Futures and Forwards

The Basics

Overview

- Descriptions
- Contrasting Futures and Forwards
- Terminology
- Eurodollar Futures
- Treasury Futures
- Equity Futures

Sources

- An Introduction to Futures & Options, CME
- CME Eurodollar Futures, CME
- U.S. Treasury Futures and Options, CBOT
- The CBOT TUT Spread

Forward Contract

- A cash forward sale or forward contract is a **private negotiation made in the present that establishes the price of a commodity to be delivered in the future**
- The commodity does not change hands until the agreed-upon delivery date
- Farmers and merchants liked these arrangements because they could lock in prices ahead of time and not worry about price fluctuations in the interim

Example: a farmer can sell his/her wheat today at a price aggreed upon today and for delivery in the future. He knows exactly how much he will get, risk is reduced somewhat.

Futures and Forwards

- **Second largest group of interest rate derivatives** in terms of notional value
  - Swaps are the largest within this group.
- Largest group of **Foreign Exchange Derivatives**

Derivative which seek to hedge away the risk on changing interest rates.

Spot and Forward Contracts

- **SPOT CONTRACT**
  - Agreement at t = 0 (today) for immediate delivery and immediate payment
  - This price is the **Spot Price**
- **FORWARD CONTRACT**
  - Agreement to exchange an asset at a specified future date for a price which is set at t = 0 (today)
    - **COUNTERPARTY RISK**, there is a danger that if the seller moves into a profitable situation, the spot price has changed to his advantage, there is a risk that the other party, who is in a loss making position, may renege on the contract, not deliver the asset or cash at maturity. How do I ensure that the other party makes good on the contract? (next page)
    - this price is called the **Forward** or **Future Price**

Agreement today to exchange some asset for a price agreed upon today for immediately delivery (meaning 2 or 3 days). The agreed upon price is called the "**SPOT PRICE**", the current price I can get for that asset. Nice thing about Spot Contract is that it is resolved immediately.

Forward Contract

- If you've ever subscribed to a newspaper or magazine, you've entered into a type of forward contract
  - If you send in a check for a one-year subscription to The Wall Street Journal, The Wall Street Journal in return agrees to
    - Deliver a specific commodity (the newspaper)
    - At a specific time (each weekday)
    - For a specific, agreed-upon price

Price is locked in, cannot be increased because the seller is experiencing new added costs.

The forward contracts we will discuss are paid when goods are exchanged.

Forward Contract

- Forward contracting offers **SEVERAL ADVANTAGES**
  - The quantity, the quality level and the time of delivery of what you've agreed to purchase are **fixed**
  - Maybe more importantly you know with certainty what the price is going to be (price is known)
  - Price certainty is important because it enables both buyers and sellers to anticipate their costs, revenues and cash flows into the future

Counterparty Risk

- **Forward contracts were useful, but only up to a point**
  - They didn't eliminate the **risk of default** among the parties involved in the trade
  - For example, merchants might default on the forward agreements if they found the same product cheaper elsewhere, leaving farmers with the goods and no buyers

Just when you need the forward contract arrangement you've made to avoid loss is exactly the time the selling party is most likely to default! The protection you thought you had bought ends up disappearing! People rarely default when they have made money on contracts, tends to be the other way around.

Comparing Forwards and Futures

	Forward Contract	Futures Contract
Nature of Transaction	Buyer and seller make a custom-tailored agreement to buy/sell a given amount of a commodity at a set price on a future date	Buyer and seller agree to buy or sell a standardized amount of a standardized quality of a commodity at a set price on, a future date
Size of Contract	Negotiable	Standardized
Delivery Date	Negotiable	Standardized
Pricing	Prices are negotiated in private by buyer and seller, and are normally not made public	Prices are determined publicly in open, **competitive**, auction-type market at a registered exchange. Prices are continuously made public

Futures Contracts are exchange traded forward contracts. Traded on a regular exchange. The other differences are listed in the table above. They are custom tailored OTCs. Usually the contracts are standardized. Can sometimes be difficult to price a forward contract. It is a problem for banks. Futures are easier because constantly traded publicly.

Comparing Forwards and Futures

	Forward Contract	Futures Contract
Regulation	State or Federal laws of commerce	3 tiers: Commodity Futures, Trading Commission, National Futures Association, and **self-regulation by the exchanges**
Issuer and Guarantor	None	Exchange clearing house (important point). **DEFAULT RISK MUCH LOWER**

If I enter into a forward contract with a bank the two parties in the transaction are me and the bank. If I enter into a futures contract I'm entering into a contract with the exchange. The other party is also entering into a contract with the exchange. If the other party defaults I don't really care because the exchange is the party which owes me the money or requires me to deliver the asset.

THE EXCHANGEIS THE PARTY GUARANTTING THESE CONTRACTS!

Comparing Forwards and Futures

	Forward Contract	Futures Contract
Security Deposit	Dependent on credit relationship between buyer and seller. May be zero	Both buyer and seller **post a performance bond** (funds) with the exchange. Daily price changes may require one party to post additional funds and allow the other party to withdraw such funds
Getting Out of Deals	Difficult to do, so most forwards result in a physical delivery of goods	To get out of a deal the person would sell the opposite position and close out the account. Fairly straight forward and easy.

When you enter into one of these contracts nothing changes hands at that point. You have zero investment. At some point in the future you may make a profit or loss depending on what the price of the asset does compared to the agreed upon forward/future price. Inherently risky, very low investment but the profit you can make varies greatly. Usually some kind of protection built into the contracts so there is less chance of default. Security deposits are used, similar to margin account where you have to maintain a certain level of assets.

Performance bond is based on riskiness of the underlying asset (more below).

Performance Bond for Futures

- A **good faith deposit** you pay to indicate that you will be able to ensure fulfillment of the contract
  - **Guarantee** that both buyers and sellers will respectively **take or make delivery** of the commodity represented by the contract
    - **Unless they offset that obligation via an opposite and equal transaction** (THIS IS NOT UNCOMMON)

Initial Performance Bond for Futures

- Futures contracts require an initial performance bond in an amount determined by the exchange itself
  - The requirements are not set as a percentage of contract value
  - Instead, they're a function of the price volatility of the commodity
  - Brokerage firms are permitted to request higher amounts from their customers, but never less than the minimum set by the exchange

Depends on the type of contract. The riskiness of the position is the relevant thing. A gov bond can have a 1% bond whereas a mini S&P500 futures contract may have a 7.5% performance contract. Safe underlying asset requires less bond. Function of price volatility.

Initial Performance Bond for Futures

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  - The requirements are not set as a percentage of contract value
  - Instead, they're a function of the price volatility of the commodity
  - **BROKERAGE FIRMS** are permitted to request higher amounts from their customers, but **never less** than the minimum set by the exchange
- Maintenance Level
- If at any time the traders account dips below a specified maintenance level they are required to add money to keep the account up to the initial performance bond level

The price of a futures contract changes everyday because it is traded actively. The profit or loss made can be credited to my account. if my bond or asset value falls below a certain pre-specified amount I may have to post more. Similar to margin accounts.

Marked-to-the-Market

- At the end of the trading day your position is **marked-to-the-market**
  - Money is added to the performance bond balance if the position has made a profit that day
  - If the account sustained a loss that day, money is deducted from the performance bond account
  - This rebalancing occurs each day after the close of trading

In the same way that a spot price for an asset changes on a daily basis, the futures price for an asset for the same contract changes on a daily basis. Everyday your contract will mean that you have made a profit or loss compared to the previous day. This is called **marking-to-market**. Sometimes your position is adjusted to the market value twice a day but always at least once.

Last Trading Day

- Every futures contract has a last day of trading, and all open positions must be closed out by this last trading day
  - For a **physical delivery contract** like CME Live Cattle, the open positions can be closed out by making an offsetting futures trade (selling) or by making/taking physical delivery of the cattle
  - For **cash-settled futures contracts**, positions can be closed out by making an offsetting futures trade (selling your position) or by leaving the position alone and having it closed out by one **final mark-to-market settlement adjustment**. One final debit or credit to your account.

In some futures contracts there really isn't an underlying asset and the only way to close them out is a final market-to-market. Final profit or loss, small last adjustment.

Terminology

- **Going Long**
  - If you buy a futures contract to initiate a position, you would be long, you've agreed to buy the commodity in the future.
  - A person who has purchased 10 pork belly futures contracts is long 10 pork belly contracts
  - Someone who is long in the market **expects prices to rise**
    - They expect to make money by later selling the contracts at a higher price than they originally paid for them

Futures Contract: futures price on a standardized contract as it is traded its future price changes. Kind of like the strike price is moving if you must compare to an option. No premium, price is the agreed price at which you will deliver (variable). Profits / losses because the future price changes as trades happen. Buyer is hoping future price goes up.

Option: premium changes but the strike price stays the same.

- **Going Short**
  - Someone who sells a futures contract to initiate a position is said to be short
  - Someone who is short in the market **expects prices to fall**
    - They expect to make money by later buying the contracts at a lower price than they originally sold them for

- **Contract Maturity**
  - Futures contracts have limited lives, known as contract maturities
  - Contract maturity is expressed in terms of months
  - Many contracts expire quarterly — towards the end of March, June, September and December

As you approach the closest quarter monthly contracts become available to be traded.

- **Delivery**
  - **Only about 3% of all futures contracts actually result in physical delivery or cash settlement** of the commodity (most contracts are closed out before expiration).
    - The other 97% are simply offset
  - **For some futures contracts, such as stock index futures, there is no physical delivery** (future delivery does not exist)
    - Rather, **positions are closed out through cash settlement**
    - The final gain or loss applied to the performance bond accounts

And notice that only 3% are even cash settled!

Calculating Profits and Losses in Trading

- **FUTURES CONTRACTS** move in minimal increments called **ticks**
  - The value of a tick is different for each futures product
  - For example, the value of a tick for a CME E-mini S&P 500 futures contract is 0.25 of an index point, the index is the S&P500 index.
  - The value of a 0.25 tick is therefore $50 x 0.25, or $12.50 per contract (for this particular contract). Granular, make or loss money in $12.50 increments.

How are Futures Prices Determined?

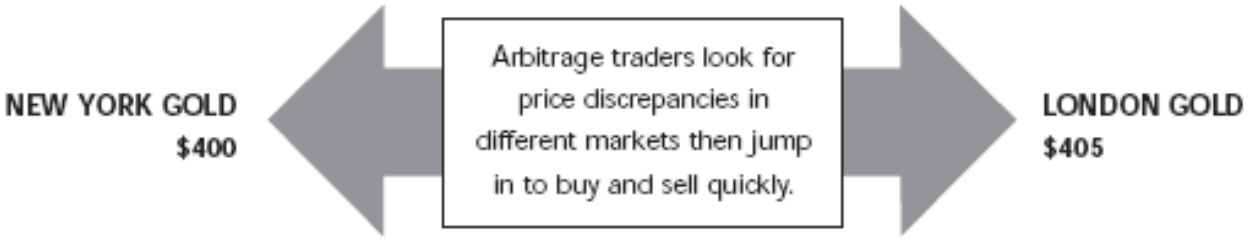
- Answer supply and demand
- Correlation to the value of the underlying asset

Supply and demand, how many people want to go long versus how many want to go short. A market clearing price. This is not to say that there is no connection between a futures price and the spot price. If the spot price of the S&P500 (for example) goes up, the futures price is likely to go up as well. Not a perfect correlation but because of arbitrage there is likely to be a connection between the two.

Contrast buying a portfolio of S&P500 stocks now or getting into a futures contract. Futures contract allows me to make a profit or loss without having to spend my money today. So there will be an interest rate component, a carrying cost. The futures contract does not have the benefit of dividends. So the prices will move in tandem but not perfectly correlated (yes correlation to underlying asset but not perfect).

What Keeps Futures Prices in Line?

- **ARBITRAGE** can be defined as the simultaneous purchase and sale of equivalent commodities (either cash or futures) in different markets in order to profit from price discrepancies



- **Arbitrage traders play a very important role in futures trading**. By acting on price discrepancies, **they help bring balance and order back into the market**

For instance if an investor believes the S&P500 is way overvalued he may sell his futures and buy spots seeking an arbitrage profit.

Eurodollar Futures

- Contract Size $1,000,000
- CME **Eurodollar futures prices are determined by the market's forecast of the 3-month London Interbank Offered Rate** (LIBOR)
  - * **The futures prices are derived by subtracting that implied interest rate from 100.00**
    - **For instance, an anticipated interest rate of 5.00 percent will translate to a futures price of 95.00 (100.00 – 5.00 = 95.00)**

This is an example of a contract where there is no underlying asset. The contract is 1 million but the performance bond is only $4000. There is no delivery, you never take delivery of 1 million dollars. This is just used to calculate profits or losses, that is all it does. It measure 3 month LIBOR offering rate, an interest rate used around the globe, banks use it to lend to each other, very liquid market, important rate. That is why this derivative appears, people need to hedge movements in LIBOR.

Futures prices are derived from supply and demand. Example: **suppose the market believes that when this contract expires LIBOR will be 5% (markets prediction). So how will the market price this contract? It will be 100 – 5 = 95**. So the price of this futures contract is $95. How do you make money? If interest rates rise the price of the contract goes down. If the market sells at $95 it is predicting the LIBOR will be 5% when this contract expires. No one sets the price by doing a calculation, it is traded. Market is predicting 5%. Now suppose something happens and the market changes it prediction to 6% LIBOR when this contract expires. If the market sells at $95 it is predicting the LIBOR will be 5% when this contract expires. No one sets the price by doing a calculation, it is traded. Market is predicting 5%. Now suppose something happens and the market changes it prediction to 6% LIBOR when this contract expires. The price of the contract goes from 95 down to 94. A dollar is lost per contract. Now if you go long you are predicting LIBOR is going to go down. You profit when the price

goes up and that happens when LIBOR goes down. Is you go short you are predicting that LIBOR is going to go up.

Basics (continued)

- Given this price construction, if interest rates rise, the price of the futures contract falls, and vice versa. Therefore,
  - To **profit from declining interest rates**, a trader would buy the futures contract (known as "**GOING LONG**")
  - To **profit from a rise in interest rates**, a trader would sell the contract (known as "**GOING SHORT**")

Contract Months extend out 10 years, quarterly

- Mar, Jun, Sep, Dec, extending out 10 years (total of 40 contracts available to trade at any given time) can place bet on what LIBOR will do from 3 months to 10 years.
  - Plus the four nearest serial expirations (months that are not in the March quarterly cycle). You get an additional 3 months worth of contracts in the beginning.
- The new contract month terminating 10 years in the future is listed on the Tuesday following expiration of the front quarterly contract

If you are someone who depends on LIBOR you can use this market to hedge movements in LIBOR, can lock in a LIBOR rate.

Example of Price Quotes, actual CME Eurodollar futures.

PIT FUTURES

CME Eurodollar Futures

Pit-Traded prices as of 03/28/08 10:44 am (est)

MTH/	--- SESSION ---					PT	EST	---- PRIOR DAY ----		
STRIKE	OPEN	HIGH	LOW	LAST	SETT	CHGE	VOL	SETT	VOL	INT
APR08	97.4175	97.4175	97.41A	97.415A	----	-1.25	294	97.4275	27742	147845
MAY08	----	----	97.625A	97.63A	----	UNCH	74	97.63	3783	18829
JUN08	97.71	97.725	97.70A	97.71B	----	UNCH	3371	97.71	198278	682453
JLY08	----	97.79B	----	97.79B	----	+.5		97.785		
AUG08	----	97.83B	----	97.825A	----	UNCH		97.825		170
SEP08	97.82	97.86	97.82	97.83	----	-.5	3795	97.835	242856	381388
DEC08	97.725	97.77	97.725	97.74	----	+.5	6445	97.735	283757	389082
MAR09	97.67	97.715	97.665	97.685	----	UNCH	3899	97.685	273135	57386
JUN09	97.45	97.51B	97.45	97.475A	----	UNCH	7064	97.475	241346	894014
SEP09	97.225	97.29B	97.22	97.26	----	+1	3485	97.25	205882	813147
DEC09	96.965	97.01B	96.95A	96.98A	----	+.5	2438	96.975	163641	565038
MAR10	96.75	96.815B	96.75	96.78A	----	+.5	3992	96.775	118835	338690
JUN10	96.53	96.59B	96.53	96.56A	----	UNCH	1275	96.56	48858	242278
SEP10	96.31	96.375B	96.31	96.35A	----	+.5	1160	96.345	35983	195851
DEC10	96.135	96.16	96.105A	96.145A	----	+1	1075	96.135	23841	175451
MAR11	95.955	96.01	95.955	95.995A	----	+1	1539	95.985	16777	112264
JUN11	95.82	95.88B	95.815A	95.86A	----	+.5	1433	95.855	9449	107684
SEP11	95.70	95.755B	95.695A	95.74A	----	+.5	1838	95.735	9049	67830
DEC11	95.605	95.63B	95.575A	95.62A	----	+.5	1948	95.615	7651	74926
MAR12	95.53	95.595B	95.485A	95.53A	----	+.5	1138	95.525	7510	84164

FORECAST

April 8th last trade means the market was predicting LIBOR at about 3.75% when this contract expires (in about 3 weeks time). This price is driven by supply and demand, not set by some person. We could construct a LIBOR yield curve based on these EURODOLLAR futures. Very active market. June 08 open interest is 682,000 contracts, very active market. Each is $1 million of notional value.

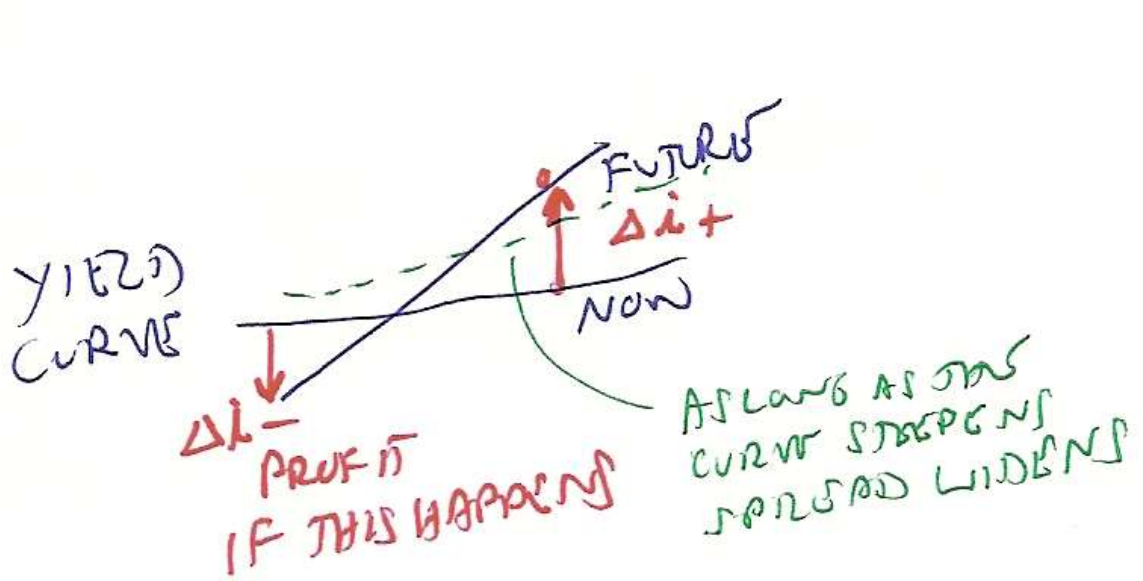
Settlement

- Last Trading Day
  - Second London bank business day prior to the third Wednesday of the contract month
- Final Settlement
  - Cash settlement to the British Bankers' Association survey of 3-month LIBOR
  - Final settlement price will be rounded to four decimal places, equal to 1/10,000 of a percent, or $0.25 per contract

How are these things actually settled? Not like a pork belly, you do not take delivery. What is the underlying "thing" used to set the price? It is done by the bankers getting quotes (above). 16 quotes, average the middle 4. This is how the final closing price is settled. Marked-to-Market everyday, happens each day.

Example – Trading Strategies

- Steepening Yield Curve Strategy
  - **General perception is that economy remains weak** and the **Federal Reserve is expected to do either nothing or to possibly lower interest rates** again
    - Buy the shorter maturity CME Eurodollar future because my bet is that the price movement is going to be an increase in interest rates at the long end and a decrease in interest rates at the short end. When I buy the short end I make money from decreasing interest rates.
    - Sell the longer maturity CME Eurodollar future
  - Anticipation that this spread will widen



As long as the yield curve steepens I will still profit. Doesn't actually have to mean that I profit at both ends. Anticipating that the spread is going to widen. Do something like trade 2 years and 10 year LIBOR, these two give an idea of the shape of the yield curve. Betting that the difference between the two and the ten is going to widen, that is the position I've taken.

Example – Trading Strategies

- Flattening Yield Curve Strategy
  - The economy is expected to strengthen further and the Federal Reserve is expected to raise short-term interest rates to head off a potential rise in inflation
    - Sell the shorter maturity CME Eurodollar future
    - Buy the longer maturity CME Eurodollar future
  - Anticipation that this spread will tighten

Flattened yield curve is the opposite, betting that the spread is going to narrow, therefore sell the shorter and buy the longer.

How Do Treasury Futures Work?

- Generally speaking, futures contracts can act as a substitute for the cash (spot) market with one major distinction:
  - Where a cash transaction demands immediate payment and delivery,
  - A futures contract provides for the delivery of the cash security at some later date.
- Futures allow the buyer and seller to agree upon the price today but defer delivery of the instrument and its payment until a future date
- The standardization of financial futures allows market participants to offset their obligations to make or take delivery by simply executing an offsetting trade to cover the existing position.
- It is a standardized asset, has performance bonds or margin requirements
- Expires on fixed dates during year. (more below)
- Can be closed by trading the opposite position. Can't take delivery of the underlying bond.
- Bought & Sold on CBOT

The futures price is calculated based on 100 – the markets forecast of LIBOR, no real carrying cost. Futures price is based on supply and demand. On the settlement date the vba produces a estimate of the 3 month LIBOR based on a survey of 16 banks and the average of the 4 middle quotes. This value becomes the final closing price of the contract. At that point the thing has its final mark-to-market and the final profit or loss is calculated.

Up to the settlement date the futures price is driven by supply and demand. At the settlement date its value is calculated on the spot LIBOR 3 month rate. This is a fairly synthetic contract.

Closing Price: can be based on quite a complicated set of events but the basic idea is that the underlying asset delivered is a treasury security.

Why are Treasury Futures Needed?

- Products for those who wish to hedge specific interest rate exposures
- And speculators who wish to take advantage of price volatility

Banks will use to hedge certain things.

How Do Treasury Futures Work? (continued)

- The terms of a futures contract are not negotiable
  - Each futures contract "defines the instrument traded", there is a choice of which instrument the seller actually delivers. (below)
  - Its notional value, contract size for 5 year T-Notes is $100,000 face value bond or debt security.
  - Price quotation (fixed, fractional)
  - Settlement method, there is delivery but can also settle by closing out and selling the opposite position. Your contract is with the exchange!
  - Expiration date is fixed.
- The price of the futures contract becomes the single point of negotiation
- The futures contract will track the price of its underlying cash security
- CBOT Treasury futures are not coupon bearing instruments

The above items are all standardized. The only thing that changes for a particular contract is the futures price. This price is driven by supply & demand.

If interest rates in economy go up bind price fall (generally). The futures price will also fall (generally) but will not be a one-to-one correlation. Will track direction of the underlying asset.

This is kind of like buying or selling a treasury security. But a difference is if you buy a treasury security in the spot market you are eligible to receive the coupon if it pays a coupon if it pays a coupon during your ownership of the security. If you buy a futures contract you do not have the rights to the coupon of the underlying asset (only possibility is when the position settles and you take delivery and there is a coupon). Only slight difference is that on the settlement date there is a calculation of a accrued coupon at the settlement date.

Generally, if a treasury note pays a coupon and you own a futures contract over that treasury note you do not get the coupon payment.

CBOT Treasury Futures: Key Concepts

- The underlying instrument for CBOT **T-bond, 10-year T-note** and **5-year T-note futures** contracts is a $100,000 face value U.S. Treasury security
- Since the **U.S. government issues significantly more debt in the 2-year maturity sector** than any other, there are more 2-year Treasury securities traded in the underlying cash market (more liquid).
  - To accommodate the resulting need for trades of greater size, the CBOT designed its **2-year T-note futures contract** to have a **face value of $200,000** to provide economies of scale for market participants (because this market is so large, bigger blocks, otherwise commissions would eat all profit).

Types: T-Bond, 10-year T-Note contract, 5-year T-Note contract. The $100,000 is a reference value. With 2-year note you are buying a bond with a PAR value worth $200,000.

TREASURY FUTURES: Comparing Contract Specifications

	Bond Futures	10-yr Note Futures	5-yr Note Futures	**2-yr Note Futures**
Face (PAR) Amount	$100,000	$100,000	$100,000	**$200,000**
Maturity	15 years +	6 1/2 to 10 years	4 1/2 to 5 years	1 1/2 to 2 years
Notional Coupon	6% coupon	6% coupon	6% coupon	6% coupon
Minimum Tick	1/32=.03125	1/64= .015625	1/64	1/128
Minimum Tick Value	$31.25	$15.625	$15.625	$15.625

Notional Coupon: in essence you buy a treasury future for x years you really buy a note with a $100,000 face value with a certain percent coupon and maturity of certain period.

We will see below when these things are settled the seller gets to chose from a range, the price of the choices is adjusted to bring each one of them back to a coupon of **X** percent. Each note is worth a different amount depending on coupon percentage, will adjust using a conversion factor to make equivalent.

Keep in mind you may have a 3 year futures contract on a 10 year note. Each of the three futures contracts described in the table above could have the same maturity but the underlying asset need not have that maturity date.

TICK EXAMPLE: 97:45 $\Longrightarrow$ $97 + \frac{45}{64} = 97.703125$ (per $100 ?)

Price Increments

- Price movements for Treasury futures are denominated in fractions of a full percentage point
  - These **MINIMUM PRICE INCREMENTS** are called **TICKS**
- T-bond futures trade in minimum increments of one thirty-second of a point equal to $31.25
- The 10-year and 5-year T-note futures trade in minimum price increments of one half of one thirty-second with a tick value of $15.625
- The minimum tick size of the 2-year T-note contract is one quarter of one thirty-second, and since its face value is double the size of the others, its tick value is $15.625

Conversion Factors

- A Treasury futures contract is a **proxy** for a variety of **issues** within a specified range of **maturities**
- To allow the futures price to reflect the full range of issues eligible for delivery, the CBOT developed a conversion factor system
  - Facilitate the T-bond and T-note delivery mechanism
  - Adjust for the coupons eligible for delivery into the futures contract
- Conversion factors link the different prices of the many eligible cash instruments and the single price of the corresponding standardized futures contract

If you had a futures contract over just 1 T-Note of T-Bond the market may be manipulated. May not be liquid. To prevent this you can actually deliver a bond or note from a range of choices based on the listed (table above) ranges of maturity. Each bond or note within the range will have different coupons. In that way each has a fundamentally different price. Ex, 15% coupon will be priced a lot higher than a bond with 3% coupon. This would allow the seller to deliver the one cheapest to him (one cheapest for him to buy and pass along). What will the price of the underlying asset be dependent on? Many things but one thing is the coupon of the asset being delivered. This is where the conversion factor comes in, each one of the possible securities that I can use to settle the contract is converted. The conversion adjusts that actual coupon to a 6% coupon.

Look at actual note, ascertain the coupon and the corresponding price, then say "if it had a 6% coupon what price would it have?" Then adjust the actual value based on the price you came up with.

This scheme gives people the ability to offer a range of products for sale, brings liquidity into market, prevents market manipulation.

Conversion Factors (continued)

- A specific conversion factor is assigned to each cash instrument that meets the maturity specifications of a Treasury futures contract
- This is used to **ADJUST THE PRICE OF A DELIVERABLE BOND OR NOTE**, **GIVEN ITS SPECIFIC MATURITY AND YIELD CHARACTERISTICS**, **TO THE EQUIVALENT PRICE FOR A 6% COUPON**
- This renders each of these securities comparable for the purpose of delivery into a single generic futures contract

Adjusting back to a 6% coupon. Each in the below table is comparable for delivery but not exactly the same. There is still an advantage of picking one over the other.

CBOT 10-year U.S. Treasury Note Futures Contract

	Issue	Maturity	Cusip	Issuance	6% Conversion Factors	
Coupon	Date	Date	Number	(Billions)	Jun. 2008	Sep. 2008
4	02/17/04	02/15/14	912828CA6	$27.0	0.8870	0.8902
4	02/15/05	02/15/15	912828DM9	$23.0	0.8744	0.8774
4 1/8	05/16/05	05/15/15	912828DV9	$22.0	0.8793	0.8822
4 1/4	08/15/03	08/15/13	912828BH2	$31.0	0.9069	-----
4 1/4	11/17/03	11/15/13	912828BR0	$29.0	0.9040	0.9069
4 1/4	08/16/04	08/15/14	912828CT5	$23.0	0.8955	0.8983
4 1/4	11/15/04	11/15/14	912828DC1	$23.0	0.8927	0.8955
4 1/4	08/15/05	08/15/15	912828EE6	$21.0	0.8848	0.8873
4 1/2	11/15/05	11/15/15	912828EN6	$21.0	0.8990	0.9013
4 1/2	02/15/06	02/15/16	912828EW6	$21.0	0.8968	0.8990
4 3/4	**05/17/04**	**05/15/14**	**912828CJ7**	**$25.0**	**0.9273**	0.9294
4 7/8	08/15/06	08/15/16	912828FQ8	$21.0	0.9194	0.9209
5 1/8	05/15/06	05/15/16	912828FF2	$21.0	0.9385	0.9398

- This table contains **conversion factors** for all long-term U.S. Treasury notes eligible for delivery as of **September 12, 2008**

These are all different 10-year notes that fall within the category of being in this range. The person who sold the futures contract will decide which one of these to deliver. Because they all have different coupons and thus different value, and different maturities as well, there are conversion factors which bring the values to a common level. However there will still be differences even after applying the conversion factor. So there is still an opportunity for the seller to deliver the cheapest possible debt security. But the conversion factors bring them all to a pretty consistent value.

A security with a coupon less than 6% will be priced at a discount to a 6% bond and will thus have a conversion factor less than 1.

(see next page also)

Conversion Factors (continued)

- A conversion factor represents the price, in percentage terms, at which $1 par of a security would trade if it had a 6% yield to maturity
  - Issues with coupons less than 6% will have conversion factors less than 1 to reflect that the issue is priced at a discount
  - Issues with coupons greater that 6% will have conversion factors greater than 1 to reflect that the coupon is priced at a premium

EXAMPLE: Invoice Price

- If a Treasury futures contract position remains open following the last day of trading in a given delivery month, the dollar value of the securities that would have to be delivered against the open position is reflected by the "invoice price"
  - The price the buyer, or "long," will pay the seller
- The invoice price is calculated by multiplying the conversion factor by the futures settlement price of a specified contract month, then adding accrued interest

Last day of trading, will be delivered against an open position with an invoice price calculated. The invoice price is the price the buyer ("the long") will pay the seller. Calculated as below (semi-annual coupon payments so coupon/2):

Invoice Amount = Contract Size x Futures Settlement Price x Conversion Factor + Accrued Interest

where: $\text{Accrued Interest} = \frac{\text{coupon}}{2} \times \frac{\#\text{ days since last coupon payment}}{\#\text{ days in coupon period}}$

(accrued interest is paid when you buy something which has been earning interest, I am repaying the seller for any interest the bond had earned)

- To **determine the invoice price** of the 4 3/4% 8-year note deliverable against the 10-year note futures contract (the 10 year is being delivered?)
- Assume a settlement price of **110-08 = 110 + 8/64 = 110.125** for Dec 2008 futures. This means that every $100 of notional value sells for $110.25. So to adjust the $100,000 price it must be grossed up by the factor 110.125/100

Invoice Amount = ($100,000 x 1.10125 x **.9273**) + Accrued Interest
= $102,118.91 + Accrued Interest

[110-08 = 110 + 8/64 = 110.125] so $100,000 is priced at

$100,000* $\frac{110.125}{100}$ =$110,125 so the invoice amount is $110,125x0.9273 +Accrued Interest

Accrued Interest
= (Coupon / 2) x (# Days since Last Coupon Payment / # Days in a Coupon Period)
= (**4.75%/2**) x 100,000 x 35 / 181 **= $459.25**

Invoice Amount = $102,234.83 + **459.25** = **$102,578.16 ← settlement price**

Invoice amount = settlement price which includes accrued interest, marked-to-market daily based on positive futures price (supply & demand).

Cheapest to Deliver

- When delivery occurs it is the choice of the seller, or "short," to determine which issue to deliver. He can chose from the range, the invoice price is calculated and the profit or loss is accounted for. He will chose the one which is cheapest to deliver, the one which gives him the largest profit on the contract.
- The cash instrument chosen is the most economical for the short to deliver
  - i.e., the security that maximizes the return of buying the cash security, holding it until delivery and then delivering it into the futures
- Since they will have to go into the cash market and purchase the security for delivery, the short seeks the particular cash instrument that maximizes the difference between what he pays for it and the invoice amount he receives from the long
- That security which maximizes this difference (i.e., has the lowest purchase price for the short) is called the "cheapest-to-deliver" security (CTD), and it is this instrument that the futures price tracks most closely

There is a correlation between spot and futures price. The correlation is to the spot price which is cheapest to currently deliver versus the futures contract. Supply & Demand but anchored to the cheapest to deliver.

You can calculate an arbitrage price, if you have enough money it is quite easy to set up a hedge to take advantage of arbitrage price opportunities between the underlying securities and a futures contract. Therefore the futures contract will correlate quite well with the cheapest to deliver. (arbitrage price calculation below)

Dollar Value (DV01)of a Basis Point

- The best way to measure the interest rate risk of a security is to quantify **how much the security's value changes when the yield moves by a single basis point**
  - This is referred to as the dollar value of a basis point, or the "Dollar Value of an 01" (DV01)
- Using the price of the security and its modified duration, a close estimate of the DV01 of a cash security

DV01 = .01 X ((.01 X modified duration) X price) [.01 x .01 is 1/10,000]

We want to know the sensitivity of the futures contract to underlying changes in interest rates. If I have a bond portfolio I can estimate what a 1 basis point change does to my portfolio value. DV01 is an equivalent measure. Estimate of how much the futures price is going to change based on a change of 1 basis point in the underlying security.

Change in value of a bond = modified duration * value of bond * interest rate shock

ΔBond ed Duration * Bond Price * Interest Rate shock

Given modified duration and price we can find DV01 because it is the change in the value of the bond given a 1 basis point change in i, the underlying yield to maturity. 1 basis point = 1%/100 = .0001

EXAMPLE

- Consider: 4 1/8s of May 2015 10-year Treasury note
  - Assume that it is the **CTD (cheapest to deliver)** and the security tracked by the Mar 2008 10-year Treasury note futures contract
- The **modified duration for this security is 7.940** and the **traded price on this day is 99-15** (this is the security currently being used to price the futures contract, this is the one we could use to manufacture a futures price arbitrage profit).
  - A **dollar amount of $99,468.75** where face value is $100,000
- The dollar value of a yield change of one basis point would be:

$$DV01 = .01 \text{ X } ((.01 \text{ X } \mathbf{7.940}) \text{ X } \mathbf{\$99{,}468.75} = \$78.98$$

This DV01 is for the bond, the debt security (not the treasury futures contract)
So here we have almost $79 change for every 1 basis point change.
THESE MOVE IN OPPOSITE DIRECTIONS. 1 BASIS POINT UP MOVES DEBT SECURITY PRICE DOWN!

DV01 of a Treasury Future

- Technically speaking, Treasury futures do not inherently have a DV01 since they are not coupon-bearing securities
  - They derive their DV01 from the instrument they track, which is usually the CTD or the on-the-run (most recently issued) Treasury security
- To move from the cash DV01 (meaning the underlying debt security) to the future's DV01 is simple

Take the cash **DV01** and **divide** it by the **conversion factor** for the security

If conversion factor < 1 price of underlying security is < $100,00 therefore it is subject to greater swings given a 1 basis point change. We divide by CF to magnify that effect.

Suppose we are trying to calculate the DV01 for the Mar 2008 10-year note futures
  - Suppose the 4 1/8s of May 2015 10-year Treasury note is the CTD
- The conversion factor for the 4 1/8s for the Mar 2008 future is .8793

$$\text{Future DV01} = \frac{\text{Cash DV01}}{\text{Conversion Factor}} = \frac{\$78.98}{.8793} = \$89.82$$

This is telling us that if these two things, the futures contract and the underlying security, were PERFECTLY correlated than a 1 basis point increase would lead to a $89.82 decrease in our futures contract. Keep in mind futures prices are driven by supply & demand, cash prices are driven by supply and demand in the spot markets, arbitrage should keep the two fairly close together but there is no guarantee on any particular day they are going to move exactly the same.

The above is telling us if we want to hedge this particular contract we do not need quite as many futures contracts because I get a bigger bang for buck on futures contract compared to underlying swap contract. A futures contract is leveraged in a sense. Bigger swings.

Arbitrage Pricing

Constructing an equivalent portfolio which will give same payoff (with some assumptions) as the futures contract therefore the price of this replicating portfolio has to be the same as the price of the underlying security. (same as the binomial method above).

- Consider two strategies
  - Borrow money and buy the underlying bond (strategy 1)
  - Buy the futures contract (strategy 2) investment in a bond today without paying for it, this is equivalent as long as we can do it.
- Ignoring mark-to-market issues and accrued coupons (profits will not be the exact same in each)
- Suppose we can borrow at a rate of 5.05%, approx. risk-free rate for 5 wks

Arbitrage Pricing: Strategy 1; barrow & buy

- The deliverable bond is selling for $98,230
  - Buying one bond costs $98,230
  - Borrow $98,230 at an annualized rate of 5.05%
  - Cash flow today is zero because we use the barrowed money to buy the bond today in the spot market.
  - At settlement (6 weeks from now) (paying back what we barrow plus interest):

Loan Repayment = $98,230 x (1 + 5.05% x 42/365) = $98,801

Arbitrage Pricing: Strategy 2

- Suppose the futures price is defined as F, go long with futures contract
  - Cash flow today is zero (ignoring performance bonds)
  - The conversion factor is 0.9040
  - At settlement we will be invoiced (assuming no accrued interest):

Invoice = F x conversion factor = F x 0.9040

Hypothetically, since both strategies are identical, the futures price should be equal to $109,095.

No Arbitrage

- The cash flows must be equal therefore setting the two strategies solutions equal gives: 0.9040 x F = $98,801 and F = $109,095

THIS SHOULD BE THE FUTURES PRICE FOR THIS UNDERLYING CONTRACT…

← Example Continued

If the two prices are not close there are arbitrage opportunities. Not a prefect analysis, people cannot barrow at the risk free rate, there are performance bond requirements, there is accrued interest. Yet there has to be some link between a futures price and a spot price.

COMMON TREASURY FUTURE TRADES

Yield Curve Spread Trading: Tens Under Twos Trade

- Two-year to 10-year yield curve segment captures the essence of the yield curve
  - A trade known as the TUT ("tens under twos") spread
    - Which involves two-year and 10-year T-note futures
  - Offers a useful way to trade yield curve spread shifts

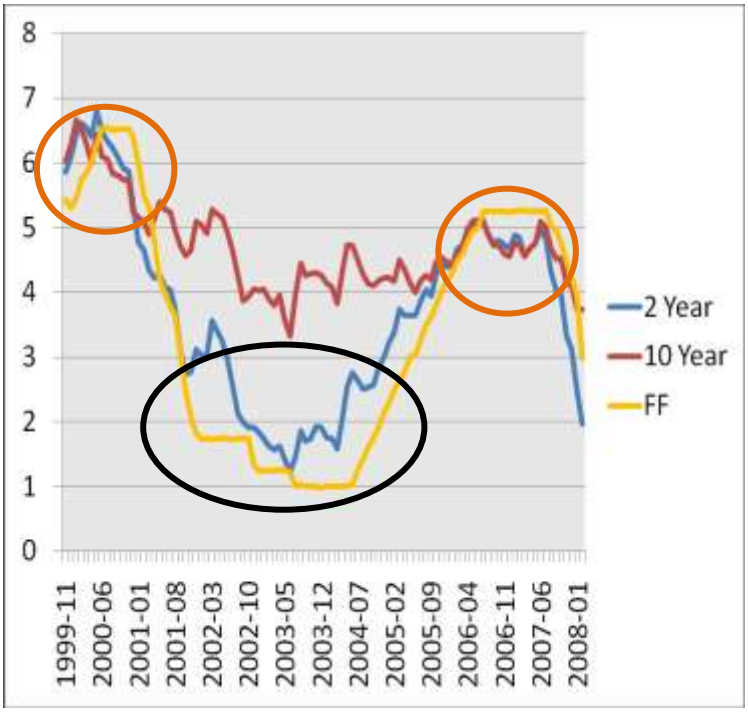
In this trade we are betting on the direction of movement in the yield curve. Will it steepen, will it flatten? Tens under Two means it involves a ten year and a two year treasury notes futures contract.

← Example Continued

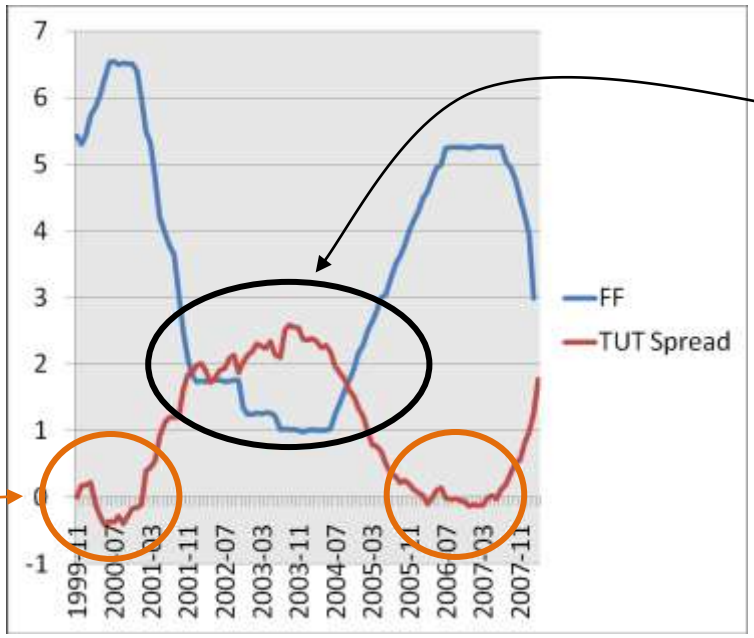
- When the Federal Reserve is actively shifting its monetary policy, the two-year yield will track the Fed Funds target rate, 2 year is more influenced by changes in the fed funds rate.
  - The 10-year yield is far less sensitive to changes in Fed policy (10 year tends to set the price for mortgages so it is not a surprise that mortgage rates do not change every time the FED changes the short term rates)

(see graphs next page)

FF: Fed Funds rate



Green is the 2 year note YTM (recall it is very influenced by FF rate). Red is 10 year, not as correlated as the FF rate.



Flat Yield Curve Regions

Steep Yield Curve Region

10 year yielding 200 basis points more than 2 year.

TUT Spread is the **difference** between the 10 and 2 year note yields.

The difference between the 10 and 2 year rates is often used as a proxy for the shape of the yield curve.

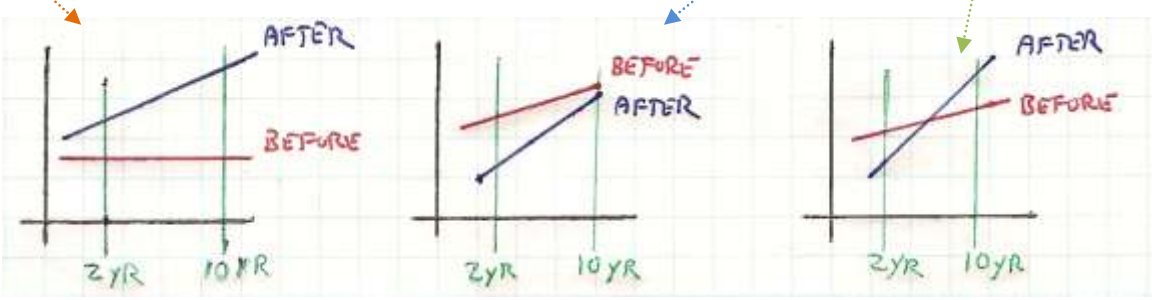
Notice that as the Fed Funds are being cut the yield curve steepens. As Fed Funds increases the yield curve flattens.

TUT Spread Strategy

- Buy the spread when you anticipate a widening yield curve spread (you believe the yield curve is going to become steeper) buy the TUT spread.
  - To **buy the TUT spread**, you buy two-year T-note futures and sell 10-year T-note futures, you believe the yield on the 10 year is going to move away from the yield on the two year. They both will change in price, may both go up or both go down, but you are betting the 10 year will see more drastic price changes than the 2 year note. Betting the 10 will decline in value faster than the 2 year note.
- Sell when you anticipate a narrowing spread
  - To sell this spread, you sell two-year and buy 10-year T-note futures

Advantages of the TUT Spread

- If you **BUY** the spread, **you gain when** the spread widens, as it will when:
  - Both yields rise but the two year rises less than the 10 year both yields go up but the two goes up less than the ten.
  - Both yields fall but the two year falls more than the 10 year, profit on the long position, loss on the short. Hoping the long profit is greater than the loss on the short position.
  - The two-year yield falls while the 10-year yield rises, profit on long position and on short position. Betting on the yield curve steepening.



Think in opposite directions, when yield goes up bond price falls. Betting that one price falls less than the other.

- If you **SELL** the spread, **you gain when** the spread narrows, as it will when:
  - Both yields rise but the two year rises more than the 10 year
  - Both yields fall but the two year falls less than the 10 year
  - The two-year yield rises while the 10-year yield falls

When the yield curve becomes steeper buy the spread.
When steep and then flattens sell the spread.

Filtering out Market Direction with Spread Ratios

- Because two-year and10-year T- note prices react differently to a given yield change, you cannot simply trade equal numbers of futures contracts and expect the result to capture the spread change accurately

  - **The best way to calculate spread ratios is to use DV01s**

$$\text{Future DV01} = \frac{\text{Cash DV01}}{\text{Conversion Factor}}$$

DV01 = .01 X ((.01 X **modified duration**) X **price**) [.01 x .01 is 1/10,000]

EXAMPLE

- Suppose 2-year T-note futures DV01 per $100 par is 0.01716
- And suppose 10-year T-note futures DV01 per $100 par is 0.06320 (has much higher modified duration)
  - **Be careful, the 2-year contract has twice the size of the 10-year contract meaning the notional value is $200,000!**
  - So buy in the proportions of
    0.01716 x **2** = 0.03432 to 0.06320
  - So approximately **two** 2-year contracts for every one 10-year contract

For every 2 two-year contracts we buy we sell one ten year contract because the ratio of 0.03432 to 0.0632 is 1.84 which is approximately 2.

FUTURES CONTRACTS OVER EQUITIES:

U.S. Stock Index Futures and Options

- Equity futures are agreements to buy or sell the value of a specific stock index at a specific price on a specific date in the future
- Traded on CME (there is a DOW futures equities traded on the CBOT)
  - S&P 500, NASDAQ-100, Russell 1000, Russell 2000, S&P MidCap 400, and the Nikkei 225 (there are more than these)

Why Trade Equity Futures?

- **Equity futures can be used as hedging instruments**
- Take advantage of the relative out-performance of one sector of the market versus another
- More efficient to trade stock index futures than baskets of stocks
  - Cost of liquidity, brokerage commissions, exchange fees, the bid/ask spread and the cost to carry the equity
  - Can easily buy ETF as well which gives exposure to indices.

If I have a long position in the spot market in the S&P500 and I am worried about short term price changes I could use futures strategies to hedge my position. takes less capital to hedge rather than sell the position.

Can also use futures strategies to take advantage of relative outperformance of one sector versus another. If I think NASDAQ will outperform S&P over the next 5 months I can short S&P futures and long NASDAQ futures. Try to magnify the difference.

BE AWARE OF THIS !!!

Construction of Indexes

- Before we can discuss these derivatives, we need to understand how indices are constructed
- How are stocks weighted?
  - **PRICE WEIGHTED** (DJIA): weight of each stock member is the relative price. So if IBM trades at $100 and Alcoa at $50 then the ratio is two to one, twice the weight placed on IBM as there is on Alcoa. So the index could change its weights simply because someone split their stock.
  - **MARKET-VALUE WEIGHTED** (S&P500, NASDAQ): the weights are market value weights. Closer to what we would think of as true weights. If IBM has twice the market value of Alcoa then IBM would have twice the influence on this index.
  - **EQUALLY WEIGHTED** (Value Line Index): each stock goes in at equal value.

Need to think about how actual stock indices are weighted. More than one way of weighting an index. The three above give an example of how it can be done.

Pricing of CME Equity Futures Contracts

- To **determine the value of a stock index futures contract**, you need to know its **multiplier** and the **current index futures level**
  - For example, the value of one CME E-mini S&P 500 futures contract is $50 x the level of the futures index, this is the futures price in essence.
    If the S&P 500 futures index level is 1200, multiply that by $50, which equals $60,000 (1200 x $50 = $60,000) This is the underlying notional value.
  - Thus, if you buy one CME E-mini S&P 500 futures contract at 1200, you are trading an instrument valued at $60,000

So your futures contract will go up or down by $50 (in this example) for every point of movement the index moves. Not a perfect correlation.