintenance margin at 90% of the initial margin, meaning the margin balance must never drop below an amount equaling 90% of the original deposit submitted when a trader opened their position. In our example, Alice and Bob's initial margin is $7,000; a maintenance margin of 90% requires the value of both traders' margin accounts to never drop below $6,300 after accounting for unrealized losses.

When the account balance drops below the maintenance margin, the exchange issues a "margin call" that requires the trader to make a deposit and bring the balance up to the level of the initial margin. If Alice gets a margin call, because her balance dropped below $6,300, she has to deposit enough funds to return the margin account to the $7,000 level. This requirement reduces counterparty risk for the exchange: it matches the exact amount required to close Alice's long position by placing an offsetting trade (i.e., the margin requirement for a new short position).

Should Alice fail to deposit additional funds after getting margin-called, the exchange automatically liquidates her oil futures position. In a liquidation, the exchange locks the trader's account, uses the margin balance to place an offsetting trade, and forcefully exits the trader from the market. Modern exchanges have sophisticated auto-liquidation systems that can instantly liquidate a trader's position the moment their margin drops by a single dollar below the maintenance margin. Auto-liquidations matter because intense swings in oil prices can spike losses on open futures positions, leaving them undercollateralized and forcing the exchange to keep the market solvent using its own funds.

By liquidating Alice and placing the offsetting trade when her margin drops to $6,299, the exchange caps its immediate financial exposure. It only needs to put up $701 in extra cash to meet the margin requirement for the offsetting trade with Charlie ($6,299 + $701 = $7,000). Because oil futures contracts are legally binding, Alice still has to pay the exchange $701 to cover the difference or risk facing real-world legal consequences. For example, the exchange can refer Alice's account to collections agencies or file a civil lawsuit to recover the funds; additionally, unpaid trading deficits may be reported to credit bureaus, which will harm Alice's credit score and make it difficult to open financial accounts in the future.

## Conclusion

Oil futures markets solve the counterparty risk problem in oil forward markets by introducing a centralized clearinghouse (an exchange) that clears trades and bears counterparty risk on behalf of market participants. The combination of centralized clearing and standardized contract terms makes oil futures easier to trade compared to oil forwards. Furthermore, traders can exit contracts before expiry by offsetting open positions, making oil futures ideal for gaining exposure to the price of oil without having to manage the underlying commodity.

Oil futures are particularly useful for commercial oil producers and consumers who seek short- and long-term protection from volatility in global energy markets. They are equally useful for speculators, arbitrageurs, hedge funds, trading houses, retail traders, and other market participants who want to trade oil price fluctuations with leverage. In oil futures trading, leverage maximizes capital efficiency for traders and provides the opportunity to make outsized gains on moderate investments when market movements align with a trader's open position. However, leverage can also magnify trading losses, making oil futures risky, particularly for under-capitalized market participants.

Although oil futures provide many benefits, certain limitations may limit their utility. As open positions are marked to market daily and intraday, participants have to maintain significant cash liquidity to keep positions open. Intense intraday price swings can cause margin balances to drop below the maintenance floor, triggering automatic liquidations and forced market exits. Also, because most oil futures are short-dated and operate on rigid monthly expiry cycles, market participants incur the financial and operational costs of continuously rolling over contracts to maintain long-term positions.

The next article in our series on oil markets will explore alternative financial instruments designed to overcome these limitations: **options** and **commodity swaps**. Oil options allow market participants, including hedgers and speculators, to lock in future oil prices without facing daily margin calls or being locked into a contract long after the market has moved against them. An oil option gives the holder the right, but not the obligation, to purchase or sell oil at a predetermined price, which is fundamentally different from an oil futures contract that legally requires both parties to fulfill the trade regardless of how much prices fluctuate (unless they exit open positions).

Commodity swaps are custom, bilateral, and legally binding agreements between two parties who agree to exchange cash flows based on the price of an underlying commodity. Crude oil swaps are structurally equivalent to a series of linked oil forward contracts, except physical oil is never delivered and only the net cash differences are settled. Oil swaps mirror the periodic settlement of cash-settled oil futures contracts, but they are negotiated over the counter and provide more flexibility around contract terms. These features make oil swaps useful tools for commercial oil producers and consumers to hedge highly tailored positions and smooth out long-term pricing volatility without going through an exchange. ■

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## Footnotes

**1.** When someone "sells" an oil futures contract, they are actually selling to the exchange; similarly, a trader who "buys" an oil futures contract is buying from the exchange. The obligation to buy and sell oil, written into the futures contract, rests on the exchange, not the individual buyers. If someone defaults, it is the exchange's responsibility to execute the defaulter's side of the agreement. As such, traders never have to worry about the person on the other side of a trade because the exchange assumes all counterparty risk and guarantees every trade. ↩

**2.** Traders accumulate losses and profits on open positions, as real-time prices fluctuate, though the profits and losses are *unrealized*. We discuss how the profit and loss (P&L) for an open oil futures position is calculated and explain why futures markets prefer to settle profits and losses daily instead of waiting until contracts expire later in the article. ↩

**3.** For example, oil futures contracts traded on the NYMEX exchange always have the terms: 1,000 barrels of WTI light-sweet oil delivered to Cushing, Oklahoma. Delivery dates are also fixed by calendar month: for example, a standard one-month oil futures contract on NYMEX stops trading three business days before the 25th day of the preceding month and physical delivery must occur within the next month. Thus, a September

WTI futures contract stops trading on August 25 and physical delivery must happen within the month of September. ↩

**4.** Oil forward markets are hard to form and scale because most contracts have different terms and valuations. If Alice has a forward contract for 10,000 barrels (@ $80 per barrel) delivered to Cushing in Oklahoma, she cannot easily trade with Bob who has a different forward contract for 5,000 barrels (@ $75 per barrel) delivered to Echo Terminal in Texas. ↩

**5.** The money a futures exchange uses to cover the financial obligations of a trader who defaults usually comes from its clearinghouse reserves or default waterfalls. ↩

**6.** If trading volume in the designated window is too low to calculate an accurate average, the two exchanges determine settlement prices in different ways. CME Group automatically aligns the settlement price to the closest available buy or sell quote, i.e., how much the last order to sell or buy oil futures prices a barrel of oil (source). ICE grants market supervisors discretionary power to manually establish a fair market value for oil, which will serve as the settlement price for that day. Market supervisors establish this value by analyzing calendar spreads, broader data from global energy markets, and other variables, though the final decision rests with the exchange (source). ↩