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)
    » hedgers 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
    • Where? ([http://www.futuresindustry.org/volume-.asp](http://www.futuresindustry.org/volume-.asp))
      – 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? Right 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 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

• 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>time</th>
<th>futures price (a)</th>
<th>margin requirement</th>
<th>cash-flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-15-05 (morning)</td>
<td>0.75 $/SF</td>
<td>$2,150 (b)</td>
<td>- $2,150 (c)</td>
</tr>
<tr>
<td>09-15-05 (close)</td>
<td>0.755 $/SF (d)</td>
<td></td>
<td>+ $ 625 (d)</td>
</tr>
<tr>
<td>09-16-05 (close)</td>
<td>0.752 $/SF (e)</td>
<td></td>
<td>- $ 375 (f)</td>
</tr>
<tr>
<td>09-19-05 (close)</td>
<td>0.74 $/SF</td>
<td></td>
<td>- $ 1,500 (g) + $ 2,150 (h)</td>
</tr>
<tr>
<td>09-21-05</td>
<td>+SF 125,000 (i)</td>
<td></td>
<td>+SF 125,000 (i) + $ 92,500 (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
  – Time
  – DJI (no split) \[
    \frac{25 + 100}{2} = \frac{25 + 50}{1.2} \quad t
  \]
  – DJI (split, d=2) \[
    \frac{30 + 90}{2} = \frac{30 + 45}{1.2} \quad t+1
  \]
  – DJI (split, d=75/62.5) \[
    \frac{30 + 45}{2} = \frac{30 + 45}{1.2} \quad Return
  \]
Market Indices: S&P 500 (NOT Exam Material)

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

• Example
  - Time \( t \) \( t+1 \) Return
  - DJI (no split) \( \frac{25+100}{2} \) \( \frac{30+90}{2} \) -4%
  - S&P (no split) \( \frac{100 \times \frac{500+100}{500+100}}{500+100} \) \( \frac{115 \times \frac{600+90}{500+100}}{500+100} \) +15%
  - S&P (split) \( \frac{100 \times \frac{500+100}{500+100}}{500+100} \) \( \frac{115 \times \frac{600+90}{500+100}}{500+100} \) +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 \text{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 $F_{t,T} = S_T > F_{t,T}$, 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
  • 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: \((S_T - 303) \times 100,000\) (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
  • 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) \times 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 \( S = 1,000 \), \( r = 4\% \), \( d = 2\% \)
    \( \Rightarrow \) 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:
    » 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: \( F=1,030 \)
      » \( S = 1000, r =4\%, d = 2\%, \text{ but } F = 1030 \)
      » a spot 3-month T-bill earns 4% per annum or 1% per qtr.
    » a \text{ 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 \( \rightarrow \) Use betas or regression
    » Betas: \( HR = \frac{\text{Portfolio B}}{\text{(Stock Index B)}} \)
    » Regression: \( S = a + HR \times F + e \)