Derivatives & Risk Management

• Previous lecture set:
  – Forward outright positions & payoffs + NDFs
  – Forward price vs. current & future spot prices

• This lecture set – Part II (Futures)
  – Futures vs. forward
    • trade in the risk, standardization, right of offset
  – Stock Index Futures

Part II: Futures

Futures vs. Forwards

• Fundamentals
  – participants, major contracts, exchanges

• Differences w/ forward contracts (main ones)
  – “trading in the risk” vs. “trading in the commodity”
    • right of offset
  – standardized, exchange-traded (not OTC)
    • trading vs. clearing; Dodd-Frank / EMIR changes
  – marking-to-market / risk control

• Differences b/ forward & futures prices
  – Theory vs. practice and arbitrage

Futures vs. Forwards 2a

• Differences w/ forward contracts (main ones)
  – 1. exchange-traded
    • Where? (http://www.futuresindustry.org/volume-4.asp)
      – U.S.A.: CME-CBOT-NYMEX-KCBT, ICE-NYBOT-NYSE, ...
      – Abroad: EUREX-ISE, SSE, Boveups, Dalian, Shanghai, Ksoon, etc.
    • How?
      – Historically: participants in the “pits”
        • brokers (cust.) vs. traders (own) vs. broker-traders
        • commission brokers (cust.) vs. locals (own)
      – Now: overwhelmingly (CME) or solely (ICE) electronic trading

Futures vs. Forwards 3

• Differences w/ forward contracts (main ones)
  – 2. Regulation
    – United States
      • government: CFTC (plus SEC, Fed, Treasury)
      • self-regulation: futures industry (NFA), exchanges
    – Canada: markets vs. trading (NOT Exam Material)
      • provincial securities commissions vs. self
      • exception: WCE (federal regulation; now part of ICE)
  – 3. Corollaries of exchange-based trading
    – standardized contracts; right of offset
      • trading risk vs. commodity?
      • risk control mechanism
Futures vs. Forwards

3A. Contract standardization
- contract size
- expiry cycle
  - currencies (CME) and indices: M-J-S-D (peso, rand?)
  - corn (CBOT): M-M-Jul-S-D
- delivery dates
  - currencies: 3rd Wednesday of the month (delivery)
  - others: mostly 3rd Friday of the month
  - exceptions exist (ex.: KC Value Line: EOM; bond futures)
- other contract specifics
  - commodity grade, delivery arrangements (or cash settlement)
- price limits (corn: 30 cents/b., none in spot mo.) & position limits
- price quotes

Futures vs. Forwards (continued)
- reading futures quotes
  - terminology
    - open interest
    - ticks (cent for oil at NYMEX, 32nd of $ for bonds at CBOT, etc)
    - spot month (when the contract expires)
    - “nearby” vs. (first-, second-…) deferred contracts
    - reversing (= offsetting) a trade
  - newspaper info
    - Hull Table 2.2, BKM
    - in class: using FT Market Data

Futures vs. Forwards

3B. Right of offset
- OTC market: Commitment
  - Really? Non-Deliverable Forwards (NDF), G10 currencies
- Futures markets: Offset is possible
  - What? Easy to get out early at a market price
  - How? offset long position by going short, & vice-versa
- 3A+3B: Trading “risk” vs. “commodity”
  - Forwards: trade in the commodity (delivery intent)
  - Futures: trade in the risk (exposure to price movements)

Futures vs. Forwards

3C. Risk control
- OTC market
  - “my word is my bond”
    - theory vs. practice (credit lines; changes since 2008)
    - Big regulatory changes after 2010 (Dodd-Frank, EMIR)
- futures markets
  - clearing house & position limits
  - margin requirements
    - opportunity cost; cash vs. T-bills
    - marking to market

Risk Control through Clearing House
- What?
  - Futures
    - exchange-run (exception: CME-CBOT used to share)
  - Options: Options Clearing Corporation (OCC)
    - owned jointly by all U.S. options exchanges
    - 12 options (including BATS) + 4 small futures exchanges
    - http://www.optionsclearing.com/learners/learnerservices/clearinghouses.jsp
- Why?
  - market liquidity vs. knowing counterparts
  - margin posts and margin calls vs. “word is bond”

Risk Control through Clearing Houses 2
- How?
  - effective “buyer” and “seller” of all futures
    - counter-party to all trades
    - guarantees execution
    - “open interest”
  - in practice
    - reversing trades (offsetting)
    - how do deliveries get carried out?
  - risk for the clearing house
    - default
Margins

- Basic Idea → security deposit
- Risk control
  - margins and margin calls
    » for both long and short parties
- Margin determinants
  - volatility of underlying asset
    – Determines extent of potential loss or gain
  - naked position vs. covered position (hedge, arbitrage, or spread)

Futures Marking-to-Market

- What?
  - daily settlement of gains and losses
  - plus “resetting” of all positions
- Why?
  - risk control
  - hedgers vs. speculators
- How?
  - numerical example
- Consequence (NOT exam material)
  - difference between futures price and forward price

Futures Marking-to-Market 2

- Forward price
  - delivery price
    – price at which the underlying asset will be delivered
    – agreed upon at time forward is entered into
  - forward/futures price
    – delivery price that would make the contract have 0 value
    – changes during life of contract (but, who cares …)
    – Forwards: who cares? Futures: it really matters!
  - forward price = delivery price
    – when contract is created

Futures Marking-to-Market 3

- Futures price
  - delivery price
    – price at which the underlying asset will be “delivered”
    – agreed upon at time futures is bought
  - futures price
    – delivery price that would make the contract have 0 value
    – changes during life of contract (and, it matters)
  - futures price = delivery price
    – when contract is bought

Futures Marking-to-Market 4

- Futures price (cont’d)
  - marking to market
    – replacement of the futures contract at the end of trading
    – every day (at least)
    – by a new contract with new delivery price
      » delivery date unchanged
      » new delivery price = futures price at close

Futures Marking-to-Market 5

<table>
<thead>
<tr>
<th>Date</th>
<th>futures price ($)</th>
<th>margin requirement</th>
<th>cash-flow ($)</th>
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<tr>
<td>09-15-05</td>
<td>0.75 5/8%</td>
<td>$2,150 (a)</td>
<td>- $2,150 (b)</td>
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<td>(Close)</td>
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<td></td>
<td>(c)</td>
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<tr>
<td>09-15-05</td>
<td>0.755 5/8%</td>
<td>+ $625 (d)</td>
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<td>(Close)</td>
<td></td>
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<td>(e)</td>
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<tr>
<td>09-16-05</td>
<td>0.752 5/8%</td>
<td>(f)</td>
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<td>(Close)</td>
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<td>(g)</td>
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<td>09-19-05</td>
<td>0.74 5/8%</td>
<td>- $375 (f)</td>
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<td>(Close)</td>
<td></td>
<td></td>
<td>(h)</td>
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<td>09-21-05</td>
<td>0.74 5/8%</td>
<td>+ $1,500 (g)</td>
<td>- $92,500 (h)</td>
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<td>(Close)</td>
<td></td>
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<td>(i)</td>
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<tr>
<td>09-21-05</td>
<td>0.74 5/8%</td>
<td>+SF 125,000 (i)</td>
<td>- $93,750 (i)</td>
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<tr>
<td>(Close)</td>
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Futures Marking-to-Market 6

- Differences b/ forward & futures prices
  - in theory
    - interest rates known
    - stochastic interest rates
      - interest rate vs. futures price (or price of underlying asset)
        » positive correlation: futures price > forward price
        » negative correlation: futures price < forward price
  - in practice / arbitrage

Index Futures

- Stock-market indices
  - basic idea
  - various types
- Stock Index Futures
  - basic idea
  - US vs. other countries
  - index futures as investment tools
    » domestic example (alternative to cash purchases)
    » indirect international diversification tool

Stock Market Indices

- Idea
  - measure of overall performance
- Examples
  - arithmetic: price-weighted (DJI)
    - stock choice
  - arithmetic: market-value weighted (S&P 500)
    - market value of equity, broader, NYSE+NASDAQ
  - geometric: Value-Line
    - downward bias (relative to return on eq.-weighted portf.)

Market Indices: DJIA (NOT Exam Material)

- Computation
  - price-weighted
  - splits, stock dividends > 10% (BK4M4 Tables 2.3 & 2.4)
- Divisor example
  - Time  
    - DJI (no split) \( \frac{25 + 100}{2} \) \( \frac{30 + 90}{2} \) -4%
    - DJI (split, d=2) \( \frac{25 + 100}{2} \) \( \frac{30 + 45}{2} \) -40%
    - DJI (split, d=75/62.5) \( \frac{25 + 50}{1.2} \) \( \frac{30 + 45}{1.2} \) 0%

Market Indices: S&P 500 (NOT Exam Material)

- Computation
  - value-weighted
  - No need to adjust for splits or stock dividends
- Example
  - Time
    - DJI (no split) \( \frac{25 + 100}{2} \) \( \frac{30 + 90}{2} \) -4%
    - S&P (no split) \( \frac{100 + 200}{100} \) \( \frac{200 + 100}{100} \) \( \frac{30 + 90}{2} \) +15%
    - S&P (split) \( \frac{100 + 200}{500 + 100} \) \( \frac{200 + 100}{500 + 100} \) \( \frac{30 + 90}{500 + 100} \) +15%

Interpreting Stock Market Indices

- DJI
  - price-weighted
  - gives return on portfolio with 1 share of each stock
- S&P 500
  - market-value-weighted
  - gives return on “market” portfolio (use for index funds)
- Value-Line
  - Not representative of the return on any portfolio
Other Relevant Market Indices

• Equally-weighted indices
  • same dollar weight on each stock
  • need to rebalance

• Foreign indices (http://finance.yahoo.com/intlindices)
  – FTSE ("Footsie")
    • Value-weighted
  – Nikkei
    • 225: price-weighted; 300: value-weighted
    – DAX, CAC-40, TSE-300 Composite, etc.

Stock Index Futures

• Idea
  • cash-settled futures contract ($nbr \times index value)
  • reduces transactions costs

• Types
  • US: DJIA 30, S&P 500, Kansas City Value Line, NYSE, …

• Why Popular
  • allows construction of cheap synthetic stock positions
  • usefulness for international portfolio diversification
  • allows hedging and arbitrage

Stock Index Futures 2

• Some specific items (microstructure)
  – Cash or actual delivery?
    – example: S&P-500 on the CME
      » short position: gives $250 \times S_t (value of index at maturity)
      » long position: gives $250 \times F_{t,T} (delivery price)
      » if F_{t,T} < S_t, then short owes $250(S_t - F_{t,T}) to long
  – “mini” index: CME’s mini
    » S&P500 mini ($50 vs. $250; 1pt = 50c vs. $2.50 per contract)
    » Nasdaq-100 ($20 vs. $100; 1pt = 20c vs. $1 per contract)
  – foreign index futures traded in the United States
    » settlement is only in U.S. dollar
    » 2 sources of risk: FX & basis ("quantos")
    » usefulness in practice: Jorion & al. (JPM 1993)

Stock Index Futures 3

• Synthetic stock positions
  • Idea
    – apply future-spot parity
    – investor can
      » buy shares of all stocks in the index (practical? ETFs)
      » or
      » go long index futures and buy T-bills to cover settlement
  • If you wish to speculate & are
    » bullish: hold long futures position, buy T-bills
    » bearish: opposite

Stock Index Futures 4

• Synthetic stock positions (continued)
  • example
    » TSE-35 is 300 for spot and 303 for 3-month
    » multiplier is $100
    » 3-month interest rate = 1% (annualized = 4%)
    » investor wants to invest $30m in Canadian market for 3 months

  ➔ Go long TSE futures & buy $30 mil. worth of T-bills
  or
  ➔ Go long TSE-35 for 3 months & buy $30 mil. worth of T-bills

Stock Index Futures 5

• Synthetic stock positions (continued)
  • example: returns from both approaches?

  ➔ Go long futures & buy $30 mil. worth of T-bills
  ➔ $30m in T-bills at 1% will be worth $30.3m in 3 months
  ➔ contract price = 303, multiplier = $100
  ➔ so, go long $30,300,000(100x$100) = 1,000 contracts
  ➔ in 3 months, you pocket: $(S_T - 303) \times $100,000 (why S_T?)
    ➔ plus you get your return on T-bills: $30,300,000
  ➔ Portfolio worth at T: $(S_T - 303) \times $100,000 + $30,300,000
Stock Index Futures 6

- Synthetic stock positions (continued)
  - example: returns from both approaches?
    - Buy $30 mil in stocks making up the TSE-35
      - $30m in TSE-35 contract price = 300, multiplier = $100
      - so, buy spot $30,000,000 (300x$100) = 1,000 “contracts”
      (in practice? TSE makes spot contracts available)
      - in 3 months, you have a portfolio worth:
        \[ S_T \times 100,000 \]

Stock Index Futures 7

- Synthetic stock positions (continued) – what if multiplier were $500?
  - TSE-35 is 300 for spot and 303 for 3-month hence
  - 3-month interest rate = 1%
  - investor wants to invest $30m in Canadian mkt for 3 months
    - go long 200 contracts: 200 x 500 (multiplier) x 300
    - buy T-bills to cover payment of futures price
      - 200 x 500 x 303 / (1+1%) = $30m
    - at maturity: net worth = 200 x 500 x $S_T$
      - 200 x 500 x ($S_T - F_0$) = 100,000 $S_T -$30.3m
      - $30m(1.01) = $30.3m

Stock Index Futures 8

- Synthetic stock positions
  - example (continued) – did we forget anything?
    - Dividends...

- \[ F = S (1 + r - d) \] (Assume delivery in 1 yr.)
  - if S = 1,000, r = 4%, d = 2%
  - Equilibrium \[ F = 1000 \times (1 + 0.04 - 0.02) = 1020 \]

Stock Index Futures 9

- Index futures in practice: Investing Abroad
  - idea: minimize transactions costs
  - risks:
    - basic risk
    - FX risk? (quantos)
    - arbitrage?
  - example

Stock Index Futures: “Arb”

- Index futures in practice: Index arbitrage
  - idea: exploit deviations from parity
  - Triple (now “quadruple”) witching hour
    - 4 Fridays per year
    - index futures + index option + some ind’l stock options
    - all expire at same time
    - exception (S&P 500)
    - volatility
      - supposedly increases (program trading)
      - fundamentals vs. market depth
      - price levels vs. arbitraging price differences

Stock Index Futures: “Arb” 2

- Index futures in practice: Index arbitrage
  - \[ F = S (1 + r - d) \]
  - You are a money market fund manager & observe
    - 3 months before S&P 500 futures settlement: \[ F = 1030 \]
      - \[ S = 1000, r = 4\%, d = 2\% \] but \[ F = 1030 \]
      - a spot 3-month T-bill earns 4% per annum or 1% per qtr.
      - a synthetic T-bill earns __?
  - When to enter & what effect on markets
    - convergence will mean that you will earn…. by…..
    - exiting (“sell on close” or exit early?)
Stock Index Futures: Hedging

- Some specific items
  - Basis risk
    - basis = futures price - spot price
    - convergence property
      » do futures price = spot price at maturity?
      » “Yes” for own hedges
        Caveat: compare apples to apples (embedded options?)
      » “Maybe” for cross hedges

Stock Index Futures: Hedging 2

- Hedging stock portfolios
  - ratios to hedge
    - Q1. When would a 1:1 ratio work?
    - Q2. Should you hedge unsystematic risk (individual stock, industry fund) with Stock Index Futures?
  - Hedge Ratios → Use betas or regression
    » Betas: HR = (Portfolio B)/(Stock Index B)
    » Regression: \[ S = a + HR \times F + e \]