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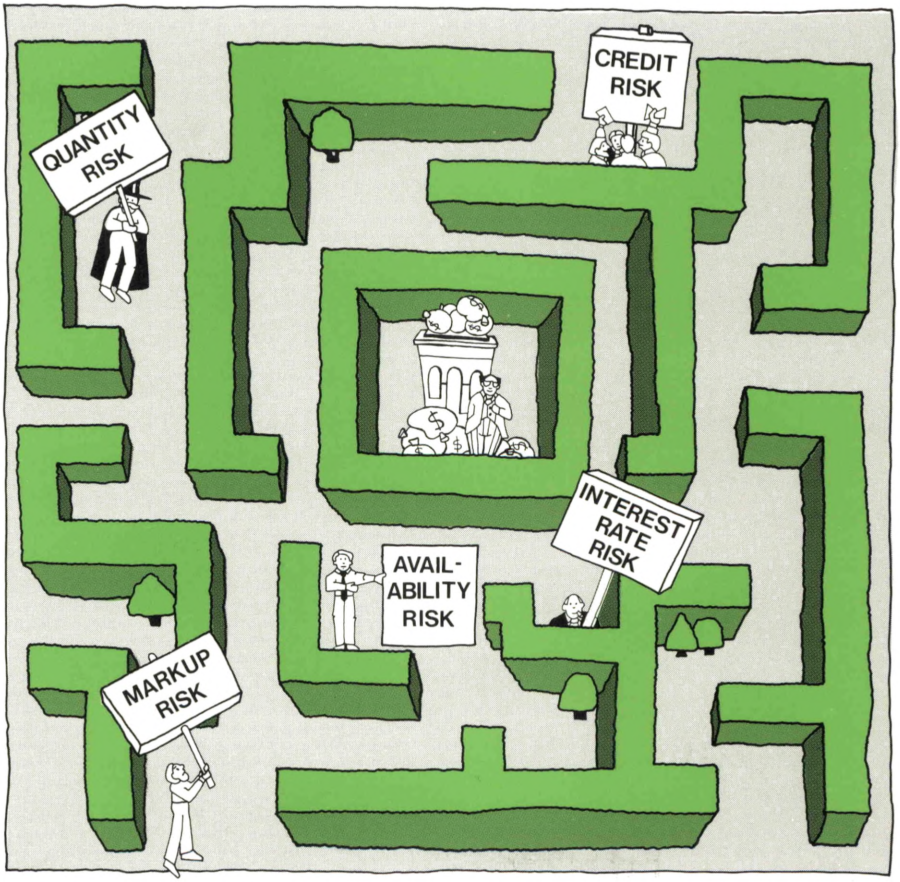

Loan Commitments
Insurance Contracts in a Risky World

Mitchell Berlin

Hedging Bank Borrowing Costs With Financial Futures

Michael Smirlock

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Increased volatility of interest rates recently has created risks for both banks and their customers. For example, when interest rates head up unexpectedly, banks can face a profit squeeze; their short-term borrowing costs are higher while the revenues on their long-term loans are tied to the lower rate. Volatility imposes other risks as well, for higher borrowing costs may limit a bank's ability to make loans available to its customers.

In this issue of the *Business Review*, two approaches to hedging these risks are presented. Mitchell Berlin analyzes loan commitments in the framework of insurance contracts between borrowers and banks. Michael Smirlock describes and discusses interest rate futures contracts, and compares the effectiveness of various kinds of futures contracts in hedging interest rate risk.

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Loan Commitments
Insurance Contracts in a Risky World

*Mitchell Berlin**

INTRODUCTION

Over the last fifteen years, banks have been increasingly concerned with managing the risks that stem from volatile interest rates, both for themselves and for their loan customers. One response to this uncertain environment has been a large increase in the volume and variety of loan commitments — promises by banks to make *future* loans at the customer's demand. These agreements provide commercial borrowers with assurance that funds will be available, often at a contractually set rate. One can view the loan commitment as an insurance contract, in which borrowers purchase protection against certain risks, and banks — as insurers — take risks upon themselves.

The growth of loan commitments reflects a more general trend toward the explicit pricing of individual customer services by banks. Although the traditional loan relationship had always provided insurance through informal understandings and implicit promises, loan commitments increasingly contain binding con-

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tractual promises and explicitly priced insurance services. An analysis of the growth of commitments and the relative growth of different types of commitments provides a striking illustration of banks' attempts to adapt traditional customer services to a riskier and less regulated environment.

WHY CUSTOMERS AND BANKS USE LOAN COMMITMENTS

Loan commitments — promises by banks to lend up to some maximum amount over a fixed period — are not new instruments. Their widespread use, though, is relatively new, especially among smaller commercial customers. This growth in loan commitments has been apparent since 1977 (the first year for which detailed data are available) for short-term, commercial and industrial (C&I) loans of all sizes (see Table 1).

The first step toward understanding this trend is to explain why customers want commitments. Why, for instance, would a commercial customer desire a commitment by a bank to make loans rather than simply apply for loans as needed? The underlying reason is that customers without commitments face considerable uncertainty about both the cost and availability of funds. An example helps to illustrate the point.

Consider Shmattas and Hatts (S&H), a medium-sized clothing manufacturer. Like many clothing firms, S&H has separate seasonal lines. Each

TABLE 1

THE SHARE OF SHORT-TERM C&I LOANS MADE UNDER COMMITMENT[a]

Size of Loan (thousands)

Year	$1 - 24	$25 - 49	$50 - 99	$100 - 499	$500 - 999	$1000 and above
1977	18%	24%	26%	41%	61%	59%
1978	15	21	27	38	63	49
1979	23	31	40	46	59	55
1980	24	30	39	47	64	51
1981	26	30	40	47	66	51
1982	36	37	48	54	63	62
1983	33	37	46	49	67	67
1984	31	38	43	54	67	71
1985	36	41	52	58	70	70

[a]The figures are constructed from a sample of 340 commercial banks of all sizes. The figures are short-term (one year or less) C&I loans granted under commitment as a percent of total short-term C&I loans.

SOURCE: "Survey of Terms of Lending at Commercial Banks," *Federal Reserve Bulletin* (various years).

winter, the firm manufactures swimsuits to be placed in department stores by early summer. Every spring, S&H produces sweaters that will be sold in the fall. Until the clothes have been sold and the remittances received from retail outlets, S&H requires funds to cover its material, labor, and warehousing costs.

In the past S&H has always borrowed from First National Bank and has built up a reputation for prompt repayment. But when it applies for its spring loan, the loan officer explains that the bank has experienced unusually large loan demand, so it can provide only half of the firm's working capital requirement. Now S&H must cut back production or make a costly search for alternative sources of funds. Without a promise to lend from the bank, S&H faces *availability risk*—the possibility of getting less funds than it needs.

In another scenario, suppose that the loan officer says that the full loan can be accommodated but at the prime rate plus 200 basis points, instead of the 100 basis point markup over prime that the bank had required on previous loans. The higher markup raises S&H's production costs and the firm must either renegotiate prior agreements with sales outlets or accept lower net revenues. Therefore, when a firm applies for separate loans as needed it is also subject to *markup risk* — the possibility of increases in the loan rate due to a higher markup. Loan commitments, though, permit customers to purchase insurance against availability risk and markup risk.[1]

A bank also finds it profitable to supply loan commitments for several reasons. First, loan commitments have some of the virtues of the more traditional long-term loans: by signing a single contract, the bank can both reduce the costs of negotiating a series of shorter-term loans, and banks can more easily plan future loan demand. At the same time, banks can take advantage of customers' willingness to pay for the insurance a loan commitment offers. The most common form of payment, a fee based on the unborrowed balance of the commitment, is especially attractive to banks seeking a stable source of income in an uncertain environment. Another benefit to the bank lies in the regulatory treatment of loan commitments. Unlike a long-term loan, a loan commitment enters the bank's balance sheet piecemeal — each time the customer borrows, the bank enters the amount borrowed as an asset. Thus the bank receives income based on the total amount committed — the interest on the loans actually made and the fee on the unborrowed balance — while its assets include only the loans granted. Since regulators require banks to maintain a minimum capital-to-asset ratio, loan commitments place less pressure than long-term loans on the bank's capital requirement while still producing income.

THE GROWTH IN COMMITMENTS REFLECTS AN INCREASED DEMAND FOR INSURANCE

The sources of borrowers' increased demand for insurance lie in a combination of factors that made loan rates more volatile in the 1970s and 1980s, and increased borrower risk. Before the 1970s, the prime rate was changed very little and very infrequently. Deposit rate regulation, low inflation rates, and the Fed's practice of restricting interest rate fluctuations ensured that bankers could attract deposits at a low, stable cost, and this permitted them to offer stable loan rates to borrowers. But as inflation and interest rates moved higher in the late 1960s and 1970s, depositors became increasingly dissatisfied with low, regulated rates of return, and bankers came under pressure to satisfy depositors' demands for market rates of return. The deregulation of interest rates on large, negotiable certificates of deposit (CDs) in 1973 permitted banks to satisfy this demand, at least for large depositors. Thus

[1]Of course, the firm still bears *interest rate risk*—the possibility of loan rate increases due to rising market rates, because virtually all loan commitments permit loan rates to move with market rates. The customer locks in a commitment to lend and often a markup, but not a fixed reference (or base) rate.

banks became more and more dependent upon liabilities whose cost moved directly with market interest rates. (See Figure 1.)

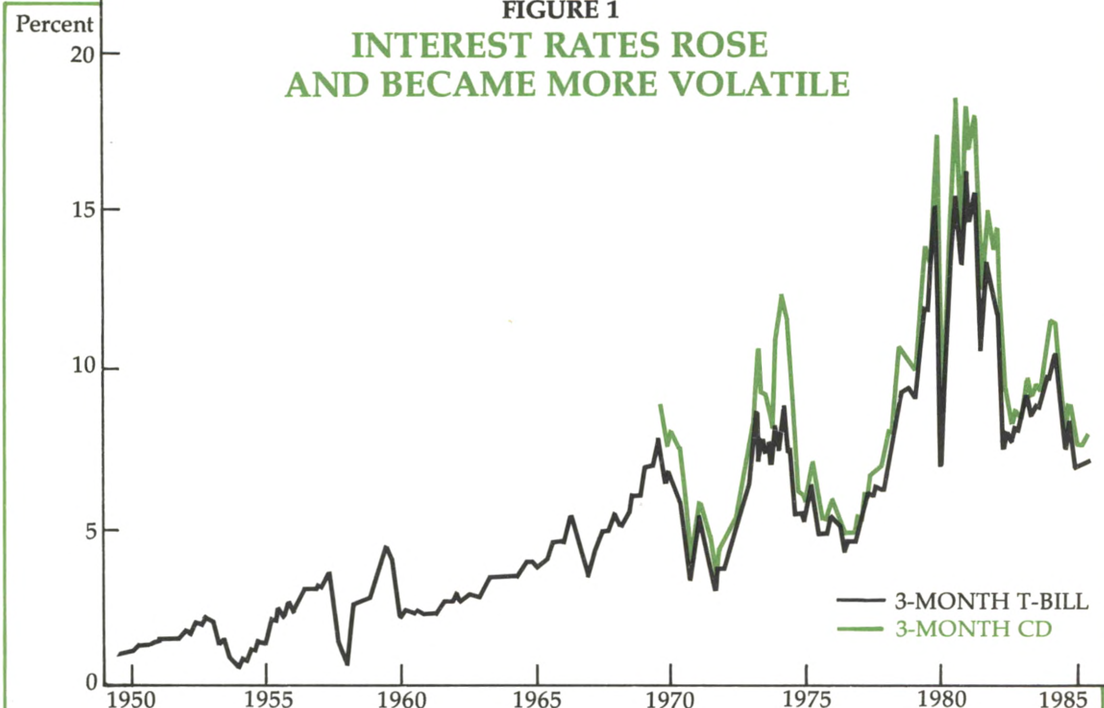
The sluggishness of the prime rate that marked the pre-1970 period was a major casualty of this transformation of the liability side of bank balance sheets. By the early 1970s, banks had begun adjusting the prime rate more rapidly in response to fluctuations in their cost of funds, and with the Fed's change in operating procedures in October 1979, bankers faced much more volatile CD rates. As CD rate fluctuations became more pronounced, borrowers were increasingly confronted with volatile loan rates.[2]

Volatile Loan Rates Increased Borrower Risk. When loan rates became more variable, customers borrowing on a loan-by-loan basis faced both greater markup risk and greater availability risk. The reason is that the bank's perception of a customer's creditworthiness depends, in part, upon the loan rate the bank charges. A firm forced to borrow at a higher rate due to an unexpected increase in the bank's cost of funds may engage in riskier behavior with a higher probability of default.[3] For instance, to protect profit margins, the clothing manufacturer may choose a less traditional, more uncertain product line in the hope that its sales revenues will be greater than normal. Although the bank cannot predict each customer's expected revenues with complete accuracy, it realizes that there are many

[2]See Brian C. Gendreau, "When Is the Prime Rate Second Choice?" this *Business Review* (May/June 1983) pp. 13-21.

[3]For a rigorous demonstration of the relationship between the loan rate and default risk, see Joseph Stiglitz and Andrew Weiss, "Credit Rationing in Markets with Imperfect Information," *American Economic Review* (June 1981) pp. 393-410.

FIGURE 1
INTEREST RATES ROSE AND BECAME MORE VOLATILE



SOURCE: Data Resources, Inc.

customers like the clothing manufacturer and raises its assessment of the average likelihood of default. For loan customers without a contractual commitment, the bank has two alternatives. One is to increase the customer's markup as compensation for increased credit risk. The other is to refuse to lend on the grounds that the higher markup increases the customer's probability of default. The first alternative confronts the loan customer with markup risk, while the second creates availability risk. These risks reduce the gains to both the bank and the borrower from maintaining a continuing loan relationship.

The greater markup and availability risk that accompanied the interest rate volatility of the 1970s and 1980s thus raised the value of insurance to the loan customer. This, in turn, generated a greater demand for loan commitments. By satisfying this demand, banks were able to maintain a traditional clientele — customers who required funds on a continuing basis.

Further insight into the banking industry's innovative response to a riskier environment requires a detailed look at how the various types of loan commitment contracts allocate risk between the bank and the borrower. Each contract type imposes a distinctive compromise between the customer's desire for protection against risk and the bank's costs of providing that insurance. Thus, it is not surprising that customers' and banks' preferences for different types of commitments have shifted as banking markets have changed.[4]

REVOLVING LOAN COMMITMENTS VS. CONFIRMED CREDIT LINES

Although all commitments involve a contractual promise to lend up to some maximum amount over a given period, *revolving loan commitments* also contain a loan formula. This loan formula includes a reference rate —either the prime rate or some market rate such as the 60-day CD rate — and a contractually fixed markup. The size of the markup is determined by the customer's creditworthiness. Revolving loan commitments therefore protect the customer against both availability risk and markup risk. In contrast, a commitment that permits the bank to set the loan rate unilaterally each time the commitment is used, or "taken down," is called a *confirmed credit line.* This type of commitment only provides insurance against availability risk.

The provision of insurance, however, is not costless for the bank. While the fixed markup provided by a revolving loan commitment is a definite advantage to the customer, it increases bank risk. Thus, customers with revolving loan commitments are usually required to compensate the bank in the form of a commitment fee. The fact that commitment fees are seldom required on confirmed credit lines indicates that it is the combination of the promise to lend and the fixed markup that poses special risks, for which the bank requires added compensation.

The first type of risk to the bank is known as *quantity risk,* the possibility that many customers will borrow unexpectedly from the bank at the same time. Although firms normally borrow funds from time to time according to their individual needs, at certain times many firms will borrow at once. This is true, in particular, when alternative sources of funds are costly and difficult to find. To satisfy an unexpectedly large loan demand, banks must compete aggressively for funds against other banks. This drives up market rates, including CD rates, and leads banks to raise the prime rate. Since loan commitments use these rates as reference rates, part of the bank's costs of meeting greater loan demand is passed on to borrowers with commitments. But the increase in the reference rate, which is only one component of the loan rate, does not necessarily compensate the bank fully for the added costs of satisfying loan demand. In particular,

[4]For interesting recent empirical discussions of loan commitment contracts, see Thomas Brady, "Changes in Loan Pricing and Business Lending at Commercial Banks," *Federal Reserve Bulletin* (Jan. 1985) pp. 1-13, and John Ham and Arie Melnick, "Bank Lending Practices and the Market for Loan Commitments: Survey and Analysis," unpublished paper, University of Haifa (Feb. 1984).

banks are subject to regulatory capital constraints and are not free to increase loans without limit. If, for example, regulators require capital equal to 6 percent of total assets outstanding, and the total loans taken down under commitment would drive the capital-to-asset ratio to 5 percent, the bank either must deny new loans to customers unprotected by commitments or must increase its capital. Either alternative is costly to the bank and these costs are not reflected in the reference rate.

The second type of risk to the bank is known as *credit risk* — the possibility of customer default. While banks face credit risk on all loans, not just loans granted under commitment, the fact that commitments extend into the future creates added uncertainty. Typically, commitments are made for 1 to 3 years. A bank may be able to evaluate a customer's creditworthiness accurately in the near term; however, a customer's ability to repay loans to be made in the future will be harder to predict. This risk is compounded because firms are especially likely to take down commitments when alternative credit sources are unavailable because of increased credit risk.

In sum, since under a revolving loan commitment, the bank is unable to adjust the markup in response either to large loan demand or to a decline in a customer's creditworthiness, the contract must contain provisions that either reduce the bank's risks or compensate the bank for the risks it bears. The commitment fee is the standard provision that compensates the bank for bearing quantity and credit risk. Since the risk borne by the bank at any time depends upon the customer's maximum potential borrowings, the commitment fee usually takes the form of a percentage payment on the unborrowed balance of the loan commitment (0.5 percent is a typical fee).[5] To limit the risks imposed by the fixed markup, commitments also contain provisions to renegotiate or even cancel the agreement if there are major declines in the customer's creditworthiness. Many commitments require that borrowers achieve a zero balance at least once a year, because the bank can use the customer's ability to clear its balance periodically as an indicator of the customer's creditworthiness. If the firm cannot clear, then the bank may decide to examine the firm's books and determine whether the commitment should be discontinued or renegotiated.[6]

Revolving Loan Commitments Have Become a Larger Share of Total Commitments... The growth in the use of revolving loan commitments has outpaced the growth of confirmed credit lines (see Table 2). How can the apparent increasing preference for revolving loan commitments be explained? Perhaps the primary reason is that the risks facing borrowers have changed with the deregulation of deposit rates. While markup risk and availability risk due to loan rate volatility have increased, another traditional source of availability risk has declined in importance because of banks' expanded liability powers. In the years before the deregulation of deposit rates, when market rates rose above deposit rate ceilings, funds flowed out of the banking system. This outflow of funds has been termed "disintermediation." Depositors shunned the below market returns offered by banks and shifted their funds into financial instruments paying higher interest rates offered by unregulated competitors. Unable to purchase sufficient funds, banks were compelled to reduce the availability of loans to customers unprotected by commitments. Since the restricted availability of loans resulted from banks' restricted access to funds rather than the increased credit risk due to high loan rates, confirmed credit lines provided adequate protection against the risk faced by the borrower in obtaining a loan.

However, the threat of disintermediation has

[5]See Ham and Melnick, "Bank Lending Practices..."

[6]Some contracts require the firm to maintain working capital above some minimum level. Such clauses have the same basic intent as provisions that require customers to clear their balance periodically.

diminished as banks have acquired enhanced powers to compete for funds. In periods of high interest rates banks can secure funds, but only at a higher cost. Thus availability risk due to disintermediation has declined in importance, while the risks arising from loan rate volatility have increased. Accordingly, revolving loan commitments have become relatively more attractive than confirmed credit lines, which provide no markup protection.[7]

...But It Is Still Efficient for Banks to Offer Both Types. The declining share of confirmed credit lines is by no means evidence that they are falling into disuse. Because different loan customers have different needs, banks will try to satisfy them with differentiated products. For example, a large firm may be confident that it will remain creditworthy and that its credit status will be verified by public rating agencies such as Standard and Poor's. This firm will find the markup protection of revolving loan commitments less valuable than will a small, unrated firm with more uncertain prospects. Also, by offering both revolving loan commitments and confirmed credit lines, banks can generate information about customers that is otherwise difficult to collect, because the customer's choice between contract types can reveal his likelihood of borrowing. Thus banks increase the predictability of loan demand.

To see this, consider a very simplified example with two different loan customers, firm A and firm B. Imagine that firm A is more likely than firm B to require funds, but that it is difficult for the bank to determine either firm's probable need for funds by direct examination. Clearly, in many cases firms know a great deal more than the bank does about their likely need for a loan. The different characteristics of the two types of commitments may induce firm A to choose a revolving loan commitment and firm B to choose a confirmed credit line, and in the process they reveal their probability of borrowing. The revolving loan commitment requires a commitment fee, but limits upward movements in the loan rate by fixing the markup; the confirmed credit line, however, requires no fee, but also places no restriction on the bank's prerogative to raise the markup and hence the loan rate. Everything else equal, firm A will be willing to pay the commitment fee to gain protection against

TABLE 2

C&I LOANS MADE UNDER REVOLVING LOAN COMMITMENTS

Year	Dollars[a] (billions)	Percent of All C&I Loans Made Under Commitment
1977	19.7	24.7%
1978	23.5	24.8
1979	31.0	27.1
1980	36.6	29.1
1981	46.3	32.6
1982	62.9	40.1
1983	62.5	41.2
1984	73.5	44.2
1985	75.0	47.8

[a]Refers to the monthly average for each year.

SOURCE: "Commercial and Industrial Loan Commitments at Selected Large Commercial Banks," Federal Reserve Statistical Release G.21 (423). The survey includes 119 large banks.

[7]Another explanation of the move to revolving loan commitments involves the different sizes of borrowers. Since the largest increase in the use of loan commitments appears to have occurred among smaller borrowers, the greater than proportional growth of revolving loan commitments may reflect the different characteristics of large and small borrowers. If, for instance, small borrowers' creditworthiness is more likely to vary over the 2- to 3-year life of a commitment, then they are more likely to demand markup protection and banks are more likely to require fee compensation for a commitment to lend. Currently available data do not permit a test of this hypothesis.

drastic loan rate increases because it is more likely to borrow. For this type of firm, protection against the loan rate increasing is very valuable. On the other hand, firm B, which is less likely to borrow, will be less concerned with the possibility of a high loan rate, and will choose the confirmed credit line to avoid paying the commitment fee.

Without this kind of information about customers, the bank is forced to plan its future funding needs as if all its customers were identical, "average" loan customers. But if customers reveal their individual probabilities of borrowing through their choice of contract type, the bank can reduce its uncertainty about likely loan demand, and can plan its funding accordingly. Since loan demand has been made more predictable, the bank bears less quantity risk.[8]

FIXED VS. FLOATING REFERENCE RATES

Choice among loan commitment contracts is not limited to deciding whether or not the markup should be contractually fixed. In addition, loans taken down under commitment differ according to the variability of the reference rate, which may be either a fixed or floating rate. For a *floating rate* loan, the reference rate is adjusted continuously throughout the life of the loan. The actual loan rate paid is some weighted average of the rates prevailing until the loan is repaid. For a *fixed rate* loan, the reference rate prevailing on the day the loan is taken down remains in force until the loan is repaid. The fixed rate loan provides the customer with insurance against *interest rate risk* — the possibility of a rise in the reference rate during the life of the loan.

Floating Rate Loans Have Become More Prevalent... Published data that aggregate ordinary loans and loans made under commitment reflect a trend toward increasing use of floating rate loans (see Table 3). This trend can be observed across all loan sizes except the very largest, which tend to have very short maturities (one month or less). The growth of floating rate loans is usually ascribed to the greater volatility of bank funding costs. When the cost of funds is variable, a bank making fixed rate loans funded by liabilities of shorter maturity faces interest rate risk. If, for example, the bank funds a 6-month fixed rate loan with 3-month CDs, an unanticipated rise in the CD rate reduces the bank's profit margin. To avoid interest rate risk, though, the bank has an alternative to the restrictive policy of matching each loan with a liability of identical maturity. If the reference rate is allowed to float, the bank can shift interest rate risk to the customer.

The most recent data distinguish fixed and floating rate loans according to whether they were granted under commitment or not. The data from the last four loan surveys indicate that a loan granted under commitment is more likely to have a floating rate than an ordinary loan. In dollar terms, the share of committed loans with floating rates in these four surveys ranged from a high of 37 percent to a low of 24 percent, while the fraction of noncommitted loans with floating rates ranged from 27 percent to 18 percent.[9]

Loan commitments come with a variety of repayment options, and customers have some flexibility in determining when to repay the loan. Uncertainty about the repayment time creates difficulty for a bank that wishes both to offer fixed rate commitments and to limit its own interest rate risk. Unless the bank can confidently predict the maturity of the loan, it is unable to fund the loan with a matching CD. Thus, banks are more likely to insist on the floating rate option for loans granted under commitment.

...But It Is Still Efficient for Banks to Offer Fixed Rate Loans. Although banks have increased

[8]For a formal model, see Anjan Thakor and Gregory Udell, "An Economic Rationale for the Pricing Structure of Bank Loan Commitments," Banking Reasearch Center Working Paper, Northwestern University (April 1984).

[9]See "The Survey of Terms of Bank Lending," Federal Reserve Statistical Release E.2. The four surveys are from November 5-9, 1984; February 4-8, 1985; May 6-10, 1985; and August 5-9, 1985.

TABLE 3
THE SHARE OF SHORT-TERM C&I FLOATING RATE LOANS[a]

Size of Loan (thousands)

Year	$1 - 24	$25 - 49	$50 - 99	$100 - 499	$500 - 999	$1000 and above
1977	25%	31%	43%	53%	55%	67%
1978	32	34	44	51	57	66
1979	22	27	36	43	62	65
1980	22	33	48	59	71	35
1981	29	39	48	59	71	35
1982	35	44	56	61	64	23
1983	35	46	52	64	68	30
1984	33	44	51	64	69	32
1985	35	49	65	73	75	21

[a]The figures are constructed from a sample of 340 commercial banks of all sizes. The figures are short-term (one year or less) C&I loans made with floating rates as a percent of total short-term C&I loans.

SOURCE: "Survey of Terms of Lending at Commercial Banks," *Federal Reserve Bulletin* (various years).

the share of floating rate loans, many loans are still granted at fixed rates. This is especially apparent for smaller loan sizes. The continued popularity of fixed rate loans indicates that in many cases there are efficiency gains when the bank provides insurance against interest rate risk.

The most important reason why the bank and customer may elect to use the fixed rate alternative is to reduce the customer's risk of default. The positive relationship between interest rate risk and default risk is a particular concern for loans granted to small borrowers, who in general find it difficult to insure against interest rate risk on their own. The bank can increase its profits by bearing the risk of increases in its cost of funds, thereby increasing the customer's probability of repayment.

In addition, banks have access to other hedging strategies that are available to only their largest loan customers. Although relatively few banks — primarily the largest money center and regional banks — have actively experimented with hedging interest rate risk through the use of futures, there has been substantial recent interest in their use. The use of such instruments as an alternative means of hedging interest rate risk has the desirable feature that risk is actually reduced for both the bank and the borrower rather than simply shifted to the borrower.

CONCLUSION

Banks have traditionally been specialists in maintaining "loan relationships" — long-term, repeated dealings with individual borrowers. In a stable and regulated world, banks and their commercial customers relied on informal promises to support a series of individual loan agreements. But the transformation of the liability side of banks' balance sheets has entailed changes in traditional lending practices. In particular, loan commitments that explicitly provide customers with insurance increasingly have replaced "implicit" or informal agreements. Thus, the terms of loan commitment contracts reflect a compromise between customers' demand for insurance and banks' costs of satisfying this demand.

Although interest rate volatility was an important factor behind the growth of commitments, a period of lower, more stable rates is not likely to lead to a decline in their use. The formalization of the loan relationship is part of a more general trend in bank-customer relations. By making the traditionally informal promises of the loan relationship explicit and binding, loan commitment contracts mirror the trend toward explicit pricing of deposit and payments services by banks. Implicit charges and informal agreements were hallmarks of highly regulated banking markets. The explicit pricing of services, including the provision of insurance to loan customers, is a direct outcome of deregulation that is not likely to be reversed.

Hedging Bank Borrowing Costs with Financial Futures

*Michael Smirlock**

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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