Introduction to Swaps

BUSS386 Futures and Options

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Lecture Outline

- Interest Rate Futures
  - Treasury bond futures
  - Eurdollar and SOFR futures
- Swaps
  - Products, pricing and risk management applications
  - Currency, commodity, total rate of return swaps
- Reading: Ch. 6.1–6.3 and Ch. 7

Interest Rate Futures

Day Count Conventions

- Pricing in financial markets started long before computers…
  - People in different countries took different strategies to ease the calculation of accrued interests over time
  - 30 days per month? 360 or 365 days per year?
- Conventions vary from country to country and from instrument to instrument
  - Actual/Acutal: US treasury bonds, Australia
  - 30/360 method: US corporate/municipal bonds, Eurobonds
  - Actual/360: US money market
  - Actual/365: Korea, UK, Japan

- $ X/Y $, where X is the number of days in a month, and Y is the number of days in a year.

Source

Day Count Conventions: Example

- Consider a Treasury bond and a corporate bond both have the same annual coupon payment dates (Principal: $100, coupon rate: 8%).
  - Their last coupon payment date is March 1, 2018, and the next coupon date is September 1, 2018.
- How much interest is accured for the period from March 1, 2018 to July 3, 2018, for the two bonds, respectively?
  - Act/Act: $\frac{124}{184} \times \$4 = 2.6957$
  - 30/360: $\frac{122}{180} \times \$4 = 2.7111$
- How about from October 3, 2018 to January 1, 2019?
  - Act/Act: $\frac{92}{181} \times \$4 = 2.0331$
  - 30/360: $\frac{90}{180} \times \$4 = 2.0000$
- Excel functions: `Days` and `Days360`

Day Count Conventions: Example (cont'd)

- What if we use Actual/365?
  - Divide 8% by 365 = 0.02191
  - Multiply by # of days from March 1 to July 3, 2018 (124) = 2.7178
- Actual/360?
  - Divide 8% by 360 = 0.02222
  - Multiply by # of days from March 1 to July 3, 2018 (124) = 2.7555
- [NB] Therefore, 8% in Actual/360 is equivalent to $8\% \times \frac{365}{360} = 8.1111\%$
  - Divide 8.1111% by 365 = 0.02222
  - Multiply by # of days from March 1 to July 3, 2018 (124) = 2.7555
- [NB] 1% in Actual/360 would earn $1\% \times 365/360$ of interest in 365 days.

Treasury Futures

- Underlying variable: "Virtual'' bond price or interest rate
  - Treasury bonds, 10-year, 5-year, 2-year Treasury notes, with 6% coupon rate in U.S., 5% in Korea
  - Federal funds rates/Eurodollar/SOFR futures $\Rightarrow$ Interest rate
- In the U.S., the bonds actually delivered by the party on the short side of the futures contract are not necessarily of those exact same maturities.
  - Acceptable government bonds/notes to deliver are:
    - Ultra T-Bond: 25 years $<$ maturity
    - Treasury Bond: $15 \leq$ maturity ≤ 25 years
    - 10-year Treasury note: $6.5 <$ maturity ≤ 10
    - 5-year Treasury note ≈ 5 %the original life must be less than 5.25 years.
    - 2-year Treasury note ≈ 2 %the original life must be less than 5.25 years.
- In Korea, TB futures are cash-settled.

Treasury Futures: Quotes

Table 6.1 Futures quotes for a selection of CME Group contracts on interest rates on May 21, 2020.

	Open	*High*	*Low*	*Prior settlement*	*Last trade*	*Change*	*Volume*
Ultra T-Bond, $100,000							
June 2020	220-06	221-31	220-06	220-17	220-28	+0-11	238,736
Sept. 2020	218-25	220-12	218-25	218-31	219-14	+0-15	137,715
Treasury Bond, $100,000							
June 2020	179-15	180-08	179-13	179-20	179-27	+0-07	395,908
Sept. 2020	177-29	178-22	177-29	178-03	178-08	+0-05	211,246

- In the U.S., thirty-seconds of a dollar per $100 face value. In Korea, percentage point.
  - $220'06 = 220 + 6/32 = 220.1875$
  - $134'215 = 134 + 21.5/32 = 134.671875$
  - $124'1525 = 124 + 15.25/32 = 124.4765625$

Treasury Bond Quotes

- The quoted price is for a bond with a face value of \$100.
- Example: a quote of 90'05 indicates that if the bond has a face value of \$100,000 its price will be $(90 + 5/32) \times 1,000 = \$90,156.25$
- This quoted price is also known as the clean price.
- The actual cash price that has to be paid by the purchaser of the bond is known as the dirty price.

Cash price = Quoted price + Accrued Interest

Treasury Bond Quotes: Example

- On March 5th 2013, there is a 11%-coupon treasury bond maturing on July 10th 2028, with a quoted price of 95'16.
- Coupons semi-annually: last coupon was paid on January 10th 2013. The next coupon date is July 10th 2013.
  - The actual number of days between Jan 10 and Mar 5 is 54.
  - The actual number of days between Jan 10 and Jul 10 is 181.
  - Each coupon pays $\$100 \times 0.11/2 = \$5.50$ (on Jan 10 and Jul 10)
- The accrued interest on Mar 5 is: $\$5.50 \times 54/181 = \$1.64$
- The cash price per \$100 face value is thus $\$95.50 + \$1.64 = \$97.14$
- The cash price of a \$100,000 face value bond is thus: \$97,140

Treasury Futures: Settlement

- Example: The Treasury bond futures contract allows the party with the short position to choose to deliver any government bond with a maturity left between 15 and 25 years.

Cash price = Quoted Price + Accrued interest

(Quoted price is called settlement price for futures.)

Cash price = Settlement Price + Accrued interest

(But the delivered bond may not be a 6% coupon bond.)

Cash price = Settlement Price × Conversion factor + Accrued interest

- Example

  - Settlement price: 120'00
  - Conversion factor: 1.3800
  - Accrued interest: $3 per $100 face value.
  - The cash received by the party with the short position (per $100 face value)

$$(1.3800 \times 120.00) + 3.00 = \$168.60$$

- `The actual price $= \$168.60 \times 1,000=\$168,600$`

Cheapest-to-Deliver Bond

- At any given time during the delivery month, there are many bonds that can be delivered in bond futures contracts
- The party with the short position, when delivering the bond, receives:

① Settlement Price × Conversion factor + Accrued interest

- The cost of purchasing the bond is:

② Quoted bond price + Accrued interest

- Thus the cheapest-to-deliver bond is the one minimizing: ② - ①

Quoted bond price − (Settlement price × Conversion factor)

Cheapest-to-Deliver Bond: Example

- The party with the short position has decided to deliver and is trying to choose between the three bonds in the table below. Assume the most recent settlement price is 93-08, or 93.25.

Bond	Quoted price	Conversion factor
1	99.50	1.0382
2	143.50	1.5188
3	119.75	1.2615

- The cost of delivering each of the bonds is as follows:

Bond 1: $99.50 - 93.25 \times 1.0382 = \$2.69$

Bond 2: $143.50 - 93.25 \times 1.5188 = \$1.87$

Bond 3: $119.75 - 93.25 \times 1.2615 = \$2.12$

The cheapest-to-deliver bond is Bond 2.

Treasury Bond Futures: Conversion factor

- The conversion factor for a bond is equal to the quoted price the bond would have (per dollar of principal) on the first day of the delivery month on the assumption that the yield curve is flat at 6% with semiannual compounding.
- Details...
  - The bond maturity and the times to the coupon payment dates are rounded down to the nearest 3 months for the purposes of the calculation (in order to be able to produce comprehensive tables).
  - After rounding, if the bond lasts for an exact number of six-month periods, the first coupon is assumed to be made in 6 months.
  - If it does not (i.e. there are extra 3 months), the first coupon is assumed to be paid after 3 months, and accrued interest is subtracted (for the 3 months preceding the present).
- [NB] In the case of the 2-year and 5-year note futures contract, a similar calculation is used to determine the conversion factor except that the time to maturity is rounded to the nearest month.