Class Notes Topic 4

(Part 1)

Forwards, Futures & Swaps

15.438 Fixed Income

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Topic 4 Overview

- Part 1
  - Forward and Futures Basics
  - Repurchase Agreements (RPs)
  - Futures Contracts
  - Duration-based Hedging with Forwards and Futures
- Part 2 (next set of class notes)
  - Interest Rate Swaps
    - Basics
    - Pricing
    - Uses
  - Currency Swaps
  - Speculative Strategies

Skills Acquired for Forwards, Futures and RPs

- Understand how to lock in future rates using forwards, futures, and repurchase agreements
- Understand basics of pricing these contracts
- Know the characteristics of some common contracts
- Recognize when taking a forward position is hedging, and when it is speculation
- Remember that when there are multiple safe ways to lock in a rate for future period, the rates must be equal (within transactions costs) to eliminate arbitrage
- Know how to use these contracts in delta and gamma hedging strategies

Forwards and Futures Basics

1) Definition: Forward Contract

- A forward contract specifies for a future transaction:

  a) **what** is to be delivered

  b) the **quantity** to be delivered

  c) the **delivery date**

  d) the **price** to be paid on the delivery date

- Note that a **"prepaid forward contract"** is the same except **payment is made when the contract is entered into**.

- *Helpful to think of the **underlying commodities** in most of the contracts to be **bonds** or other fixed income securities.*
  - However, some common contracts are directly on rates

Forwards and Futures Basics

2) **Definition: Forward Rate** (in the context of a forward contract)

- A forward rate is the rate (YTM) implied by the forward price and other characteristics of a security specified in a forward contract.
  - It will be specified on whatever basis is appropriate for the underlying security (e.g., bond equivalent for a Treasury bond or note)

- Practice Problem 4-1: Find the implied forward YTM for the following forward contract written today: "I will deliver to you in one year $1 million face value of a 3 year 6% coupon Treasury note, at a price of $98 per $100 face value." Express the forward YTM on a bond-equivalent basis.

Forwards and Futures Basics

3) For every forward contract, there must be a **buyer** and a **seller**. These are known as the **long** and the **short** side of the contract:

- Taking a **long position** is buying an asset (i.e., a bond).
  - Taking a long position in a bond or loan forward contract is a commitment to lend in the future at a rate set today.
- Taking a **short position** is selling an asset (i.e., a bond).
  - Taking a short position in a bond or loan forward contract is a commitment to borrow in the future at a rate set today.
- *Note that when contract treats the underlying as a rate instead of a bond it flips which side is described as long (e.g., swaps)*

4) Definition: A **hedge** is a transaction undertaken to reduce the risk of an existing position.

- E.g., if you are long in (own) a bond, risk is reduced by taking the short side of a bond forward contract, and vice versa for a short position in a bond.

Forwards and Futures Basics

5) A **futures contract** is a special kind of forward contract. It is traded on an organized exchange.

- Futures contracts are highly standardized, and subject to special rules.

- **Special Features of Futures Contracts:**
  - **standardized delivery dates**
  - **standardized commodities**
  - transferable and **highly liquid**
  - **clearing house puts its credit between buyers and sellers**
  - special rules include **margin requirements** and **marking to market**
  - most contracts are closed out prior to delivery date

Forwards and Futures Basics

6) **Forwards and futures are always a zero-sum game**. The rule for who gains and who loses is that:

  - You gain from buying a bond futures contract (going long) if the realized price rises above the locked-in futures price (interest rates fall).
  - You gain from selling a bond futures contract (going short) if the realized price falls below the locked-in futures price (interest rates rise).

- Still, a futures contract can benefit both sides by providing a hedge (i.e., insurance) against other exposures, or by providing a way to speculate.

The Fundamental Relation Between Forward Prices and Spot Prices for Bonds:

- $$P_0 = F_t/(1+Y_t)^t \qquad \text{(Eq. 4.1)}$$

where

- P_0 = current spot price of the bond
  - (same as prepaid forward price)
- F_t = Forward price for delivery of the bond at the end of t periods
- Y_t = t period spot yield (effective rate per period)

- This implies **price convergence**: as the delivery date nears, the forward price for the bond tends to approach its cash price.
- It can be derived from the fact that prices in forward contracts must be consistent with the implied forward rates in the yield curve.

Example 4.2: Say the spot yield curve is given by:
$Y_1 = 3\%$, $Y_2 = 6\%$, $Y_3 = 8\%$, $Y_4 = 8.5\%$ (effective annual rates).

The corresponding implied **forward rates** are: f(0,0,1) = 3%, f(0,1,2)=9.09% , f(0,2,3)= 12.11%, f(0,3,4) = 10.01%

- Problem: Find the spot price today, and forward price at time of delivery, of a 2-year, 5% coupon bond with $100 face & annual payments, to be delivered in:

    (a) 2 years,

    (b) 1 year,

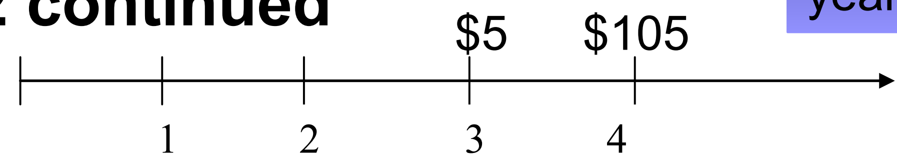
    (c) today.

- Verify that the cash and forward prices at delivery are consistent with equation (4.1).

Example 4.2 continued

Delivery in 2 years

(a)



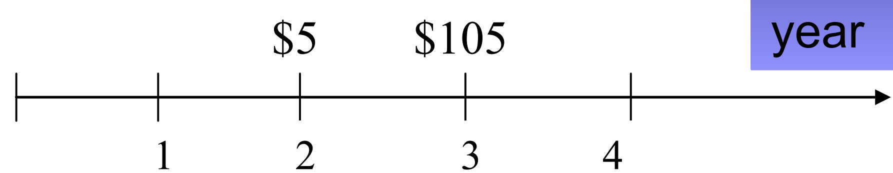
$P_0 = 5/(1.08)^3 + 105/(1.085)^4 = 79.734$

$F_2 = 5/1.1211 + 105/[(1.1211)(1.1001)] = 89.596$

Notice $79.73 = 89.596/(1.06)^2$

Delivery in 1 year

(b)



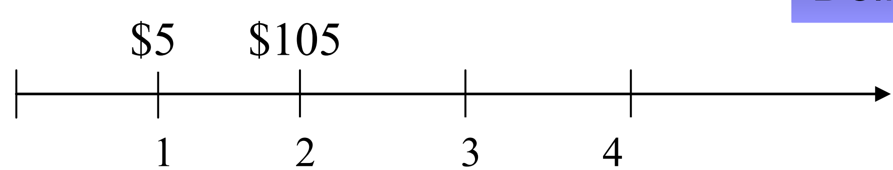
$P_0 = 5/(1.06)^2 + 105/(1.08)^3 = 87.802$

$F_1 = 5/1.0909 + 105/[(1.0909)(1.1211)] = 90.437$

Notice $90.437/1.03 = 87.802$

Delivery today

(c)



$P_0 = 5/(1.03) + 105/(1.06)^2 = 98.304 = F_0$

(PRACTICE PROBLEM 4-2) For the rates given in example 4-2, show that an arbitrage opportunity exists if you can lock in a borrowing rate of 9% on a one-year loan starting in 3 years (i.e., receive money in year 3, pay it back in year 4). Be explicit. Show the trades you would make to exploit this opportunity if you could go long or short in zero coupon bonds at the prices implied by the spot yield curve.

Repurchase Agreements

Repurchase Agreements (RPs)

- A **repurchase agreement** is a specific type of short-term loan that is collateralized with securities.
  - The borrower is said to enter a repurchase agreement or a “repo” or an “RP”.
  - The lender is said to enter a reverse repurchase agreement or a “reverse.”
  - The language is the opposite when referring to transactions of the Federal Reserve.

RP Basics

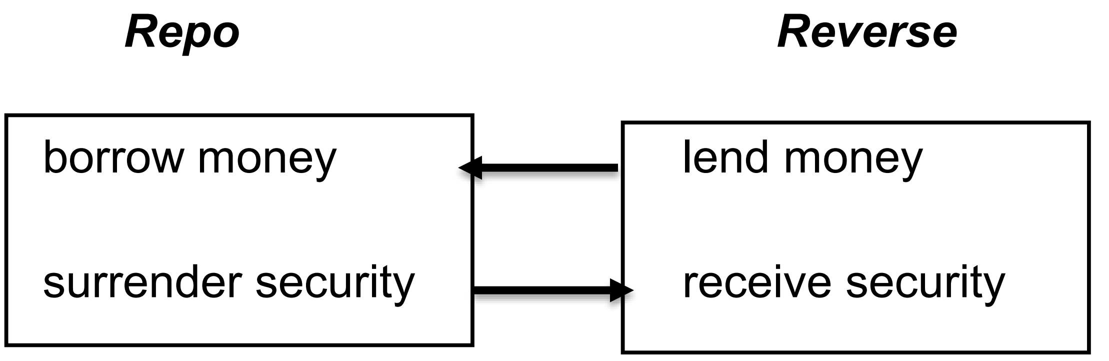
- A **repurchase agreement** specifies two transactions:
  - One party (the borrower) sells securities to a second party (the lender) at an agreed upon price today. That price is the loan amount.
  - It is also agreed that the borrower will buy the same securities back from the lender at a specified future date and price. That future price is the loan's face value.

- Importantly, ownership of the securities actually is transferred to the lender for the duration of the loan.
  - Triparty involves a custodian bank. Bilateral is between 2 counterparties.
  - Basis for SOFR "secured overnight funding rate"

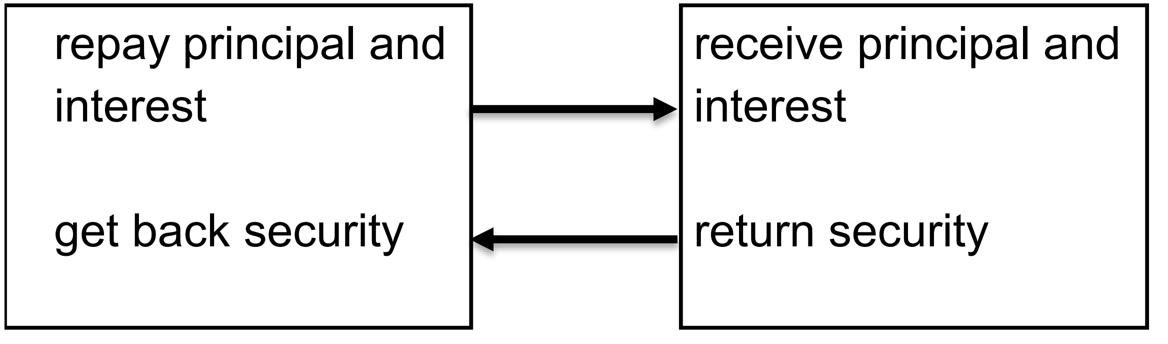
- Most RPs are direct transactions between banks and their customers, or between dealers.

- There is no secondary market, but one can get out of an RP by "reversing in" or "reversing out" (taking an opposite position).

Time 0


Repo
Reverse
borrow money
surrender security
lend money
receive security

Time T


repay principal and interest
get back security
receive principal and interest
return security

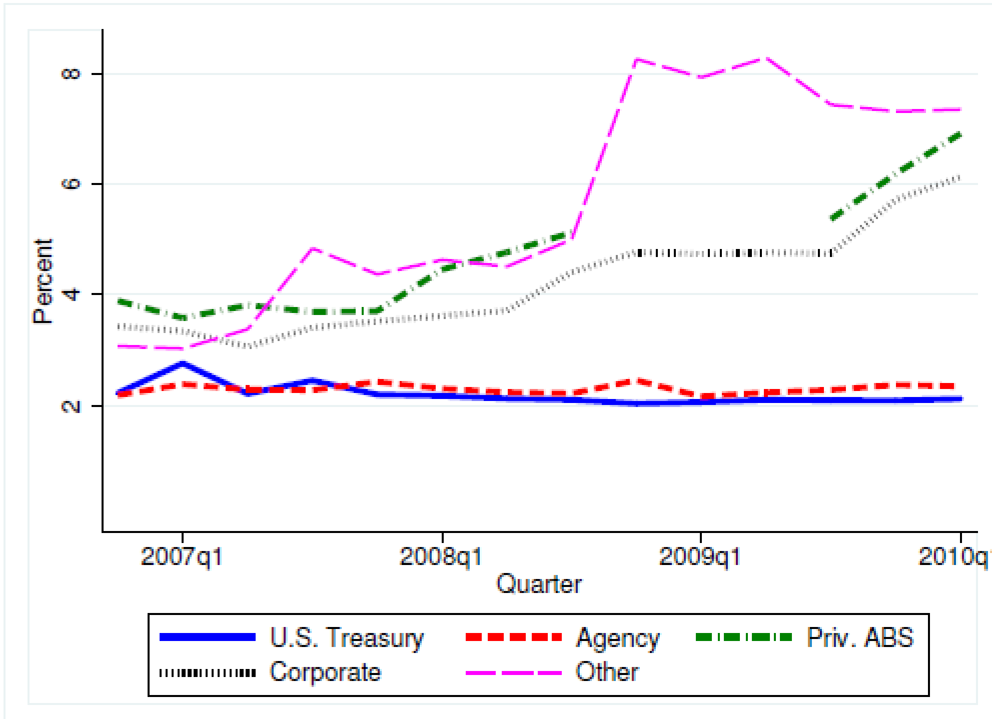
The many uses of RPs

- Collateralized short-term borrowing and lending
  - Investing short-term idle cash (e.g., by corporations)
  - Financing dealer inventories
  - Obtaining reserves (by banks and other depository institutions)
- Obtaining cash while avoiding realizing capital gains or losses from selling securities
- Adjusting the money supply (by the Fed)
- Obtaining securities to short
- Creating "synthetic" forward positions
  - E.g., to speculate on interest rate and spread movements (usually by dealers and arbitrageurs)

RP Basics (continued)

- **MATURITIES**
  - **Overnight RPs** most common
  - **Term RPs** generally range from 1 to 6 months
  - **Open RPs** are extended unless one of the parties chooses to terminate the transaction
- **RISK**
  - The risk involved is small due to collateral and short maturity
  - But RPs are not risk free. The value of the collateral can change over time, and there have been dramatic instances of fraud
  - Lender is usually protected by a "haircut"
  - Is the borrower also at risk?
- **INTEREST**
  - Interest on RPs is quoted as a **simple interest rate on a 360 day basis**.
    - The interest rate may depend on collateral quality and maturity

Haircuts by Collateral Type (vw.)



Example 4.3: Borrowing and Lending with RPs

- You purchase $1,000,000 face value in T-bills for $975,000 in an overnight repurchase agreement quoted at 8.75%.
  - (For simplicity, we'll always assume no haircut unless stated otherwise)
- *Are you borrowing or lending money? How much do you sell the bills back for the next day? What is the interest payment?*
- Answer: You're lending money overnight and receiving the securities as collateral.
  - P0 = $975,000.
  - The interest payment will be:
  - I = $975,000(0.0875)x(1/360) = $236.98.
  - Thus, the next morning, you receive $975,236.98 and return the T-bills.

Using RPs to borrow securities

- Sometimes the motive behind a reverse transaction is not to lend money but rather to borrow the security.
- The reverse side of an RP agreement can use the securities for other transactions as long as the RP contract is outstanding.
  - Typically used to set up or cover a short position.
    - For instance, securities dealers may "reverse in" securities to speculate on rate increases, or to exploit an arbitrage opportunity.

Using RPs to finance dealer inventories

- Mechanics of Financing Securities Inventories
  - Dealers use repurchase agreements to finance inventories.
  - Securities are traded during the day for settlement at the day's close.
  - Because settlement does not occur until the end of the day, without any cash a dealer may purchase securities, hoping to resell them at a favorable price later in the day.
  - If the securities are not sold, the dealer enters into an overnight RP using the securities as collateral.
  - The dealer can then use the funds raised with the RP to pay the original seller of the securities. (Note that some capital is needed to cover any haircut.)
  - The next day, the dealer receives the securities back and again tries to sell them.

Using RPs to finance dealer inventories

- Mechanics of Financing Securities Inventories *(continued)*
  - If the securities are sold, part (or all) of the proceeds goes to pay the RP holder.
  - If not, the dealer will enter another RP and use the funds raised to pay the first RP holder.
  - This borrowing rollover continues until the dealer sells the securities or they mature.
  - Since long-term rates usually exceed short-term rates, dealers often profit using this financing method. When they do, it is known as **"positive carry."**
  - If short-term rates rise above long-term rates, dealers may end up paying more for this overnight financing than they earn on the securities. This is known as **"negative carry."**

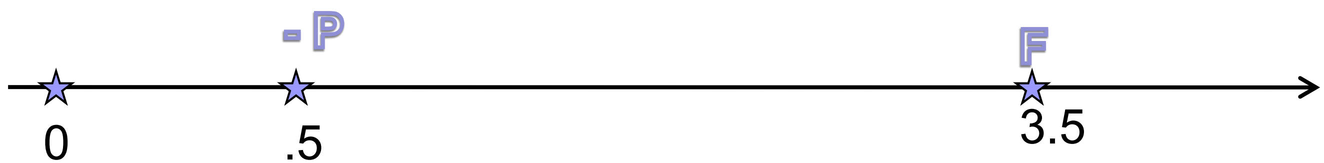
Using RPs to Create Synthetic Forward Contracts

- **Definition:** A **"synthetic"** forward position is created when a trader enters into a set of transactions that result in the same set of cash flows as if a forward contract had been used.

- Long and short synthetic forward positions in bonds are frequently created using RPs in combination with spot market transactions.

Example 4.4: Creating a Synthetic Long Position

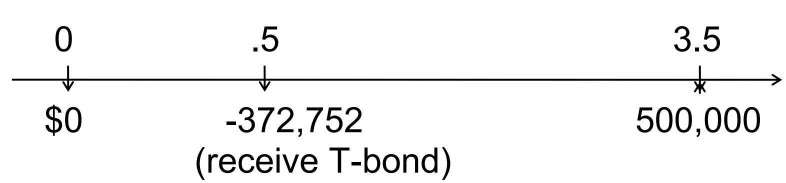
- This example shows how a term RP, along with spot transactions, can be used to synthetically create a **long forward position**.
- Specifically, we will describe transactions that lock in the purchase price of a 3-year zero-coupon T-bond in 6 months.



- *The plan:*
  - Borrow money today in a 6-month term RP, using a 3.5 year zero-coupon T-bond as collateral. The bond is purchased with the borrowed money. (Zero net cash flow at time 0)
  - At the end of six months the loan is repaid and the 3-year T-bond repurchased at the price preset in the RP.

Example 4.4: Creating a Synthetic Long Position (*continued*)

- A numerical example…
  - Assume that today the yield on the 3.5 year T-bond is 10% (b.e.b) and that the interest rate on six month term RP is 9.8% (360 day basis).
    - bond price is $500,000/(1.05)^7 = $355,340.
  - To create a synthetic long position follow these steps:
  - **Time 0:** Enter into a 6 month RP to borrow $355,340 using the F=$500,000 bond as collateral. At exactly the same time, buy the F=$500,000 bond in the market for $355,340 and use it as collateral. **The net cash flow is $0.**
  - **Six months later:** Repay the RP loan plus interest. This is
  - -$355,340(1 + (.098)180/360) = -$372,752
  - Receive (the same) bond with F=$500,000, and 3 years to maturity.
  - *The cash flows must be identical to those for the equivalent forward contract, since any discrepancy would represent an arbitrage opportunity.*
  - How would you create the equivalent synthetic short position?



Practice Problem 4.3. Imagine that you want to take a short position in 60 day CDs to be delivered in 30 days. Below are current CD rates, and current RP rates for RPs collateralized with high quality CDs. Find the cash flows you can lock in. Describe the terms of the equivalent forward contract.

30 day CD	i=5.62%	overnight RP	i=5.8
60 day CD	i=5.66%	10 day RP	i=5.86
90 day CD	i=5.71%	20 day RP	i=5.91
		30 day RP	i=5.98

Futures Contracts

Futures Markets for Fixed Income Securities

- "No arbitrage" conditions imply that futures prices are almost identical to forward prices
  - That is, if you could borrow more cheaply with a futures than a forward, you'd short the futures and go long in the forward, generating an arbitrage profit.
  - But a small differences arise due to the effects of interest earnings on margin accounts, and counterparty risk.
- We will look at several important contracts:
  1. 3-month Eurodollar deposits
  2. 3-month SOFR futures
  3. U.S. Treasury Bond Futures

All trade on the Chicago Mercantile Exchange (CME).

The 3-month Eurodollar Futures Contract

- Can be used (in combination with spot transactions) to effectively lock in a future borrowing or lending rate (a LIBOR rate) over a future 3-month period
- **Features:**

  (a) Each contract is for $1mm face value of Eurodollar three month time deposits paying the rate set in the futures contract.

  (b) Delivery months are March, June, September and December, plus four more near-in months.

  (c) Contracts are cash-settled, which means that delivery never takes place. The settlement price is determined by a formula for averaging LIBOR rates from major banks.

  (d) Quoted in terms of simple interest rates, converted to an index value. The index equals 100 - i, where i is the simple add-on interest.

Link to CME

The 3-month Eurodollar Futures Contract

- Every day contracts are marked to market, and margin accounts are adjusted to reflect any gain or loss.
- When the contract is closed out, the gain or loss on the contract is equal to the net change in the margin account.
- For every basis point change in the 90-day LIBOR rate, $25 is transferred between margin accounts for each contract.
  - ($25 = $1,000,000(.0001)*90/360).
- Margin accounts must be maintained above a minimum level.

Example 4-5: Marking a Eurodollar Futures Contract to Market

- Enter a **long position** in one contract quoted at 97.35 maturing next March.
- What is the implied rate in the futures market?
  - 100-97.35 = 2.65, or 2.65%
- What happens to your margin account over time? It depends on the path of the 90-day March LIBOR rate implied by the futures market…

	futures implied 90-day LIBOR	daily change in account	cumulative change in account
day 1	2.70%	-125	-125
day 2	2.71%	-25	-150
day 3	2.65%	150	0
day 4	2.68%	-75	-75
day 5	2.63%	125	50

Example 4-6: Locking in a future borrowing rate with Eurodollar futures

- In Jan. 2018, a bank wants to lock in a borrowing rate on $1m for a period running from Sept. 2018 to Dec. 2018, when it will borrow money to fund a loan it has committed to make.
  - The Sept. 2018 eurodollar futures contract is quoted at **94.15.**
- Questions:
  1. Does the bank take a long or short position in the futures market? What rate does it lock in?
  2. How much does the bank gain or lose on the contract if it is held to maturity, assuming that the 3-mo. LIBOR rate in September turns out to be 6.25%?
  3. What is the bank's effective borrowing rate in September (taking into account the actual borrowing rate, and gains or losses on the contract)?

Example 4-6: continued

1. Does bank take a long or short futures position? What rate is locked in?
   - Take a short position. The rate is 100-94.15 = 5.85%
2. How much is the gain or lose on the contract if it is held to maturity? (For illustration, we assume that the 3-mo. LIBOR rate in September turns out to be 6.25%.)
   - Shorting a contract locks in a borrowing rate, and bank gains if rates rise.
   - Gain is (625-585)$25=$1,000, which is received at the contract's maturity in September.
   - *Think of this as the cumulative change in the bank's margin account.*

<u>Example 4-6</u>: continued

3. What is your effective borrowing rate in September?
   (Take into account your actual borrowing rate, and gains or losses on the contract)

   In Sept you can borrow $1mm for 90 days at the then current rate of 6.25%. At the end of 90 days, the lender is paid:

   $$\$1,000,000(1 + 0.0625(90)/360) = \$1,015,625.$$

   The total cash received in September is:

   $$\$1,000,000+[(625-585)\$25] = \$1,001,000.$$

   The effective rate (on a 360 day basis) solves:

   $$\$1,001,000(1 + r(90)/360) = 1,015,625$$

   so the effective rate, r = 5.844% (very close to the 5.85% quoted futures rate)

The 3-month SOFR futures contract

- SOFR = Secured Overnight Financing Rate
  - An overnight RP rate
- SOFR is the replacement for LIBOR proposed by regulators
- New contract structured to be somewhat similar to popular Eurodollar contract
  - Same maturity, settlement months, value of 1 bp per contract, etc.
- Also fundamental differences between SOFR and Eurodollar futures
  - SOFR is backwards looking geometric average of overnight rates
  - No real term structure of SOFR rates
  - No term premium in rate
  - No risk premium in rate
- To date low volume compared to Eurodollars

The U.S. Treasury Bond Futures Contract

- Each contract is for $100,000 face value of any qualifying Treasury Bond. All T-bonds with at least 15 years to maturity or to first call (and maturity of less than 25 years) qualify for delivery.
- Delivery months are March, June, September and December.
- The final settlement price is determined by a formula using a conversion factor applied to the delivered bond. The conversion factor is based on a 6% yield.
  - P = Q x C x 1,000
  - Q = quoted futures price
  - C = conversion factor
  - P = price paid at settlement for delivery on one contract

Link to CME

Determining the Conversion Factor

- **The rule for finding the conversion factor is to discount cash flows on a deliverable bond at 6%.**

- **Example 4.7**: Suppose that the Treasury bond futures price is \$102 8/32 on an expiration date (=\$102.25). A 9.5% T-bond with 24 years to maturity is delivered. At a yield of 6%, the price would be 1.44217 per \$1 face value. This is the conversion factor.

  Upon delivery of the bond, the short would receive \$100,000(1.0225)(1.442) = \$147,444.50 per contract (plus any accrued interest).

Options in the T-Bond Futures Contract

(1) Quality Delivery Option

short chooses the "cheapest to deliver" bond, i.e., the bond which maximizes:

(futures price at settlement)(conversion factor) - (spot market price)

(2) Delivery Option

short can choose when in delivery month to deliver

(3) Wildcard Option

futures price determined at 2 p.m.

short can buy security to deliver between 2 p.m. and 4 p.m., so short has option to wait if predicts price will fall

How will these options affect contract price?

Do they encourage or discourage volume?

<u>Example 4.8</u>: Finding the Cheapest to Deliver

- Today is March 1, 2018, which is an expiration date for the Treasury bond futures contract, and the closing futures price is $101. The following two bonds are among the many that qualify for delivery:

Maturity (years)	Coupon (semiannual)	Price (per $100 face)	Conversion Factor
20	6.0%	$110.677	1.0
16	5.4%	$97.140	0.939

- Which of these bonds is cheaper to deliver? Explain briefly.
- Answer:
  - 20 year bond: 101 - 110.677 = -9.677
  - 16 year bond: 101*.939 - 97.140 = -2.301
  - The 16 year bond is the cheaper to deliver.

- *Note: Neither of these would actually be delivered. The <u>cheapest</u> to deliver will always match the contract price paid, because cash and futures prices converge on delivery date.*

<u>Example 4.9</u>: Closing out a T-bond futures contract before maturity

- Say that in Aug. ‘13 you use a T-bond futures contract that expires in Dec ’13 to hedge against (or bet on) rates falling. The current quoted “price” in the futures market is 101 2/32.
  - You take a long position in one contract.
  - You effectively lock in a buy price of $101,062.50 on a qualifying 6% T-bond to be delivered on the contract in Dec. ‘13
  - Daily changes in the contract price are reflected as gains or losses in your margin account.
- Say in Sept. ‘13 you want to close out this position. The current price for the Dec. ’13 futures is 102.
  - To offset your long position, take a short position in one Dec. ’13 contract.
  - Contract is closed out at $102,000.
  - The difference (102,000 – 101,062.50) is the gain in your margin account between Aug. and Sept. You close out the account and pocket this difference.

Duration-based hedging with forwards and futures

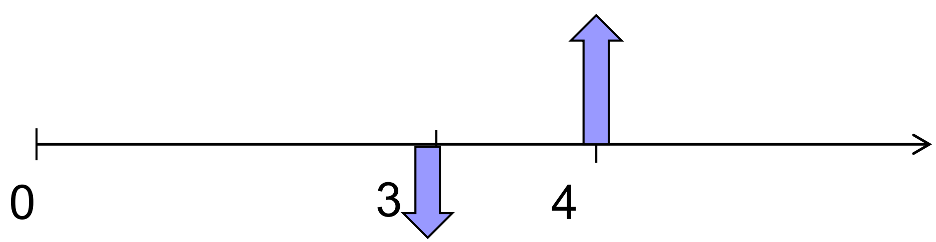
Duration of a Forward or Futures Contract

- The dollar duration of a forward contract equals the dollar duration of the **replicating portfolio of spot market positions**.
  - Recall that the dollar duration of a bond is defined as $D_m(P)$, and that $dP/dy = -D_m(P)$
  - **Definition:** The **dollar duration of a forward bond contract** is equal to the duration of the security specified in the forward contract multiplied by the prepaid forward price of the security.
  - **Definition**: The **prepaid forward price** is the present value of the forward price.

Example 4.10: Dollar duration of a forward contract

- Recall that a forward contract is equivalent to a portfolio consisting of a long and a short position in zero coupon bonds of equal value.
- Using this, we can derive an expression for the **yield-sensitivity of the present value of the forward contract**.
- E.g., a long forward contract in a one-year bond to be delivered 3 years in the future:
  - Equivalent to a long position in a 4-year zero coupon bond, and a short position of equal value in a 3-year zero coupon bond.
  - Assume contract is such that $P_0(3) = P_0(4) = \$100$;
  - $V_0 = P_0(4) - P_0(3) = 0$; $D_m(4) = 4/(1+y/k)$; $D_m(3) = 3/(1+y/k)$
    - $dV_0/dy = dP_0(4)/dy - dP_0(3)/dy = -D_m(4)P_0(4) + D_m(3)P_0(3)$

      $= -(D_m(4) - D_m(3))100 = -(4-3)\times 100/(1+y/k)$



Note that the modified duration of the security in the contract is $1/(1+y/k)$, and the prepaid forward price, $P_0(3)$, is \$100.

Using Futures in a Duration-Based Hedge

- *The problem:* There are very few futures contracts available. Hence, the duration of the future obligation being hedged may differ from the duration of the commodity in the futures contract.
- *The solution:* Adjust the number of futures contracts bought or sold to minimize the mismatch. This uses the idea of delta hedging using a hedge ratio.
- Recall that: $$dP \approx -PD_m dY$$
  - P = bond price; dP = change in bond price; Y = yield (APR); dY = change in yield; D_m = modified duration
- Similarly, if F is the contract price for an interest rate futures contract, then

$$dF \approx -FD_F dY$$

  - where D_F is the modified duration of the futures contract, and F is the price (technically, the prepaid forward price) of the security in the futures contract.
- For the contract to serve as a hedge, we want dF = dP, which implies **equating the hedge ratios** in a long and short position**:**

$$PD_m = FD_F$$

Note: if effective duration is different than modified duration, use effective duration in this formula instead.

Example 4.11: Using Futures in a Duration-Based Hedge

- **The Problem:**
  - Your company expects to receive $5 million next March, which it will invest in a 9-month CD until the funds are needed to open a new plant.
  - Currently the 9 month rate is 8% (on a 360 day basis), and you are afraid that rates will fall between now and March.
  - Assume that the yield curve is approximately flat.
  - A 3-month Eurodollar futures contract expiring in March is quoted at 92.2.
- **Questions:**
  - How can you use this contract to hedge against a fall in rates?
  - How many contracts do you need?
  - Calculate the effective rate you earn over the 9 months if the CD rate falls to 6% in March.

Example 4.11: Using Futures in a Duration-Based Hedge (continued)

- **The Answer:**
  - Take a long position in futures to hedge against a fall in rates.
  - 100 - 92.2 = 7.8%, rate you lock in on a 3-mo eurodollar contract.
  - D_F = .25/(1.02). On the 9-month CD, D_m = .75/(1.06). P = $5m.
  - Equating the hedge ratios implies
    - F = $5m(.75/1.06)/(.25/1.02) ≈ $15m. (literally $14.43m but rounded here to 15)
  - Since each contract is for $1m, go long in 15 contracts to lock in the quoted lending rate. If rates fall to 6%, then the profit on the futures contracts is 15($25)(780-600) = $67,500.
  - In March you invest 5,067,500 at 6%, which returns 5,067,500(1 + .06(270/360)) = 5,295,538 nine months later. The effective rate on the $5m solves:
  - 5,000,000(1 + r(270/360)) = 5,295,538. Solving for r, r=7.88%, very close to the rate quoted on the 3 mo eurodollar contract.

A final note: Comparing examples 4.10 and 4.11

- You may be wondering why in example 4.10 there is a present value adjustment to dollar duration and in 4.11 there isn't. The reason is in the timing…
    - In 4.10, duration is being calculated in a way that is relevant to hedging a time 0 position with a forward contract with cash flows 3 and 4 periods later.
    - In 4.11, an anticipated cash position starting in March is being hedged with a futures contract also expiring in March; hence no time value adjustment is needed.