Bank gap management and the use of financial futures

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Interest rate "gap" management has become an increasingly important part of bank funds management over the past decade. This management technique matches liabilities to assets of similar maturity lengths and risk classes.

As interest rates have become more volatile and have climbed to historically unprecedented high levels, the degree to which variable-rate assets are different from variable-rate liabilities (or, in other words, the amount of variable-rate assets supported by fixed-rate funds) has caused concern. This "gap"—really an imbalance—measures the exposure of bank net interest margin, that is, interest income less interest expense, to unexpected changes in market interest rates.

Such changes can result in gains or losses in a bank's portfolio. Losses result if the bank finances its fixed-rate long-term loans with relatively short-term funds and market interest rates rise. Losses also occur if relatively fixed-rate longer-term funds are used and lending rates fall. Gains can be made if interest rates move in the other direction. A bank, then, is exposed to interest rate risk whenever there is a quantitative imbalance between its fixed-rate liabilities and its fixed-rate assets of the same maturity.

Bankers have recognized the importance of gap management in reducing interest rate risk and achieving acceptable bank performance.[1] Furthermore, bank regulators are paying increased attention to a bank's gap position. They are concerned that exposed asset and liability positions could threaten the profitability of some banks and, therefore, their capital positions if interest rates should move adversely. Controlling the size of the gap is an important function of bank funds management and managers are now using financial futures contracts to hedge exposed asset and liability positions.

To what extent can bank profits be stabilized by trading financial futures? To what extent are bank futures trading decisions constrained by the regulatory requirement that futures positions represent bona fide hedges of interest rate exposure? This paper provides some insight into how financial futures can be used as vehicles for reducing interest rate exposure and managing the gap position, and may aid regulators in their supervision of bank use of these instruments.

The basic funds gap concept

In a typical gap management process, bank management is asked to dichotomize all items, both assets and liabilities, on the balance sheet according to interest rate sensitivity. An asset or liability with an interest rate subject to change within a year is considered variable. One that cannot change for more than a year is considered fixed. The imbalance between fixed-rate liabilities and fixed-rate assets is a gap that can be expressed either as dollars or as a percentage of total earning assets. If fixed-rate liabilities exceed fixed-rate assets, the bank has a positive gap. Under rising short-term interest rates, this positive gap would increase net interest margin. But declining short-term interest rates, with a positive gap, would exert downward pressure on net interest margin.

If fixed-rate liabilities are less than fixed-rate assets, there would be a negative gap. With a negative gap, net interest margin would decline if short-term interest rates rose and increase if short-term interest rates fell.

Table 1 presents the gap position (the difference between rate-sensitive assets and rate-sensitive liabilities divided by total assets) in the fourth quarter of 1983 and the first three quarters of 1984 for twenty large domestic banks in the United States. During the December-September period, the 20-bank sample became generally more liability-sensitive. The rate sensitivity gap as a percent of total assets in the third quarter of 1984 ranged from −12.1 percent at Bank of America

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Table 1
Rate sensitivity gap as a percentage of total assets* twenty large banks

	1983	1984		
	Fourth quarter	First quarter	Second quarter	Third quarter
Bank of America	−11.4	−10.5	−13.8	−12.1
Bank of New York	6.6	7.2	5.8	0.8
Bankers Trust Company	3.9	5.9	−1.1	1.7
Chase Manhattan Bank	9.0	−2.7	−3.5	−5.0
Chemical Bank	1.9	2.2	−2.8	−1.0
Citibank	−1.8	−3.1	−2.9	−3.6
First Interstate Bank, California	−1.8	−1.8	−0.3	−0.2
First National Bank of Boston	−0.9	−2.5	−1.1	−0.4
First National Bank of Chicago	−4.1	−9.0	−6.9	−8.6
Interfirst Bank, Dallas	−4.2	−5.3	−2.5	−5.0
Irving Trust Company	−4.0	2.5	4.7	2.0
Manufacturers Hanover Trust Company	5.9	5.4	4.6	2.7
Marine Midland Bank	−1.9	−7.5	−5.8	−4.2
Mellon Bank	−3.2	2.0	4.3	4.2
Morgan Guaranty Trust Company	−2.4	−1.4	−0.7	−4.0
National Bank of Detroit	0.8	−0.2	0.7	1.0
North Carolina National Bank	−2.1	3.2	2.2	2.2
RepublicBank, Dallas	2.4	3.6	1.2	2.1
Security Pacific National Bank	−4.1	−4.7	−4.6	−6.8
Wells Fargo Bank	−1.9	−5.7	−5.9	−4.9
Average	−0.3	−1.1	−1.4	−1.9

*One-year rate sensitivity gap.

Rate-sensitive assets include all assets repricing or maturing within one year and comprise loans and leases, debt security, and other interest-bearing assets.

Rate-sensitive liabilities are all those liabilities scheduled to reprice or mature within one year and include domestic time certificates of deposits of $100,000 or more, all other domestic time deposits, total deposits in foreign offices, money market deposit accounts, Super NOWs, and demand notes issued to the U.S. Treasury.

Source: Salomon Brothers, "Bank Analysts Rate Sensitivity Quarterly Handbook First Quarter 1984," July 27, 1984 and "Bank Analysts Quarterly Handbook Third Quarter 1984," January 29, 1985. The use of these figures does not constitute an endorsement of these estimates or the underlying methodology by the Federal Reserve System.

to 4.2 percent at Mellon Bank, compared with a range between −11.4 percent at Bank of America and 9.0 percent at Chase Manhattan Bank in the fourth quarter of 1983.

Controlling the size of gaps such as those in Table 1 is an important function of bank funds management. To keep from relying too much on short-term funds, banks set a limit on the use of variable-rate liabilities to finance fixed-rate long-term assets. Thus, while federal funds are a constant source of funds for some banks, their use to finance fixed-rate long-term assets—with their potential for exposing banks to interest rate risk—is limited to a permissible range by, say, the ratio of variable-rate assets to variable-rate liabilities.

The size of the gap has a major influence on the volatility of earnings. If, for example, all variable interest rates changed 1 percent, a 30 percent gap would have a $6 million effect on pretax earnings of a bank with $2 billion in assets. The acceptable size of the gap, then, varies with a bank's interest rate expectations.

The tendency, of course, is for banks expecting higher interest rates to accept large positive gaps, with the plan being to reverse the gap before interest rates turn down. But because demand for short-term loans is usually heaviest when interest rates are highest, most banks cannot close large gaps when they want to. For banks expecting lower interest rates, the appropriate strategy would involve accepting negative gaps.

The gap, then, indicates the extent to which banks have used fixed-rate liabilities to fund variable-rate assets. The larger this imbalance the more exposed the bank is to interest-rate risk; the closer to zero this imbalance, the better off the bank is with regard to interest rate risk. Such a gap, however, shows nothing of a bank's assets and liabilities that are repriced within the gapping period.[1] All that matters with the "basic" gap approach is that repricing occurs during the gapping period; it does not matter when during the period the repricing occurs. For example, suppose the gapping period is one year and all the rate-sensitive assets are repriced on day 1, while all the rate-sensitive liabilities are repriced on the last day of the year. If variable-rate assets equal variable-rate liabilities, the gap measurement would show incorrectly that the bank portfolio is hedged against unexpected changes in market interest rates.

Maturity bucket approach

The maturity bucket approach attempts to solve the intraperiod problem by measuring the gap for each of several subintervals of the gapping period. Balance sheet items are grouped in a number of maturity "buckets"; for example, one day, one to three months, three to twelve months, one to five years and so on. Balance, or maturity, gaps, are computed for each bucket. These separate dollar gap values are called incremental gaps and they algebraically sum to the total that is measured by the basic funds gap model.

Asset and liability positions can be hedged by setting each incremental gap equal to zero. If rates are expected to rise, positive gaps should be put into place; the opposite holds for expected rate declines. The use of incremental gap rather than the basic funds gap model increases the probability that net earnings will turn out to be as expected.

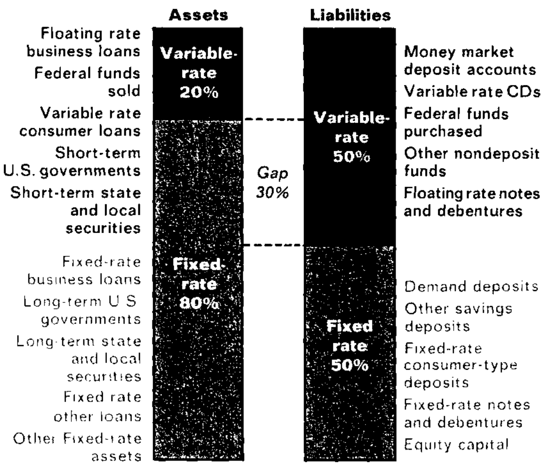
One of the drawbacks of this technique, as well as of the basic funds gap concept, is that it assumes interest rate changes for assets and liabilities of all maturities are of the same magnitude. There is overwhelming evidence that interest rate changes occur in varying magnitude.[2] The gap literature has handled this issue of different interest rate change magnitudes by assuming that the volatility of the interest rates in question is in constant proportion to the volatility of some standard interest rate.

The standardized gap

The standardized gap is a concept that adjusts for the relative volatilities of various instruments. A more volatile interest rate financial instrument has a greater impact on income when it is reset, so it should contribute more to the standardized gap than other, less volatile, interest rate financial instruments. In the gap literature, historical interest rate change data on various rate-sensitive assets and liabilities are used to estimate interest rate change proportionalities. These proportional factors measure the rate volatility of rate-sensitive assets and liabilities relative to a standard of account. Consider for example the bank depicted in Figure 1. If the rate-sensitive liabilities are \$500 and the rate-sensitive assets are \$200, there is a naive gap of −\$300. But suppose the rate-sensitive liabilities are treated as \$500 in 90-day large certificates of deposit (CDs) and the rate-sensitive assets as \$200 in 30-day commercial paper and the 90-day large CD rate is 105 percent as volatile as the yield of 90-day Treasury bill futures while the 30-day commercial paper rate is 31 percent as volatile.[3] Then the standardized gap is −\$463. (The \$500 in 90-day large CDs is equivalent to the volatility of $1.05 \times \$500 = \$525$ in 90-day Treasury bill futures. The \$200 in 30-day commercial paper is equivalent to the volatility of $0.31 \times \$200 = \$62$ in 90-day Treasury bill futures. The standardized gap position is $\$200 \times 0.31 - (\$500 \times 1.05 = -\$463)$.)[4]

Now let the rate-sensitive liabilities be 6-month money market certificates of deposits (MMCs). Dew has estimated that the yield of 6-month MMCs was 185 percent as volatile as the yield of 90-day Treasury bill futures con-

Figure 1
Rate sensitivity gap*



*There can be some trade-off between maturity and fix versus variable rate instruments on bank balance sheets.

tracts. The standardized gap of the above bank whose rate-sensitive liabilities are 6-month MMCs is −$863. The naive gap, in both cases, remains −$300.

Therefore, a bank that has more variable-rate liabilities than variable-rate assets and whose variable rate liabilities are, say, 90-day large CDs, has a different exposure to rising rates than one whose variable-rate liabilities are 6-month MMCs. This is because various assets and liabilities of different maturity have different sensitivities to changes in interest rates. By taking into account relative interest rate volatilities, the standardized gap increases the probability that net earnings will turn out to be as expected.

The best benchmark

There are several factors to consider in choosing the benchmark to use in estimating the effective contribution of money market instruments to the standardized gap. First, the relationship between the benchmark rate and other interest rates affecting the net interest margin of the institution should not vary substantially with the passage of time, since the contribution of other instruments to the rate exposure of the firm has been based on the historical relationship between the benchmark rate and those other interest rates.

One property that would make a benchmark rate desirable from this point of view is that it should have a maturity as close as possible to the average maturity of all other instruments affecting the incremental gap position. This will minimize the impact of shifts in the slope of the yield curve on the accuracy of the estimated relationship between the benchmark rate and the other interest rates affecting the standardized gap.

A second way to assure the reliability of estimates of the standardized gap is to choose a benchmark rate that is market-determined. Administered rates may change their relationships to predominantly market-determined interest rates found on the balance sheets of financial institutions. Therefore, it seems reasonable to avoid the prime rate, the Federal Reserve discount rate, and perhaps the federal funds rate, in choosing a benchmark. The current gap literature recommends that financial futures contracts be used as benchmark instruments because futures rates are market-determined and the contracts themselves are useful in adjusting the gap position in the direction desired by the bank. If the calculation of the standardized gap yields a positive number for a given month, the firm is asset-sensitive[5] and therefore should go long in, say, 90-day Treasury bill futures for delivery in that month or the month nearest it. If the calculation yields a negative number, the firm is liability-sensitive and therefore should go short in 90-day Treasury bill futures.

In interpreting the standardized gap concept, as well as the other gap concepts, it it important to remember that it does not measure the interest rate risk resulting from the effect of changes in interest rates on present values of cash flows and periodic principal payments of assets and liabilities.

Duration gap model

Duration, a concept first introduced by Frederick R. Macaulay, has recently been used in the gap literature to measure interest rate risk resulting from the effect of changes in interest rates on present values of cash flows and periodic principal payments of assets and liabilities. Duration is defined as the period of time that elapses before a stream of payments generates one-half of its present value.

Conceptually, duration is computed by weighting the present value of each future cash flow by the number of periods until receipt of payment and then dividing by the current price of the security, or

$$D = \frac{\sum_{t=1}^{N} t\, PV(F_t)}{\sum_{t=1}^{N} PV(F_t)} \qquad (1)$$

where D is duration, t is length of time (number of months, years, etc.) to the date of payment, $PV(F_t)$ represents the present value of payment (F) made at t, or $\frac{F_t}{(1+i)^t}$; i represents the appropriate discount rate, and $\sum_{t=1}^{N}$ is the summation from the first to the last payment (N).

Duration is an important measure of the average life of a security because it recognizes that not all the cash flow from a typical security occurs at its maturity. Duration of a stream of positive payments is always less than the time until the last payment or maturity, unless the security is a zero-coupon issue, in which case duration is equal to maturity. Duration expresses also the elasticity of a security's price relative to changes in the interest rate and measures a security's responsiveness to changes in market conditions.

Consider the extreme case of two banks, each holding loans with ten-year terms to maturity and with identical yields to maturity. Bank A loans make no interest payments during the term of the contract and return their face value at the end of the ten-year period. Bank B loans make 6 percent interest payments per year for each of the ten years. Further, assume that the two banks purchased the loans during a period when the yield curve was rising and the loans are funded with 7-1/2 year zero-coupon deposits. Thus, the interest rate on the financing is lower than the interest rate on the loans. A summary of these conditions and an analysis of the banks' exposure to interest rate risk are presented in Table 2.

Bank A is more exposed to interest rate risk than Bank B. The average term-to-maturity per dollar of payment stream for the interest-payment loan is approximately equal to that for the deposit. That is, the duration or the "true" term to maturity of Bank B's interest-payment loan is less than 10 years because the bank is getting its funds back faster with the interest-payment loan. Fisher and Weil estimate the duration of the 6 percent loan to be 7.45 years.[6] Since the duration equals maturity for zero-coupon instruments, the duration of 7.50 years for Bank B's deposit is approximately equal to the duration of the loan so that the bank is hedged against unexpected changes in interest rates. On the other hand, the term to maturity and duration are ten years for Bank A's noninterest-payment loan. As a result, Bank A is exposed to gains or losses from unexpected changes in interest rates because the duration of its assets is greater than the duration of its liabilities.

Banks, then, can hedge against uncertain fluctuations in the prices and yields of financial instruments by managing their loans and investments so that the duration composition of their asset portfolio matches the duration composition of their liabilities. Because of the typically short duration of banks' liabilities and the traditional emphasis on liquidity, they often prefer to hold short-duration to medium-duration assets.

If a bank accepts a liability, say, a deposit of short duration, it can offset that liability by lending for the same duration. In theory, cash flows from the asset can be used to pay off the debt coming due at the same time. The bank is, presumably, content to make its profit on the spread between the interest rate paid on the liability and the rate charged on the loan.

To the extent, however, that banks try to match the duration of an asset with the duration of a liability, they may give up opportunities for profits because asset duration does not fit into the duration structure of the existing portfolio. Although the duration of the loan may initially be equal to that of the liability, it may not remain so over the life of the loan. As the loan ages, its duration may change at a different rate than that of the liability funding it. So the bank will be exposed to interest rate risk.

Furthermore, duration will be accurate only if the yield curve is presumed to shift in a parallel fashion—i.e., where the slope of the curve remains flat. The assumption of a stable yield and slope is unrealistic since normal interest rate movements involve greater fluctuations in short-term than in longer-term interest rates. Despite these shortcomings, the application of duration analysis to gap management helps improve bank understanding of interest rate risk.

Table 2
Analysis of bank exposure to interest rate risk

Bank A

Assets	Liabilities
Duration of the ten-year maturity loan is ten years since it is a zero-coupon instrument.	Duration of the 7.50-year zero-coupon deposit is 7.50 years.

Because the duration of its assets is greater than that of its liabilities, Bank A is exposed to gains or losses from unexpected changes in interest rates. That is, when interest rates move, capital value of the loan will move more than that of the deposit.

Bank B

Assets	Liabilities
Duration of the ten-year 6 percent coupon loan is 7.45 years.	Duration of the 7.50-year zero-coupon deposit is 7.50 years.

Since the duration of the loan is approximately equal to the duration of the deposit, Bank B is protected against unexpected movements in interest rates.

In a typical gap management process, the bank attempts to protect net interest income against unexpected changes in interest rates over some gapping period. One year is usually chosen for this gapping period. Expected net interest income over the gapping period can be expressed as

$$\begin{aligned} NII = {} & RSA[(1 + Y_{rsa})^{T_{rsa}}(1 + K_{rsa})^{(1-T_{rsa})} - 1] \\ & - RSL[(1 + Y_{rsl})^{T_{rsl}}(1 + K_{rsl})^{(1-T_{rsl})} - 1] \end{aligned} \quad (2)$$

where $T_{rsa}(T_{rsl})$ is the length of time (fraction of a year) to the date of payment of the rate-sensitive asset (liability); RSA (RSL) is the rate-sensitive asset (liability) book value at the beginning of the year of a single cash inflow (outflow) that will occur at time $T_{rsa}(T_{rsl})$; $Y_{rsa}(Y_{rsl})$ is the rate-sensitive asset (liability) contractual interest rate; and $K_{rsa}(K_{rsl})$ is the rate-sensitive asset (liability) expected interest rate upon any repricing during the gapping period.

It can be inferred from equation (2) that net interest income will be protected against unexpected changes in interest rates provided that the weighted market value of the rate-sensitive asset equals the weighted market value of the rate-sensitive liability where the weights are equal to the fraction of the year from repricing to the end of the a year.[7] Since both the asset and liability are single-payment instruments, duration is equal to maturity expressed as fractions of a year. The duration of the rate-sensitive asset, D_{rsa}, is T_{rsa} and that of the rate-sensitive liability, D_{rsl}, is T_{rsl}.

The duration gap (DG) that measures the exposure of net interest income to unexpected changes in interest rates can be defined most simply as the difference between the present value of rate-sensitive assets times one minus their duration and the present value of rate-sensitive liabilities times one minus their duration[8], or

$$\begin{aligned} DG = {} & MVRSA\,(1 - D_{rsa}) \\ & - MVRSL(1 - D_{rsl}) \end{aligned} \quad (3)$$

where MVRSA and MVRSL are the present values of rate-sensitive assets and liabilities, respectively.

The sign of DG indicates the type of rate risk to which the bank is currently exposed. The larger DG is in absolute value, the greater is the risk. If the calculation of DG yields a positive number, then the bank is asset-sensitive and exposed to falling interest rates. If the calculation yields a negative number, then the bank is liability-sensitive and exposed to rising interest rates. The duration gap thus defined yields a single-valued risk index that is not only convenient but at least as accurate an indicator of risk as the risk level derived from the maturity bucket approach.

Financial futures reduce bank exposure

Financial futures markets give banks a chance to hedge exposed asset and liability positions. The primary function of futures markets is to transfer the risk of commodity price changes to speculators who are willing to take the risks. Financial futures provide protection against losses from unexpected adverse price changes by enabling participants to lock into a future price, currently quoted in the futures market.

A futures contract is a standardized contract which establishes, in advance, the purchase (and sale) price of a commodity for delivery and settlement at a fixed future time. The futures price embodies the market's expectations of the spot price of the item that will prevail at the time of delivery.[9]

Hedging involves taking a position in the futures market that is equal and opposite to a current or a planned future position in the spot or cash market. Therefore, regardless of the movement in prices, losses in one market will be offset by gains in the other. A successful hedge requires that cash market prices and futures market prices move in the same direction. The difference between the prices in the two markets is called the basis.

The hedge would be perfect if the basis did not change—that is, if the futures and cash prices moved in the same direction by the same amount. In real life, the basis rarely remains constant.[10] Hedgers watch for changes in basis risk, that is, in the relationship between futures and cash prices that could expose them to a loss or gain.

A bank can hedge the interest rate risk caused by the mismatch in the duration of the firm's assets and liabilities. When a negative duration gap exists, a normal bank response would be to extend the duration of liabilities or reduce the duration of the assets. But alternatively, financial futures could be sold to hedge this exposure. When a positive duration gap exists, a normal bank response would be to extend the duration of the assets or reduce the duration of the liabilities. But a banker also can hedge this asset-sensitivity by buying financial futures.

Consider the case of a bank whose net asset and liability positions are shown in Table 3. It has initially extended loans with face values of $500, $600, $1000, and $1400 to be repaid in a single payment at the end of 90 days, 180 days, 270 days, and 360 days, respectively. For simplicity, loans that mature at the end of 90 days, 180 days, 270 days, and 360 days are assumed to be rolled over for 360 days, 270 days, 180 days, and 90 days, respectively. The interest rate for any loan account is 12 percent.[11] The present value of these loans, and, therefore the total value of the loan portfolio, is $3,221.50 (=$500 / $(1.12)^{.25}$+ $600 / $(1.12)^{.50}$+ $1,000 / $(1.12)^{.75}$+ $1400 / (1.12)). To finance the loan portfolio, the bank borrows $3,221.50 in 90 day large certificates of deposits (CDs) at 10 percent interest. The two percentage-point spread is the return earned by the bank for employing its specialized capital in intermediating between borrowers and lenders. This will be the spread bank funds management is content to make over the planning period.

Table 3
Interest-sensitive assets and liabilities

Days	Assets	Liabilities
90	$ 500	$3,299.18
180	600	
270	1,000	
360	1,400	

The amount that the bank will owe in 90 days is $3299.18 (= $3,221.50$(1.10)^{.25}$), which it plans to pay by borrowing this amount for another 90 days. The bank anticipates being able to roll the large CDs over every 90 days at the same interest rate.

A summary of the present value of the asset and liability positions and the corresponding net interest income in each of the 90-day periods is presented in Table 4. As that table reveals, the net interest income on the initial investment of $3,221.50 yields a return of 2 percent ($64.63 / $3221.50).

In this example, the bank is subject to considerable interest rate risk because its fixed-rate loans mature at various times during the year while all of its deposit liabilities must be rolled over every 90 days. The duration of the large CDs is .25 years—the duration of a single payment is always the time to the payment date. The duration of the loan portfolio is .73 years (.25($486.03 / $3,221.50) + .50($566.95)/ $3,221.50) + .75($918.52 / $3,221.50) +

(\$1,250 / \$3,221.50)). The duration gap (DG) is negative and equals −\$1,514 (\$3,221.50 (1 −.73)−\$3,221.50 (1−.25)).[12] As a practical matter, the assets' longer duration implies that a given change in interest rates will change the present value of the assets more than it will affect the present value of the liabilities. The difference, of course, will change the value of the bank's equity. By appropriately structuring a hedge, the bank can effectively insure that net interest income will turn out to be as expected—yielding the 2 percent return.

The financial futures market can be used in at least two ways to remove this duration imbalance: 1) to shorten the duration of the assets to .25 years, or 2) to lengthen the duration of the liabilities to .73 years. Since this bank is net long, i.e., the duration of its assets is longer than the duration of its liabilities, the appropriate futures positions for a hedge will always be short; i.e., it will involve the sale of futures contracts. Suppose, to hedge its exposure to interest rate risk, the bank decides to form a "loan-with-futures" portfolio consisting of both cash loans and futures contracts. The duration of a portfolio containing cash loans and futures contracts is given most simply by[13]

$$D_p = D_{rsa} + D_f \frac{N_f FP}{V_{rsa}} \qquad (4)$$

where D_p is the duration of the entire portfolio; D_{rsa} is the duration of the cash loan portfolio; D_d is the duration of the deliverable securities involved in the hypothetical futures contract from the delivery date; V_{rsa} is the market value of the cash loan portfolio; N_f is the number of futures contracts, and FP is the futures price.

Table 4
Current value of assets and liabilities

Days	Assets	Liability	Net interest income
0	\$3,221.50	\$3,221.50	\$ 0.00
90	3,314.08	3,299.18	14.90
180	3,409.31	3,378.74	30.57
270	3,507.28	3,460.21	47.07
360	3,608.08	3,543.65	64.43

Return on assets = \$64.43/\$3,221.50 = 2.0 percent

Table 5
Portfolio characteristics for the duration analysis

D_p	=	.25 years
D_{rsa}	=	.73 years
D_f	=	.25 years
FP	=	\$97.21
V_{rsa}	=	\$3,221.50

Since the goal is to shorten the asset duration to .25 years, it must be that D_p = .25 years. Table 5 summarizes the relevant data. The price of each future contract is \$100 / $(1.12)^{.25}$ = 97.21. These (hypothetical) contracts call for delivery of \$100 face value of Treasury bills having 90 days remaining until maturity. Since Treasury bills are pure discount instruments, their duration will always be equal to the number of years to maturity, which is 90 days or .25 years.[14]

Solving the above equation for the number of futures contracts yields −64, which indicates that the number of Treasury bills futures contracts to sell short at the beginning of the planning period is 64. Because no cash changes hands at the time the futures contracts are originated and no deliveries are made, the futures contracts per se do not change the current cash value of the portfolio, which remains \$3,221.50.[15] However, as time passes and interest rates change, the futures contracts must be marked to market and any changes in the price settled in cash on the day they occur. Thus, changes in the value of the futures contracts change the cash value of the portfolio.

Suppose the bank sells 64 (hypothetical) 90-day Treasury bills futures contracts at a price of 97.21 to hedge its net interest rate exposure. Now assume that interest rates rise unexpectedly by 200 basis points immediately following this transaction and remain 200 basis points higher indefinitely.[16] Assume also that all cash flow receipts during the 360-day planning period can be reinvested at 14 percent.[17] Table 6 presents the effect of the interest rate shift on asset and liability values, the futures contracts, and the asset and liability values at the end of the planning period (360 days). Table 7 presents the same result without financial futures. As Table 6 reveals, the bank was able to earn 14 percent on the asset port-

Table 6
Effects of a 200-basis point increase in yields on realized interest rates spread (with futures)

	Assets	Liabilities
Original portfolio value	$3,221.50	$3,221.50
New portfolio value	3,180.31	3,207.02
Gain/loss on futures	27.52	0.00
Total portfolio change	(13.67)	(14.48)
Beginning portfolio value	3,207.83	3,207.02
Value of all accounts at day = 360	3,656.92	3,591.86
Annualized yield spread over 360 days	$\frac{\$3,656.92-\$3,591.86}{\$3,221.50} = \frac{\$65.06}{\$3,221.50} = 2.0\%$	

folio and paid 12 percent on its large CDs. The unexpected increase in interest rates causes the present value of the loans to fall more ($41.19) than the present value of the liabilities ($14.48). By itself, this would cause a reduction in the bank's equity and in the spread between the rate earned on the loan portfolio and the rate paid on the large CDs (see Table 7). At the same time, however, the increase in interest rates generates a gain of $27.52 from the futures contracts. Other things the same, this causes equity to rise, and allows the bank to maintain its 2 percent spread between the rate earned on assets and the rate paid on large CDs. The effects of a 200-basis-point decline in yields on realized interest rate spread are summarized in Table 8.[18]

Thus the use of financial futures enables the bank to eliminate its exposure to interest rate risk. The formulation of a bank futures position in light of its entire mix of assets and liabilities helps to balance the interest sensitivity of duration-mismatched assets and liabilities. These macro financial futures hedges are an effective means for banks to reduce the variability of net interest margin and improve the stability of bank profits.

While macro hedges are important gap management tools, they must be used with a great deal of care and attention. Due to the nature of banks' assets and liabilities, gap positions can change rapidly. Therefore, the size of the interest-sensitive gap being hedged may also vary significantly from day to day. Because of this, when a macro hedge is employed, it must be monitored continuously and sometimes modified, if a target gap or interest sensitivity is to be maintained. The value of the futures contracts employed in macro hedges is also marked to market and the associated income or expense shown on the income statement in each reporting period.

Table 7
Effects of a 200-basis point increase in yields on realized interest rates spread (without futures)

	Assets	Liabilities
Original portfolio value	$3,221.50	$3,221.50
New portfolio value	3,180.31	3,207.02
Total portfolio change	(41.19)	(14.48)
Beginning portfolio value	3,180.31	3,207.02
Value of all accounts at day = 360	3,625.55	3,591.86
Annualized yield spread over 360 days	$\frac{\$3,625.55-\$3,591.86}{\$3,221.50} = \frac{\$33.71}{\$3,221.50} = 1.05\%$	

Table 8
Effects of a 200-basis point decrease in yields on realized interest rates spread (with futures)

	Assets	Liabilities
Original portfolio value	$3,221.50	$3,221.50
New portfolio value	3,264.05	3,236.31
Gain/loss on futures	(28.16)	0.00
Total portfolio change	(14.39)	(14.81)
Beginning portfolio value	3,235.89	3,236.31
Value of all accounts at day = 360	3,559.48	3,495.21
Annualized yield spread over 360 days	$\frac{\$3,559.48-\$3,495.21}{\$3,221.50} = \frac{\$64.07}{\$3,221.50} = 2.0\%$	

Accounting rules and futures contracts

Current accounting procedures for futures contracts are set out in a uniform policy on bank contract activity issued by the Federal Reserve Board, the Federal Deposit Insurance Corporation, and the Comptroller of the Currency on November 15, 1979, revised March 12, 1980. Federal regulations give banks the option of carrying futures contracts on a mark-to-market or lower-of-cost-or-market basis. Other rules require all open contract positions be reviewed at least monthly, at which time market values are determined. Futures contracts are valued on either the market or lower-of-cost and market method, at the option of the bank, except that the accounting for trading account contracts and cash positions should be consistent. Underlying securities commitments relating to open futures contracts are not reported on the balance sheet; the only entries are for margin deposits, unrealized losses and, in certain instances, unrealized gains related to the contracts. In addition, banks must maintain general ledger memorandum accounts or commitment registers to identify and control all commitments to make or take delivery of securities. Following monthly contract valuation, unrealized losses would be recognized as a current expense item, and banks that value contracts on a market basis would also recognize unrealized gains as current income. Acquisition of securities under futures contracts are recorded on a basis consistent with that applied to the contracts, either market or lower-of-cost-or-market.

The Financial Accounting Standards Board (FASB), in its ruling effective December 31, 1984, introduced new guidelines for futures contracts. The new rules allow firms to use hedge accounting for future transactions.* In hedge accounting, a futures position is defined as a hedging transaction if it can be linked directly with an underlying asset or liability and if the price of the futures contracts is highly correlated with the price of the underlying cash position. If these conditions are met, and if the underlying cash position is not carried at market, futures gains or losses can be *deferred* until the position is closed out. The gains or losses can then become part of the accounting basis of the underlying cash position, to be *amortized* over the remaining life of the asset or liability, and therefore taken into income gradually.

The FASB standards require that banks and other firms formulate their hedged positions in light of their entire mix of assets and liabilities so that macro interest rate exposure is reduced by micro hedges. By insisting that all futures hedges be linked to an identifiable instrument "or group of instruments, such as loans that have similar terms" to qualify for hedge accounting, the FASB is encouraging banks to analyze thoroughly their overall exposure to interest rate risk as well as the components that make up that risk. The FASB standards, however, do not allow hedge accounting for the macro hedging of an overall gap on a bank's balance sheet that cannot be identified with a specific item.

The FASB statements call for the classification of deferred gains and losses as an adjustment to the carrying amount of the hedged items. Bankers should be aware that if such an adjustment is made to appropriate general ledger accounts, the computation of average daily balances for the purpose of determining average yields will be distorted unless special provisions are made. In addition, other FASB statements require that the amortization of the deferred futures gains or losses to interest income or expense start no later than the date that a particular contract is closed out. Profits or losses from the futures position must be taken into the income stream over that time period when the bank expected an adverse impact from interest rates.

*Bank regulators reactions to FASB statement, if any, are yet to be determined. As a result, banks futures transactions are still governed by federal banking regulations.

In managing its asset and liability positions in the financial futures markets, a bank is limited by federal guidelines to transactions related to the bank's business needs and its capacity to meet its obligations. By taking a position in the futures market, a bank should reduce its exposure to loss through interest rate changes affecting its investment portfolio.

Conclusions

The recent increases and broad fluctuations in interest rates have led many banks to a better understanding of interest rate risk and how to manage it. The use of gap management can be particularly important to bank funds management as a technique to manage interest rate risk. A bank can reduce the risk of loss due to unfavorable changes in interest rates by hedging its duration gap. The use of financial futures and the duration approach to gap management enables the bank to maintain a predetermined spread and to lock in an anticipated rate of return.

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[1] See Sanford Rose, "Dark Days Ahead for Banks," *Fortune* (June 30, 1980), pp. 86-90.

[2] The length of time over which net interest margin is to be managed.

[3] See Paul L. Kasriel, "Interest Rate Volatility in 1980." *Economic Perspectives,* Federal Reserve Bank of Chicago (January/February 1981), pp. 8-17.

[4] These numbers were taken from James Kurt Dew, "The Effective Gap II: Two Ways to Measure Interest Rates Risk," *American Banker* (September 18, 1981), p. 4.

[5] The historical volatility of an entire spectrum of assets and liabilities relative to a benchmark financial instrument can be calculated using regression analysis. Dew (1981) shows how such calculations are made.

[6] This means that when interest rates change, interest income changes more than interest expense.

[7] See Lawrence Fisher and R. Weil, "Coping with the Risk of Interest Rate Fluctuations: Returns to Bondholders from Naive and Optimal Strategies." *Journal of Business* (October 1971).

[8] The market value of a contractual flow of $RSA(1 + Y_{rsa})^{T_{rsa}}$ dollars T_{rsa} periods from now is $RSA(1 + Y_{rsa})^{T_{rsa}}/(1 + K_{rsa})^{T_{rsa}}$. Similarly, the market value of a contractual flow of $RSL(1 + Y_{rsl})^{T_{rsl}}$ dollars T_{rsl} periods from now is $RSL(1 + Y_{rsl})^{T_{rsl}}/(1 + K_{rsl})^{T_{rsl}}$. It is assumed that all asset and liability interest rates are affected equally when any movement in rates occur.

[9] See Alden Toevs, "Gap Management: Managing Interest Rate Risk in Banks and Thrifts," *Economic Review,* Federal Reserve Bank of San Francisco (Spring 1983), pp. 20-35.

[10] For a discussion of this point see Albert E. Burger, Richard W. Lang, and Robert H. Rasche, "The Treasury Bill Futures Market and Market Expectations of Interest Rates," *Review,* Federal Reserve Bank of St. Louis (June 1977), pp. 2-9.

[11] As a futures contract moves toward maturity, the futures price and cash price tend to converge. Therefore, basis narrows predictably over time.

[12] A flat yield curve is assumed for ease of exposition.

[13] See Alden Toevs, *op. cit.*

[14] For further details, see G. O. Bierwag, George G. Kaufman and Alden Toevs, "Duration: Its Development and Use in Bond Portfolio Management," *Financial Analysts Journal,* (July-August 1983), pp. 15-35 and Gerald D. Gay and Robert W. Kolb, "Interest Rate Futures as a Tool for Immunization," *The Journal of Portfolio Management* (Fall 1983), pp. 65-70.

[15] G. O. Bierwag, George G. Kaufman, and Alden Toevs, *op. cit.*

[16] A cash or liquid security margin requirement is generally maintained.

[17] Zero basis risk is assumed.

[18] Actually the reinvestment rate is not certain. However, the assumption of a 14 percent reinvestment rate simplifies the example with no loss in generality.

[19] It is interesting to note that if a bank were to engage in the type of hedge in these examples when it was exposed to loss from increases in interest rates, it would not only limit the potential rise in bank costs from unfavorable shifts in interest rates but agree implicitly to limit the potential of its lower costs from favorable shifts in interest rates. The bank must be content with the usual profits from lending.