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Volatile Mortgage Rates— A New Fact of Life?

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New Methods for Savings and Loans To Hedge Interest Rate Risk 3

By Charles S. Morris and Thomas J. Merfeld

Increased interest rate volatility in recent years has led to a greater volatility in profits at savings and loan associations. To help stabilize their profits, some S&L's are implementing interest rate hedging programs. These programs use financial instruments such as interest rate swaps, financial futures and options on financial futures. Because hedging programs introduce their own risks, S&L's should thoroughly examine all aspects of the programs before employing them.

Volatile Mortgage Rates— A New Fact of Life? 16

By Howard L. Roth

Mortgage interest rates now move much more closely with capital market rates than in the past. This important development stems in part from the removal of mortgage usury ceilings. But the main reason for the closer relationship of mortgage rates to capital market rates is growth of the secondary mortgage market.

New Methods for Savings and Loans To Hedge Interest Rate Risk

By Charles S. Morris and Thomas J. Merfeld

The savings and loan industry has experienced severe problems in recent years. Profit rates have fallen substantially from the high levels of the late 1970s and failures have risen. Profits also have been highly variable in recent years. While the variability in profit rates can be attributed to many factors, one of the most important factors has been the variability in interest rates. For example, interest rates rose sharply in the early 1980s and then declined, while savings and loan profit rates fell sharply and then rose. Changes in interest rates had such strong effects on the profitability of savings and loans because their portfolios, which consisted primarily of long-term fixed-rate mortgages funded by short-term liabilities, were exposed to a high degree of interest rate risk.

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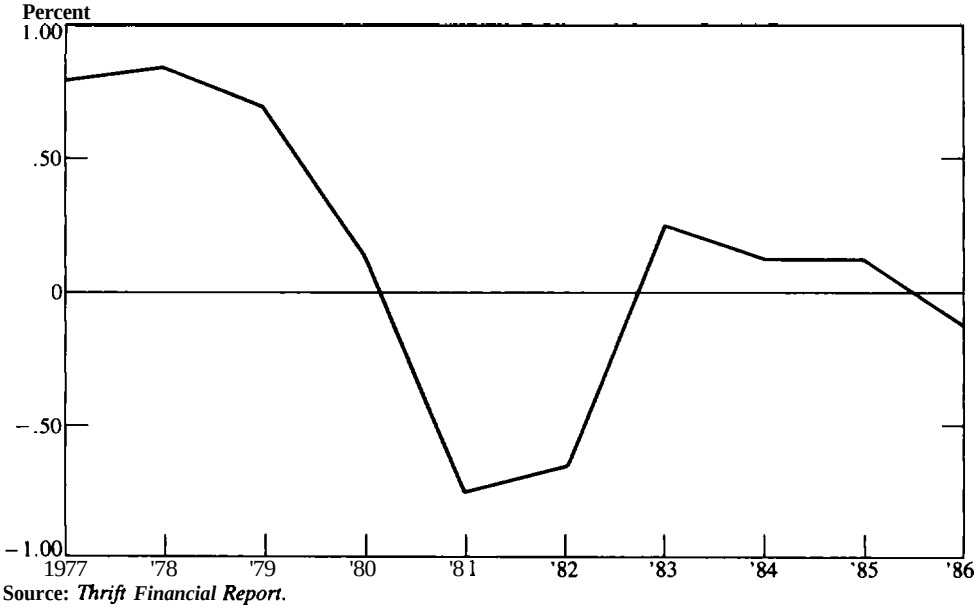
As interest rates rose and profits declined, many savings and loans reduced their exposure to changes in interest rates by restructuring their asset and liability portfolios. For example, some savings and loans reduced the share of their assets in long-term fixed-rate mortgages and increased the share of their assets with variable rates, such as adjustable-rate mortgages, or with short maturities, such as commercial loans. And some savings and loans reduced their reliance on short-term deposits by switching to longer-term sources of funds. Although these balance sheet adjustments did reduce the exposure of the savings and loan industry to changes in interest rates, the industry is still substantially exposed to future swings in interest rates.

Some savings and loans have further reduced their interest rate risk by using new financial instruments to hedge against changes in interest rates. This article explains how savings and loans have used three of these hedging instruments—interest rate swaps, financial futures, and options on financial futures—to reduce interest rate risk. While providing benefits, hedging strategies are

CHART 1
Return on assets at FSLIC-insured savings and loans



Source: *Thrift Financial Report.*

complex and can expose savings and loans to new risks. As a result, savings and loans must thoroughly examine all aspects of hedging techniques before deciding to implement an interest rate risk hedging program.

The first section of this article documents the variability of profits at U.S. savings and loans over the past several years and shows that there is a negative relationship between interest rates and savings and loan profit rates. The second section defines interest rate risk, shows why interest rate risk is different for savings and loans than for other types of financial institutions, and presents evidence of the current exposure of the U.S. savings and loan industry to future movements in interest rates. The third section defines hedging and discusses how interest rate swaps, financial futures, and options on financial futures can be used to hedge interest rate risk. The final section discusses the benefits and costs of interest rate risk hedging.

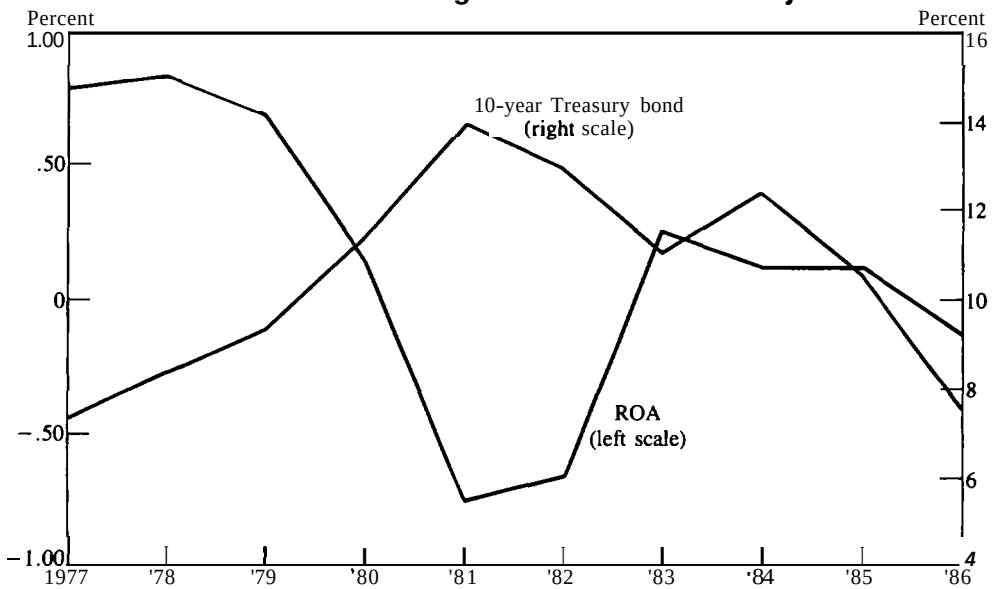
Variability of S&L profits

The profitability of U.S. savings and loans (S&L's) has been extremely variable in recent years. Chart 1 shows the variability of S&L profit rates since 1977, as measured by return on assets (ROA). After reaching a high of about 0.8 percent in 1978, the average ROA of S&L's fell more than 150 basis points to about -0.7 percent in 1981. Thus, within a span of three short years, the U.S. S&L industry went from being an industry with high profits to one with high losses. Profits did return to the industry in 1983, although they were well below the levels of the late 1970s. Since 1983, profit rates have continued to fall, and in 1986 the industry once again had net losses.

Although S&L profits can vary for several reasons, one reason often cited for the high variability in profits in recent years has been interest rate variability. Like S&L profits, interest rates have been highly variable in recent years, and

CHART 2

Return on assets at FSLIC-insured savings and loans and Treasury bond rate



Source: *Thrift Financial Report* and Board of Governors of the Federal Reserve System.

interest rates and S&L profits have tended to move in opposite directions for most of the period from **1977** to **1986.** Chart **2** shows the relationship between the 10-year Treasury bond rate and the ROA of the **S&L** industry from **1977** to **1986.** For example, from **1977** to **1981** interest rates rose **6.5** percentage points and S&L profits fell **1.5** percentage points, while from **1981** to **1983** interest rates fell **2.8** percentage points and **S&L** profits rose 1.0 percentage points.[1]

[1] The correlation **coefficient** between the **S&L** industry's ROA and the 10-year Treasury note rate over the 1977-86 period is −0.75. and it is statistically significant at the 2 percent level. A close examination of Chan 2 suggests that the correlation has weakened in the last two years. For example, in 1986, both interest rates and profit rates fell. One explanation for the weaker correlation is that the benefits of falling interest rates on industry profits have been masked by large losses at some **S&L's**. For example, losses have risen and profits have fallen at some **S&L's** in the last two years because of rising losses on loans and real estate dependent on depressed sectors of the economy, such as commercial real estate, agriculture, and energy. Another reason **often** cited for declining profits in the last two years is **poor** management at some **S&L's**.

Interest rate risk at savings and loans

The negative relationship between S&L profits and interest rates suggests that **S&L's** have been highly exposed to interest rate risk. The nature of interest rate risk at **S&L's,** however, is different from that at other types of financial institutions because of the prepayment option of fixed-rate mortgages—assets which are much more sensitive to changes in interest rates than any other asset held by the typical **S&L.** Thus, in order to understand how **S&L's** can hedge interest rate risk, it is first necessary to understand the nature of interest rate risk of fixed-rate mortgages.

The nature of S&L interest rate risk

Interest rate risk is the risk that changes in interest rates will change the market value of an institution's net worth. The market value of an

institution's net worth is the difference between the market value of its assets and the market value of its liabilities. The market value of an asset or liability is the present value of the stream of payments provided by the asset or liability. Present value is:

$$PV = \frac{C_1}{1+R} + \frac{C_2}{(1+R)^2} + \frac{C_3}{(1+R)^3} + \ldots + \frac{C_T}{(1+R)^T} + \frac{P_T}{(1+R)^T}$$

where C_i is the periodic coupon payment made at the end of period i, P is the principal payment made at the end of the last period, R is the market rate of interest, and T is the number of periodic payments.[2] In this formula, for given principal and coupon payments, the market value of the asset or liability varies inversely with changes in the rate of interest.

Generally speaking, the interest rate risk of an institution depends on the relative interest rate sensitivity of the market value of its assets and liabilities. The interest rate risk of a typical S&L, however, depends primarily on the interest rate risk of its asset portfolio because the market value of its liabilities is not highly sensitive to changes in interest rates. When interest rates change, the market value of assets and liabilities with long maturities changes more than the market value of assets and liabilities with short maturities.[3] The value of a typical S&L's liabilities is not very sensitive to changes in interest rates because most of its liabilities are short term. On the other hand, most of a typical S&L's assets are long-term fixed-rate assets, and therefore their values are very sensitive to changes in interest rates. Because the value of fixed-rate mortgages is much more sensitive to changes in interest rates than any other asset held by the typical S&L, the interest rate risk of an S&L is best understood by understanding how changes in interest rates affect the value of fixed-rate mortgages.

Fixed-rate mortgages are different from most other securities because borrowers have the option of repaying the balance of the principal without penalty any time during the life of the mortgage. The payment stream specified in a typical fixed-rate mortgage contract is a constant monthly payment over the life of the mortgage. Borrowers usually exercise the 'option of prepaying their loans, however, so that the actual payment stream is usually a constant monthly payment for a period less than the life of the mortgage followed by a lump-sum payment of the remaining principal.

The actual payment stream of a fixed-rate mortgage looks like that of a typical fixed-income security such as a Treasury bond.[4] The interest rate risk of fixed-rate mortgages, however, is more complicated than that of fixed-income securities such as Treasury bonds because prepayments, and therefore the length of the payment stream, are uncertain and change when interest rates change. The prepayment option makes it conceptually useful to separate the effect of interest rate movements on the market value of mortgages into two components: a fixed-income effect and a prepayment effect.

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2 For simplicity of exposition, expected future interest rates are assumed to equal the current interest rate in the present value formula. Otherwise, it would be necessary to put a period subscript on each interest rate in the formula.

3 For example. if the interest rate is 10 percent, the present value of a $100 10-year bond that pays a $10 coupon every year is $100, and the present value of a $100 I-year bond that pays a $10 coupon is $100. If the interest rate rises to 12 percent, the present value of the 10-year bond falls $11.30 to $88.70, while the present value of the I-year bond falls only $1.77 to $98.23.

4 For example, the monthly payment on a $100.000 30-year fixed-rate mortgage with a 10 percent annual rate of interest is $877.57. In terms of the present value formula, C equals $877.57 every period. P equals 0, R equals 10112. and T equals 360. If the mortgage was paid off after ten years. the remaining principal would be $90,938.35. Thus, the actual payment stream of the mortgage would not be the constant stream of payments of $877.57 a month for 30 years as specified by the contract. but, just like any other fixed-income security, a constant stream of $877.57 a month for ten years and a lump sum payment of $90,938.35 after ten years. Again in terms of the present value formula. C equals $877.57, P equals $90,938.35, and T equals 120.

The fixed-income effect is the effect of changes in interest rates on the value of a fixed-rate mortgage holding the length of the payment stream—that is prepayments—constant. In terms of the present value formula, the fixed-income effect is the effect of a change in R on the present value of a mortgage when C, P, and T do not change. Since the payment stream does not change and the interest rate is in the denominator of the present value formula, the fixed-income effect causes the market value of a mortgage to move in the opposite direction of a change in interest rates. When interest rates fall, the present value of the payment stream rises and thus the market value of the mortgage rises. When interest rates rise, the present value of the payment stream falls and the value of the mortgage falls. These are the same changes in value experienced by other fixed-income securities, such as Treasury bonds, when interest rates change.

Changes in interest rates have an additional effect on mortgage values—a prepayment effect—because prepayment rates change when interest rates change. One reason prepayment rates vary with interest rates is that home sales vary with interest rates. When interest rates fall, homeowners are more likely to move up the decision to buy a new home so that existing mortgages are paid off sooner than if interest rates had not declined. When interest rates rise, homeowners are more likely to postpone the purchase of a new home so that existing mortgages are paid off later than if interest rates had not risen. Another reason prepayment rates vary with interest rates is that homeowners can refinance their homes. Refinancing prepayments, however, occur only when interest rates fall, not when they rise. As a result, the prepayment effect is larger when interest rates fall than when they rise.

The prepayment effect modifies the fixed-income effect such that mortgages rise in value less than other fixed-income securities when interest rates fall, and mortgages fall in value more than other fixed-income securities when interest rates rise.[5] For example, when interest rates fall, the rate of prepayments increases and mortgages will be paid off sooner than if interest rates had not changed. Since the principal from mortgages is paid off at an earlier date than the principal from similar fixed-income securities that cannot be prepaid, the principal from mortgages has to be reinvested at the new and lower interest rate at an earlier date than the principal from fixed-income securities. As a result, the value of the mortgage does not increase as much as a fixed-income security that does not prepay, such as a Treasury security.

In contrast, when interest rates rise, the rate of prepayments decreases and mortgages will be paid off at a date later than if interest rates had not changed. In this case, the principal from mortgages is paid off at a later date than the principal from similar fixed-income securities that do not have a prepayment option. The principal from the mortgages, therefore, will not be reinvested at the new and higher interest rate until a later date than the principal from fixed-income securities. As a result, the value of the mortgage decreases more than a fixed-income security that does not prepay.[6]

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5 The discussion of the prepayment effect assumes that the current interest rate equals the mortgage coupon rate. If the current interest rate is greater than the mortgage coupon rate, mortgages would rise in value more than fixed-income securities when interest rates fall, and they would fall in value more than fixed-income securities when interest rates rise. If the current interest rate is less than the mortgage coupon rate, mortgages would rise in value less than fixed-income securities when interest rates fall. and they would fall in value less than fixed-income securities when interest rates rise.

6 In terms of the present value formula. the prepayment effect is the effect of a change in T on the present value of a mortgage *given* the change in R. The explanation of the prepayment effect is in terms of income flows rather than in terms of the effect of a change in T on the present value of a mortgage. Although the prepayment effect can be explained in terms of the effect of a change in T on present value, the discussion in this article is in terms of income flows because it is a more natural explanation of how changes in prepayment rates affect mortgage values.

The relative sizes of the prepayment and fixed-income effects depend on the size of the change in interest rates. The prepayment effect is relatively small for small changes in interest rates, say, plus-or-minus 100 to 150 basis points. One reason for this is that a small change in interest rates has only a small effect on home sales. Another reason is that refinancings will not increase much when interest rates fall if the decline in interest rates is not large enough to offset the refinancing fees. When the change in interest rates is large, however, the prepayment effect can be substantial, especially when interest rates fall. The prepayment effect is larger for a large decrease in interest rates than for an equally large increase in interest rates because refinancings rise sharply when interest rates fall by large amounts but do not change when interest rates rise by large amounts.[7]

The exposure of the S&L industry to interest rate risk

The S&L industry's balance sheet gives an idea of the industry's exposure to interest rate risk. Table 1 presents the S&L industry's balance sheet in 1981—the year that interest rates peaked—and Table 2 presents the industry's balance sheet in 1987.

Table 1 shows that the U.S. S&L industry was exposed to a great deal of interest rate risk in 1981. In 1981, 78 percent of the S&L industry's assets were mortgages. Data on the share of fixed-rate mortgages are not available. However, federally chartered S&L's were not allowed to make adjustable-rate mortgages until 1981 and only a few states allowed state-chartered S&L's to make adjustable-rate mortgages before 1981. Thus, most of those mortgage loans were fixed-rate mortgages—assets whose values are extremely sensitive to interest rate changes. The liabilities used to fund the assets were primarily short term. Deposits and savings accounts were 78 percent of assets, a large share of which were probably passbook accounts, and borrowed

TABLE 1
Balance sheet of FSLIC-insured savings and loans, December 1981

		Percent of assets
Assets		
Mortgage loans*		78
Nonmortgage loans		3
Liquidity portfolio		10
Fixed assets		2
Other assets		8
Total		100
Liabilities		
Deposits and savings accounts		78
Borrowed money		14
Due in 1 year or less	8	
Due in 1 year or more†	6	
Other liabilities		4
Net worth		5
Total		100

*Includes pass-through securities
†Includes mortgages on association premises, subordinated debentures, and mortgage-backed bond issues

Source: *Quarterly Thrift Financial Aggregates*. Federal Home Loan Bank Board

[7] In fact, for large changes in interest rates. the prepayment effect can overwhelm the fixed-income effect and cause the value of a mortgage to move in the same direction as interest rates. For example, from December 31, 1985 to June 30, 1986, the yield on 10-year Treasury bonds fell from 9.01 percent to 7.34 percent and the price of the 12-percent-coupon Government National Mortgage Association mortgage pass-through securities (GNMA 12s) fell from 107.13 to 105.75.

money due in one year or less was 8 percent of assets. Since the value of short-term liabilities is relatively insensitive to changes in interest rates, it should be of no surprise that S&L profits declined as interest rates rose in 1980 and 1981.

Comparing Table 2 with Table 1 clearly shows that many S&L's have restructured their balance sheets in recent years and reduced interest rate risk. They have reduced the sensitivity of their net worth to changes in interest rates by making their asset portfolios less sensitive to changes in interest rates and their liability portfolios more sensitive. For example, the sensitivity of assets to changes in interest rates has fallen as the share of assets in adjustable-rate mortgages has increased from essentially nothing in 1981 to 31 percent in 1987. And many S&L's have chosen to rely more heavily on longer-term borrowings, such as Federal Home Loan Bank advances, which have increased the sensitivity of liabilities to changes in interest rates.[8] As a result of these portfolio changes, future increases in interest rates will be less detrimental to the net worth of S&L's than in the past because the value of assets will fall by less and the value of liabilities will fall by more than they would have in previous years.[9]

Although the S&L industry has reduced its exposure to changes in interest rates by restructuring its balance sheet, Table 2 also suggests that the industry is still exposed to substantial interest rate risk. In 1987, fixed-rate mortgages were 39 percent of assets and still the largest category of industry assets. On the other hand, variable-rate deposits, deposits with maturities of less than three years, and other borrowed money were still the largest sources of funds, amounting to 77 percent of assets. Moreover, although longer-term sources of funds were 23 percent of assets, the maturities of these funds are generally much

TABLE 2
Balance sheet of FSLIC-insured savings and loans, June 1987

		Percent of assets
Assets		
Mortgage loans*		69
Adjustable rate or balloon	31	
Fixed rate	39	
Nonmortgage loans		7
Liquidity portfolio		14
Fixed assets		1
Other assets		10
Total		100
Liabilities		
Deposits and savings accounts		75
NOW, MMDA, and passbook accounts	23	
Fixed-maturity (1 year or less)†	29	
Fixed-maturity (1 to 3 years)	15	
Fixed-maturity (over 3 years)	8	
Borrowed money		19
FHLB advances	9	
Other borrowed money	10	
Other liabilities		2
Net worth		4
Total		100

*Includes pass-through securities
†Includes fixed-maturity and variable-rate accounts

Source: *Quarterly Thrift Financial Aggregates*, Federal Home Loan Bank Board

8 Although the maturity distribution of Federal Home Loan Bank advances is not reported, most Federal Home Loan Bank advances have a maturity of more than one year. On the other hand, "other borrowed money," the other major category of borrowed money, is typically short term.

9 This implicitly assumes that restructuring the balance sheet does not affect any of the other risks to which S&L's are exposed, such as credit risk. The effect of restructuring the balance sheet on credit risk is discussed more fully below.

shorter than the expected lives of fixed-rate mortgages.

New methods for hedging interest rate risk

Not all S&L's have relied solely on balance sheet restructuring techniques to reduce interest rate risk. Some S&L's have further reduced their interest rate risk by using new financial instruments to hedge their net worth against changes in interest rates. Interest rate swaps, financial futures, and options on financial futures are three instruments that are widely available for hedging interest rate risk.

What is interest rate risk hedging?

In many ways, interest rate risk hedging is like buying an insurance policy that protects net worth from changes in interest rates. In an insurance contract, if a covered event occurs—a car accident, a hospital stay, or the like—the insurer compensates the insured party. In the same way, if a change in interest rates causes the value of the S&L's net worth to change and if the appropriate hedge was chosen, the increase in the value of the hedging assets will compensate the S&L. But just as a policyholder must pay an initial premium for insurance, an S&L that hedges its net worth must pay for hedging assets.

More formally, hedging net worth against changes in interest rates is defined as taking a position in an asset—the hedging asset—such that the change in the value of the hedging asset due to a change in interest rates is equal and opposite to the change in the value of net worth due to the change in interest rates.[10] Hedging reduces the sensitivity of net worth to changes in interest rates—that is, it reduces interest rate risk—because the value of the hedging asset changes just enough to offset the change in the value of net worth. It is important to realize, however, that in reducing interest rate risk, hedging not only protects net worth from declining when interest rates rise, but it also prevents net worth from rising when interest rates fall. Thus, an important difference between hedging and standard insurance contracts is that standard insurance contracts do not require the insured party to forego unexpected gains.

The intuition behind interest rate risk hedging techniques is fairly simple. First, an S&L must estimate how much its net worth changes for a given change in interest rates at the current level of interest rates. Second, it must estimate how much the value of the hedging asset changes for a given change in interest rates at the current level of interest rates.[11] The S&L can then determine the position and the number of units of the hedging asset that it needs by setting the estimated change in the value of net worth equal to the estimated change in the value of the hedging asset times the number of units of the hedging asset.[12]

Although the intuition behind hedging techniques is fairly simple, the implementation is quite complicated. To begin with, just as many different

[10] Throughout the remainder of this article, what is meant by "a change in interest rates" is that all interest rates change by the same amount, that is, the change in the yield curve is parallel, and that the change is equal across sectors.

[11] The hedging process described in the text is known as "macro hedging" because the interest rate risk of the S&L's overall net worth is being hedged. For regulatory and accounting purposes. however, S&L's must "micro hedge." Micro hedging involves hedging specific assets and liabilities, as opposed to the S&L's overall net worth. Although S&L's must associate hedges with specific assets or liabilities, the discussion of hedging in the text is in terms of macro hedging because the relevant issue is the effect of a hedge on net worth.

[12] For example, if it is estimated that a 100-basis-point increase in interest rates will cause the value of an S&L to fall $1 million and the value of the hedging asset to fall $10,000, then the S&L could hedge its net worth by selling 100 units of the hedging asset.

forms of insurance can be purchased to cover a given contingency—such as term, whole, or universal life policies—S&L's can choose from a wide array of hedging assets. Hedges are generally formed using many of the available hedging assets, but the choice of which hedging assets to use is a very difficult problem. S&L's must try to choose the mix of those hedging assets that reduces interest rate risk at the lowest cost. The choice is complicated further because the best hedge for a small change in interest rates might not be the best hedge for a large change in interest rates. Thus, the hedge must be chosen such that it insulates the S&L from both small and large changes in interest rates. Finally, in a good hedging program, hedge positions must be reevaluated and changed frequently because changes in interest rates, the asset and liability mix, and maturity structure of the portfolio cause the interest rate sensitivity of net worth to change.

Interest rate risk hedging instruments

A number of hedging instruments have been developed in recent years. Interest rate swaps, financial futures, and options on financial futures are three widely available hedging instruments that S&L's can use to hedge interest rate risk. An important difference between these three instruments is their effectiveness in hedging the fixed-income component of interest rate risk and the prepayment component.

Interest rate swaps. An interest rate swap is a contract in which one party—the fixed-rate payer—agrees to make a sequence of level payments to another party—the floating-rate payer—in exchange for a sequence of payments that vary with prevailing interest rates. This contract can be thought of as the exchange—that is, the "swapping"—of interest payments on some underlying fixed-rate and floating-rate loans without an exchange of the principal. The typical maturity of a swap contract is three to ten years. Interest rate swaps are a particularly inexpensive means of hedging because the fees for arranging the swap and settling and guaranteeing the agreement are fairly small.[13]

Interest rate swaps are useful for hedging the interest rate risk of S&L's because swaps essentially allow S&L's to trade a variable-rate cost of funds for a fixed-rate cost of funds. S&L's lose when interest rates rise and gain when interest rates fall because their costs of funds rise and fall with interest rates but the receipts from fixed-rate mortgages do not change. An S&L can insulate itself from changes in interest rates by becoming the fixed-rate payer and floating-rate receiver in a swap. The S&L can use the receipts from its portfolio of fixed-rate mortgages to make the fixed-rate swap payments. Since the floating-rate swap receipts vary with interest rates, the swap receipts can be used to pay the S&L's variable-rate cost of funds. Thus, if interest rates change, the S&L's cost of funds is, in effect, fixed because its swap payment is fixed while changes in its variable-rate swap receipts would match changes in the costs of its liabilities.[14]

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13 For a more comprehensive discussion of interest rate swaps, see Ian G. Loeys, "Interest Rate Swaps: A New Tool for Managing Risk," *Business* Review. Federal Reserve Bank of Philadelphia, May/June 1985.

14 This discussion of how swaps can hedge interest rate risk is in terms of changes in income inflows meeting changes in interest outflows rather than in terms of the formal definition of a hedge given in the text—that is, changes in the value of the hedging asset offsetting changes in the value of net worth. The discussion in the text is in terms of income flows because it is a more natural explanation of how a swap insulates an institution from interest rate swings. There is, however, an equivalent explanation in terms of changes in asset values. In particular, suppose interest rates rise. An S&L's net worth would decline because the market value of its assets would fall while the market value of its liabilities would not change. But the market value of the swap rises because the S&L's variable-rate receipts rise while its payments remain the same. The rise in the swap value, therefore, offsets the fall in net worth. When interest rates fall, the market value of the S&L's net worth rises but is offset by a decline in the value of the swap.

Swaps are a good hedge for the fixed-income component of interest rate risk but not for the prepayment component. Swap contracts, as currently constituted, cannot be terminated when interest rates fall and the mortgages that the swaps are hedging prepay. If interest rates fall, an S&L that is the fixed-rate payer in a swap will find itself committed to making a sequence of level payments that exceed the return it can earn when it relends the prepaid mortgage principal. Since the change in the prepayment component is small for small changes in interest rates, swaps are a good instrument for hedging against small changes in interest rates. But for large changes in interest rates, the prepayment component is large. Thus, the existence of the prepayment component of interest rate risk means that S&L's cannot rely exclusively on swaps to hedge against interest rate risk.

Financial futures. Financial futures are contracts that promise the holder delivery of a specified quantity of a financial asset on a predetermined date in the future for a predetermined price. Financial futures are similar to futures contracts for other commodities such as wheat or hog bellies. The only difference is that a financial futures contract is based on a financial asset rather than a tangible commodity. There are a variety of financial futures trading on a number of different exchanges that S&L's can use to hedge against changes in interest rates. Most hedging by S&L's, however, is done using Treasury bond or Eurodollar futures.[15] The maturities of financial futures range from three months to two and a half years.[16] Like interest rate swaps, financial futures are a particularly inexpensive means of hedging. The initial downpayment (margin requirement) on a position is not only small but also earns the market rate of interest, and the fees for opening and closing a position are small.[17]

S&L's can use financial futures to hedge interest rate risk by taking a short position in—that is, by selling—financial futures. For example, suppose an S&L takes a short position in Treasury bond futures. When interest rates rise, the values of both Treasury bonds and mortgages fall. However, an S&L that is short Treasury bond futures benefits because the price of the Treasury bond that it has to purchase for delivery has fallen below the price at which it agreed to sell the bond. That is, the value of the S&L's short futures position has risen. This rise in the value of the S&L's short futures position offsets the decline in the value of its mortgage portfolio and net worth.

Like swaps, short positions in financial futures provide S&L's with an effective hedge against the fixed-income component of interest rate risk, but they cannot hedge accurately against the prepayment component. For example, because the prepayment option is present in mortgages but

15 For example. futures in Treasury bills, bank CD's, Eurodollars, and foreign exchange trade on the International Money Market exchange in Chicago, futures in Treasury bonds and notes trade on the Chicago Board of Trade exchange, futures in the S&P 500 and 100 indices trade on the Chicago Mercantile Exchange, and futures in the Value Line index trade on the Kansas City Board of Trade exchange.

16 Swaps are often thought to be better than financial futures for hedging fixed-rate mortgages against changes in interest rates because the length of the swap contract—typically three to ten years—is closer to the maturity of fixed-rate mortgages than is the length of the financial futures contract. According to this argument, since the average life of a 30-year fixed-rate mortgage is in the neighborhood of ten years, a single swap contract could hedge the mortgage whereas several futures contracts would be needed over the life of the mortgage. This reasoning does not necessarily hold, however, because in a good risk management program, hedge positions should be reevaluated and changed frequently.

17 For a more detailed discussion of financial futures, see Nancy H. Rothstein and James M. Little, *The Handbook of Financial Futures.* McGraw-Hill Book Company. New York. 1984.

not in Treasury securities, mortgages increase in value less than Treasury bonds in response to a decrease in interest rates. Conversely, mortgages decrease in value more than Treasury bonds in response to an increase in interest rates. For small changes in interest rates, this difference between mortgages and Treasury securities is negligible, but for large swings in interest rates, the difference can be substantial. Since a short position in Treasury bond futures hedges a Treasury bond portfolio exactly, it cannot be an accurate hedge for a mortgage portfolio in the face of a large change in interest rates. Thus, just as with swaps, S&L's cannot rely exclusively on financial futures to hedge against interest rate risk.

Options on financial futures. To hedge against large interest rate changes and to protect themselves from prepayment risk, S&L's can use options. There are two basic kinds of options: call options and put options. A call option is a contract that gives its owner the right, but not the obligation, to buy a fixed amount of a specified asset at a fixed price—the strike price—at any time on or before a given date—the expiration date. A put option is a contract that gives its owner the right to sell a fixed amount of a specified asset at a fixed price at any time on or before a given date. The maturities of options on financial futures range from three to nine months. S&L's use options in conjunction with swaps and financial futures to hedge interest rate risk because options can hedge the prepayment component of interest rate risk.[18]

Options are well suited to hedging the prepayment component of interest rate risk because the mortgage borrower's option to prepay when interest rates fall is in fact a call option.[19] Mortgage lenders have implicitly written call options to mortgage borrowers because the borrowers have the option to buy back—that is, prepay—their mortgages at par when interest rates fall. Since the prepayment effect is due to the implicit sale of a call option with each mortgage, mortgage lenders can offset the prepayment effect when interest rates fall by buying call options.[20] Call options on financial futures are the option mortgage lenders typically use to hedge against prepayment risk. For example, if interest rates fall by a large amount, the price of options on financial futures will rise by a large amount and offset the negative effect of rising prepayment rates on mortgage values. Calculating the precise number and kind of options to combine with the swaps and financial futures in the hedging portfolio is a complicated task, but it is possible to construct such a mix that practically eliminates an institution's interest rate risk.[21]

The benefits and costs of hedging

Although hedging is a very effective tool for managing interest rate risk at S&L's, only a few S&L's have instituted hedging programs. Whether an S&L's management chooses to adopt

18 For a more detailed discussion of options on financial futures. see Anatoli Kuprianov, "Options on Shon-Term lnterest Rate Futures," *Instruments of the Money Marker,* Federal Reserve Bank of Richmond, 1986, pp. 193-206.

19 The discussion of how options are used to hedge the prepayment effect implicitly assumes that the initial interest rate equals the mortgage coupon rate. In addition, the discussion is in terms of a decrease in interest rates because a decrease in rates is empirically more important. The reason for this is that the effect of refinancings on prepayment rates is more important than the effect of home sales, and refinancings rise only when interest rates fall.

20 To offset the prepayment effect when interest rates rise above the mortgage coupon rate, mortgage lenders must buy put options.

21 For an example of the combination of options that would be used to hedge the prepayment effect, see Douglas T. Breeden and Michael J. Giarla, "Hedging Interest Rate Risks With Futures, Swaps and Options," ***The Handbook of Mortgage-Backed Securities,*** Second Edition, Frank J. Fabozzi, ed., Probus Publishing Co., Chicago, 1988.

a hedging strategy for managing interest rate risk depends on its evaluation of the relative benefits and costs of hedging.

The benefits of hedging

One advantage of hedging over balance sheet restructuring is that positions in hedging assets can be taken almost instantaneously, whereas it may take several months or longer to restructure a balance sheet. The ability to change hedging positions quickly is important because the interest rate sensitivity of an S&L's net worth changes frequently with changes in interest rates, the S&L's asset and liability mix, and the maturity structure of the S&L's portfolio.

A second advantage of hedging is that the transactions costs of forming a hedge are relatively low. On the other hand, the costs of restructuring the liability side of the balance sheet toward longer-term funding sources can be quite large. An S&L might have to spend a lot of time and pay a large premium to convince its customers to switch from short-term to long-term deposits. Or if it were to try to borrow in the bond market it would have to meet the Securities and Exchange Commission's disclosure requirements, pay for a credit rating, bear the cost of collateral, and pay advertising, legal, and underwriting fees.

Finally, hedging does not increase credit risk, whereas restructuring the asset side of the balance sheet toward adjustable-rate mortgages may increase credit risk. Credit risk is the risk that borrowers will not repay their loans. Adjustable-rate mortgages have more credit risk than fixed-rate mortgages because borrowers are less likely to be able to meet the higher payments of adjustable-rate mortgages in periods of rising interest rates.

The costs of hedging

The benefits of hedging interest rate risk do not come without cost. The fixed costs of setting up a hedging program can be significant. For example, new personnel must be hired to run the hedging program, and data and computer software have to be acquired to calculate correct hedging positions. Alternatively, if an S&L does not want to run a hedging program itself, it would have to hire a consulting firm to run the hedging program. In addition to these setup costs, an S&L that institutes a hedging program also exposes itself to a new type of risk called basis risk and increases its exposure to managerial risk.[22]

Basis risk. When an S&L uses hedging techniques to reduce interest rate risk, it in effect trades interest rate risk for basis risk. Basis risk is the risk that the actual changes in the value of net worth and the hedging assets due to a change in interest rates will differ from the expected changes. An S&L must estimate the changes in the value of its net worth and the changes in the prices of hedging assets due to a change in interest rates when it sets up a hedge. Thus, if the changes differ from what was expected, the change in the value of the hedge position will not exactly offset the change in the value of net worth.[23]

Basis risk arises because the effect of interest rate changes on asset and liability values is uncertain. Because of this uncertainty, the responses of the value of net worth and the prices of hedg-

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22 **Although an S&L that institutes a hedging program reduces its exposure to interest rate risk. it is still exposed to the many other risks to which all S&L's are exposed, such as liquidity risk, credit risk, and the risk that the slope of the yield curve will change. Thus. a hedged S&L still faces risks that must be managed.**

23 **More precisely, basis is the difference between the price of a hedging asset and the price of the asset being hedged. When interest rates change, the basis may also change. The change in basis is uncertain, however. because changes in the prices of the hedging asset and the asset being hedged are uncertain. Basis risk, then, is the risk that the actual change in basis due to a change in interest rates will differ from the expected change in basis.**

ing assets can only be estimated. For example, prepayment rates on fixed-rate mortgages are uncertain so that the effect of a change in interest rates on prepayment rates, and therefore on mortgage values, can only be estimated. If prepayment rates rise more than was expected when interest rates fall, the negative effect of rising prepayments on mortgage values will be greater than expected. But, if the value of, say, an option contract does rise by the expected amount in response to falling interest rates, the prepayment effect will not be perfectly offset. On the other hand, the effect of changes in interest rates on the value of hedging assets is also uncertain. Thus, if interest rates rise and mortgage values fall as expected, the value of, say, Treasury bond futures could rise by less than expected and not fully offset the decline in mortgage values.

Although S&L's must bear basis risk when they employ hedging strategies, basis risk is generally much less than the interest rate risk they would bear if they did not hedge. If an S&L hedges and, at the very least, is on the correct side of the hedging asset, the value of the hedging asset will at least partially offset the change in the value of net worth when interest rates change. On the other hand, if the S&L does not hedge, the decline in net worth will not be offset at all. Thus, the net change in the value of a hedged S&L will almost surely be less than the net change in the value of an unhedged S&L.

Managerial risk. An S&L also increases its exposure to managerial risk when it employs a hedging program. Broadly defined, managerial risk is the risk that management will make decisions that reduce the value of the firm and increase the probability of failure. Hedging increases managerial risk for an S&L because it is another area of business where an incorrect decision can adversely affect its market value.

Managerial risk can be contained, however, if a hedging program is properly implemented. Hedging strategies are generally quite complex, and the proper implementation of a hedging program requires that management is well informed about the complexities. Managers must understand how hedging works and what a hedging program can and cannot do. And they must continually monitor the program to make sure that the hedging assets are not used for inappropriate purposes, such as speculating on future movements in interest rates. To the extent that management understands hedging, is well informed about hedging strategies and their complexities, and monitors the situation to make sure that hedging assets are used appropriately—that is, to reduce interest rate risk—the increase in managerial risk should be small.

Conclusion

Historically, savings and loans, by their very nature, have been exposed to a substantial amount of interest rate risk. Traditionally, savings and loans primarily held long-term fixed-rate mortgages that were funded with short-term liabilities. This mismatch was never a problem in years when interest rates were stable. In recent years, however, the variability of interest rates combined with the industry's exposure to interest rate risk has been disastrous. Most savings and loans have reduced—but not eliminated—their exposure to interest rate risk by restructuring their balance sheet. Some savings and loans have further reduced their exposure to interest rate risk by using interest rate swaps, financial futures, and options on financial futures to hedge against future changes in interest rates. Hedging strategies are complex, however, and savings and loans must thoroughly examine all aspects of hedging techniques before deciding to implement an interest rate risk hedging program.

Volatile Mortgage Rates— A New Fact of Life?

By Howard L. *Roth*

The sharp rise in mortgage interest rates in the spring of **1987** had several adverse effects. Rates on fixed-rate mortgages soared as much as two percentage points between April and June, pricing some prospective buyers out of the housing market. A number of lenders were hurt by mortgage commitments they had made before the rise in rates. Some lenders also suffered losses on their holdings of mortgages and mortgage-backed securities as the rise in rates reduced the market value of these assets. And a few large securities firms suffered large losses on mortgage-backed securities that had not yet been sold.

Beyond underscoring the importance of hedging against swings in interest rates, the increase in mortgage rates illustrated how quickly these rates can react to changes in capital market rates. The quick response of mortgage rates to capital market rates was not limited to last spring. When capital market rates rose in the fall of **1987,** mortgage rates quickly followed. And when capital market rates fell after the October stock market collapse, mortgage rates again followed closely. The experience last year suggests that mortgage rates may have become more responsive to changes in other capital market rates. If so, what has caused this increased responsiveness?

Growth of the secondary mortgage market has been the main factor causing mortgage rates to move more closely with capital market rates. As a result, the volatility of mortgage rates now is similar to the volatility of capital market rates. The first section of this article puts last spring's increase in mortgage rates in perspective by comparing it with previous changes. The second section discusses developments besides the growth of the secondary mortgage market that might have affected the relationship between mortgage rates and capital market rates. The third section examines why growth of the secondary mortgage market would be expected to affect the relationship. The fourth section documents the closer relationship now of mortgage rates to capital market rates and estimates how much more

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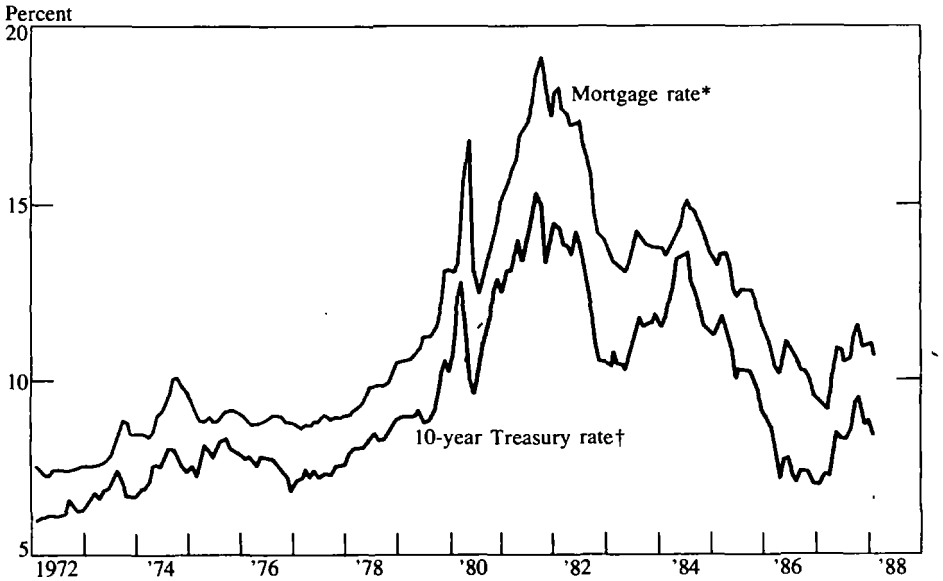
CHART 1
Mortgage rates and the 10-year Treasury rate



*FHLMC survey-based effective rate on new commitment for 30-year, fixed-rate mortgages.

†10-year, constant-maturity Treasury rate.

volatile mortgage rates have been since 1984 because of the closer relationship.

Putting last spring's increase in perspective

Mortgage interest rates changed dramatically twice last year. But even the sharp increase in the spring was not as large as some of the changes in the late 1970s and early 1980s. What was unprecedented was how closely mortgage rates mirrored changes in capital market rates.

The rise in mortgage rates last spring was indeed sharp. One measure of mortgage rates—the Federal Home Loan Mortgage Corporation's (FHLMC's) survey-based measure of rates on 30-year, fixed-rate conventional home mortgages—jumped 79 basis points in April and another 77 basis points in May.[1] The runup in April was the largest monthly change since October 1982 and was almost three times the average monthly change between January 1983 and March 1987.

But the increase in rates last spring was not as spectacular as some changes in the late 1970s and early 1980s. For example, the FHLMC series rose 119 basis points in November 1979 and 224 basis points in March 1980 before falling 207 basis points in May 1980 and another 155 basis points in June 1980.

The late 1970s and early 1980s was a period of extreme volatility for both mortgage rates and capital market rates. Chart 1 shows the FHLMC

[1] The Freddie Mac survey is restricted to level-payment, first mortgages with 80 percent loan-to-value ratios.

mortgage rate series and the 10-year constant-maturity Treasury rate since 1972.[2] This chart gives the general impression that mortgage rates and the 10-year Treasury rate have varied less in the last two years than they did between 1978 and 1985 but more than they did between 1972 and 1978. To be sure, some of the extreme volatility between 1978 and 1985 was due to the general upward trend in interest rates between 1978 and 1981 and the subsequent downward trend between 1981 and 1985. However, when these trends are removed, as in the empirical investigation of the fourth section, mortgage rates and capital market rates continue to be extremely variable in the early 1980s.[3]

What was most remarkable about the behavior of mortgage rates last year, however, was how closely mortgage rates mirrored changing capital market rates. For example, when concern about the dollar led to sharp increases in Treasury bond yields last spring, mortgage rates responded almost immediately. The adjustment of mortgage rates to the change in capital market rates was essentially complete within a month. In contrast, in the 1970s and early 1980s, mortgage rates generally adjusted to changes in market interest rates with a lag of a month or two. The dramatic changes in the FHLMC rate in 1979 and 1980, for example, lagged changes in Treasury bond yields by about a month.

The quicker adjustment of mortgage rates to changes in capital market rates should make the volatility of mortgage rates more like the volatility of capital market rates. Suppose, for example, that capital market rates were to rise 100 basis points one month and fall 100 basis points the next. If mortgage rates matched only a fraction of both the rise and fall in capital market rates, the volatility of mortgage rates would be less than the volatility of capital market rates. But if mortgage rates matched the whole rise and fall of capital market rates, mortgage rates would be as volatile as capital market rates. Other examples could be given, but the point is simple. Mortgage rates varied less than capital market rates in the past but recently have come to behave more like capital market rates. Thus, the variability of mortgage rates has increased relative to the variability of capital market rates. Stated another way, mortgage rates have become more variable than they would have been without the closer relationship to capital market rates.

Removal of rate ceilings

Innovation and deregulation fundamentally changed financial markets in the 1970s and 1980s. Two developments that could have affected the relationship between mortgage rates and capital market rates were deposit rate deregulation and the lifting of mortgage usury ceilings. Disentangling the effects of these developments is difficult. Deposit rate deregulation was an ongoing development that spanned much of the period and overlapped the lifting of mortgage usury ceilings. While deposit rate deregulation should have reduced the responsiveness of mortgage rates to capital market rates, the lifting of mortgage usury ceilings should have increased responsiveness.

Deposit rate deregulation

Before the secondary mortgage markets were well developed, the supply of mortgage credit was determined primarily by the supply of deposits

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2 Rates on 30-year, fixed-rate mortgages are commonly compared with the 10-year Treasury rate. With sales and refinancings, 30-year, fixed-rate mortgages have an average maturity of about ten years.

3 The effects of trend can be removed by taking first differences of the two interest rate series before computing variances. When this is done, the 1970s continue to be years of relative stability for both interest rate series. And the mid-1980s are years of intermediate variability, less variable than the early 1980s but more variable than the 1970s.

to banks and thrifts. Banks and thrifts obtained funds to increase mortgage lending primarily by attracting additional deposits. As market interest rates rose, banks and thrifts found it necessary to offer higher rates on deposits or otherwise to increase the appeal of deposit accounts. The higher costs of attracting funds were passed on to mortgage borrowers in the form of higher mortgage rates. That is, banks and thrifts were willing to expand mortgage credit only at higher mortgage rates.

The ability of banks and thrifts to expand mortgage credit was limited, however, by regulatory ceilings on deposit rates. When deposit rates rose to the ceilings, little more could be done to attract more deposits. The supply of mortgage credit then became less responsive to changes in market interest rates. Several times in the 1960s and 1970s, deposits grew very slowly when market rates rose above deposit rate ceilings. In some cases, deposits actually declined. Increases in market interest rates not only eroded deposits but also reduced the supply of mortgage credit by making other investments more appealing than mortgages to banks and thrifts. With no change in demand for mortgage credit, the reduced supply would be expected to cause a sharp increase in mortgage interest rates. Thus, deposit rate ceilings contributed to the sensitivity of mortgage rates to changes in market interest rates.

The deregulation of deposit rate ceilings should have reduced the variability of mortgage rates relative to capital market rates. A transition to relatively lower volatility would be expected as banks and thrifts were increasingly allowed to offer accounts free of rate ceilings. The first significant development along these lines was in June 1978, when banks and thrifts were authorized to offer 6-month money market certificates with a ceiling rate indexed to the 6-month Treasury bill rate.[4] The next significant developments were the nationwide authorization of NOW accounts in December 1980, the authorization of MMDA accounts in December 1982, and the authorization of Super NOW accounts in January 1983. More deregulation followed, but the remaining deposit rate ceilings probably did not significantly constrain banks and thrifts in their efforts to expand deposits. Therefore, by the early 1980s, deposit rate deregulation had likely come to the point where ceiling rates no longer contributed much to the sensitivity of mortgage rates to changes in market interest rates.

Removal of usury ceilings

Unlike the deregulation of deposit rates, removing usury ceilings has probably increased the responsiveness of mortgage interest rates to changes in capital market rates. State usury ceilings limited adjustment of mortgage rates when market interest rates were high. Unable to raise mortgage rates above legal ceilings, lenders were forced to allocate mortgage credit by such nonprice terms as lower loan-to-asset ratios, higher origination fees, and additional points.[5]

As recently as April 1, 1980, 39 states had usury ceilings on mortgage rates.[6] Of these, 18 states had floating ceilings tied to a market index. The rest had fixed-rate ceilings. Although floating-rate ceilings could have been raised when

4 For a chronology of new accounts and deregulation, see Patrick I. Mahoney, Alice P. White, Paul F. O'Brien, and Mary M. McLaughlin, "Responses to Deregulation: Retail Deposit Pricing from 1983 through 1985," Staff Study No. 151, Board of Governors of the Federal Reserve System. January 1987.

5 Some have argued that banks and thrifts rationed credit even when usury ceilings were not binding. For an analysis of this argument, see William R. Keeton, "Deposit Deregulation, Credit Availability, and Monetary Policy." *Economic Review.* Federal Reserve Bank of Kansas City, June 1986, pp. 2642.

6 *See* Donna C. Vandenbrink, "Usury Ceilings and DIDMCA," *Economic Perspectives.* Federal Reserve Bank of Chicago, September/October 1985, pp. 25-30.

capital market rates rose above the usury ceiling, the adjustment was often so slow that the ceilings remained binding for considerable periods.

The Depository Institutions Deregulation and Monetary Control Act of **1980** (DIDMCA) preempted state ceilings on residential mortgage loans as of April 1, **1980.** Strictly speaking, DIDMCA did not abolish mortgage usury ceilings. The law gave states the right to override the federal preemption by acting before April 1, **1983.** Although some states exercised this right, it is unlikely that usury ceilings have kept mortgage rates from adjusting to changes in capital market rates since DIDMCA took effect.

In summary, the net effect of these developments is unclear. While the removal of deposit rate ceilings probably reduced the responsiveness of rates on fixed-rate mortgages to capital market rates, the removal of mortgage usury ceilings probably had the opposite effect. The net effect could be determined only empirically. But another, perhaps more important, development may have outweighed all others. That development was the growth of the secondary mortgage market.

Growth of the secondary mortgage market

Until development of the secondary mortgage market, most mortgage credit was supplied regionally. Mortgage rates reflected the demand for and supply of mortgage credit within regions, and thus did not generally respond fully to changes in capital market rates. Growth of the secondary mortgage market transformed the provision of mortgage credit from a regional to a national activity. Homeowners today collectively compete with business and government for funds in the capital markets. With mortgage markets effectively integrated into the capital markets, mortgage rates more closely reflect capital market rates.

Regional markets

Before the development of the secondary mortgage markets, markets for mortgage credit were primarily regional in nature. And mortgage rates reflected the demand for and supply of mortgage credit in each region. The supply of mortgage credit in a region was determined primarily by the amount of mortgage credit banks and thrifts provided in the region. Demand for mortgage credit depended primarily on the regional demand for housing. With no national market for mortgage credit, mortgage rates in some regions could differ significantly from rates in national capital markets. Mortgage rates differed significantly between regions because of regional variations in demand or supply conditions. For example, regional variation in deposit growth could cause regional variation in the supply and, in turn, the cost of mortgage credit.

Developments in national capital markets had only limited effects on mortgage rates. Comparatively few depositors considered capital market instruments close substitutes for deposits in their local banks and savings and loans. Few depositors adjusted their balances immediately to changes in the spread between capital market rates and deposit rates. Instead, they waited, at least for a while, to see if the change was short lived. The economic costs of moving funds—including the time required to find out what rates were elsewhere and to fill out the necessary forms to transfer funds—were significant. These costs had to be weighed against the opportunity cost of lower interest income. Also, the psychic costs of moving funds may have been significant, as indicated by the amounts of funds still held in deposits with rates that did not seem competitive. Because of these costs, the effect of a change in capital market rates on a depository institution's supply of deposits, and thus on its supply of mortgage credit, was limited and spread out over time.

Moreover, banks and thrifts did not consider

capital market instruments good substitutes for mortgage loans. For example, some banks and thrifts continued making mortgage loans even when returns on capital market investments rose above those available on mortgages, partly to maintain long-term customer relationships. Moreover, most savings and loans were required to keep a high proportion of their portfolios in mortgages or mortgage-related assets. For these reasons, mortgage rates in local markets adjusted only partially to changes in capital market rates.

Mortgage rates adjusted relatively slowly. Many depository institutions priced mortgages according to average costs. Changes in market interest rates affected the interest costs only on new time deposits. As a result, a change in market interest rates was not fully reflected in an institution's average costs until all its existing time deposits had matured. Thus, average-cost pricing of mortgages slowed the adjustment of mortgage rates to changes in market rates.

Secondary mortgage markets: forging a national market

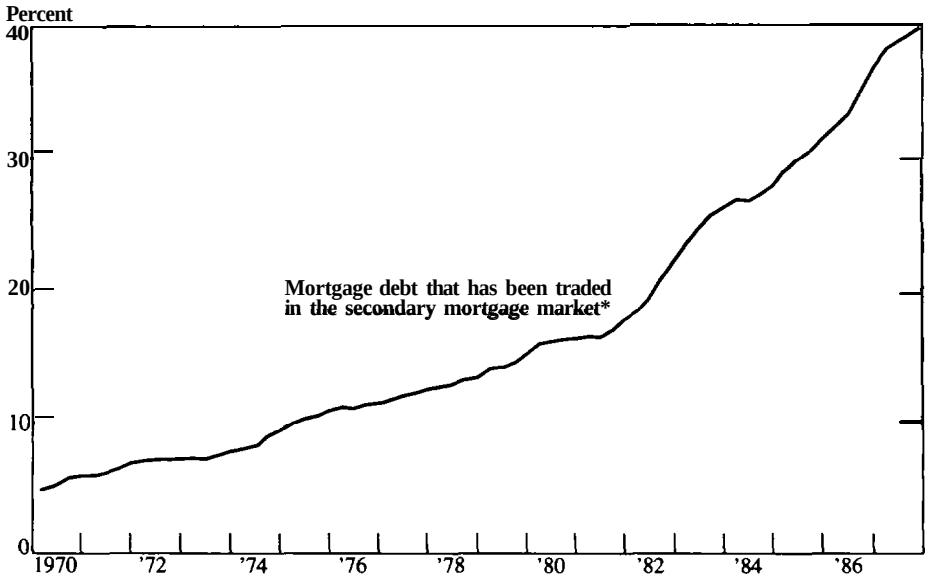
The emergence of the secondary mortgage market has helped unify regional mortgage markets into a single national mortgage market. A range of institutions take part in the trading of mortgages and mortgage-related securities in the secondary mortgage markets. Such mortgage originators as savings and loan associations, commercial banks, and mortgage companies sell mortgages to other institutions. The biggest buyers of mortgages are federal credit agencies—the Government National Mortgage Association (GNMA), the Federal National Mortgage Association (FNMA), and Freddie Mac (FHLMC). These agencies buy mortgages, pool them, and either sell shares in the pool or issue debt with the pool as collateral. A variety of institutions purchase these mortgage-backed securities—savings and loans, commercial banks, mutual funds, life insurance companies, private pension funds, state and local retirement funds, and state and local credit agencies. The nationwide buying and selling of mortgage securities by financial institutions has led to the separation of mortgage origination, which is still predominantly regional, from mortgage funding, which is now national.

The secondary mortgage market has grown dramatically in recent years. Mortgage debt held by federal credit agencies and in pools sponsored by these agencies has grown as a proportion of mortgage debt outstanding from less than 6 percent in 1970 to more than 38 percent today. As shown in Chart 2, this proportion grew steadily from 1970 to 1981 and then began growing significantly faster.

The increased growth of the secondary mortgage market coincided with the initiation of new mortgage pass-through programs by FHLMC and FNMA in the early 1980s. Pass-through securities, the most common mortgage-backed securities, represent interests in a pool of mortgages. The issuer of pass-through securities receives the principal and interest payments on the mortgages in the pool and passes those payments through to holders of the securities. Growth of pass-throughs since 1981 has been phenomenal. Issuance of pass-through securities by FHLMC, FNMA, and GNMA grew from less than $25 billion in 1981 to more than $250 billion in 1986. The dollar amount of pass-through and other mortgage-backed securities issued in 1986 was almost twice the amount of corporate bonds issued.

The development of the secondary mortgage market has reduced the variation in mortgage rates across regions. Mortgage originators that sell their mortgages in the secondary mortgage market are present in every major mortgage market. Their presence makes it difficult for other mortgage originators to offer mortgages at rates other than those determined by the secondary mortgage

CHART 2
Growth of the secondary mortgage market



Source: Federal *Reserve Bulletin*, various issues.

***Mortgage debt held by federal credit agencies and in pools sponsored by these agencies as a percent of total I- to 4-family mortgage debt outstanding.**

markets. An originator that offered mortgage credit at an interest rate higher than the rate determined nationally would see demand for its mortgages dry up. And an originator that offered credit at a rate lower than the rate determined nationally would be giving up profits needlessly.

Since mortgage rates are now determined in the secondary mortgage market, the cost structures of mortgage originators in a regional market have little bearing on regional mortgage rates. Banks and thrifts no longer rely on depositors in their area to fund mortgages. So it is unnecessary to increase deposit rates to increase the supply of mortgage credit. Supplying mortgage credit according to the average cost of mortgage credit instead of the marginal cost does not impede close adjustment of local mortgage rates to changes in capital market rates. Nor does hesitancy by depositors in transferring funds in response to changes in spreads between deposit rates and capital market rates. These factors also have no bearing on the total amount of mortgage credit extended in the market. The amount of mortgage credit extended in the market is determined by the demand for mortgage credit at the mortgage rate determined in the secondary mortgage market.

Estimates of the effect of secondary mortgage markets

To see whether mortgage rates have come to move more closely with capital market rates and, if so, whether the development of the secondary mortgage market has been instrumental in this change, a model of mortgage rates was estimated. The estimates confirm the suspected closer adjustment of mortgage rates to capital market rates and

TABLE 1
Correlation between mortgage rates and capital market rates

Year	Correlation*
1972	−0.22
1973	0.19
1974	0.46
1975	−0.18
1976	0.16
1977	−0.49
1978	0.42
1979	0.34
1980	0.33
1981	0.42
1982	0.80†
1983	0.81†
1984	0.65†
1985	0.76†
1986	0.58†
1987	0.91†

*Correlations are between month-to-month changes in the FHLMC mortgage rate and the 10-year Treasury rate.

†Significantly different from zero at a 5-percent confidence level.

point to the development of the secondary mortgage markets as the primary cause of the closer relationship. The estimates also show how much more variable mortgage rates have become because of their closer relationship to capital market rates.

A model of mortgage rates

The impression that mortgage rates have become more closely tied to capital market rates is supported by the closer correlation between mortgage rates and capital market rates. Table 1 shows simple correlations between monthly changes in the 10-year Treasury rate and in the FHLMC mortgage rate. From 1972 through 1981, the correlation was generally small and statistically insignificant, perhaps reflecting variability in the timing and magnitude of the response of mortgage rates to changes in capital market rates. In contrast, the correlation since 1981 has increased and become statistically significant, suggesting a closer relationship between mortgage rates and capital market rates.

To explore the relationship more closely, a general model of mortgage rates was estimated by regression techniques. The model is based on the assumption that the weekly changes in the FHLMC mortgage rate depend on the difference between the 10-year Treasury rate and the mortgage rate the previous week. Empirical estimates of the model were used in determining how closely mortgage rates adjusted to changes in the 10-year Treasury rate over the estimation period.[7]

The model was first estimated over two periods—the first ending when mortgage usury ceilings were preempted by DIDMCA on April 1, 1980, and the second period beginning then. Results of these regressions are shown in the first two columns of Table 2. The results confirm that mortgage rates have become more responsive to capital market rates in the 1980s. The value of b, which measures this responsiveness, more than tripled in the more recent period. This result is consistent with the view that the secondary mortgage market has increased the responsiveness of mortgage rates to capital market rates. But because most of the growth of the secondary mortgage market has taken place since 1980, the results are also consistent with the view that the elimination of mortgage usury ceilings was responsible for the increased responsiveness. The results are not, however, consistent with the

[7] More detail on the model is given in the box on page 25.

TABLE 2
Estimated mortgage rate equations

	Jan. 5, 1972 to Mar. 26, 1980	Apr. 2, 1980 to Aug. 5, 1987	Apr. 2, 1980 to Dec. 28, 1983	Jan. 4, 1984 to Aug. 5, 1987
Estimated Parameters				
	0.048 (3.109)	0.156 (10.744)	0.160 (8.933)	0.465 (13.445)
c	2.020 (8.274)	2.640 (5.197)	3.012 (26.066)	2.292 (14.857)
Summary Statistics				
R^2	0.02	0.23	0.29	0.50
Standard error (percentage points)	0.142	0.119	0.129	0.092

Note: t-statistics in parentheses

view that the deregulation of deposit rate ceilings was an important development. This development should have reduced the responsiveness of mortgage rates to capital market rates.

So finding an increased responsiveness of mortgage rates to capital market rates indicates that growth of the secondary mortgage market and removal of mortgage usury ceilings jointly had a greater impact on mortgage rates than did the deregulation of deposit rates. These results shed no light on whether the development of the secondary mortgage market or the removal of mortgage usury ceilings was the predominant influence.

An indication of the importance of the growth of the secondary mortgage markets can be obtained, however, by examining the behavior of mortgage rates in the post-usury ceiling period. The secondary mortgage markets grew rapidly in the 1980s. The principal difference between the mid-1980s and the early 1980s is that the secondary mortgage market has become much more significant in the mid-1980s. If mortgage rates moved more closely with capital market rates in the last four years than in the previous four years, growth of the secondary mortgage markets must have been an important factor. To determine whether this was the case, the model was estimated over two subperiods in the 1980s—the period from the preemption of usury ceilings in April 1980 through the end of 1983 and the period from the beginning of 1984 through August 5, 1987. These results are shown in the

Model

A partial adjustment model was used to relate the FHLMC measure of mortgage rates to the 10-year constant-maturity Treasury rate. In this model, the mortgage rate adjusts to changes in the spread between the 10-year Treasury rate and the mortgage rate. The model is given as follows:

$$r^m_t - r^m_{t-1} = b \bullet (r^{tb10}_t - r^m_{t-1} + c) + u_t$$

$$0 \leq b \leq 1$$

where r^m is the FHLMC mortgage rate, r^{tb10} is the 10-year Treasury rate, and u_t is an error term. The parameter c is the equilibrium spread between the mortgage rate and the 10-year Treasury rate. As the equation is written, c is expected to be greater than zero. That is, in equilibrium, the mortgage rate is expected to be higher than the 10-year Treasury rate.

The parameter b determines how closely the mortgage rate moves with the 10-year Treasury rate when the mortgage rate is out of equilibrium. The closer b is to 1, the more closely the mortgage rate moves with the 10-year Treasury rate. A value of b equal to 1 would indicate that the mortgage rate moves perfectly with the 10-year Treasury rate; that is, the spread between the two rates is constant. At the other extreme, a value of b equal to 0 would indicate that the mortgage rate is unrelated to the 10-year Treasury rate.

The form in which the equation was estimated is obtained by expanding the right-hand side of the equation above.

$$r^m_t - r^m_{t-1} = b \bullet c + b(r^{tb10}_t - r^m_{t-1}) + u_t$$

That is, week-to-week changes in the FHLMC mortgage rate were regressed on the difference between the current 10-year Treasury rate and the previous week's mortgage rate.

A maximum likelihood procedure that corrects for the first-order serial correlation in the errors was used in estimating the model. The estimated coefficients and other regression results are shown in Table 2.

third and fourth columns of Table 2.

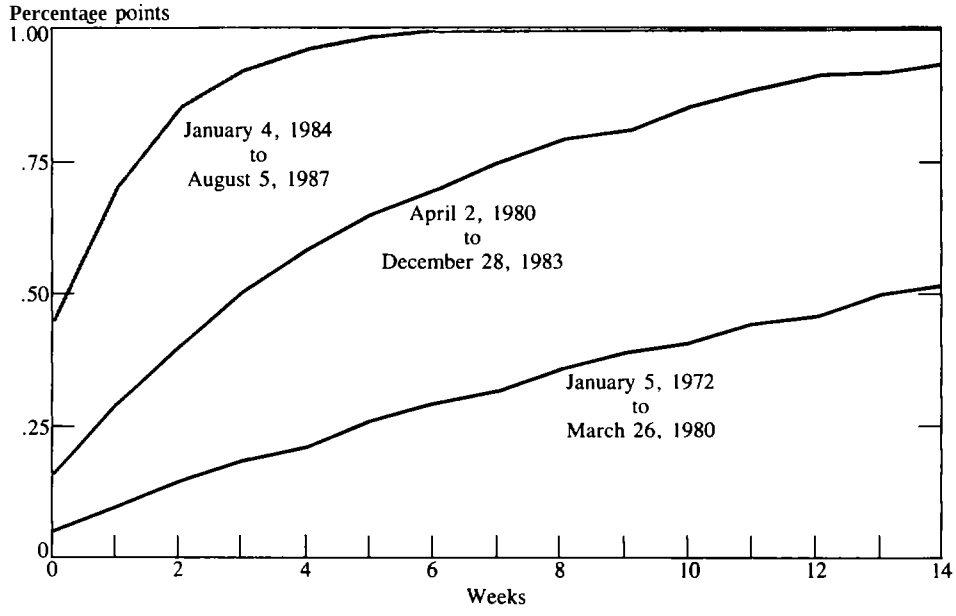
Regression results from these two periods confirm that the development of the secondary mortgage market has been important in affecting the relationship between mortgage rates and capital market rates. The mortgage rate moved significantly more closely with the 10-year Treasury rate in the mid-1980s regression than in the early 1980s regression, as demonstrated by the increase in the estimated value of b from 0.160 in the early 1980s to 0.465 in the mid-1980s. Moreover, the statistical significance of b (as measured by the t-statistics) increased in the more recent period, as did the percentage of variation in mortgage rates explained by changes in capital market rates (as measured by the R^2).

One way to measure the effects of closer adjustment of mortgage rates to capital market rates is to simulate the model estimated over the usury ceiling period and the two post-usury ceiling periods for a one-percentage-point increase in the 10-year Treasury rate. The results of this experiment are shown in Chart 3. As is clear from Chart 3, the estimated model suggests that mortgage rates in the most recent period adjusted almost completely to the change in the Treasury rate within four weeks. In contrast, the model estimated with data from earlier periods suggests that adjustment was much slower before the growth of the secondary mortgage market.

Another way of comparing how closely mortgage rates adjust to changes in capital market rates

CHART 3

Quicker adjustment of mortgage rates to capital market rates



Note: The chart shows how much the FHLMC mortgage rate is predicted to change in the weeks following a one-percentage-point change in the 10-year Treasury rate.

is to see how long it takes mortgage rates to complete their adjustment to the change in the Treasury rate. According to the regression estimates for the most recent period, the adjustment would now be nearly complete in eight weeks.[8] In contrast, the regression results from earlier periods suggest that complete adjustment took about 27 weeks in the early 1980s and about 94 weeks in the 1970s.

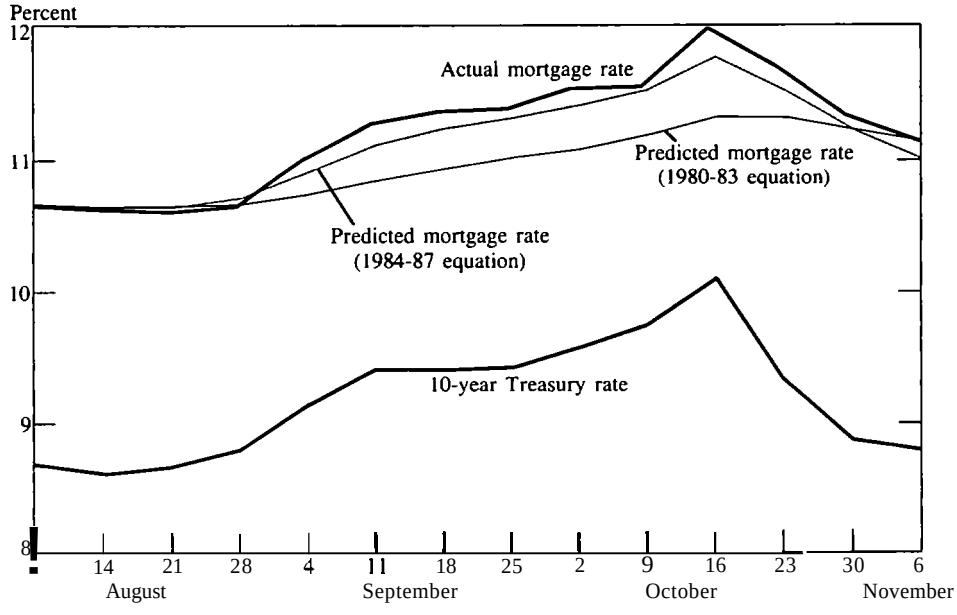
Effect on volatility

The two regressions from the post-usury ceiling period also were used to show how much the growth of the secondary mortgage market has increased the volatility of mortgage rates. The equations were used to predict the reaction of mortgage rates to changes in capital market rates last summer and fall and the subsequent easing of capital market rates after the October stock market collapse. The results are shown in Chart 4, which compares the mortgage rate predicted by the equations estimated with data from the 1980-83 period and the 1984-87 period with the actual mortgage rate. The mortgage rate predicted by the equation estimated with the more recent data adjusts more quickly to the rise in the 10-year Treasury rate in late August and early September. As a result, this equation tracks the increase in mortgage rates better than the equation estimated with the earlier data. Furthermore, mortgage rates predicted by the equation estimated with the more recent data more quickly reflects the easing of rates in mid-October.

[8] "Almost complete" is defined as 99-percent-complete. The number of weeks necessary for 99-percent-complete adjustment is given by the smallest integer that is greater than ln(.01)/ln(1-b).

CHART 4

Predicted response of mortgage rates to changes in capital market rates, 1987



As shown in Chart 4, the closer adjustment of mortgage rates to changes in capital market rates has increased the volatility of mortgage rates. The variance of week-to-week changes in mortgage rates over the period shown in Chart 4 is more than twice as high for the equation estimated with the more recent data than for the equation estimated with the earlier data. Thus, the closer adjustment of mortgage rates to capital market rates appears to have contributed to the volatility of mortgage rates last summer and fall.[9]

Another estimate of how much more volatile mortgage rates have become as a result of their more rapid adjustment to changes in capital market rates was obtained directly from the estimated parameters of the model. This estimate was made by comparing the predicted volatility of mortgage rates over the 1984-87 period, using the parameter estimates from the 1980-83 period, with the predicted volatility of mortgage rates over the 1984-87 period, using the parameter estimates from the 1984-87 period.[10] These calculations show that the more rapid adjustment of mortgage rates has led to about a 25-percent increase in mortgage rate volatility.

In summary, the regression results, like the simple correlations reported in Table 1, confirm

[9] To claim that mortgage rates are twice as variable because of their closer adjustment with capital market rates would be to overstate the case. This claim would hold only if mortgage rates had no residual variance—that is, if all the variability of mortgage rates stemmed from variability in capital market rates. Such is clearly not the case, as is shown in the regression results in Table 2.

[10] In this analysis, the 10-year Treasury rate is assumed to follow a random walk with the variance of week-to-week changes in the 10-year Treasury rate set equal to its variance in the 1980-83 estimation period. With this assumption, the variance of week-to-week changes in the mortgage rate is obtained directly from the equation given in the box on page 25.

a closer relationship between mortgage rates and capital market rates. The regressions from the post-usury period indicate that growth of the secondary mortgage market has helped tie the rates closer together. Furthermore, these regressions indicate that mortgage rates have been as much as 25 percent more variable since 1984 than they would have been if the secondary mortgage market had not become increasingly important in financing housing.

Conclusions

The closer tie between mortgage rates and capital market rates is due partly to the growth of the secondary mortgage market. Because of the closer tie, mortgage rates have been more volatile than they otherwise would have been. And mortgage rates are likely to continue reflecting the volatility of capital market rates more closely.

The sudden increase in mortgage rates last spring brought considerable losses at some financial institutions and frustrated many prospective homebuyers. The lesson to be learned from that experience is that the nation's mortgage markets are now more closely tied to the overall capital system. In effect, mortgage markets have been integrated into the capital markets, and developments affecting capital markets will increasingly affect mortgage markets.

Have volatile mortgage rates become a fact of life? More than in the past, the answer depends on the volatility of capital markets. One of the drawbacks to financial innovation and deregulation is that they have created the means for disturbances in one market to ripple through other markets. But few would dispute that the secondary mortgage market has been instrumental in achieving important social objectives, including a way for market participants to protect themselves from unexpected changes in interest rates.

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