

Managing Interest Rate Risk with Interest Rate Futures

By Charles S. Morris

Increased interest rate volatility in the 1970s and 1980s has led to greater volatility in the returns on bonds and other fixed income assets. Consequently, investors in bonds and financial institutions with fixed income assets and liabilities on their balance sheets are now exposed to much greater risks from capital gains and losses. The problem is compounded because managing risks caused by interest rate volatility has traditionally been difficult and costly.

During the last 15 years, however, many new financial instruments have been developed to help investors manage risks caused by increased interest rate volatility. One of the most popular types of instruments is interest rate futures contracts. Interest rate futures allow investors to protect the value of their fixed income invest-

ments by providing a hedge against interest rate changes. Interest rate futures are now an important tool for investors who want to protect themselves from interest rate volatility.

This article explains how interest rate futures, when properly used in a hedging strategy, allow investors to manage interest rate risk. The first section of the article defines interest rate risk, examines its impact on investors and institutions, and discusses how interest rate risk can be managed. The second section provides an introduction to interest rate futures and discusses why they are good assets for hedging interest rate risk. The third section shows how investors and institutions can use interest rate futures to manage interest rate risk and discusses some of the other risks involved in using interest rate futures.

Interest rate risk and interest rate risk management

Bonds and other fixed income assets have become riskier investments in recent years.

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These assets are riskier, not because issuers are more likely to default on their obligations, but because interest rates have become more volatile. This section explains why increased interest rate volatility has increased the risk of fixed income assets, provides some examples of investors and institutions affected by greater interest rate volatility, and discusses methods of managing interest rate risk.

What is interest rate risk?

Investments in fixed income assets, such as bonds, are risky because the volatility of their prices can lead to unexpected capital gains and losses. The risk of an asset can be measured by the volatility of its returns, which is the sum of the income flows from the asset plus any changes in its price. Since the income flows from a fixed income asset, such as the coupon payments and maturity value of a coupon bond, are fixed, the riskiness of the asset depends only on its price volatility. For example, as the volatility of a bond's price rises, the bond's riskiness rises because unexpected capital gains or losses are more likely.

The primary cause of volatility in the price of a fixed income asset is interest rate volatility.¹ Indeed, the volatility in prices due to interest rate changes is commonly termed "interest rate risk." For example, when interest rates fall, the price of a bond rises; when interest rates rise, the price of a bond falls. The sensitivity of a fixed income asset's price to

interest rates, that is, the degree of interest rate risk, depends largely on the asset's maturity. The longer to maturity, the larger the change in price due to a change in interest rates.²

Interest rate volatility has risen sharply in recent years. Chart 1 shows the volatility of interest rates on 1-year and 10-year Treasury securities from 1955 to 1988. Interest rate volatility in each year is measured by the standard deviation of the monthly interest rates during that year. The average standard deviation of 1-year interest rates over the 1979-88 period was more than twice that of the 1955-78 period, rising from 0.5 percent per month over the 1955-78 period to 1.2 percent over the 1979-88 period. The relative increase in the volatility of 10-year rates was even sharper. The average standard deviation of 10-year interest rates over the 1979-88 period was more than three times higher than that over the 1955-78 period, rising from 0.25 percent to 0.8 percent. The rise in interest rate volatility over those periods is not limited to 1-year and 10-year rates, but is typical of the volatility of interest rates at all maturities.

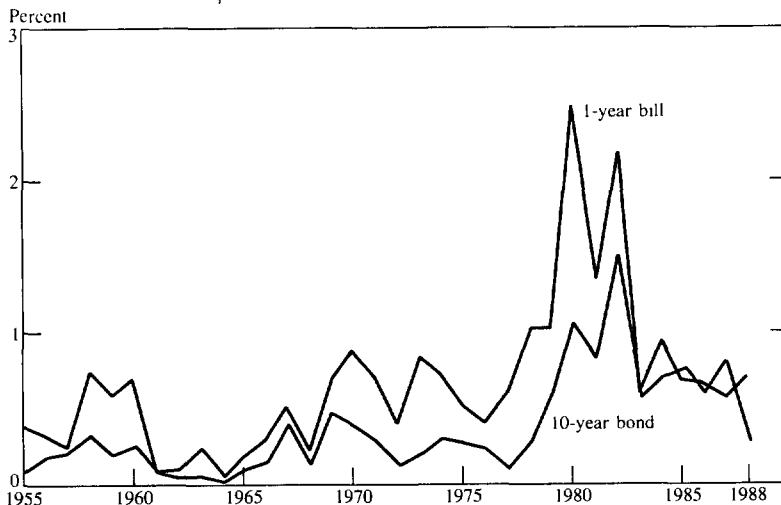
Who is affected by rising interest rate volatility?

Many investors and business firms are exposed to greater risks because of the increase in interest rate volatility in recent years. Examples include individual and institutional

¹ The riskiness of a fixed income asset also depends on the volatility of other factors that affect its price, such as the creditworthiness of the issuer and the liquidity of the asset.

² This assumes a uniform change in rates on all maturities. The interest rate sensitivity of a fixed income asset also depends on other factors, such as the size of the coupon payments and the dates the coupon payments are received.

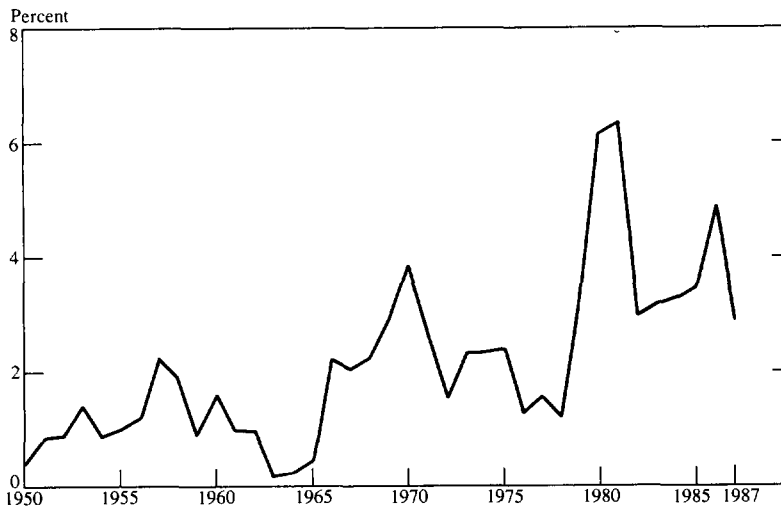
CHART 1
Interest rate volatility



Note: Annual standard deviations of monthly constant maturity rates for 1-year U.S. Treasury bills and 10-year U.S. Treasury bonds.

Source: Board of Governors of the Federal Reserve System.

CHART 2
Bond market volatility



Note: Annual standard deviations of total monthly returns on a long-term U.S. Treasury bond index.

Source: Center for Research in Stock Prices.

investors in government and corporate bonds, depository institutions such as banks and savings and loans, securities dealers, mortgage banks, and life insurance companies to name a few.

One group of investors exposed to greater risks is investors in bonds. The rising risk of holding bonds is clear from Chart 2, which shows the volatility of returns on U.S. Treasury bonds from 1950 to 1987. Bond market volatility in each year is measured by the standard deviation of the monthly percentage returns on a long-term U.S. Treasury bond index during that year.³ Bond market volatility rose from an average annual standard deviation of 1 percent per month over the period from 1950 to 1965 to 2.25 percent over the period from 1966 to 1978. Bond market volatility rose further from 1979 to 1987, averaging 4.1 percent per month.

Rising interest rate volatility has also increased the risk exposure of depository institutions, such as banks and S&Ls. When interest rates rise, the market value of their net worth generally falls; when interest rates fall, the market value of their net worth generally rises. The market value of an institution's net worth is the difference between the market values of its assets and liabilities. The effect of a change in interest rates on the market value of a firm's net worth depends on the relative interest rate sensitivities of its assets and liabilities, which primarily depend on their relative maturities.

³ Although the volatility of total returns is the same as price volatility for a given bond, the volatilities are not the same when the composition of a bond portfolio changes over time because the coupon payments change. Since the composition of the portfolio that underlies the index in Chart 2 changes, the volatility of total returns is shown.

Because the assets of banks and S&Ls generally take longer to mature than do their liabilities, the value of their assets is more sensitive to changes in interest rates than the value of their liabilities. As a result, when interest rates rise, for example, the net worth of a depository institution falls because the value of its assets falls more than the value of its liabilities.

Securities dealers are also exposed to greater risks due to rising interest rate volatility. When interest rates rise, securities dealers suffer losses like other bondholders because the value of the bonds they are holding in inventory falls.⁴ Securities dealers can also suffer losses when interest rates fall, however, because they often commit themselves to delivering bonds at a future date for a fixed price when they do not have the bonds in inventory or the funds to purchase them immediately. If interest rates fall before a dealer purchases the bonds, he will suffer a loss because the price he has to pay for the bonds he has to deliver will be higher than he had expected when he made the initial commitment.

Mortgage banks are also exposed to greater interest rate volatility. A mortgage bank originates mortgages and then sells them to other investors. In general, mortgage banks hold very few mortgages on their balance sheet. They can suffer losses if interest rates rise, however, because they typically commit to a mortgage

⁴ Securities dealers make a profit on their bonds when interest rates fall. Indeed, all investors in fixed income assets make a profit when interest rates move in one direction and suffer a loss when interest rates move in the other direction. In the remaining examples, the discussion will focus on how a change in interest rates in only one direction affects an investor. The direction of the change in interest rates that is used is the one that produces a loss for the investor.

rate before the mortgage is actually closed and sold. If interest rates rise between the time they commit to a rate and the time the mortgage is sold, the value of the mortgage will fall; and mortgage banks will get a lower price than they had expected when they made the initial commitment.

A final example of a group of firms exposed to greater risks due to rising interest rate volatility is life insurance companies. For example, changes in interest rates affect life insurance companies because when interest rates fall the spread earned on Guaranteed Interest Contract (GIC) commitments falls. In recent years, life insurance companies have become heavy issuers of GICs, which are securities that guarantee a fixed interest rate on invested funds over a several-year period. GICs are generally purchased by long-term investors, such as pension funds and company thrift plans. Often, a life insurance company will commit to a rate on a GIC for a short time period before it receives the funds. Life insurance companies can suffer losses if interest rates fall during the commitment period because when they receive the funds from the GIC, they will have to invest the funds at a lower rate than they had expected when they committed to the GIC rate. As a result, the spread earned on the GIC falls.⁵

What is risk management and hedging?

Investors and business firms manage risk by

⁵ Viewed another way, a GIC commitment is a fixed rate liability that is not matched by an asset. When interest rates fall, the value of the GIC commitment rises, but there is no asset whose value also rises. Therefore, the insurance company's net worth falls when interest rates fall.

choosing the amount of risk to which they want to be exposed. The choice of how much risk to bear varies with every investor. For example, some investors will choose to accept the increased price volatility of fixed income investments of recent years, while others will take actions to reduce the riskiness of their fixed income investments. In general, though, investors will not choose to minimize risk because there are costs to reducing risk. The most important cost is that the expected return on their investment also falls when risk is reduced.

Traditionally, investors have found it difficult and costly to reduce risks caused by interest rate volatility. Investors in bonds, for example, typically could reduce interest rate risk only by selling some of their bonds and buying short-term money market instruments. Financial institutions exposed to interest rate risk had to rely on balance sheet restructuring to reduce the mismatch between the maturities of their assets and liabilities.

In recent years new financial instruments—such as interest rate futures, options on interest rate futures, and interest rate swaps—have been developed that allow investors in fixed income assets to manage interest rate risk at a relatively low cost by hedging. In general, hedging is a risk management strategy in which investors choose assets such that changes in the prices of the assets systematically offset each other. Fixed income investors can hedge the interest rate risk of an asset, such as a Treasury bond, by buying or selling hedging assets whose values change in the opposite direction to the value of the Treasury bond when interest rates change. The interest rate riskiness of a hedged Treasury bond is lower than the interest rate riskiness of the unhedged bond because the change in the value of the hedging asset due

to a change in interest rates offsets at least some of the change in the value of the bond. It is important to realize, however, that hedging reduces price volatility because it offsets increases as well as decreases in the price of the Treasury bond.

For any given fixed income asset, the best hedging instrument for reducing interest rate risk is the one whose price is most closely related to the price of the asset when interest rates change. The more closely the prices are related, the larger the reduction in risk that is possible because changes in the price of the hedging asset are more likely to offset changes in the price of the asset being hedged.

While hedging can reduce risk, it generally cannot completely eliminate risk. Hedging will completely eliminate risk only if the values of the portfolio and hedging asset are perfectly related. However, the prices of the assets being hedged and the hedging asset are rarely perfectly related because of differences in factors such as credit quality, liquidity, maturity, and call or prepayment options. Thus, as a practical matter, hedging is an activity that permits investors to manage, but not eliminate, risk.⁶

⁶ The risk that remains after a portfolio has been hedged is called *basis risk*. If the riskiness of a portfolio is measured by the standard deviation of the change in its value, the minimum level of basis risk that can be achieved through hedging is

$$\sigma_h = \sigma_p \sqrt{1 - \rho^2},$$

where σ_p is the standard deviation of the change in the value of the unhedged portfolio, and ρ is the correlation coefficient between the changes in the values of the portfolio and the hedging asset. The maximum percentage reduction in risk is

$$100(\sigma_p - \sigma_h) / \sigma_p = 100(1 - \sqrt{1 - \rho^2}),$$

which depends only on ρ , and risk will be completely eliminated only if ρ equals 1 or -1 .

An introduction to interest rate futures

Of the variety of financial instruments used to hedge interest rate risk, one of the most popular is interest rate futures. This section describes interest rate futures, discusses the types of interest rate futures available, and explains why they are good hedging instruments.

What are interest rate futures?

An interest rate futures contract is an agreement between two parties to buy or sell a fixed income asset, such as a Treasury bond or Treasury bill, at a given time in the future for a predetermined price. For example, if in January a person buys March Treasury bond futures, he is simply agreeing to buy Treasury bonds in March. On the other hand, if in January he sells March Treasury bond futures, he is simply agreeing to sell Treasury bonds in March. Nothing is exchanged when the futures contract is written because it is only an agreement to make an exchange at a future date. The price of a futures contract is the price the buyer agrees to pay the seller for the asset when it is delivered.⁷

⁷ The delivery dates for most interest rate futures are in March, June, September, and December. The actual delivery date varies with the contract. For example, the seller of a Treasury bond contract at the Chicago Board of Trade can deliver Treasury bonds on any day in the contract month, although the last trading day is seven business days prior to the last business day of the month. Although some interest rate futures have contract months that extend out to three years, most of the contracts traded are contracts with the nearest delivery month.

Delivery of the asset in a futures contract rarely occurs, however. The reason is futures traders can always close out the contracts they have bought or sold by taking an offsetting position in the same futures contract before delivery occurs. For example, rather than taking delivery, a buyer of ten March Treasury bond futures can settle his position by selling ten March Treasury bond futures. Similarly, a seller of ten March Treasury bond futures can settle his position by buying ten March Treasury bond futures. In 1988, Treasury bonds were delivered in less than 0.1 percent of all Treasury bond futures traded at the Chicago Board of Trade, which are one of the most widely traded interest rate futures.⁸

Since a futures trader who has settled an initial position has both bought and sold futures, his profit depends on the prices of the futures he has bought and sold. Just like any other trader, futures traders make a profit when they buy futures at a price lower than they sell futures, and they suffer a loss when they buy futures at a price higher than they sell futures. Whether a person makes a profit or suffers a loss, therefore, depends on two conditions: first, whether he initially bought or sold futures, and second, whether the price of the futures rises or falls between the time he enters the initial contract and the time he takes an offsetting position.

A buyer of futures makes a profit when the futures price rises and suffers a loss when the

futures price falls. Suppose, for example, on January 10 a person buys a March Treasury bond futures contract for \$95 per \$100 face value of Treasury bonds, and on February 15 he settles his position by selling a March Treasury bond futures contract for \$97. Under these circumstances, the person would make a profit of \$2 per \$100 face value of Treasury bonds because he has one agreement to buy Treasury bonds in March for \$95 and another agreement to sell Treasury bonds in March for \$97. On the other hand, if the price falls to \$92 on February 15, he would lose \$3 per \$100 because he has one agreement to buy Treasury bonds for \$95 and another agreement to sell Treasury bonds for \$92.

In contrast, a seller of futures suffers a loss when the futures price rises and makes a profit when the futures price falls. This time, suppose on January 10 a person sells a March Treasury bond futures contract for \$95, and on February 15 he settles his position by buying a March Treasury bond futures for \$97. The person would suffer a loss of \$2 because he has one agreement to sell Treasury bonds in March for \$95 and another agreement to buy Treasury bonds in March for \$97. On the other hand, if the price falls to \$92 on February 15, he would make a profit of \$3 because he has one agreement to sell Treasury bonds for \$95 and another agreement to buy Treasury bonds for \$92.

Interest rate futures are relatively new financial instruments. While futures on commodities have been trading on organized exchanges in the United States since the latter half of the 1860s, the first interest rate futures contract did not start trading until October 1975, when the Chicago Board of Trade (CBT) introduced futures on Government National Mortgage

⁸ For some interest rate futures, such as the Eurodollar time deposit futures on the International Monetary Market exchange, all contracts must be settled by taking an offsetting position. That is, delivery of the underlying instrument is not allowed.

Association (GNMA) certificates.⁹ Since then, futures on many different fixed income assets have been developed. However, there are still many fixed income assets, such as corporate bonds, on which no futures are traded.

The assets on which interest rate futures are traded span the maturity spectrum—interest rate futures on short-term, medium-term, and long-term assets are traded on several futures exchanges in the United States and abroad. The first futures contract on a short-term asset was the Treasury bill futures contract, which was introduced on the International Monetary Market (IMM) exchange in 1976. Since then, interest rate futures on other short-term assets, such as Eurodollar time deposits and 30-day interest rates, have begun trading on several exchanges, with the IMM Eurodollar futures being the most popular.¹⁰ Interest rate futures on medium-term assets, such as Treasury notes, are also traded on several exchanges.¹¹ Finally, there are interest rate futures on long-term assets, such as Treasury bonds and a municipal bond index, with the CBT Treasury bond futures being the most popular.¹²

⁹ Although the GNMA futures contract was initially successful, it stopped trading in December 1984.

¹⁰ Treasury bill futures are also traded on the MidAmerica Commodity Exchange in Chicago. Eurodollar futures are also traded on the London International Financial Futures Exchange. The 30-day interest rate futures contract is traded at the Chicago Board of Trade.

¹¹ Treasury note futures are traded on the Chicago Board of Trade exchange, the MidAmerica Commodity Exchange in Chicago, and the Financial Instrument Exchange, a division of the New York Cotton Exchange.

¹² Treasury bond futures are also traded on the MidAmerica Commodity Exchange in Chicago and the London International Financial Futures Exchange. Futures on the municipal bond index are traded at the Chicago Board of Trade.

The success of interest rate futures is shown in Chart 3. One measure of activity in a futures market is a contract's open interest—the number of contracts not yet offset by opposite transactions or delivery. Chart 3 shows the open interest in the CBT Treasury bond futures contract from 1978 to 1988. Although open interest in Treasury bond futures is fairly volatile, the trend is clearly upward. Chart 3 also shows open interest rose sharply in 1980 and 1981—the two peak years in bond market volatility (Chart 2)—suggesting that investors took advantage of the futures market for managing risk.

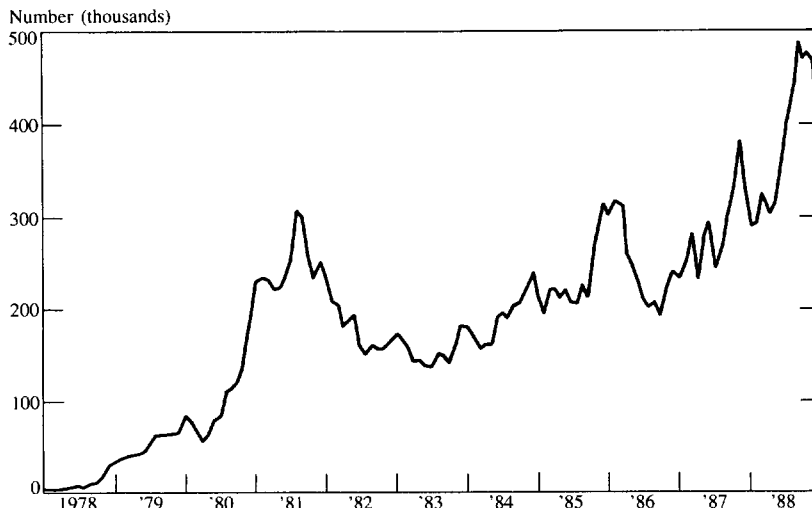
Why are interest rate futures good hedging assets?

Interest rate futures are good hedging assets for two reasons. First, the transaction costs of buying and selling them are relatively low. Second, interest rate futures prices are closely related to the prices of many fixed income assets when interest rates change.

The transaction costs of establishing a futures position are low because nothing is really being bought or sold—the contract is just an agreement to make a trade at a future date. When a position is established, the only outlays are broker fees and commissions and an initial margin deposit with the broker.¹³ The fees paid to brokers and traders are quite small. For example, the cost of establishing and settling a position in a CBT Treasury bond futures con-

¹³ The margin on a futures contract is "good faith" money deposited with a broker to assure him that losses can be covered in the event of adverse price movements.

CHART 3
Treasury bond futures open interest



Note: Values are monthly averages of daily open interest in the nearest Chicago Board of Trade Treasury bond futures contract with at least one month until expiration.

Source: Data Resources Inc.

tract, which is based on \$100,000 face value of bonds, is about \$41.¹⁴ The initial margin is also very small—the margin on a CBT Treasury bond futures used for hedging purposes is \$2,000—and the margin generally earns a market rate of interest.¹⁵

¹⁴ See Arnold Kling, "Futures Markets and Transaction Costs," in Myron L. Kwast, ed., *Financial Futures and Options in the U.S. Economy: A Study by the Staff of the Federal Reserve System* (Washington, D.C.: Board of Governors of the Federal Reserve System, 1986), pp. 41-54.

¹⁵ The minimum initial margin a person must deposit when establishing an open position in a futures contract and the minimum level that must be maintained is set by the exchanges and is changed from time to time. The margin level depends on factors such as the volatility of the price of the underlying instrument and the maximum daily change in the futures price the exchange allows. Margins also may

Interest rate futures hedge the interest rate risk of many fixed income assets successfully because interest rate futures prices are closely related to the prices of many fixed income assets. The prices are closely related because interest rate futures prices are sensitive to changes in interest rates just like fixed income asset prices. The price of any futures contract—whether it is an interest rate, exchange rate, commodity, or any other type of futures contract—is always very closely related to the

depend on whether a person is just buying or selling futures alone or is buying or selling futures to establish a hedge. The margin on an outright purchase or sale of CBT Treasury bond futures is \$2,500. Although interest is generally paid on the initial margin, interest is not paid on additions to the margin account because additions represent losses that have been transferred to the accounts of parties that have gained from price movements.

price of the underlying asset.¹⁶ Since interest rate futures are based on fixed income assets and the prices of these assets move in the opposite direction of interest rates, interest rate futures prices move in the opposite direction of interest rates.

Like any other hedging asset, though, the extent to which a given interest rate futures contract will provide an effective hedge for a fixed income asset depends on how closely the futures price is related to the price of the asset being hedged. Chart 4, for example, shows that the prices of a 30-year Treasury bond and the CBT Treasury bond futures are nearly identical.¹⁷ The small differences that do exist are shown at the bottom of the chart. Because of this close

¹⁶ The relationship between the price of a futures contract and the price of its underlying asset is most easily seen on the last day of trading for a particular contract, at which time the two prices must be exactly equal. In general, if there are no transaction costs and capital markets are perfect, the difference between a futures price and the price of the underlying asset can be no larger than the net cost of holding the underlying asset in inventory—inventory costs less income flows from the asset—until the futures contract expires. This relationship between the price of a futures contract and the price of its underlying asset is known as the cost of carry theory of futures prices. Prices do deviate slightly from cost of carry, though, because of transaction costs and capital market imperfections. For a detailed discussion of the relationship between interest rate futures prices and bond prices, see James M. Little, “What are Financial Futures?” in Nancy H. Rothstein and James M. Little, eds. *The Handbook of Financial Futures* (New York: McGraw-Hill Book Company, 1984), pp. 35-66.

¹⁷ The closeness of these two prices should not be surprising. The CBT Treasury bond futures price should be very closely related to the price of its underlying asset, which is an 8 percent 20-year Treasury bond. Since 30-year Treasury bond prices and 20-year Treasury bond prices are closely related, the futures price, and the bond price in Chart 4 are closely related.

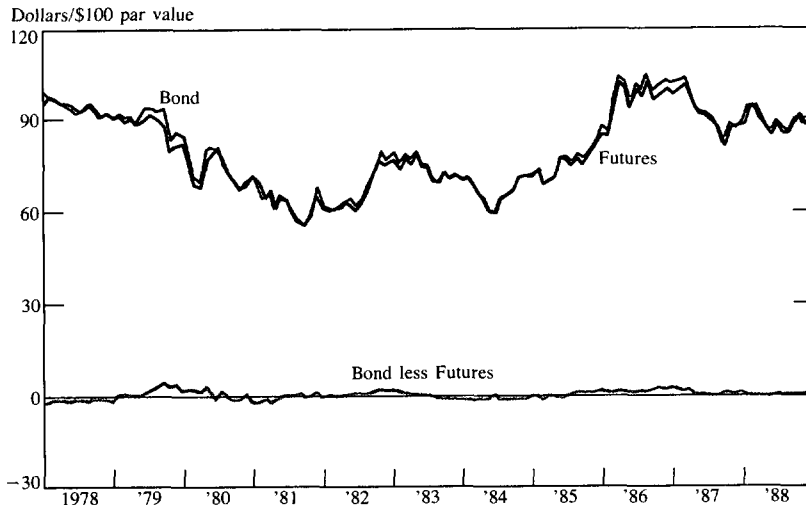
relationship, Treasury bond futures should be very effective at hedging Treasury bonds against interest rate volatility.

In contrast, the price of the CBT Treasury bond futures is not as closely related to the price of a 30-year corporate bond as to the price of the 30-year Treasury bond (Chart 5). The difference between the corporate bond price and the futures price is clearly more variable than the difference between the Treasury bond price and the futures price.

The prices of corporate bonds and Treasury bond futures are less closely related because corporate bond prices can change for a variety of reasons other than changes in the general level of interest rates. For example, the price of a corporate bond would fall if the issuer’s credit rating fell or if adverse general economic conditions led investors to believe the chances of default were more likely. The price of a corporate bond could also fall if a large investor decided to sell his share of an issue. Since these factors would not affect the price of a Treasury bond, a Treasury bond futures contract would not hedge an investor against these price changes. As a result, Treasury bond futures should be a less effective hedge for a corporate bond than for a Treasury bond.¹⁸

¹⁸ Viewed another way, Treasury bond futures are less effective in hedging the *total* risk of a corporate bond than a Treasury bond because (1) Treasury bond futures only hedge interest rate risk, and (2) interest rate risk accounts for a smaller share of the total risk of a corporate bond than of a Treasury bond. In terms of hedging only the interest rate risk of a corporate bond—that is, changes in the price of the corporate bond due to changes in interest rates—Treasury bond futures should be fairly effective.

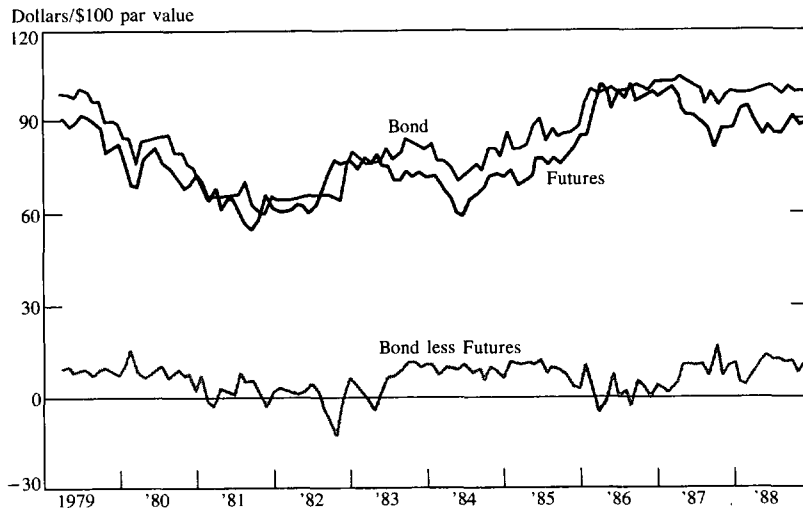
CHART 4
Treasury bond futures price and treasury bond price



Note: The bond price is the price of the 9 ¼ percent 30-year Treasury bond that matures in November 2007. The futures price is the price of the nearest Chicago Board of Trade Treasury bond future with at least one month until expiration.

Source: Data Resources Inc.

CHART 5
Treasury bond futures price and corporate bond price



Note: Corporate bond is an A-rated 9 ½ percent 30-year bond of a U.S. industrial firm. The futures price is the price of the nearest Chicago Board of Trade Treasury bond future with at least one month until expiration.

Source: Data Resources Inc.

Managing interest rate risk with interest rate futures

Businesses and investors use interest rate futures in a variety of ways to manage interest rate risk. Hedging strategies can be complex, however, and this can expose investors to new risks. This section provides some specific examples of how interest rate futures are used to hedge interest rate risk and then discusses some of the other risks involved in hedging with interest rate futures.

Hedging interest rate risk with interest rate futures

Investors can hedge interest rate risk by selling or buying interest rate futures. Whether an investor sells or buys futures depends on how changes in interest rates affect the value of his portfolio.

In general, an investor who suffers losses on his investment portfolio when interest rates *rise* hedges interest rate risk by *selling* interest rate futures.¹⁹ When interest rates rise, interest rate futures prices fall. If an investor loses money on his portfolio when interest rates rise, then, he needs to make a profit from falling futures prices. That is, he needs the gain on his futures contract to offset the loss on his original investment portfolio. Since sellers of futures make a profit when futures prices fall, the investor would hedge by selling futures. Similarly, when interest rates fall, the losses on the futures off-

¹⁹ Of course, an equivalent statement of this rule is that an investor who makes profits on his investment portfolio when interest rates fall hedges interest rate risk by selling interest rate futures.

set the profits on the original investment portfolio.

Conversely, an investor who suffers losses on his portfolio when interest rates *fall* hedges by *buying* interest rate futures. When interest rates fall, interest rate futures prices rise. If an investor loses money on his portfolio when interest rates fall, he needs to make a profit from rising futures prices. Since buyers of futures make a profit when futures prices rise, the investor would hedge by buying futures. Similarly, when interest rates rise, the losses on the futures offset the profits on the portfolio.

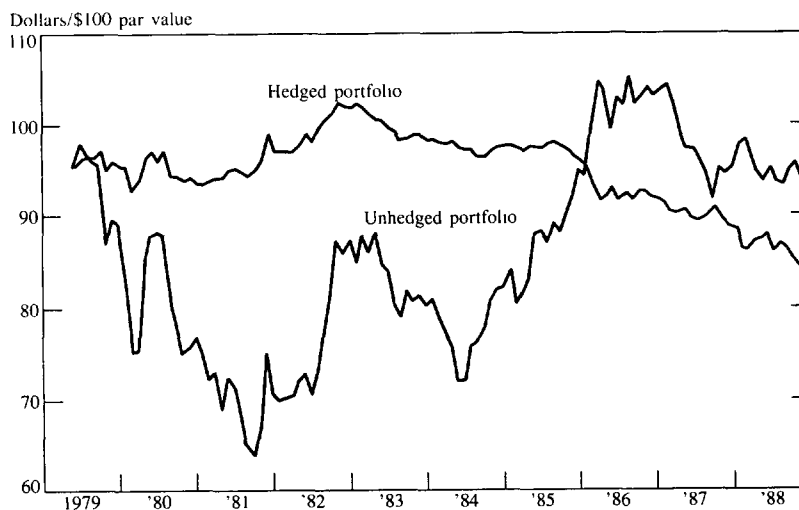
Hedging a Treasury bond portfolio. Treasury bond prices fall when interest rates rise, so an investor in Treasury bonds would hedge his portfolio against changes in interest rates by selling interest rate futures. In this way, a gain or loss on the Treasury bonds would be offset by a loss or gain on the futures contracts.

An example of the reduction in price volatility that can be achieved by hedging is shown in Chart 6. This chart shows the price of a portfolio of unhedged Treasury bonds and the price of a hedged portfolio. The unhedged portfolio contains 30-year and 10-year U.S. Treasury bonds. The bonds are hedged using the CBT Treasury bond futures.²⁰ The value of the

²⁰ This example assumes the investor wants to minimize risk. For simplicity, the value of the hedged portfolio ignores the effects of margin requirements, transaction costs, taxation, accounting practices, and regulatory requirements, all of which could affect the value of the hedge and the hedging strategy. The prices are end-of-month data, and the futures price is on the nearest contract with at least one month until expiration.

The example does not account for the possibility that risk could be reduced further by (1) using futures with contract months that are farther out, and (2) estimating the number of contracts to sell over shorter time periods and then

CHART 6
Hedging treasury bonds



Note: The bond portfolio is an equally weighted portfolio of the 30-year U.S. Treasury bond that matures in November 2007 and the 10-year U.S. Treasury bond that matures in May 1989. The hedged price is the price of the minimum risk hedged portfolio of bonds using the nearest futures contract with at least one month until expiration.

Source: Data Resources Inc.

hedged portfolio of bonds is clearly less variable than the value of the unhedged portfolio. The volatility of the price of the hedged portfolio, measured by the standard deviation of the change in price, is 60 percent lower than the volatility of the price of the unhedged portfolio.

Hedging a corporate bond. An investor in corporate bonds would hedge his portfolio against changes in interest rates by selling interest rate futures because corporate bond prices fall when interest rates rise. Corporate

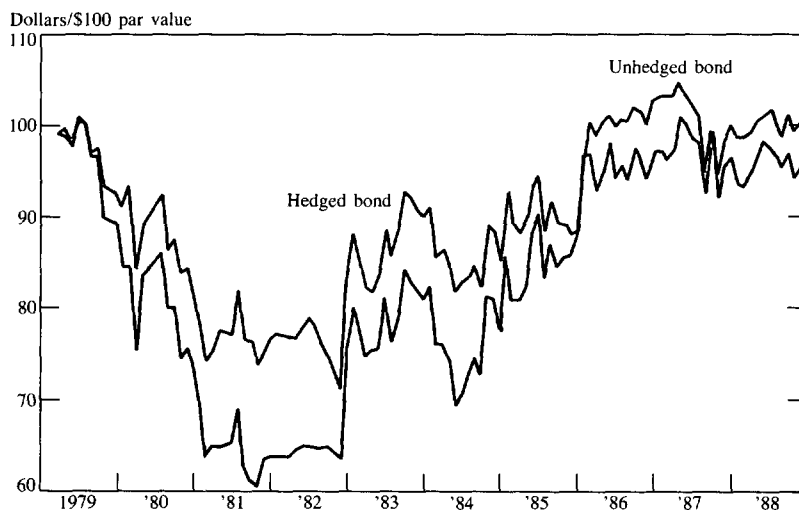
bond futures do not exist, so the investor would use Treasury bond futures as a hedge. Treasury bond futures should be a less effective hedge for corporate bonds than for Treasury bonds, however, because Treasury bond futures prices are not as closely related to corporate bond prices as to Treasury bond prices.

An example of the reduction in the price volatility of a corporate bond that can be achieved by hedging is shown in Chart 7. This chart shows the prices of an A-rated 9-1/2 percent 30-year bond of a U.S. industrial company and the value of the hedged bond.²¹

adjusting the number of contracts to account for the changes. On the other hand, the example could be overstating the degree of risk reduction because the number of contracts sold is estimated from actual price data over the hedging period, whereas investors must estimate the number of contracts using data from periods prior to the hedging period.

²¹ The qualifications and assumptions that applied to the hedge of the Treasury bond portfolio also apply to this example (see footnote 20).

CHART 7
Hedging corporate bonds



Note: Corporate bond is an A-rated 9½ percent 30-year bond of a U.S. industrial firm. The hedged price is the price of the minimum risk hedged bond using the nearest futures contract with at least one month until expiration.

Source: Data Resources Inc.

The value of the hedged bond is still quite variable, but less variable than the unhedged portfolio. The standard deviation of the change in the value of the hedged bond is 8 percent lower than that of the unhedged portfolio. As expected, Treasury bond futures are a less effective hedge for corporate bonds than for Treasury bonds.²²

²² Although Treasury bond futures did not provide a good hedge for a single corporate bond, they should provide a better hedge for a portfolio of corporate bonds. The corporate bond in this example had an A rating, which suggests that credit risk is at least partly responsible for the relatively poor relationship between the bond price and the futures price. A diversified portfolio of corporate bonds, however, would be exposed to less credit risk, and therefore its price would be more closely related to the futures price.

Depository institutions. Depository institutions, such as banks and S&Ls, would hedge net worth against changes in interest rates by selling interest rate futures because their net worth generally falls when interest rates rise.²³

²³ The best futures contract for hedging a depository institution's net worth is one whose price sensitivity to interest rate changes is as close as possible to the sensitivity of the institution's net worth to interest rate changes. The sensitivity of the institution's net worth to interest rate changes rises with the extent to which its asset and liability maturities are mismatched. Thus, institutions whose maturity structure is only slightly mismatched would choose futures contracts based on short-term assets, such as Treasury bills or Eurodollar time deposits. On the other hand, institutions whose maturity structure is highly mismatched would choose futures contracts based on longer term assets, such as Treasury bond and note futures.

When interest rates rise, the net worth of a typical depository institution falls because the value of its assets falls by more than the value of its liabilities. For example, suppose an S&L has assets with a market value of \$100 million and liabilities with a market value of \$90 million, resulting in a net worth of \$10 million. If interest rates rise, the value of the assets might fall by, say, \$5 million to \$95 million. Since the liabilities have shorter maturities, their value would fall by only, say, \$4 million to \$86 million, resulting in a net worth of \$9 million. But interest rate futures prices also fall when interest rates rise. So if the S&L sells interest rate futures, the gain on the futures when interest rates rise would offset some of the \$1 million decline in net worth due to the rise in interest rates.²⁴

Securities dealers. Securities dealers hedge interest rate risk by selling interest rate futures sometimes and buying them at other times. Securities dealers would hedge the bonds they have in inventory against changes in interest rates like any other bondholder by selling interest rate futures. On the other hand, securities dealers would hedge bonds they are committed to deliver at a future date for a predetermined price against changes in interest rates by buying interest rate futures.

To understand when securities dealers would buy futures, consider the following example. Suppose a securities dealer has agreed to deliver \$10 million face value of Treasury bonds for \$90.00 per \$100 face value of bonds in two months, and the current price of the bonds is \$89.50 per \$100. If the dealer had the bonds in inventory or the funds to buy them, he would make a profit of \$0.50 per \$100, or \$50,000. If not, though, he faces the risk that interest rates will fall and bond prices will rise. For example, if interest rates fall and bond prices rise \$0.25, he would have to pay \$89.75 per \$100 for the bonds, and the profit on the commitment would fall 50 percent to \$25,000. However, if interest rates fall, the futures price should rise. Since a person who buys a futures contract makes a profit when its price rises, the profit on the futures should offset much of the decrease in the profit on the commitment when interest rates fall.

Mortgage banks. Because the value of mortgage commitments falls when interest rates rise, mortgage bankers would hedge mortgage commitments against changes in interest rates by selling interest rate futures. For example, suppose a mortgage banker commits to a 10 percent interest rate on a \$100,000 mortgage. If the mortgage closes in two months and interest rates do not change, the mortgage banker could sell the mortgage for \$100,000. However, if interest rates rise, the value of the mortgage will fall. If, for example, the mortgage value falls to \$98,000, the value of the mortgage commitment would fall \$2,000. But since interest rates rose, interest rate futures prices would have fallen. Therefore, if the mortgage banker sells interest rate futures, the profit on the futures he sold would offset the loss on the mortgage commitment when interest rates rise.

²⁴ Of course, when interest rates fall, the value of the S&L's assets will rise more than the value of its liabilities, but the gain in net worth will be offset by a loss on the futures. In other words, like any other hedging asset, futures offset capital gains as well as capital losses. In the remaining examples, the discussion will focus on how hedging with futures offsets capital losses, but it is important to remember that futures hedges also offset capital gains.

Life insurance companies. Life insurance companies would hedge GIC commitments against changes in interest rates by buying interest rate futures. For example, suppose a life insurance company commits to a 10 percent interest rate on a GIC but will not receive the funds for two months. In addition, suppose the life insurance company expects to invest the funds in an 11 percent corporate bond. If interest rates do not change in the two-month period, the life insurance company would earn a spread of one percentage point. But if interest rates fall and the corporate bond rate falls to, say, 10.5 percent, the spread earned on the GIC would fall 50 percent to 0.5 percentage points. When interest rates fall, though, interest rate futures prices rise. Therefore, by buying futures, life insurance companies can offset declines in the spread on GIC commitments when interest rates fall.²⁵

The risks of hedging with interest rate futures

Although hedging with interest rate futures allows investors to reduce interest rate risk, it generally cannot completely eliminate risk. All hedges generally contain some residual, or basis, risk. Moreover, hedging also introduces some new risks. Some of those risks are credit risk, marking to market risk, and managerial risk.

Basis risk. The risk that remains after an

²⁵ Recall that a GIC commitment is a fixed rate liability that is not matched by an asset. Therefore, net worth falls when interest rates fall because the increase in the value of the GIC commitment is not offset by an increase in the value of an asset. Since net worth falls when interest rates fall, the GIC commitment can be hedged against changes in interest rates by buying interest rate futures.

investor hedges his portfolio is called basis risk. An investor who hedges his portfolio with interest rate futures bears basis risk because, when interest rates change, the change in the price of the futures contract does not perfectly offset the change in the price of the asset being hedged. Fixed income asset prices can change for reasons other than changes in interest rates. As a result, the basis risk in a hedge will be relatively high when factors other than interest rates are an important source of the changes in the price of the asset being hedged.

For example, an asset's price will fall if the issuer's credit rating falls or if the asset is relatively illiquid and a large amount is sold. Since these factors would not affect the prices of interest rate futures, such as Treasury bond futures, interest rate futures cannot offset price changes caused by such factors. In fact, that is why Treasury bond futures proved to be a less effective hedging instrument for the corporate bond than for the Treasury bond portfolio in the examples used in the preceding section.

Credit risk. The credit risk in an interest rate futures hedge is not that the opposite party in the futures contract will default, but that the opposite party in the asset being hedged will default. Individuals do not have to be concerned about the opposite party defaulting on a futures contract because every futures exchange has a clearing organization that is a party to every futures contract in order to guarantee the integrity of the contract.²⁶ That is, the clearing house is the seller in every contract bought

²⁶ The exchanges are also protected because many exchanges have limits on the amount a futures price can change within a day. The limits are equal to the minimum margin deposit that individuals must have on deposit with their broker.

and the buyer in every contract sold. But the risk remains that an investor will end up with an unhedged open futures position if there is a default on the asset being hedged.

For example, suppose an investor in corporate bonds hedges his portfolio against changes in interest rates by selling interest rate futures. If interest rates fall, the prices of the bond and futures will rise. Since futures were sold, the investor would suffer losses on the futures, but those losses would be offset by the gains on the bonds. If the bond issuer defaults, though, the investor would have the losses on his futures position but no gains to offset the losses.

Marking to market risk. Marking to market risk is the risk investors will have to cover futures losses when the contract is marked to market at the end of each day. All futures exchanges require every unsettled futures position to be marked to market every night and settled daily. That is, at the end of each day, funds are transferred from individuals who lose on their contracts to individuals who gain on their contracts so that buyers and sellers actually realize the gains and losses from daily price changes as they occur. A problem could occur for those who suffer losses on their futures position, though, because they must make immediate cash outlays. Although losses on futures contracts are generally offset by gains on the asset being hedged, investors usually do not receive those gains as they occur. Therefore, investors would either have to liquidate other investments and lose the associated income flows or pay interest on borrowed funds to cover their futures losses as they occur.

Managerial risk. Managerial risk, broadly defined, is the risk futures will be used inappropriately and result in greater, rather than less, risk. This is really a "catch all" category

that accounts for anything else that can go wrong with a hedging program. One major reason managerial risk arises is interest rate futures can be used for speculative purposes. In addition to being good assets for hedging, futures are also good assets for speculating on price movements for two reasons. First, it costs very little to open a futures position, and second, an open unhedged futures position is as risky as the underlying asset. While speculators play an important and useful role in futures markets, an institution that wants to hedge with futures must have internal controls to make sure those responsible for hedging are not speculating.

Managerial risk also arises because futures hedging strategies are complicated. Because they are complicated, it is possible for managers to make incorrect decisions that significantly lower a firm's value. For example, suppose a manager wants to minimize the interest rate risk of his bond portfolio, but he overhedges by selling too many futures contracts. If interest rates were to fall, the losses on the futures position could be much greater than the gains on the bonds. Thus, when overhedged, the riskiness of a portfolio is greater than the minimum level of risk and the return is less than that associated with the minimum level of risk. In fact, the riskiness of an overhedged portfolio can be even greater than the riskiness of the unhedged portfolio. To control this risk, it is important that managers understand the complexities of hedging with interest rate futures, the capabilities and limitations of a hedging program, and the need to continually monitor hedging programs.

Conclusion

The riskiness of investments in bonds and

other fixed income assets has increased in recent years because of increased interest rate volatility. The lack of traditional low-cost methods for managing this increase in interest rate risk led to the development of many new financial instruments that can be used to hedge interest rate risk. One of the most popular types of instruments is interest rate futures contracts. Interest rate futures are now trading on exchanges around the world, and they have become an important part of virtually every

portfolio manager's tool kit for managing interest rate risk.

This article showed how interest rate futures can be used to manage interest rate risk. In many cases, interest rate risk can be substantially reduced. It must be remembered, though, that hedging with interest rate futures can be complex, and investors must thoroughly examine all aspects of interest rate futures and hedging techniques before implementing a hedging strategy.