Futures Markets: Speculating and Hedging

The most actively traded futures contracts in the world are the interest rate futures such as Eurodollar or US. Treasury bonds contracts. Commercial banks and money managers use these futures to hedge their interest rate exposure, i.e., to protect their portfolios of loans, investments, or borrowing against adverse movements in interest rates. They are also used by speculators as leveraged investments, based on their forecasts of movements in interest rates. Organized markets for interest rate futures exist for instruments in several currencies. Following the United States and the United Kingdom, most countries with a major bond market have either already developed, or are in the process of developing, a futures market for long-term bonds and sometimes short-term paper.

Active U.S. dollar markets exist in three-month U.S. Treasury bills and Eurodollar deposits for short-term interest rates and in 20-year 8% Treasury bonds for long-term rates. Other futures contracts have been introduced for certificates of deposit (CDs), commercial paper, 5- and 10-year Treasury bonds, and the mortgage bons known as Ginnie Maes, or GNMA. Similarly, the London International Financial Futures Exchange offers a 3-month sterling deposit contract, a 3-to $4\frac{1}{2}$-year 12% U.K. gilt contract, and a 20-year 12% U.K. gilt contract. The Paris Bourse (MATIF) proposes a 15-year 10% government bond contract and 3-month Treasury bill and PIBOR contracts. The Tokyo Stock Exchange offers contracts on 10-year bonds with a 6% yield. The Sydney Futures Exchange proposes contracts for 3-month Australian bills and 10-year Australian bonds. Eurodollar contracts are traded on several exchanges in the United States, Canada, London, and Singapore. These interest rate futures markets are growing rapidly throughout the world, and new contracts are continually created to fit the needs of banks and investors. Major bond contracts will be given in a figure.

The quotation method used for these contracts is difficult to understand but tends to be similar among countries. Contracts on short-term instruments are quoted at a discount from 100. At delivery, the contract price equals 100 minus the interest rate of the underlying instrument. For example, three-month Eurodollar contracts are denominated in units of $1 million; the price is quoted in points of 100%. For this reason the September contract in one of the figures that will be presented is quoted at 93.61% on the CME. The price of 93.61% is linked to an interest rate on three-month Eurodollar deposits of 6.39% (100 minus 93.61). If the three-month interest rate at delivery is less than 6.39%, the buyer of the contract at 93.61 will make profit.

This quotation method is drawn from the Treasury bill market. However, further calculations are required to drive the profit or loss on such a futures position, since the interest rates for the three-month instruments are quoted on an annual basis. The true interest paid on a three-month instrument is equal to the annual yield divided by four. Therefore the profit or loss on one unit of a Eurodollar contract (or any other three-month financial contract) equals the futures price variation divided by four. The total gain or loss on one contract is therefore equal to

$$\text{Gain(loss)=(Futures price variation/4)Size of the contract}$$

Assume that in September the Eurodollar interest rate drops to 6% on the delivery date. The futures price will be 94% on that date. The profit to the buyer of one contract is :

$$\text{Gain} = ((94\%\text{-}93.61\%)/4)\ \$\ 1\ \text{million} = \$975$$

The same quotation technique is used for Treasury bills and other short-term interest contracts.

Interest Rate Futures in Details

Students might go over this part, to have a better idea about the pricing, reporting and explanations of the different interest rate futures.

1) Treasury Bills

Note: It is recommended that you look at the appendix if you have a problem understanding this section.

Treasury bills futures and Eurodollars futures contracts are futures whose underlying instrument is a short-term debt obligation. The Treasury bill futures contract, which is traded on the IMM, is based on a 13-week (three-month) Treasury bill with a face value of $1 million. More specifically, the seller of a Treasury bill futures contract agrees to deliver to the buyer at the settlement date a Treasury bill with 13 weeks remaining to maturity and a face value of $1 million. The treasury bill delivered can be newly issued or seasoned. The futures price is the price at which the Treasury bill will be sold by the short and purchased by the buyer. For example, a nine-month Treasury bill futures contract requires that nine months from now the short deliver to the long $1 million face value of a Treasury bill with 13 weeks remaining to maturity. The Treasury bill could be a newly issued 13-week Treasury bill or a Treasury bill that was issued one year prior to the settlement date and therefore at the settlement has only 13 weeks remaining to maturity.

Treasury bills are quoted in the cash market in terms of an annualized yield on a bank discount basis, where:

$$Y_D = (D/F) \times (360/t)$$

where

Y_D is the annualized yield on a bank discount basis (expressed as a decimal)

D = dollar discount, which is equal to the difference between the face value and the price of a bill maturing in t days.

F = face value

t = number of days remaining to maturity

The dollar discount (D) is found by:

$$D = Y_D \times F \times (t/360)$$

In contrast, the Treasury bill futures contract is not quoted directly in terms of yield but instead on an index basis that is related to the yield on a bank discount basis as follows:

$$\text{Index price} = 100 - (Y_D \times 100)$$

For example, if $Y_D = 8\%$, the index price is : 100 - (0.08×100) = 92.

It will be seen that the **index price** of an instrument differs from its actual price because it is the price of an instrument with the same annual yield but maturing in a year. The primary purpose of this convention is that all instruments with the same annual yield will have the same price, regardless of maturity. Conversely, instruments with the same price will have the same yield to maturity and bank discount basis. This clearly facilitates comparison of annual yields across maturities.

Given the price of the futures contract, the futures yield on a bank discount basis for the futures contract is determined as follows:

$$Y_D = (100 - \text{Index price})/100$$

To see how this works, suppose that the index price for a Treasury bill futures contract is 92.52. The futures yield on a bank discount basis for this Treasury bill futures contract is:

$$Y_D = (100 - \text{Index price})/100 = (100\text{-}92.52)/100 = 0.0748 \text{ or } 7.48\%$$

The price that the buyer of a futures contract must pay the seller at the settlement date is called the **invoice price**. In this case of the Treasury bill futures contract, the invoice price that the buyer of $ 1 million face value of 13-week Treasury bills must pay at settlement is found by first computing the dollar discount, as follows:

$$D = Y_D \times F \times (t/360) = Y_D \times \$1,000,000 \times (t/360)$$

where t is either 90 or 91 days. Typically, the number of days to maturity of a 13-week Treasury bill is 91 days.

The invoice price is then:

Invoice price = $1,000,000- D

For example, for the Treasury bill futures contract with an index price of 92.52 (and a yield on a bank discount basis of 7.48%), the dollar discount for the 13-week Treasury bill to be delivered with 91 days to maturity is:

$$D = 0.0748 \times \$1,000,000 \times (91/360) = \$18,907.78$$

The invoice price is : $1,000,000 - $18,907.78 = $981,092.22.

The minimum index price fluctuation or "tick" for this futures contract is 0.01. A change of 0.01 for the minimum index price translates into a change in the yield on a bank discount basis of one basis point (0.0001). The change in the value of one basis point will change the dollar discount, the therefore the invoice price, by:

$0.0001 \times \$1,000,000 \times (t/360)$

for a 13-week Treasury bill with 91 days to maturity, the change in the dollar discount is:

$0.0001 \times \$1,000,000 \times (91/360) = \$25.28$

For a 13-week Treasury bill with 90 days to maturity, the change in the dollar discount would be $25. Despite the fact that a 13-week Treasury bill typically has 91 days to maturity, market participants commonly refer to the value of a basis point for this futures contract as $25.

2) Eurodollar CD futures

Eurodollars certificates of deposit (CDs) are denominated in dollars but represent the liabilities of banks outside the United States. The contracts are traded on both the International Monetary Market of the CME and the London International Financial Futures Exchange. The rate paid on Eurodollar CDs is the London Interbank Offered Rate (LIBOR).

The three-month Eurodollar CD is the underlying instrument for the Eurodollar CD futures contract. As with the Treasury bill futures contract, this contract is for $1 million of face value and is traded on an index-price basis. The index-price basis in which the contract is quoted is equal to 100 minus the annualized futures LIBOR. For example, a Eurodollar CD futures price of 94.00 means a futures contract three-month LIBOR of 6%.

The minimum price fluctuation (tick) for this contract is 0.01 or (0.0001 in terms of LIBOR). This means that the price value of a basis point for this contract is $25, found as follows. The simple interest on $1 million for 90 days is equal to:

$\$1{,}000{,}000 \times (LIBOR \times 90/360)$

If LIBOR changes by one basis point to (0.0001), then :

$\$1{,}000{,}000 \times (0.0001 \times 90/360) = \$25$

The Eurodollar CD futures is a cash settlement contract. That is, the parties settle in cash for the value of a Eurodollar CD based on LIBOR at the settlement date. The Eurodollar CD futures contract is one of the most heavily traded futures contracts in the world. It is frequently used to trade the short end of the yield curve, and many hedgers have found this contract to be the best hedging vehicle for a wide range of hedging situations.

3) Treasury bond Futures

The underlying instrument for a Treasury bond futures contract is $1,00,000 par value of a hypothetical 20-year, 8% coupon bond. The futures price is quoted in terms of par being 100. Quotes are in 32nds of 1%. Thus a quote for a Treasury bond futures contract of 97-16 means 97 and 16/32nds, or 97.50. So, if a buyer and seller agree on a futures price of 97-16, this means that the buyer agrees to accept delivery of the hypothetical underlying Treasury bond and pay 97.50% of par value, and the seller agrees to accept 97.50% of par value. Since the par value is $100,000, the futures price that the buyer and seller agree to pay for this hypothetical Treasury bond is $97,500.

The minimum price fluctuation for the Treasury bond futures contract is a 32nd of 1%. The dollar value of a 32nd for a $100,000 par value (the par value of the underlying Treasury bond) is $31.25. Thus, the minimum price fluctuation is $31.25 for this contract.

We have been referring to the underlying as a hypothetical Treasury bond. Does this means that the contract is a cash settlement contract, as is the case with stock index futures described. The answer is no. The seller of Treasury bond futures who decides to make delivery rather than liquidate his position by buying back the contract prior to the settlement date must deliver some Treasury bond. But what Treasury bond. The Chicago Board of Trade allows the seller to delivery one of several Treasury bonds that the CBT declares is acceptable for delivery. The specific bonds that the seller may delivery are published by the CBT prior to the initial trading of a futures contract with a specific settlement date.

A table will be presented to show the Treasury issues that the seller could have selected from to deliver to the buyer of the September 1994 futures contract (or any other dates). The CBT makes its determination of the Treasury issues that are acceptable for delivery from all outstanding Treasury issues that meet the following criteria: an issue must have at least 15 years to maturity from the date of delivery, if not callable; in the case of callable bonds, the issue must not be callable for at least 15 years from the first day of the delivery month.

The delivery process for the Treasury bond futures contract makes the contract interesting. At the settlement date, the **seller** of a futures contract (**the short**) is required to **deliver** the **buyer** (**the long**) $100,000 par value of an 8%, 20-year Treasury bond. Since no such bond exists, the seller must choose from one of the acceptable deliverable Treasury bonds that the CBT has specified. Suppose the seller is entitled to deliver $100,000 of a 6%, 20-year Treasury bond to settle the futures contract. The value of this bond, of course, is less than the value of an 8%, 20-year bond. If the seller delivers the 6%, 20-year, this would be unfair to the buyer of the futures contract who contracted to receive $100,000 of an 8%, 20-year Treasury bond. The value of a 10%, 20-year Treasury bond is greater than that of an 8%, 20-year bond, so this would be a disadvantage to the seller.

How can this problem be resolved (students are not responsible for this part)!!

To make delivery equitable to both parties, the CBT has introduced conversion factors for determining the invoice price of each acceptable deliverable Treasury issue against the Treasury bond contract with a specific settlement date begin trading. A table will present those acceptable issues, with their conversion factor (The conversion factor is based on the price that a deliverable bond would sell for at the beginning of the delivery month if it were to yield 8%). The conversion factor is constant throughout the trading period of the futures contract. The short must notify the long of the actual bond that will be delivered one day before the delivery date.

The invoice price for the Treasury bond futures contract is the futures price plus accrued interest. However, as just noted, the seller can deliver one of several acceptable Treasury issues and to make delivery fair to both parties, the invoice price must be adjusted based on the actual Treasury issue delivered. It is the conversion factors that are used to adjust the invoice price. The invoice price is:

Invoice price = contract size × Futures contract settlement price × conversion factor + Accrued interest.

Suppose the Treasury bond futures contract settles at 94-08 and that the short elects to delivery a Treasury bond issue with a conversion factor of 1.20. The futures contract settlement price of 94-08 means 94.25% of par value. As the contract size is $100,000, the invoice price the buyer pays the seller is:

$\$100{,}000 \times 0.9425 \times 1.20 +$ Accrued interest $= \$113{,}100 +$ Accrued interest

In selecting the issue to be delivered, the short will select from all the deliverable issues the one that is cheapest to deliver. This is issue is referred to as the **cheapest-to-deliver** issue and it plays a key role in the pricing of a futures contract. The cheapest-to-deliver issue is determined by participants in the market as follows. For each of the acceptable Treasury issues from which the seller can select, the seller calculates the return that can be earned by buying that issue and delivering it at the settlement date. Note that the seller can calculate the return since he knows the price of the Treasury issue now and the futures price at which he agrees to deliver the issue. The return so calculated is called the **implied repo rate.** The cheapest-to-deliver issue is then the one issue among all acceptable Treasury issues with the highest implied repo rate since it is the issue that would give the seller of the futures contract the highest return by buying and then delivering the issue.

In addition to the choice of which acceptable Treasury issue to deliver - sometimes referred to as the **quality option** or **swap option** - the short position has two more options granted under CBT delivery guidelines. The short position is permitted to decide when in the delivery month the delivery will actually take place. This is called the **timing option**. The other option is the right of the short position to give notice of intent to deliver up to 8:00 P.M. Chicago time after the closing of the exchange (3:15 P.M. Chicago time) on the date when the futures settlement price has been fixed. This option is referred to as the **wild card option**. The quality option, the timing option, and the wild card option (in sum referred to as the **delivery option**), mean that the long position can never be sure of which Treasury bond will be delivered or when it will be delivered.

D) Applications of Interest Rate Futures

Interest rates futures are used for the following:

- Speculate on the movement of interest rates.
- Hedge against adverse interest rate movements.

a) Speculation Using Interest Rate Futures

The price of a futures contract moves in the opposite direction from interest rates: when rates rise (fall), the futures price will fall (rise). An investor who wants to speculate that interest rates will rise (fall) can sell (buy) interest rates futures. Before interest rate futures were available, investors who wanted to speculate on interest rates did so with the long-term Treasury bond: shorting it if they expected interest rates to rise, and buying it if they expected interest rates to fall. There are three advantages of using interest rate futures instead of the cash markets (trading long-term Treasuries themselves). First, transaction costs are lower for futures compared to cash markets. Second, margin requirements are lower for futures than for Treasury securities; using futures thus permits greater leverage. Finally, it is easier to sell short in the futures market than in the Treasuries market.

In the interest rate futures market, it is possible to speculate by holding an outright position, or by trading a spread. An outright position, such as buying a T-bill futures, is a simple bet on the direction of interest rates. A spread speculation involves a bet on a change in the relationship between two futures prices.

1) Speculating with Outright Positions

In this setup, the long trader is betting that interest rates will fall so that the price of the futures will rise. The short trader is betting that interest rates will rise so that the futures price will fall.

As an example of an outright speculation, we consider a trader who anticipated rising interest rates on September 20, 1990, following the Iraqi invasion of Kuwait. In particular, the trader believes that short-term rates will rise, so she trades the Eurodollar contract shown below. To profit from rising interest rates, the trader must be short in the interest rate futures. Accordingly, she sells one DEC 90 Eurodollar contract at 90.30. Five days later, interest rates have risen and the futures contract trades at 90.12. Satisfied with the profit, she sells, for a gain of 18 basis points. Because each basis point is worth $25, her total profit is $450.

Speculating with Eurodollar Futures

Date	Futures Market
September 20	Sell 1 Dec 90 Eurodollar Futures at 90.30
September 25	Buy 1 Dec 90 Eurodollar Futures at 90.12

Profit: 90.30 - 90.12 = 0.18

Total Gain: 18 basis points ×$25 = $**450**.

2) Speculating with Spreads

An intracommodity spread is typically a speculation on the term structure of interest rates, for example, a spread between the nearby and distant T-bill futures. An intercommodity spread can be a speculation on the changing shape of the yield curve, or it can be a speculation on shifting risk levels between different instruments. For example, T-bills, and T-bonds have the same default risk, so a bond/bill spread is a yield curve speculation. Often, an intercommodity spread is a speculation on changing risk levels between different instruments, for example, a spread between T-bills and Eurodollars.

An Intracommodity T-bill Spread

The table below represents the spot rates and futures rates for T-bills. As the spot rates show, the yield curve slopes upward, with three-month bills yielding 10 percent and 12-month bills yielding 12 percent. The table shows three futures contracts, with the nearby contract maturing in three months. For the futures contracts, the futures yields are consistent with the term structure given by the spot rates. Faced with such circumstances, particularly with a very steep upward sloping yield curve, a speculator might believe that the term structure would flatten with six months. Even if one were not sure whether rates were going to rise or fall, the speculator could still profit from a T-bill futures spread by entering the transactions shown below.

Spot and Futures T-Bill Rates for March 10

Time to Maturity	**Spot Rates**	**Futures contract**	**Futures yield**	**IMM Index**
3 months	10.00%	JUN	12.00%	88.00
6 months	11.00%	SEP	12.50	87.50
9 months	11.50%	DEC	13.50	86.50
12 months	12.00%			

Speculating on T-bill Futures

Date——————————————————————**Futures Market**

March 20..Buy the DEC T-bill Futures at 86.50

....Sell the SEP T-bill Futures at 87.50

April 30..Sell the DEC T-bill futures at 88.14

....Buy the SEP T-bill futures at 89.02.

Profit:

DEC..................SEP

88.14..................87.50

-86.50..................-89.02

1.64......................-1.52

Total Gain: 12 basis points $\times$\$25 = \$**300**.

If the yield curve flattens, the yield spread between successively maturing futures contracts must narrow. Currently, the yield spread between the DEC and SEP futures contracts is 100 basis points. By buying the more distant DEC contract and selling the SEP futures contract, the trader bets that the yield differential will narrow. If the yield curve flattens, no matter whether the general level of rates rises or falls, then this spread strategy gives a profit. As the above table shows, yields have fallen dramatically by April 30. The yield on the DEC contract has fallen from 13.50 percent to 11.86 percent and the SEP yield has moved from 12.50 percent to 10.98 percent. For the profits on this speculative strategy, the important point is that the yield spread has changed from 100 basis points to 88 basis pints. This generates a profit on the spread of 12 basis points, or $300 because each basis point change represents $25. The same kind of result could have been obtained in a market with rising rates, as long as the yield curve flattens.

This example shows that all interest rates futures intracommodity spreads are speculations on the changing shape of the yield curve. No matter what change in the shape of the yield curve is anticipated, there is a way to profit from that change by trading the correct interest rate futures spread.

A T-Bill/T-bond spread

Consider a flat yield curve, with the rates show below:

Spot and Futures yields for June 20

Cash Market	Yield	Futures contract	yield	IMM Index
3-month T-bill	12.00%	SEP T-bill	12.00%	88.00
6-month T-bill	12.00%	DEC T-bill	12.00	88.00
10-3/8s 2007-12	12.00%	SEP T-bond	12.00	
12 months		DEC T-bond		

Here all rates, spot and futures, are at 12 percent, representing a perfectly flat yield curve. If a trader believes that the yield curve is going to become upward sloping, two strategies could take advantage of this belief. First, the trader could use an intracommodity spread similar to the spread used before. Since the speculator anticipates a positively sloping yield curve, he or she could sell the distant T-bill futures and buy the nearby T-bill futures. This spread would be speculating that the yield curve would upward sloping for the very low maturity instrument represented by the T-bills.

With an upward sloping yield curve, however, we could expect the greatest difference in yields between short maturity and long maturity instruments, that is, between T-bills and T-bonds. This implies that long-term yields are expected to rise relative to short-term yields. To take advantage of this anticipated change in yields, the trader might use an intercommodity spread shown below.

Speculating on T-bill Futures

Date	**Futures Market**
June 20	Sell the DEC T-bond futures at 69-29 with a yield of 12%
	Buy the DEC T-bill futures at 88.0 with a yield of 12%
October 14	Buy the DEC T-bond futures at 65-24 with a yield of 12.78%
	Sell the DEC T-bill futures at 87.80 with a yield of 12.20 %

Profit:

T-bond	**T-bill**
69-29	87.80
-65-24	-88.00
4-05	-.20
= $4,156.25	=-$500

Total profit:= $3,656.25.

If long-term yields are expected to rise relative to short-term yields, the best spread strategy calls for selling the futures contract on a long-term instrument while buying a futures on a short-term instrument. This is exactly the course pursued by a speculator who transacts as shown above. With yields at 12 percent, the T-bond instrument has a price of 69-29, and the T-bill futures price is 88.00. By October 14, yields have moved as anticipated , with T-bond futures yields at 12.778 percent and the T-bill futures at 12.20 percent. For the T-bond contract, this gives a price change of 4-05. Since each 32nd of a point of par represents $31.25 on a T-bond futures contract, this gives a total profit on the T-bond contract of $4,156.25. On the T-bill side, rates have not risen as rapidly, only 20 basis points. Since each basis point represents $25, there is a loss on the T-bill futures of $500. When the T-bill loss is offset against the T-bond gain, the net profit from the speculation is $3,656.25.

b) Hedging using Interest Rates Futures

Basically three types of hedges are used in the financial futures market today; the long hedge, the short hedge, and the cross hedge. Cross hedges may be either long or short. Each type of hedge meets the unique trading needs of a particular group of investors. All three types become popular as interest rates and security prices have become more volatile in recent years.

1) The Long (or Buying) Hedge

The **long hedge** involves the purchase of futures contracts today before the investor must buy the actual securities desired at a later date. The purpose of the long hedge is to guarantee (lock in) a desired yield in case interest rates decline before securities are actually purchased in the cash market.

As an example of a typical long hedge transaction, suppose that a bank or other institutional investor anticipates receiving $1 million in 90 days from today. Assume that today is April 1 st. and funds are expected on July 2nd. The current yield to maturity on securities the investor hopes to purchase in July is 12.26 percent. We might imagine that these securities are long-term U.S. Treasury bonds, which appeal to this investor because of their high liquidity and zero default risk. Suppose, however, that interest rates are expected to decline over the next three months. If the investor waits until the $1 million in cash is available 90 days from now, the yield on Treasury bonds may well be lower than 12.26 percent. Is there a way to lock in the higher yield available now even though funds will not be available for another three months.

Yes, if a suitable long hedge can be negotiated with another trader. In this case, the investor can purchase (go long) 10 September Treasury bond futures contracts at their current market price. (Recall that Treasury bond futures are sold in $100,000 denominations). The number of bond futures contracts required can be figured as follows:

Value of Securities to be hedged/Denomination of the futures contract=$1 million/$100,000=10 contracts

Cash payment on these contracts will not be due until September[1].

Suppose their price currently is 68-10, or $68,312.50 on a $100,000 face value contract. Assume too that, as expected, bond prices risk and interest rates fall. At some later point, the investor may be able to sell the futures contracts at a profit, because their prices tend to rise along with rising bond prices in the cash market. Selling bond futures at a profit will help this investor offset the lower yields on Treasury bonds that will prevail in the cash market once the $1 million actually becomes available for investing on July 2nd.

The details of this long hedge transaction are given below.

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[1]In many practical situations, the security to be hedged and the time for risk protection will not exactly match available futures contracts. These differences introduce uncertainty into the process of determining exactly how many futures contracts will be needed. A useful formual that takes many of these problems into account is the following:

Number of futures contracts = (Value of Securities or loans to be hedged/denomination of futures contracts) $\times$ (Volatiltity ratio of price movements in the cash (spot) security relative to the price in the futures contract) $\times$ (Days exposed to risk in the cash market/Term of futures contracts).

where the volatility ratio is the percentage change in market price of the cash (spot) security relative to the percentage change in price of the desired futures contract over the **most recent** period. For example, if we wish to hedge $1 million in corporate bonds for 60 days with $100,000-denominated Treasury bond futures contracts covering 90 days and recent price movements of corporate bonds and T-bond futures have displyaed a volatility ratio of 0.75, then

Number of futures contracts needed = $1 million/$100,000 $\times 0.75 \times 60/90 \approx 5$ contracts.

An Example of a Long Hedge Using U.S. Treasury Bonds

Spot Market Transactions...**..Futures Market Transactions**

April 1: ————————————————————————————————————**April 1:**

A portfolio Manager for a financial ————————————————————The Portfolio manager purchases

institution wished to "lock in" a yield of———————————————————10 September Treasury bond futures

12.26 percent on $1 million of 20 year, $8\frac{1}{4}$ percent——————————contracts at 68-10

U.S. Treasury bonds at 68-14

July 2:————————————————————————————————————**July 2:**

The portfolio manager purchases——————————————————————-The portfolio manager sells 10

$1 million of 20-year, $8\frac{1}{4}$ percent U.S.————————————————–September contracts Treasury bond

Treasury bonds at 82-13 for a yield of 10.14%.——————————futures contracts at 80-07

Results——**Results:**

Opportunity **loss** of **$139,687.50** due——————————————————**Gain** of **$119,062.50** on futures

to lower Treasury bond yields and higher bond prices.

We note that on July 2nd, the investor goes into the spot market and buys $1 million in $8\frac{1}{4}$ percent, 20-year U.S Treasury bonds at a price of 82-13. At the same time, the investor sells 10 September Treasury bond futures at 80-07. Due to higher bond prices (lower yields) in July, the investor loses $139,687.50, because the market price of Treasury bonds has risen from 68-14 to 82-13. This represents an opportunity loss because the $ 1 million in investable funds was not available in April when interest rates were high and bond prices low. However, this loss is at least partially offset by a gain in the futures market of $119,062.50, because the 10 September bond futures purchased on April 1st were sold at a profit on July 2nd. Over this period, bond futures rose in price from 68-10 to 80-07. In effect, this investor will pay only $705,000 for the Treasury bonds bought in the cash market on July 2nd. The market price of these bonds will be $824,062.50 (or 82-13) per bond, but the investor's net cost is lower by $119,062.50 due to a gain in the futures market.

2) The Short (or selling) Hedge

A financial device designed to deal with rising interest rates is the **short hedge**. This hedge involves the immediate sale of financial futures until the actual securities must be sold in the cash market at some later point. Short hedges are especially useful to investors who may hold a large portfolio of securities they plan to sell in the future but, in the meantime, must be protected against the risk of declining security prices. We examine a typical situation in which a securities dealer might employ the short hedge.

Suppose the dealer holds $1 million in U.S. Treasury bonds carrying an $8\frac{3}{4}$ percent coupon and a maturity of 20 years. The current price of these bonds is 94-26 (or $948.125 per $1,000 par value), which amounts to a yield of 9.25 percent. However, the dealer is concerned that interest rates may rise. Any increase in interest rates would bring about lower bond prices and therefore reduce the value of the dealer's portfolio. A possible remedy in this case is to **sell bond futures** to counteract the anticipated decline in bond prices. For example, suppose the dealer decides to sell 10 Treasury bond futures at 86-28 and 30 days later is able to sell $1 million of 20-year, $8\frac{3}{4}$ percent Treasury bonds at a price of 86-16 for a yield of 10.29 percent. At the same time, the dealer goes into the futures market and **buys** 10 Treasury bond contracts at 79-26 to offset the pervious forward sale of bond futures.

The financial consequences of these combined trades in spot and futures markets are offsetting as shown below. The dealer has lost $83,125 in the cash market due to the price decline in bonds. However, a gain of $70,625 has resulted from the gain in the futures price. This dealer has helped insulate the value of his security portfolio from the risk of price fluctuations through a short hedge.

An Example of a Short Hedge Using U.S. Treasury Bonds

Spot Market Transactions	**Futures Market Transactions**
October 1:	**October 1:**
A securities dealer owns $1 million of 20-year, $8\frac{3}{4}$ percent U.S. bonds priced at 94-26 to yield 9.25%	The dealer sells 10 Treasury bond futures contracts at 86-28
October 31:	**October 31:**
The dealer sells $1 million of 20-year $8\frac{3}{4}$ percent U.S. Treasury bonds at 86-16 to yield 10.29%	The dealer purchases 10 Treasury bond futures contracts at 79-26
Results	**Results:**

Opportunity **loss** of **$83,125** in spot market———————————————**Gain** of **$70,625** on futures

3) The Cross Hedging

Another approach to minimizing risk is the **cross hedge** - a combined transaction between the spot market and the futures market using different types of securities in each market. This device rests on the assumption that the prices of most financial instruments tend to move in the same direction and by roughly the same proportion. Because this is only approximately true in the real world, profits or losses in the cash market will not exactly offset losses or profits in the futures market because basis risk is greater with a cross hedge. Nevertheless, if the investor's goal is to minimize risk, cross hedging is often preferable to a completely unhedged position.

As an example, consider the case of a bank that holds good-quality corporate bonds carrying a face value of $5 million and an average maturity of 20 years. The bank's portfolio manager anticipates a rise in interest rates, which will reduce the value of the bonds. Unfortunately, there is only a limited futures market for corporate bonds, and the portfolio manager fears that he or she cannot construct an effective hedge for these securities. However, futures contracts exist for U.S. Treasury bonds, providing a short cross hedge against the risk of a decline in the value of the corporate bonds.

To illustrate how such a cross hedge might take place, suppose that on January 2nd the total market value of the bank's corporate bonds is $3,673,437.50. This means that each $1,000 par value bond currently carries a market price of $73.469 (73-15 on a $100 basis). The portfolio manager decides to sell 50 Treasury bond futures contracts at 81-20 ($816.25 per $1,000 face value. About two months later, on March 14, interest rates have risen significantly. The value of each corporate bond has fallen to 64-13 ($644.06 per $1,000 bond). At this point, the bank's portfolio manager decides to sell these bonds, receiving $3,220,312.50 from the buyer. This represents a loss of $453,125. At the same time, however, the portfolio manager buys back 50 U.S. Treasury bond futures contracts at 69-20. The result is a gain from futures trading of $600,000. In this particular transaction, the gain from futures more than offset the loss in the cash market.

An Example of a Short Cross Hedge Involving Corporate and U.S. Treasury Bonds

Spot Market Transactions..**..Futures Market Transactions**

January 2: ————————————————————————————**January 2:**

A Commercial bank holds a diversified ———————————The bank's portfolio manager

portfolio of $ 5 million in high-grade——————————————sells 50 U.S. Treasury bond

corporate bonds with an average maturity————————————futures contracts at 81-20
of 20 years and a current market value
of 73-15 per bond. The market value of the
total portfolio is, therefore, $3,673,437.50

March 14:—————————————————————————————————**March 14:**
The market price per bond falls to 64-13——————————The portfolio manager purchases 50
for a total value of the portfolio of $3,220,312.50—————-U.S. Treasury bond futures contracts
when sold——————————————————————————at 69-20

Results————————————————————————————————————**Results:**
The total **loss** in value of the corporate——————————————**Gain** of $600,000 the Treasury
bonds is $453,125———————————————————————bond futures contracts

Basis Points

Interest rates on securities traded in the open market rarely are quoted in whole percentage points, such as 5 percent or 8 percent. The typical case is a rate expressed in hundredths of a percent: for example, 5.36 percent or 7.62 percent. Moreover, most interest rates change by only fractions of a whole percentage point in a single day or week. To deal with this situation, the concept of the basis point was developed. A basis point equals 1/100 of a percentage point. Thus, an interest rate of 10.5 percent may be expressed as 10 percent plus 50 basis points, or 1,050 basis points. Similarly, an increase in a loan or security rate from 5.25 percent to 5.30 percent represents an increase of 5 basis points.

More Examples

Example 1: Reading Eurodollar Futures quotations

Eurodollar futures prices are stated as an index number of three-month LIBOR, calculated as: F = 100 - LIBOR. For example for a hypothetical contract with delivery on June 17, 1998, with a settlement price of 93.24 on Monday, August 26, 1996. The implied three-month LIBOR yield is thus 6.76 percent. The minimum price change is one basis point (bp). On $1,000,000 of face value, a one basis-point change represents $100 on an annual basis. Since the contract if for a 90-day-deposit, one basis point corresponds to a $25 price change.

Example 2: Eurodollar Futures Hedge

As an example of how this contract can be used to hedge interest rate risk, consider the treasurer of a MNC, who on August 26, 1996, learns that his firm expects to receive \$20,000,000 in cash from a large sale of merchandise on June 17, 1998. The money will not be needed for a period of 90 days. Thus, the treasurer should invest the excess funds for this period in a money market instrument such as a Eurodollar deposit.

The treasurer notes that three-month LIBOR is currently 5.53125 percent. The implied three-month LIBOR rate in the June 1998 contract is considerably higher at 6.76 percent. Additionally, the treasurer notes that the pattern of future expected three-month LIBOR rates implied by the pattern of Eurodollar futures prices suggest that it is expected to increase through time. Nevertheless, the treasure believes that a 90-day rate of return of 6.76 percent is a decent rate to **"lock in,"** so he decides to hedge against lower three-month LIBOR in June 1998. By hedging, the treasurer is locking in a certain return of \$338,000 ($=\$20{,}000{,}000 \times 0.0676 \times 90/360$) for the 90-day period the MNC has \$20,000,000 in excess funds.

To construct the hedge, the treasurer will need to buy, or take a **long position**, in Eurodollar futures contracts. At first it may seem counterintuitive that a long position is needed, but remember, a decrease in the implied three-month LIBOR yield causes the Eurodollar futures price to increase. To hedge the interest rate risk in a \$20,000,000 deposit, the treasurer will need to buy 20 June 1998 contracts.

Assume that on the last day of trading in the June 1998 contract three-month LIBOR is 5.50 percent. The treasurer is indeed fortunate that he chose to hedge. At 5.50 percent, a 90-day Eurodollar deposit of \$20,000,000 will generate only \$275,000 of interest income, or \$63,000 less than at a rate of 6.76 percent. In fact, the treasurer will have to deposit the excess funds at a rate of 5.50 percent. But the shortfall will be made up by profits from the long futures position. At a rate of 5.50 percent, the final settlement price on the June 1998 contract is 94.50 (=100- 5.50). The profit earned on the futures position is calculated as: $(94.50 - 93.24) \times 100 \text{ bp} \times \$25 \times 20 \text{ contracts} = \$63{,}000$. This is precisely the amount of the shortfall.

Appendix

Treasury bills, T-bills and Eurodollars Futures

Note: Students can omit this part, if they understood the previous explanations.

Treasury Bills

Treasury bills pay interest not through coupons but by selling at a discount. The bill is purchased at less than face value. The difference between the purchase price and the face value is called the **discount**. If the investor holds the bill to maturity, it is redeemed at face value. Therefore, the discount is the profit earned by the bill holder.

Bid and ask discounts for several T-bills for the business day of June 12 of a particular year are as follows:

Maturity	Bid	Ask
6/18	4.75	4.56
7/16	5.16	5.10
10/15	5.63	5.59

The bid and ask figures are the discounts quoted by dealers trading in Treasury bills. The bid is the discount if one is selling to the dealer, and the ask if the discount if one is buying from the dealer. Bid and ask quotes are reported daily in the *The Wall Street Journal*.

To find an estimate of the T-bill rate, we use the average of the bid and ask discounts, which is, for example for 6/18, is (4.75 + 4.56)/2 = 4.66. Then we find the discount from par value as 4.66(7/360) = 0.0906, which reflects the fact that the bill has 7 days until maturity. Thus, the price is:

100 - 0.0906. (for a face value of 100).

Note that the price is determined by assuming a 360-day year. This is a long-standing traditions in the financial community, originating from the days before calculators, when bank loans often were for 60, 90, or 180 days. A banker could more easily calculate the discount using the fraction 60/360, 90/360, or 180/360. This tradition survives today.

The yield on our T-bill is based on the assumption of buying it at 99.9094 and holding it for 7 days, at which time it will be worth 100. This is a return of (100 - 99.9094)/99.9094 = 0.00091. If we repeated this transaction every seven days for a full year, the return would be:

$(1.00091)^{365/7} - 1 = 0.0484.$

where 1.00091 is simply 100/99.9094, or one plus the seven-day return. Note that wen we annualize the return, we use the 365-day year. (some books still use 360 days).

Treasury-bills futures

Again, T-bills are auctioned each week and normally mature in 91 days. T-bills are pure-discount instruments, and the discount is quoted on a 360-day basis.

Although generally 91-day bills are delivered, the futures contract allows delivery of a 90-, 91-, or 92-day bill. To augment the supply of deliverable bills, the futures contract expiration is timed to correspond to the date on which the U.S. Treasury's 365-day bill, which is auctioned every four weeks, has 90, 91, or 92 days remaining. However, the contract price is always quoted base on a 90-day bill. For example, suppose a T-bill futures contract is priced such that the discount is 8.25. The IMM quotes the bill price as 100 - 8.25 = 91.75. This is **called the IMM index.** Therefore, when you observe the futures price, it will be 91.75. However, that is not the actual price at which you trade the contract and thus is not the real futures price. That actual futures price per $100 is given by the formula:

$$f = 100 - (100 - \text{ IMM index })(90/360) \tag{0.1}$$

for example, if the IMM index is 91.75,

$$f = 100 - (100 - 91.75)(90/360) = 97.9375 \tag{0.2}$$

The standard size of a single contract is $1 million face value of T-bills, thus, the futures price is $979,375.

The purpose of assuming a 90-day bill in the formula is that it implies that a one-point move in the IMM index converts to a $25 change in the futures price. For example, if the IMM index goes up to 91.76, the futures price will be $979,400. Thus, followers of the contract can quickly assess the dollar impact of a change in the IMM index. If the holder of the short position elects to make delivery of a 90- or 92-bill, the formula is adjusted on the delivery day so that 90 or 92 is used instead of 90 in calculating the final price.

The contract expiration months are March, June, September, and December, going out about two years. The last trading day is the business day prior to the date of issue of T-bills in the third week of the month. Delivery can take place on the business day after the last trading day and any day thereafter during the expiration month.

Eurodollars

The primary Eurodollar interest, called LIBOR for London Interbank Offer Rate, is considered one of the best indicators of the cost of short-term borrowing. A major difference between T-bills and Eurodollars is the manner in which their rates are interpreted. The T-bill is a discount instrument, and the Eurodollar is an add-on instrument. For example, although we noted that T-bills and Eurodollars would not have equivalent rates, suppose we assume the quoted rate is 10 percent for both 90-day T-bills and Eurodollars. Then we know that the T-bill price per \$100 face value would be 100 - 10(90/360) = 97.5 and that the yield would be $(100/97.5)^{365/90} - 1 = 0.1081$. Thus, the investor puts down \$97.50 today and receives \$100 in 90 days. For a Eurodollar deposit of \$97.50, the interest would be figured as \$97.50(0.10)(90/360)=\$2.44, thus the investor would get back \$97.50 + \$2.44 = \$99.94 at expiration. The return would be $(99.94/97.50)^{365/90} - 1 = 0.1054$. T-bills will not, however, yield more than Eurodollars in general because T-bills have no credit risk while Eurodollar borrowers could default. The Eurodollar rate would simply be quoted higher.

The Eurodollar futures contract is based on a three-month Eurodollar time deposit, which is a loan made by one bank to another. The contract is for \$1 million face value and is quoted by the IMM index method. The contract is settled through cash. The settlement price on the last day of trading is the LIBOR rate as determined by the CME clearinghouse. Contract expirations are March, June, September, and December and extend out 10 years. The last trading day is the second London Business day before the third Wednesday of the month. There is also a contract on the rate on 30-day Eurodollar deposits.