Hedging Bank Borrowing Costs with Financial Futures

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In response to the increased volatility of interest rates, many banks have sought to reduce their interest rate risk by offering floating rate loans to their commercial customers. This allows banks to make the revenues on their longer-term loans more responsive to the interest rates that determine their shorter-term borrowing costs.

The problem with these floating rate loans is that they do not eliminate interest rate risk; instead, such loans transfer the risk from the lender to the borrower, which may not be a very good solution for the bank after all. Floating rate loans may cause the cash flow of the borrower to fluctuate with interest rates, introducing an element of uncertainty into the borrower's planning and budgeting program. Since many bank customers will be reluctant to accept this uncertainty, they will seek fixed rate financing from sources other than the bank. As a result, the bank may lose not only the customer's loan business, but also the firm's other banking business. Another problem for banks is that, because a floating rate loan can have a significant impact on the cash flow of the customer, it may increase the riskiness

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of the loan. Further, since borrowers are generally willing to pay a premium to avoid interest rate risk, the bank is passing up additional revenue by not offering a fixed rate loan. There are thus incentives for the bank not to transfer this interest rate risk to the borrower. To the extent the bank can hedge the interest rate risk at low cost, however, it can make a fixed rate loan, maintain good customer relations, and earn additional income while incurring minimal interest rate risk.

Interest rate futures can provide banks with a low-cost method for hedging the interest rate risk in making fixed rate loans. Bankers recognize this and recent surveys show that the most frequently cited actual and potential use of interest rate futures is to hedge the interest expense of anticipated borrowings.[1] Banks that use futures for this purpose have concentrated their futures trading in those contracts that best reflect their short-term borrowing costs. These are the futures contracts for domestic certificates of deposit (CDs), Eurodollars, and Treasury bills (T-bills).

Despite this choice of contracts, however, most analyses of the effectiveness of hedging bank borrowings have concentrated entirely on T-bill futures contracts as the hedging instrument. While these analyses find that banks can substantially reduce their interest rate exposure by hedging with futures, they do not consider whether T-bill futures are as good as, better, or worse than using CD futures or Eurodollar futures to hedge. But, in order to see whether one futures contract is a better hedge than another, we first need to establish a good understanding of banks' interest rate risk and how futures in general hedge that risk.

BANK INTEREST RATE RISK

Bank interest rate risk manifests itself in changes in the net interest margin—and therefore net income—when interest rates change.[2] Most interest rate risk is a result of asset and liability mismatches, that is, when assets and liabilities have different maturities.[3] This is precisely the cause of interest rate risk in offering a fixed rate loan. Suppose a bank decides to fund a 6-month fixed rate loan with two consecutive 3-month CDs. The bank's expected costs then depend on the current rate on a 3-month CD, and on the rate expected on a 3-month CD in three months. Typically a bank would estimate the expected cost by simply assuming that today's 6-month CD rate is the average of today's 3-month rate and the expected 3-month rate three months from now. So, for example, if today's 6-month rate is 12 percent, and today's 3-month rate is 10 percent, the expected rate in three months on a 3-month CD would be 14 percent. But, in an environment of volatile interest rates, by the time the bank goes to roll over the CD in three months, the 3-month rate might be 16 percent. If the bank were dealing in $1 million CDs, the additional costs of this rate change would be substantial: since a one basis point change in the 3-month borrowing rate implies an additional $25 in interest expense, a difference of 200 basis points amounts to $5,000 more interest expense

[1]See, for example, James Booth, Ron Smith, and Robert Stolz, "Use of Interest Rate Futures by Financial Institutions," *Journal of Bank Research* 15 (Spring 1984) pp. 15-20.

[2]Net interest margin is defined as the difference between interest revenue and interest expense over a given time period. It is frequently expressed as a percent of assets.

[3]This is true assuming the bank is hedging its cash flow. Recent literature on bank interest rate risk has also emphasized hedging the value of bank equity. Hedging the value of bank equity, however, involves determining the market value of assets and liabilities, which can be very difficult, and their price sensitivity or duration, which again can be quite difficult. Many banks instead choose to match or hedge cash flows over particular time intervals (for example, less than one year, or one to two years) or between particular balance sheet items. Both these methods can partially protect the value of the bank's equity and can also smooth the reported income of the bank. The example considered in this paper is that of hedging between balance sheet items. For an explanation and example of market value hedging using a duration analysis, see George Kaufman "Measuring and Managing Interest Rate Risk: A Primer," Federal Reserve Bank of Chicago *Economic Perspectives* (Jan./Feb. 1984) pp. 16-29.

than the bank expected. This additional unexpected interest expense—the interest rate risk—means that the profitability of the loan falls, and the reason it arises is because the maturities of the asset and the liability are mismatched.

Indeed, the most common mismatch of maturities for a bank is much like the example, when liabilities are short-term and assets are relatively long-term. Futures may provide an inexpensive way to hedge the interest rate risk that results from this mismatch.[4] To illustrate this we can evaluate the effect of using a futures contract to hedge the interest rate risk in the example. But first, a few fundamentals about futures contracts.

A PRIMER ON INTEREST RATE FUTURES

An interest rate futures contract, simply stated, is a promise between two parties to exchange a financial instrument for a stated price and terms of delivery at a specified time and place in the future. An interest rate futures contract is standardized as to the quantity of the financial instrument to be bought or sold, the minimum characteristics or quality of the instrument, and the specification of where and when the exchange is to be made. This standardization is a major distinguishing feature between futures contracts and forward contracts, which are not standardized in any of these terms.

Another unique feature of futures is that the trading party is always the clearinghouse, which is made up of exchange members who also act as traders. When one trader agrees to deliver and another to take delivery, they do so not with each other but with the clearinghouse. The clearinghouse thereby acts as guarantor of performance of all futures contracts traded on a particular exchange. In this way, the clearinghouse creates a futures contract that can be traded without concern for the identity or creditworthiness of the other party to the contract. At the end of the day, the clearinghouse matches "buy" and "sell" contracts for the day and informs every exchange member of its net settlement status.

In fact, delivery is rarely ever made or taken because most traders "close out" their position before delivery is due by taking an offsetting position of equal size.[5] For example, a trader who agreed to deliver 10 contracts of some good simply takes a position to accept delivery of 10 contracts of the same good. The final result is simply a profit or loss to the trader.

When a trader buys or sells a $1 million 90-day T-bill futures contract he opens a margin account that might require an initial deposit, known as the initial margin, of only $1,500. Yet the value of the futures contract and the futures position changes in the same magnitude as the T-bill or underlying instrument.[6] That is, a one basis point change in the discount rate on an actual $1 million T-bill changes its price by $25;

[4]Financial futures provide an inexpensive hedging method relative to adjusting the actual balance sheet. There are, however, definite costs to a bank using futures contracts. In addition to brokerage costs, first-time users must set up internal auditing and accounting systems, hire traders or open a futures account with a trader, and handle the daily cash flow associated with futures contracts. These transaction costs are often deemed substantial enough to preclude small banks from trading futures.

[5]Traders in futures are considered either hedgers or speculators. A hedger in the futures market is an individual or institution whose futures market position is designed to offset the risk created by a financial position in some other market. A speculator is an individual who tries to anticipate price changes in commodities or financial instruments (such as futures) in order to profit through the sale or purchase of futures contracts or of the actual physical commodity.

[6]A straightforward way to see this is to consider the investor who buys a financial futures contract for a security for $100. He pays nothing for this contract except that he puts up a margin. Suppose the security is currently priced at $100. In this case, nobody would pay him for his right to buy it. But suppose the price of the security rose to $110. In this case, the holder of the futures contract could buy the security for $100, and turn right around and sell it for $110, making a profit of $10—which reflects the rise in the price of the security. Other investors will now be willing to pay the holder of the futures contract up to $10 for the right to buy the security at $100. This change once again reflects the change in the value of the security that underlies the futures contract.

a one basis point change in the discount rate on a T-bill futures contract results in the same $25 change, but, in the case of the futures contract, the investor puts up less than 1 percent of the invested funds.[7]

This leverage is not without cost. Unlike the cash market, daily settlements of profits and losses on futures contracts are made to each trader's margin account; that is, futures positions are "marked to market."[8] This means that daily changes in the value of the futures position due to changes in the price of the futures contract(s) are used to adjust the margin account. Profits increase the dollar amount in the margin account, while losses reduce this amount. If the margin account falls below a given level, termed the maintenance margin, the trader must bring the margin account to its initial level. Thus, futures contracts involve a cash flow to adjust the margin account that does not characterize the cash market and which introduces an additional element of risk.

The "Long" and "Short" of Profits and Losses in the Futures Market. As with any other exchange, a financial futures market participant can take one of two positions: long or short. A buyer of a futures contracts takes a long position. That is, he contracts to take delivery of securities in the future at a specific price that is determined today. A seller, on the other hand, takes a short position. That is, he agrees to deliver securities in the future at a specific price that is determined today.

To see how profits and losses are made in the futures markets, consider first the buyer of a futures contract. The buyer has agreed to take delivery of some securities at a specified date at some specified price. If, at the time of delivery, the cash price is higher than the delivery price, the trader can take delivery of the securities at the price specified in the contract and turn around and sell them at the higher market price, making an immediate profit. If the cash price on the delivery day is lower than the stated delivery price in the contract, the buyer incurs losses. Thus, his profit or loss is the difference between the cash and futures contract prices, less transaction costs (such as brokerage commissions). Prior to the actual delivery date, market participants form expectations about what the prevailing cash price for the securities will be on the delivery date. At any time, the change in the value of the futures position reflects the difference between the expected price of the securities on the delivery day and the delivery price agreed to in the futures contract. Accordingly, a long position makes profits when the price of the futures contract rises and incurs losses when it falls.

The analysis of the short position is similar. The seller of a futures contract has agreed to deliver securities at a specified date at the price agreed upon in the contract. The seller can be viewed as having to buy the securities at the prevailing market price at the time of delivery and delivering them to the buyer at the price specified in the futures contract. If the actual or expected price at the time of delivery exceeds the futures contract price, then the seller must pay more for the securities than he receives upon delivery, so that he will incur losses. If the market price is below the futures contract price, the seller can purchase the securities at a lower price than he receives for delivery and thus that short position earns profits. Accordingly, a short position incurs losses when the actual price of a futures contract rises and makes profits when it falls.

In sum, changes in the prices of interest rate futures contracts primarily reflect changes in the prices of the underlying deliverable security. If

[7]The discount rate expresses the return as a percentage of the face value of the instrument, whereas the interest rate expresses the return as a percentage of the market value of the instrument.

[8]The cash market refers to a market in which transactions for the purchase or sale of financial instruments are immediate and are conducted at agreed on prices and terms. For a bank, even if the market value of securities bought or issued in the cash market changes, the value on the bank balance sheet does not change. The only exception to this is if the cash market transaction involved the trading account of the bank's securities portfolio.

expectations change and interest rates in June are expected to be higher than previously thought, an interest rate futures contract calling for June delivery will fall in price (since interest rates and bond prices are inversely related). On the other hand, if interest rate expectations decrease, the futures contract price will rise. This implies that the buyer of a financial futures contract makes profits when interest rates fall unexpectedly and incurs losses when interest rates rise unexpectedly, while a short position loses money when interest rates fall unexpectedly and makes profits when interest rates rise unexpectedly.

Whether a financial institution takes a long or short position in its hedging strategy depends entirely on how increases or decreases in interest rates affect bank profits, which in turn depends on the maturity structures of its assets and liabilities. If a bank's profits fall when interest rates rise, it will want a futures position that increases in value when interest rates rise; that is, a short position in the futures market. Conversely, if interest rate increases result in additional cash market profits, it will want a long position in the futures market.

CD, Eurodollar, and T-Bill Futures Contracts. The CD, Eurodollar, and T-bill futures markets have many common features and can all be used to hedge bank interest rate risk. The major trading center for the 90-day T-bill, 90-day CD, and 90-day Eurodollar time deposit futures contracts is the International Monetary Market of the Chicago Mercantile Exchange, known on the street as the IMM or "Merc."

The major difference among these contracts involves the delivery process (see FINANCIAL FUTURES CONTRACT TERMS, p. 18). In delivery on a T-bill futures contract, the short simply delivers to the long a $1 million T-bill with 90 days to maturity. Delivery on the CD futures contract is more complex. Since many banks issue CDs, the exchange must decide which banks' CDs are deliverable. In financial markets, some banks' CDs are exchanged on a "no-name" basis, meaning that one of those bank's CDs is considered the same high quality as another "no-name" bank's CD. Since "top-tier" banks, those whose CDs form the deliverable set, are somewhat interchangeable, the risk in this delivery process may not be great. More important, CDs do not have to have 90-day maturity and can range from between 2½ to 3½ months to maturity from the time of delivery. Additionally, since deliverable CDs comprise less than 10 percent of the total CD market, there is some price risk due to limited supply. These three factors introduce an element of uncertainty into pricing CD futures that is at least partially responsible for its relatively light trading activity.

Unlike their CD and T-bill counterparts, there is no delivery instrument for Eurodollar futures contracts and all settlements are made in cash. This simply means that no delivery of a Eurodollar deposit occurs, and profits or losses on any day are simply the crediting or debiting to a trader's account the difference between the value of the contract at final settlement and the previous day's settlement price. The final settlement price is determined by the clearinghouse. This price is determined by first obtaining 3-month Eurodollar time deposit rates from twelve major banks in the London Eurodollar market. The clearinghouse then drops the two highest and lowest quotes and uses the arithmetic mean of the remaining eight quotes as the settlement price.

The contract size for each futures instrument is $1 million in face value of the underlying instrument. Futures contracts for each of these instruments are traded that mature in March, June, September and December up to 2½ years in the future. The prices of these futures contracts are quoted according to the IMM index. This index is equal to 100 less the yield (in percent) on the futures contract. Thus if the yield on the futures contract is 10 percent, the IMM index value is 90.

The minimum price change from the previous price for each of these contracts is .01, which is equal to one basis point. Each basis point change in prices changes the value of each of these futures contracts by $25. As a result, computing changes in the value of the position is straight-

FINANCIAL FUTURES CONTRACT TERMS

	Treasury Bill	Certificate of Deposit	Eurodollar
Exchange	IMM Division of Chicago Mercantile Exchange	Same as T-bill	Same as T-bill
Contract Size	$1,000,000	Same as T-bill	Same as T-bill
Deliverable Grade	U.S. Treasury bill with 90, 91, or 92 days to maturity	"No Name" CDs; deliverable banks announced 2 business days before 15th of delivery month and must mature 2½ to 3½ months after delivery[a]	Cash settlement with clearing corporation
Price Quotation	Index: 100 minus discount yield	Index: 100 minus add-on interest	Index: 100 minus add-on interest
Minimum Fluctuation	.01% (1 basis point = $25)	Same as T-bill	Same as T-bill
Initial Margin[b]	$1,500	Same as T-bill	Same as T-bill
Maintenance Margin[b]	$1,200	Same as T-bill	Same as T-bill
Trading Hours	8:00 a.m. to 2:00 p.m. Chicago time	7:30 a.m. to 2:00 p.m. Chicago time	Same as CD
Months Traded	March, June, September, and December	Same as T-bill	Same as T-bill

[a]See Exchange rules for additional restrictions.
[b]Subject to changes in Exchange rules.

forward. If a buyer purchases any one of these futures contracts at 90 and its price rises to 91, the buyer earned 100 basis points times 25 or $2,500.

THE HEDGING STRATEGY

Returning to our example, suppose a bank (or any financial institution) is going to make a 6-month fixed rate loan of $1 million that is funded with a 3-month CD. At the same time, the bank is concerned that interest rates will rise unexpectedly by the time it goes to roll over the CD in three months to retain the funds needed to finance the last three months of the loan. To hedge this risk, the bank will use the futures market.

The bank's hedging strategy is as follows. Since the bank is worried about interest rates rising, at the time the loan is made the bank initiates the hedge by taking a short position in the futures market; it will then remove the hedge by taking an offsetting long futures position when it rolls over the CD in three months. The length of the hedge thus corresponds to the length of time the bank is exposed to interest rate risk. The gain or loss per $1 million futures contract is equal to $25 multiplied by the difference between the price of the futures contract when the hedge is initiated and the price of the futures contract when the hedge is closed out. This amount is then multiplied by the number of futures contracts in the transaction to determine the total dollar gain or loss from the futures position.

The size of the bank's futures position, that is, the number of contracts the bank sells, depends on the effect of changing interest rates on its future borrowing cost, which will depend on the size and maturity of the cash market position, and on the specific futures contract used in setting the hedge. For a bank issuing a $1 million CD in three months, the change in borrowing cost in the cash market is equal to $25 multiplied by the difference between the actual borrowing rate and the expected borrowing rate. This change in borrowing cost is equal to the gain or loss from an unhedged position.

In sum, the gain or loss from the hedged position is equal to the change in borrowing costs in the cash market plus the change in the value of the futures position. As an example, suppose at the time the loan is made the expected interest rate on a 3-month CD to be issued in three months is 10 percent. If, when the bank rolls over the CD, interest rates have risen to 12 percent, the interest expense of the (unhedged) bank will be $5,000 higher than expected. Suppose, however, that at the time the loan is made the bank sold one futures contract and the interest rate on this contract rose from 10 to 12 percent over the life of the hedge. In this case, the futures position would yield a $5,000 profit. Thus, there is no change in net borrowing costs. Likewise, in this case, there would be no change in net borrowing costs if interest rates fell, for the bank would gain $5,000 in the cash market and lose $5,000 from its futures position. This is an example of a "perfect" hedge, that is, one where gains (losses) in the futures market position are exactly offset by losses (gains) in the cash market.

Setting the Hedge Ratio and Basis Risk. An important issue in effective hedging is determining the appropriate number of futures contracts to use in the hedge. The number of futures contracts per $1 million CD to be issued is termed the *hedge ratio.* Studies of the hedge ratio have traditionally suggested that a way to arrive at a perfect hedge is to equate the face value of the securities to be hedged with the securities used to hedge. Since the face value of the hedging securities is also $1 million, the dollar-for-dollar hedging technique sets the hedge ratio equal to 1. This hedging strategy is termed a *naive hedge,* in part because it ignores *basis,* which is the difference between cash and futures market rates. The use of a naive hedging strategy may yield poor hedging results. Suppose, for example, that every time the cash market rate changes 10 basis points, the futures market rate changes by only 5 basis points. In this case, if the CD rate rose 100 basis points the futures rate would rise only 50 basis points. The hedged position would have resulted in a net increase in borrowing costs of 50 basis points or $1,250, which is far from a perfect hedge.

If the hedge ratio had instead been set equal to 2—that is, two futures contracts sold for every CD to be issued—the hedge would have been perfect. The 100 basis point rise in the CD rate would have increased borrowing costs by $2,500 and each futures contract would have risen in value by $1,250. The increase in cash market borrowing costs of $2,500 would have been exactly offset by the increase in the value of the futures market position so that there would be no change in net borrowing costs.

There are few perfect hedges. This is so because of *basis risk,* which refers to unexpected changes in the cash-futures rate relationship. If there were no basis risk, a hedge would always be perfect. To see this, consider the example where the CD rate is 11 percent, the T-bill futures rate is

10 percent and the hedge ratio is two. Suppose the rate on T-bill futures rose 50 basis points to 10.50 percent. Given the hedge ratio of 2, we would expect the CD rate to rise by 100 basis points to 12.00 percent. Note that even though the basis has increased to 150 basis points, this change was expected and accounted for via the hedge ratio. If the CD rate increase had not been 100 basis points, then there would have been an unexpected change in the basis and the hedge would not have been perfect. What the actual relationship between these rates will be over the life of the hedge, and therefore the exact hedge ratio that would result in a perfect hedge, cannot be known with certainty at the time the hedge is placed. Accordingly, hedgers rely on historical data to estimate the relationship that is expected to prevail over the life of the hedge.[9]

Choosing the Hedging Instrument. In setting a hedge, the hedger should attempt to minimize basis risk. In general, a *direct hedge*, that is, hedging a cash market instrument with a futures contract on the same underlying instrument, involves less basis risk than a *cross hedge*, that is, hedging a cash market instrument with a futures contract on a different underlying instrument. This suggests that using a CD futures contract to hedge a CD issue will provide superior results to using T-bill or Eurodollar futures contracts to hedge CD issues.

For several reasons, however, this may not be the case. First, the rate on the CD futures contract is, unlike its counterparts, not strictly related to a 3-month borrowing rate since the deliverable instrument may have a maturity of between 2½ to 3½ months. Further, deliverable grade CDs comprise only 10 percent of the entire CD market, so that the supply and demand for these CDs affects the futures contract price. This supply constraint may be reflected in the cash rate on deliverable CDs being different from the cash rate on other CDs, so that the futures price may not only reflect prevailing cash market rates.[10] Additionally—and in part because of the above reasons—there is a potential lack of liquidity in the CD futures market. The CD futures contract has had less than one-quarter the trading activity of either the T-bill or Eurodollar futures contract. This relatively small trading volume suggests potentially large hedgers might face adverse price movements at the time of their transactions. That is, when large hedgers go to buy CD futures contracts, the price will increase because of their demand so that these hedgers may not be able to purchase the desired number of contracts at the quoted futures price.

We might expect Eurodollar futures to provide a better cross hedge of bank CDs than T-bill futures since Eurodollar rates reflect an actual bank borrowing rate, whereas T-bills reflect a default-free borrowing rate. In periods of a "flight to safety," T-bill and CD rates may even move in opposite directions.[11] Both T-bill and Eurodollar rates, however, are dominated by general movements in interest rates so that they may provide very similar hedge results.

HEDGING EFFECTIVENESS

To investigate which contract provides the most effective hedge, hypothetical 3-month hedges of CD borrowings were formed and evaluated for five banks from three different geo-

[9]In practice, the appropriate hedge ratio is typically measured as the regression coefficient on futures rates in a linear regression of cash market rates on futures rates.

[10]Specifically, this supply constraint implies that there may not be enough deliverable grade CDs available to meet the demand for delivery against futures contracts. In this case, the futures price may change solely because of the supply and demand conditions for deliverable grade CDs and not because of more general movements in CD interest rates. This will decrease the effectiveness of any hedge.

[11]A "flight to safety" is characterized by investors switching from risky securities, such as CDs, to risk-free Treasury securities. The demand for risk-free securities will increase relative to the demand for risky securities. As a result, there will be a drop in the risk-free rate and an increase in the risky rate. A good example of this was the movement in T-bill and CD rates during the time period when the severe financial difficulties of Continental Illinois were announced.

graphical regions: Citibank, Chase Manhattan, and Manufacturers Hanover in New York; First Chicago in Chicago; and Bank of America in San Francisco. The current 3-month and 6-month CD rates and prices of the CD, T-bill, and Eurodollar futures contracts were obtained from Data Resources, Inc., for every Thursday from January 1, 1984 through December 31, 1984. The futures price data are obtained for the same sample period for the CD, T-bill and Eurodollar market.

For any given day, the expected 3-month CD rate in three months is calculated from the current 3-month and 6-month CD rates. To assess the unhedged position, we then look at the rate at which the second CD actually is issued in 13 weeks (91 days or approximately three months). The difference between the issuing rate and the expected borrowing rate gives the difference in basis points between the actual and expected borrowing costs in the cash market. Multiplying this difference by $25 gives the dollar difference in interest expense per $1 million borrowed.

Taking the average of the absolute basis point difference between the actual and expected borrowing rate over the sample period provides a good measure of the interest rate exposure from remaining unhedged.[12] The higher this average is, the greater the deviation of actual from expected borrowing costs and the more uncertainty there is in future bank costs. As shown in the first row of Table 1, the average difference ranged between

[12]This is superior to a simple average of the difference, because in the latter large errors of opposite signs cancel each other out yielding an improperly low measure of interest rate risk. When the absolute value is used these errors reinforce each other to give a more accurate measure of risk exposure. This risk measure is also used by Michael Smirlock in, "An Analysis of Cross Hedging CDs with Treasury Bill Futures: Bank Specific Evidence," (Federal Reserve Bank of Philadelphia Working Paper No. 85-4, 1985). That paper also contains a more extensive discussion and analysis of hedging CDs with T-bill futures.

TABLE 1

HEDGING EFFECTIVENESS

Row	Variable Description	Bank of America	Chemical Bank	Chase Manhattan	First Chicago	Manufacturer's Hanover
1.	Unhedged Interest Rate Exposure[a]	64	63	73	62	65
2.	Hedge Ratios for Futures Contracts[b]					
	T-bill	1.21	1.16	1.30	1.27	1.09
	CD	1.04	1.07	1.03	1.09	.98
	Eurodollar	.97	.99	1.04	1.07	.98
3.	Hedged Interest Rate Exposure[a]					
	T-bill	34	27	21	17	26
	CD	42	25	18	20	28
	Eurodollar	47	26	18	20	26

[a]Measured as the absolute average basis point difference between actual and expected borrowing rates.

[b]The hedge ratios are calculated using ordinary least squares to estimate the equation $CD_{it} = a + bFUT_{jt} + e_t$ where CD_{it} is the CD rate of bank i at time t and FUT_{jt} is the rate on futures contract j at time t. There are 5 banks and 3 futures contracts, so that 15 regressions were estimated. The estimates of coefficient b are the hedge ratios reported in the Table.

62 and 73 basis points for each bank. This implies an average dollar difference in actual from expected borrowing costs of between $1,550 and $1,825 per $1 million borrowed.

If the bank is concerned that interest rates will rise unexpectedly, a short position in the futures market would be taken when the expected borrowing rate is calculated. The size of the futures position will depend on the hedge ratio, which will differ depending on the bank and the futures contract instrument. These hedge ratios, shown in the second row of Table 1, were estimated using historical data on the relationship between cash market and futures market rates. The futures contract used in setting the hedge is the contract whose maturity is closest to, but after, the date the CD is rolled over.[13] When the second 3-month CD is issued, the bank takes a long position in the futures contract, thus closing out the futures position. The change in the futures price over the life of the hedge represents the gain or loss from the futures position.

To assess the *hedged* position, we look at the change in the rates in both the CD and futures markets.[14] The net change in the rates in these two markets represents the change in the borrowing rate from a hedged position (using the estimated hedge ratios). This amount multiplied by $25 gives the dollar difference in the interest expense per $1 million borrowed from a hedged position. As with the unhedged position, the average of the absolute basis point difference between the realized and expected borrowing costs is used to measure interest rate exposure under a hedging strategy. This average difference, reported in the third row in Table 1, is between 17 and 47 basis points, depending on the bank and futures contract used. This implies an average dollar deviation from target borrowing cost of between $425 and $1,175 per $1 million borrowed.

Comparing the average basis point deviations from the expected borrowing rate for the hedged and unhedged position gives some idea of the effectiveness of futures contracts in decreasing bank risk. In all cases, the average deviation from expected costs using futures was less than that of the unhedged position. With the exception of Bank of America, this average deviation is less than one-half and closer to one-third that of the unhedged position. Although the banks had different levels of risk exposure, the risk reduction from hedging was reasonably uniform across banks. These findings suggest that banks can achieve a substantial reduction in risk exposure from hedging with futures.

The futures contract that provides the most risk reduction is the one that minimizes deviations from the expected borrowing rate. No futures contract clearly dominates the other two. In par-

[13]So, for example, a futures position taken in April to hedge a 3-month CD to be issued in July would involve selling a September futures contract. Additionally, since futures rates are actually biased estimates of expected cash market rates and converge to the expected cash market rate at maturity, it may be argued that the time to delivery should be included as an independent variable in the hedge ratio regressions. Given the contracts used here and their relatively short maturity, this bias is likely to be small and to have very little effect on the hedge ratios. Accordingly, time to delivery is not included as an independent variable.

[14]Anderson and Danthine ("Hedging and Joint Production: Theory and Illustration," *Journal of Finance*, May 1980, pp. 487-498) suggest that a portfolio of futures contracts will provide a more effective hedge than using a single futures contract. That is, using the T-bill, CD, and Eurodollar futures contracts in combination will result in a lower deviation from expected borrowing cost than using any one single contract to hedge. They argue that there is less basis risk when a portfolio of futures is used than when a single futures contract is used to hedge. The rationale is the same as that for using a portfolio of stocks to eliminate risk or price movements not related to general market movements. While the Anderson and Danthine insight is valid, that approach is not taken here because it does not allow for direct comparison of hedging effectiveness among specific futures contracts. Also, transaction costs are probably lower and expertise higher when one futures contract is used so that a bank might want to concentrate in one instrument. Finally, reducing basis risk is more important when the futures market and cash market instruments are substantially different, which is not the case in this study.

ticular, using CD futures to hedge a CD issue does not necessarily result in the most effective hedge. Cross-hedging with either T-bill futures or Eurodollar futures was superior to CD futures in several cases. The only bank for which the choice of futures contract makes a notable difference is Bank of America, and in this case the T-bill contract is superior.

CONCLUSIONS

The results of this analysis suggest that banks can hedge CD funding risk and better meet the financial needs of their customers through the use of financial futures. A comparison of several hedging instruments suggests that regardless of which futures contract a bank selects as a hedging instrument, the bank can substantially reduce interest rate exposure by hedging. Thus, futures can provide the bank with an effective way to "lock in" future borrowing costs.

In terms of specific hedging instruments, there is little difference in the hedging effectiveness of the different futures contracts in all but one of the cases examined. Further, given the potential liquidity problem inherent in the CD futures market, these findings suggest a bank hedging its CD funding risk can use either the Eurodollar or T-bill futures contract as its hedging instrument. Neither of these two contracts, however, clearly dominated the other in terms of hedging effectiveness. Whichever alternative is used, financial futures can provide a bank with an efficient method to manage interest rate rate risk and, in turn, allow a bank to improve its ability to meet the financial service needs of its customers.

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