Derivatives & Risk Management

• Interest-rate derivatives
  • FRA’s & T-Bill futures
  • Swaps
    » Hedging International Financing Transactions
    » All-In Cost of Capital Computations
  • T-Bond & T-Note futures
    – This lecture

Part III: Interest Rate Derivatives

Interest-Rate Derivatives (Recap. slide)

• Forward rate agreements (FRA)
  • OTC contract; users “lock in” implied forward rate
• Interest Rate Futures (IRF) and T-Bill Futures
  • exchange traded futures contracts
  • underlying: 90-day interest rate (contrast with FRA)
• Interest-rate Swaps
  • OTC contract; converts exposure: fixed <-> floating
  • Bundle of “time against time+6months” FRA’s
• Government bonds futures
  • Exchange-traded futures on a long-term government bond

T-Bond & T-Note Futures: Outline

• Bond quotes
  • money-market instruments
  • T-notes & T-bonds
  • corporate & municipal bonds
• T-Bond & T-Note futures
  • Pricing
  • Conversion factor
  • Options, including wild card

Bond Prices and Yield Quotes

• Money-market instruments
  • zero-coupon bonds
  • quotes vs. actual yields
• Long-term bonds
  • quotes
    » US government T-notes & T-bonds
    » corporate & municipal bonds
  • accrued interest

Long Term Bond Prices & Yield Quotes

• US government
  • T-Notes (< 10 years) vs. T-Bonds (10 to 30 years)
  • denominations (> $1,000), coupons (semi-annual)
  • bonds may be callable (typically last 5 years)
  • prices
    » quoted bond prices
    » (percentage + 32nds of 1%) of face value
    » accrued interest
    » n/N = actual # of days / actual # of days in ref. period
    » example: March 1 to July 7 → n = 124 days
T-Bond & T-Note Futures 2

• Options for short party
  • 1. bond to deliver
    – range of bonds can be delivered
    – dealt with by:
      » limit in bonds that can be delivered
      » conversion factor (varies with bond delivered)
  • 2. timing
    » timing sequence and futures contract trading
  • 3. wild card
    » closing times: bond market’s vs. futures market’s

T-Bond & T-Note Futures 3

1. Delivery option

<table>
<thead>
<tr>
<th>Futures contract</th>
<th>Time to maturity (from 1st day of delivery month)</th>
<th>Bond delivered</th>
<th>Price quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-bond</td>
<td>15 yrs and callable for 15 yrs</td>
<td>$100,000</td>
<td>Bond 5.25%+1/2 and 1.2 32nds of $</td>
</tr>
<tr>
<td>10-year T-bond</td>
<td>10 yrs and callable for 13 yrs</td>
<td>$100,000</td>
<td>Bond 5.25%+1/8 and 1/2 32nds of $</td>
</tr>
<tr>
<td>5-year T-note</td>
<td>5 yrs and callable for 13 yrs</td>
<td>$100,000</td>
<td>Bond 5.25%+1/8 and 1/4 32nds of $</td>
</tr>
<tr>
<td>2-year T-note</td>
<td>2 yrs and callable for 13 yrs</td>
<td>$200,000</td>
<td>Bond 6%+1/8 and 1/4 32nds of $</td>
</tr>
</tbody>
</table>

T-Bond & T-Note Futures 4

• Conversion factor
  • why?
    » short party has large range of bond choices
    » so the playing field must be “levelled”
  • what?
    » commit short party to deliver “nominal” 6% T-bond
      (used to be 8% before March 2000; still 6% despite...)
  • how?
    » adjust bond price (to be paid by long party)
    » as if its annual YTM were 6% (3% semi-annual)
    » on 1st day of delivery month
  • in practice
    » CME Group (prev. CBOT) builds comprehensive tables

T-Bond & T-Note Futures 5

• Computing conversion factors
  – A. Simplification #1
    • what?
      » bond maturity and times to coupon payment date
      » are rounded off to closest (i.e., earliest) 3 months
    • examples
      » bond has 20 years and 2 months to maturity
        ➔ assume bond has 20 years to go
      » first coupon is to be paid in 4 months
        ➔ assume coupons start in 3 months
• Computing conversion factors
  – B. Simplification #2
  – I. bond has exact # of half years after rounding off
    > assume 1st coupon is paid in 6 months
    > assume other coupons are paid every 6 months thereafter
      » example: bond w/20 years & 56 days left, 10% coupon

\[
P = QP = \frac{\$5}{(1 + 0.03)^{20}} + \frac{\$100}{(1 + 0.03)^{56}} = \$146.23
\]

\[
\text{conversion factor} = \frac{P}{\text{par}} = \frac{\$146.23}{\$100} = 1.4623
\]

• Computing the conversion factors
  – B. Simplification #2 (continued)
  – II. bond doesn’t have exact # of half years after rounding off
    » means there must be an extra 3-month period
      > assume 1st coupon is paid in 3 months
      > assume other coupons are paid every 6 months thereafter
      » example: bond w/18 years & 96 days left, 8% coupon

\[
Q_P = \frac{1}{(1 + 0.03)^{18}} \left( \frac{\$4 + \frac{\$4}{(1 + 0.03)^{96}} + \$100}{(1 + 0.03)^{96}} \right) = \$123.99
\]

• Cheapest-to-deliver bond
  – long party
    » must take delivery of bond chosen by short party
    » worth: bond price + accrued interest
  – short party
    » can deliver any bond
    » hence, it will buy the cheapest one on the market
    » that meets the requirements of the exchange
    » thus, must be bond for which:
      » futures price times conversion factor - bond price is highest

• Cheapest-to-deliver bond: example
  – futures price: current quote = 93:08
  – there are 3 deliverable bonds, with QP and CF:
    » #1: QP=99:16, CF=1.0382
    » #2: QP=143:16, CF=1.5188
    » #3: QP=119:24, CF=1.2615
  – cheapest to deliver? compute the cost of delivering
    » #1: 99.50 - (93.25 x 1.0382) = $2.69
    » #2: 143.50 - (93.25 x 1.5188) = $1.87 (smallest loss)
    » #3: 119.75 - (93.25 x 1.2615) = $2.12

• 2. Timing option
  – 3-day delivery sequence
    » short can initiate any bus. day in delivery month minus 2 days
    » day 1 (position day)
      » short informs clearing house of intent to deliver
    » day 2 (notice of intention day)
      » clearing corp. matches oldest long to delivering short
    » day 3 (delivery day)
      » short delivers to long
      » long pays
      » title passes (long has all ownership rights & liabilities)
T-Bond & T-Note Futures 13

• 2. Timing Option (continued)
  • last day of trading
    » deliverable contract stops trading
    » 7th business day before last business day
    » of delivery month
  • settlement
    » in that period, all positions must be settled by delivery
    » but short position still chooses when to deliver
  • value
    » short party may wait for cash prices to drop
    » so the option is valuable & reflected in futures price

T-Bond & T-Note Futures 11

• 3. Wild Card option
  • differences in closing time
    » futures stop trading on CBOT at 2PM, CST
    » intent to deliver by 8PM, CST
    » T-bonds stop trading after 2PM CST (4PM EST)
  • option for short party
    » can exploit decreases in cash prices & cheapest bond
    » by deciding to deliver after trading on futures ends
  • consequences for option pricing
    » theory
    » practice: assume all is known and use F-S parity

T-Bond & T-Note Futures 14

• T-bond futures pricing (NOT Exam Material)
  • theory
    » options need to be priced
    » tools to do so: Options
  • if options were worthless
    » assume all is known
    » use forward-spot parity (I = PV of future cash-flows)
      » $F_t \cdot (B_0-I)e^{r(T-t)}$
      » or $F_{T,t} \cdot (B_0-I)e^{r(T-t)}$

T-Bond & T-Note Futures 15

• Quotes & Marking to Market
  • example: go long 1(one) T-bond futures at open

<table>
<thead>
<tr>
<th>time</th>
<th>futures price</th>
<th>margin requirement</th>
<th>cash-flow</th>
<th>cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>01-11-02</td>
<td>$103,750</td>
<td>$2,700(a)</td>
<td>-$2,700</td>
<td>-$2,700</td>
</tr>
<tr>
<td>(morning)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01-11-02</td>
<td>$102,968.75</td>
<td>-$781.25</td>
<td>-$3,481.25</td>
<td></td>
</tr>
<tr>
<td>(close)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01-15-02</td>
<td>$104,750</td>
<td>-$1,781.25</td>
<td>-$1,700</td>
<td></td>
</tr>
<tr>
<td>(close)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01-18-02</td>
<td>$102,750</td>
<td>-$2,000</td>
<td>-$3,700</td>
<td></td>
</tr>
<tr>
<td>(close)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01-22-02</td>
<td>$101,750</td>
<td>+$1,000</td>
<td>-$1,700</td>
<td>-$2,700</td>
</tr>
<tr>
<td>Then offset at</td>
<td>$103,750</td>
<td></td>
<td>+$2,700</td>
<td>$0</td>
</tr>
</tbody>
</table>

(a) Initial margin (Maintenance = $2,000)