Futures Pricing

Futures contract is an agreement to buy

- a fixed amount (& quality) of a product
- at a specified price
- at a specified time in the future

At the time the contract is begun, no money changes hands (no investment)

- the value of the contract is returned to zero
- every day by "settling up"
  - transferring money from the seller(buyer) to the buyer(seller) if the futures price goes up(down)

Forward Pricing

Forward contract is an agreement to buy

- a fixed amount (& quality) of a product
- at a specified price
- at a specified time in the future
- No daily settling up

Thus, forwards and futures differ only because of the daily settling up provision

- Important to reduce default risk
- Randomness in short-term interest rates causes differences in forward and future values

Financial Futures Contracts: Stocks

Futures contract on the S&P 500 index:

- Chicago Mercantile Exchange (MERC)
- $50 times the index value (E-mini)
- very actively traded
- used for hedging large stock portfolios
  - portfolio insurance
- settled in cash

S&P Index Futures: Arbitrage Pricing

<u>Alternative strategies:</u>

(1) buy S&P futures at a price F_0 & Treasury bills with an interest rate of r_f equivalent to buying the stock S_0

- if the price of the index at maturity is S_T, then the payoff to (1) is:
  $[S_T - F_0] + [(1+ r_f) S_0]$

(2) buy S&P index at a price S_0 and receive dividend D

- the payoff to strategy (2) is:
  $[S_T + D]$

S&P Index Futures: Arbitrage Pricing

Alternative strategies:

Equating the payoffs to these two strategies gives:

$$F_0 = [(1+ r_f) S_0] – D$$

In pseudo-return form:

$$[F_0 - S_0] / S_0 = r_f – D / S_0$$

The percent basis equals the difference between the interest rate r_f and the dividend yield $d = D / S_0$ on the index

If the interest rate is less than the dividend yield, the futures price should be lower than the spot price

S&P Index Futures: Arbitrage Pricing

Arbitrage relation is often called the “cost-of-carry”

- buying the stock today costs you the time value of money
- but buying the futures contract costs you the dividend that the stockholder receives

S&P Index Futures: Arbitrage Pricing

3 month maturity	
S_0	2414.23
F_0	2411.25
r_f (annual rate Tbill)	0.920
r_f (annual rate Eurodollar)	1.198
annual S&P dividend yield, d	1.920
implied d (Tbill)	0.925
implied d (Eurodollar)	1.203
implied r_f (annual rate)	1.925

So there are two ways to evaluate the formula:

Assume the interest rate you are using is "correct" and solve for the implied dividend yield, d

Or, assume the dividend yield is correct and solve for the implied interest rate, r_f

The basis is consistent with a higher "interest rate" (e.g., LIBOR), or with lower dividend yield, d

S&P Index Futures: Arbitrage Pricing

E-mini S&P 500 Futures Quotes Globex

Settlement prices for the E-mini S&P 500 may differ slightly from the "true" settlement price displayed on CME's Daily Bulletin. These slight variances in settlements are the result of rounding due to differences in the minimum tick sizes between the E-mini contracts and the full-sized contracts. Additionally, the settlement price displayed on the Daily Bulletin matches that of the full-sized contracts for purposes of marking-to-market, as the contracts are offsettable, on a 5:1 basis.

Example: E-mini S&P 500 futures contracts are traded in .25 increments and the full-sized S&P 500 contracts in .10 increments.

Month	Last	Change	Prior Settle	Open	High	Low	Volume
6/1/2017	2414.25	12.25	2402	2403	2416.5	2402.5	869770
9/1/2017	2411.25	12.25	2399	2400.5	2413.25	2400	4829

http://www.cmegroup.com/trading/equity-index/us-index/e-mini-sandp500.html

http://www.cmegroup.com/trading/equity-index/us-index/e-mini-sandp500_contract_specifications.html

Financial Futures Contracts: Bonds

Futures contract on Treasury Bonds:

- Chicago Mercantile Exchange (CME)
- $100,000 face value
- Maturity of 15 to 25 years

Futures contract on Eurodollars:

- Chicago Mercantile Exchange (CME/IMM)
- $1,000,000 principal value
- Maturity of 3 months
- 100 points minus 3 month LIBOR offered rate
  - LIBOR = 2.55%, then price = 97.45
  - One interest rate basis point = $25
- Settled in cash

Financial Futures Contracts: Bonds

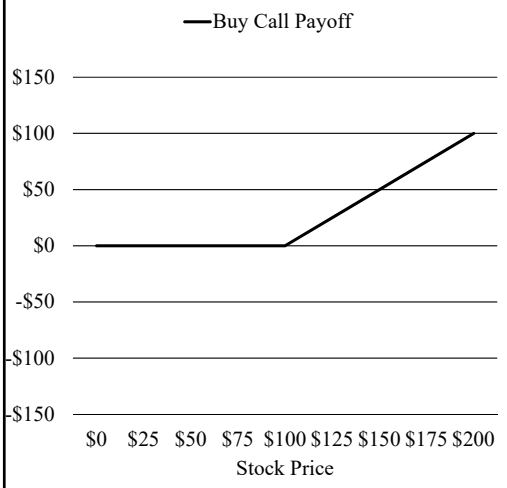
U.S. Treasury Bond Futures Quotes Globex

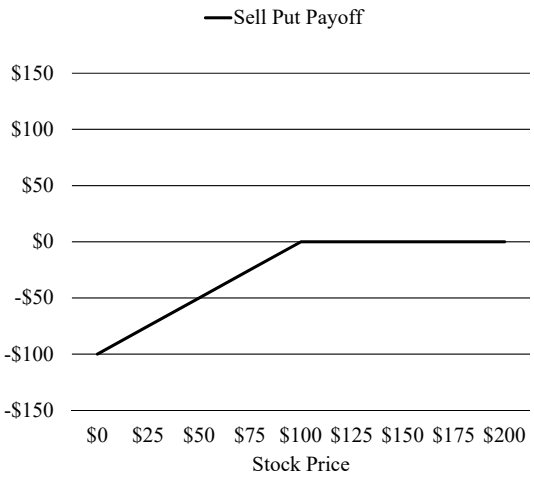
Month	Last	Price	Change	Prior Settle	Open	High	Low	Volume
6/1/2017	153'27	153.8438	+0'10	153'17	153'24	154'02	153'15	294087
9/1/2017	152'20	152.6250	+0'11	152'09	152'18	152'26	152'07	187483

tick size is 1/32

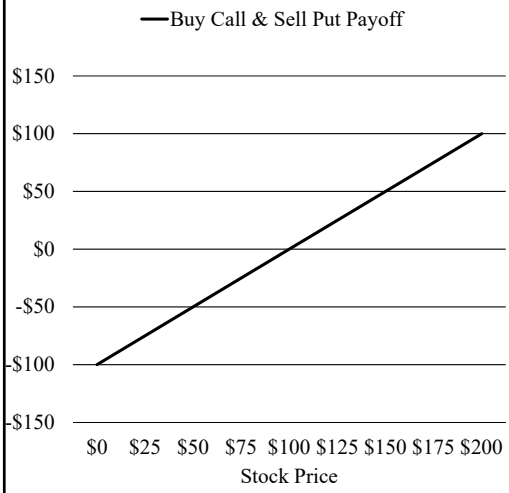
http://www.cmegroup.com/trading/interest-rates/us-treasury/30-year-us-treasury-bond_contract_specifications.html?optionExpiration=M7

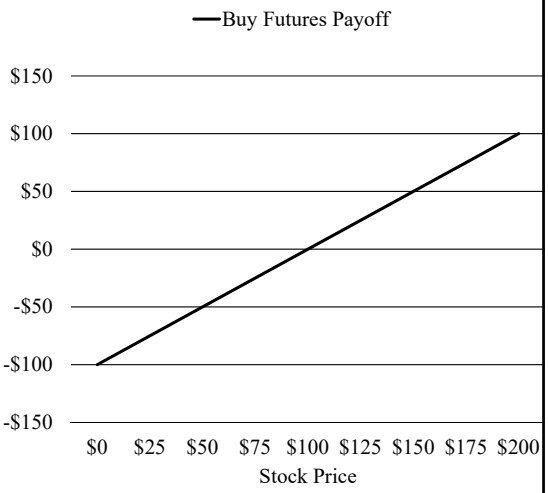
Financial Futures Contracts: Relation to Option Pricing





Financial Futures Contracts: Relation to Option Pricing





Financial Futures Contracts: Relation to Option Pricing

Long futures positions is equivalent to buying a call and selling a put with exercise prices equal to the futures price

- selling the futures is equivalent to selling a call & buying a put

Payoff from futures contract is symmetric

- you can make a lot of money if you guess right
- but you can lose a lot of money if you are wrong

Other Futures Contracts

Financial:

- other interest rates (Treasury notes, Fed Funds, etc.)
- other US stock indexes (Nasdaq, DJIA, Russell)
- US sector stock indexes (Energy, Tech, Health Care, etc.)
- foreign stock indexes (Nikkei, China, FTSE, Brazil, India)
- Foreign exchange (UK, Japan, Euro, etc.)
- Metals (gold, silver, etc.)
- Options on Futures

Agricultural:

- corn, wheat, soybeans, hogs, cattle, etc.

Others:

- Weather, real estate

Options on Futures Contracts

Most Popular:

- Eurodollar options
- Treasury Note options (5 and 10-year maturity)
- Crude Oil
- Natural Gas (Europe)
- S&P 500 E-mini
- Corn
- Euro FX
- Gold

Caveat Emptor

Financial futures are a cheap way to take on a lot of risk

- low transactions costs
- large leverage (margins of 5 to 15%, versus 50% for stock purchases)
  - i.e., you have to provide about $100,000 of Treasury bills as collateral to bet $1,000,000 on stock or bond price moves

Unless you have (macroeconomic) "inside information," you should use futures (& options) for risk management

- hedging

Hedging with Financial Futures: Portfolio Insurance

Used to reduce the (market) risk of a large, well-diversified stock portfolio

1. buy put options on S&P index
   - puts lower bound on losses
2. sell call options on S&P index
   - increases value if stock prices fall or stay level, but you lose if stock prices rise a lot
3. sell S&P 500 futures contracts against a portion of your portfolio
   - as if you were investing in Tbills with that portion of your investment

Hedging with Agricultural Futures

Suppose you are a farmer in North Dakota who will have 100,000 bushels of northern spring wheat to sell in August

You want to hedge the price risk associated with this sale in the futures market

Do you take a long or short position in the futures market?

- Because your underlying exposure is a long wheat position, you offset that risk with a corresponding short position in the futures market

Hedging with Agricultural Futures

How many bushels of wheat do you want to short in the futures market?

The optimal size of your position (and the effectiveness of your hedge) will depend on the basis risk in the wheat futures market

Basis Risk

basis = spot price of asset to be hedged -
futures price of contract used to hedge

The basis can be different from zero for many reasons:

- underlying asset
- delivery date
- delivery location

Basis Risk

Let S_1 = spot price at time t_1
S_2 = spot price at time t_2
F_1 = futures price at time t_1
F_2 = futures price at time t_2
b_1 = basis at time t_1
b_2 = basis at time t_2

Basis Risk

Consider a hedger who knows an asset will be sold at time t_2 and opens a short hedge at time t_1

The net price obtained at time t_2 is

$$S_2 + F_1 - F_2 = F_1 + (S_2 - F_2)$$
$$= F_1 + b_2$$

The value of F_1 is known at time t_1. Thus the only remaining risk is the risk associated with b_2.

This is called basis risk

Hedging with Basis Risk

If the basis is constant, then the optimal hedge amount is equal to your underlying exposure

$$h = -Q = -100{,}000 \text{ bu.} / (5000 \text{ bu per contract})$$
$$= -20 \text{ contracts}$$

- But, futures contracts in Kansas City are for delivery of hard red winter wheat in Kansas City, and the current delivery months are July and September
- Thus, the futures price can vary significantly from the spot price

Hedging with Basis Risk

You can often estimate basis risk with a linear regression

$$\Delta P_s = \alpha + \beta (\Delta P_f) + e$$

The variance of e is a measure of the basis risk in your hedge portfolio

The optimal hedge amount $h = - Q \beta$

Suppose $\beta = .93$. Then,

$h = -Q \beta = -100{,}000(.93)/5000 = -18.6$ contracts

Hedging with Basis Risk: Additional Issues

Which contract?

How many different contracts?

Use multiple regression

$\Delta P_s = \alpha + \beta_1 (\Delta P_{f1}) + \beta_2 (\Delta P_{f2}) + e$

$h_1 = -Q \beta_1$

$h_2 = -Q \beta_2$

What futures delivery date should you choose?

Financial Futures: Questions

(1) If you had inside information about a specific company, how might you use options or futures to augment your investment strategy? Discuss:

- options on individual stocks
- options on market indexes
- futures on market indexes

(2) If you wanted to adjust the risk of your company's pension fund portfolio, would you use options & futures to do this? Why, or why not?

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Data used for these slides can be accessed at:

http:\\schwert.ssb.rochester.edu\brn481\brn481fut.xlsx

http:\\schwert.ssb.rochester.edu\brn481\brn481fut.zip

Home Page:

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