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

- **Definition**
  - Basic principle: similar to forwards
  - In practice: delivery rare *(most investors offset early)*

- **Right of offset**
  - What? Right to get out early at a *market* price
    - vs. Forward: can get out early *only* if counterparty agrees
  - Why?
    - encourages speculation (which reduces hedging costs)
    - hedges can use gain/loss on futures to alleviate loss/gain on the underlying (idea similar to NDF; settlement differences)
  - How? Standardization + Risk control

### Futures vs. Forwards 2a

- **Differences w/ forward contracts** (main ones)
  - 1. *exchange-traded*
      - U.S.A.: CME-CBOT-NYMEX-KCBT; ICE-NYBOT-NYSE; ...
      - Abroad: EUREX-ISE, NSE, Bovespa, Dalian, Shanghai, Kospi, 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 4

- 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 5

- 3A. Contract standardization (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 6

- 3B. Right of offset
  - OTC market: Commitment
    - Parties in theory cannot get out of a forward agreement
      - Really? Non-Deliverable Forwards (NDF), G10 currencies
  - Futures markets: Offset is possible
    - What? How 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 7

- 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 market
    - 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/clearing/clearing-services/exchanges.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

Forward price = delivery price

Forward/futures price = delivery price

Forwards: who cares? Futures: it really matters!
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>
</tr>
</thead>
<tbody>
<tr>
<td>09-15-05</td>
<td>0.755 $/SF</td>
<td>$2,150 (b)</td>
<td>- $2,150 (c)</td>
</tr>
<tr>
<td>(close)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09-16-05</td>
<td>0.702 $/SF</td>
<td>(d)</td>
<td>- $375 (d)</td>
</tr>
<tr>
<td>(close)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09-19-05</td>
<td>0.74 $/SF</td>
<td>(f)</td>
<td>- $1,380 (g)</td>
</tr>
<tr>
<td>(close)</td>
<td></td>
<td></td>
<td>+ $2,150 (h)</td>
</tr>
<tr>
<td>09-21-05</td>
<td>-SF 125,000 (i)</td>
<td></td>
<td>- $10,000 (i)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>+SF 125,000 (i)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>+ $93,750 (i)</td>
</tr>
</tbody>
</table>
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% (BKM4 Tables 2.3 & 2.4)

- Divisor example
  
<table>
<thead>
<tr>
<th>Time</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJI (no split) [ \frac{25 \times 100}{2} ]</td>
<td>[ \frac{30 + 90}{2} ]</td>
</tr>
<tr>
<td>DJI (split, d=2) [ \frac{25 \times 100}{2} ]</td>
<td>[ \frac{30 + 45}{2} ]</td>
</tr>
<tr>
<td>DJI (split, d=75/62.5) [ \frac{25 \times 50}{1.2} ]</td>
<td>[ \frac{30 + 45}{1.2} ]</td>
</tr>
</tbody>
</table>

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

- Computation
  - value-weighted
  - No need to adjust for splits or stock dividends

- Example
  
<table>
<thead>
<tr>
<th>Time</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJI (no split) [ \frac{25 \times 100}{2} ]</td>
<td>[ \frac{30 + 90}{2} ]</td>
</tr>
<tr>
<td>S&amp;P (no split) [ \frac{500 \times 100}{2} ]</td>
<td>[ \frac{600 + 90}{2} ]</td>
</tr>
<tr>
<td>S&amp;P (split) [ \frac{500 \times 100}{2} ]</td>
<td>[ \frac{600 + 90}{2} ]</td>
</tr>
</tbody>
</table>

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 (Sub $ 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 x S_T (value of index at maturity)
      - long position: gives $250 x F_T (delivery price)
      - if F_T ≥ S_T, then short owes $250(S_T - F_T) to long
    - "mini" index: CME’s mini
      - S&P500 mini ($50 vs $250; 1pt = $50 vs. $2.50 per contract)
      - Nasdaq-100 ($20 vs $100; 1pt = $20 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 ("quanto")
      - 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
  • 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 mkt for 3 months
    → Go long TSE futures & buy $30 mil. worth of T-bills
    or
    → Buy $30 mil. in stocks making up the TSE-35

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/(303x$100) = 1,000 contracts
    » in 3 months, you pocket: ($s_T - 303) x $100,000 (why $s_T?)
      plus you get your return on T-bills: $30,300,000
    » Portfolio worth at T: ($s_T - 303) x $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 (100x$300) = 1,000 "contracts"
        (in practice? TSE makes spot contracts available)
      - in 3 months, you have a portfolio worth:
        $ T \times 100,000

Stock Index Futures 7

- Synthetic stock positions
  - example (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) * 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 x (1 + 0.04 - 0.02) = 1020
Stock Index Futures 9

- Index futures in practice: Investing Abroad
  - idea: minimize transactions costs
  - risks:
    » basis 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 x F + e