

The Prepayment Risk of Mortgage-backed Securities

By Sean Beckett

Since their creation in 1970, mortgage pass-through securities have played an increasing role in the portfolios of depository institutions. By 1988, savings and loan associations held 16 percent of their assets in mortgage-backed securities (MBSs). Commercial banks also have been increasing their share of the MBS market in recent years; they currently hold 3 percent of their assets in MBSs. Moreover, the participation of commercial banks in this market is likely to increase since mortgage pass-throughs receive favorable treatment under risk-based capital guidelines recently approved by federal regulators.

The attractions of federal agency pass-throughs for bank and S&L portfolio managers are easy to see. Most important are the federal agency guarantees, which virtually eliminate the credit

risk of mortgage pass-throughs. In addition, an active secondary market provides high liquidity for pass-throughs. Finally, pass-through securities offer investors higher yields than comparable Treasury securities.

Despite their agency guarantees and other advantages, mortgage pass-through securities still expose investors to important risks. For one thing, the value of a mortgage pass-through is sensitive to changes in interest rates, a characteristic pass-throughs share with Treasury bonds. More important, and unlike Treasury bonds, a mortgage pass-through may be prepaid at any time. This risk of prepayment affects the interest sensitivity of mortgage pass-throughs and makes the timing of their cash flows difficult to predict.

Because of prepayment risk, mortgage-backed securities may be an unsuitable investment for many smaller depository institutions. This article examines the risks of investing in mortgage pass-through securities and highlights the role of prepayment risk. The article is divided into three sections. The first section describes the mortgage pass-through securities issued by the federal agen-

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cies and highlights the risks associated with mortgage prepayments. The second section explores the factors that determine prepayments and reports the prepayment experience of MBSs issued by the Federal National Mortgage Association (FNMA). The third section considers the practical problems prepayments pose and suggests some ways managers can reduce prepayment risk.

Mortgage pass-through securities

Mortgage pass-throughs are a relatively new security. Federal housing agencies have issued MBSs for just under 20 years.¹ Although MBSs are one of the most successful new securities of the last few decades, some of their characteristics are unfamiliar to many portfolio managers. This section describes the mortgage pass-through securities issued by the housing agencies, examines the risks of these securities, and discusses the central role played by prepayment risk.

The market for mortgage pass-through securities

Mortgage pass-through securities are *pro rata* shares in the principal and interest payments from a pool of mortgages that underlies the securities. Between 50 and 250 basis points of the mortgage interest payments are retained by the issuing agency and the firm that originated and services the mortgages in the pool, but all other cash flows including mortgage prepayments, are “passed-through” to the investors. Since pass-throughs are shares in a specific pool of mortgage loans, mortgages that are prepaid are not replaced by new mortgages. Instead, the size of the mortgage

pool shrinks as both prepayments and ordinary mortgage amortization reduce the balances of the mortgages in the pool.

The active secondary market for mortgage pass-throughs began in 1970 with the issue of the first MBSs by the Government National Mortgage Association (GNMA).² These pass-throughs were based on pools of mortgages guaranteed by the Federal Housing Administration and the Veterans Administration; that is, the individual mortgages in the pools were government-guaranteed. In 1971, the Federal Home Loan Mortgage Corporation (FHLMC) began issuing MBSs based on pools of conventional mortgages.³ FNMA was the last of the three agencies to enter the MBS market. FNMA began issuing MBSs based both on pools of conventional mortgages and on pools of government-guaranteed mortgages in 1981.⁴

The MBS market has grown rapidly in the 18 years since the first GNMA issue. The outstanding balance of mortgage pass-throughs issued by these three agencies has grown to over \$761 billion in the second quarter of 1988. From 1971 to 1988, the outstanding balance of pass-throughs has grown at an annual average rate of around 40 percent. These outstanding balances now account for almost a quarter of the total mortgage debt in the United States.⁵

¹ The term “MBS” is sometimes used to describe any mortgage-backed asset, not just mortgage pass-throughs. For the purposes of this article, only pass-throughs are included in MBSs.

² For a more extensive discussion of the secondary mortgage market, see Gordon H. Sellon, Jr. and Deana VanNahmen, “The Securitization of Housing Finance,” Federal Reserve Bank of Kansas City, *Economic Review* (July/August 1988), pp. 3-20.

³ Conventional mortgages are mortgages that are not federally guaranteed or insured.

⁴ In recent years, pass-throughs have been based on a variety of different types of mortgages, including adjustable rate mortgages. This article considers only MBSs based on pools of fixed rate mortgages, the category that accounts for the majority of mortgage pass-throughs.

⁵ *Federal Reserve Bulletin*, vol. 74, No. 12 (December 1988), Table 1.54, p. A39.

Depository institutions hold a significant share of the outstanding MBSs in their portfolios. Savings and loan associations hold \$212 billion of MBSs, roughly 28 percent of the amount outstanding, while commercial banks hold \$85 billion of MBSs, roughly 11 percent of the amount outstanding.⁶ Life insurance companies and private pension funds also hold considerable amounts of MBSs.⁷

The risks of mortgage pass-throughs

The suitability of mortgage-backed securities as an investment depends to a great extent on their risks. In looking at the risks of MBSs, a useful frame of reference is another asset of roughly similar expected maturity, such as a 10-year Treasury bond. MBSs and Treasuries can be compared on the basis of four types of risk: credit risk, liquidity risk, interest rate risk, and prepayment risk.

Credit risk, or the risk of default, is absent from both Treasury securities and MBSs. Treasury securities are backed by the full faith and credit of the U.S. government. MBSs are guaranteed by the federal agencies that issue them. These guarantees virtually eliminate the credit risk of the mortgages in the pool. In the case of MBSs issued by the Government National Mortgage Association, these guarantees carry the full faith

and credit of the United States. In other words, GNMA securities are as safe as Treasury securities. The MBSs offered by FNMA and FHLMC carry the explicit guarantee only of the issuing agency; however, these pass-throughs are considered by market participants to be default-free.⁸

Like Treasuries, MBSs have little liquidity risk. MBSs are issued in large denominations, have an active secondary market, and hence are almost as liquid as Treasury securities. As a result, depository institutions holding MBSs can easily adapt to unanticipated inflows or outflows of deposits.⁹

Holdings of both MBSs and Treasury bonds expose an institution to interest rate risk, the risk that changes in interest rates will greatly affect the market value of the asset. It is important for investors to keep in mind that pass-throughs, like Treasury bonds, are long-term investments and therefore subject to substantial interest rate risk.

Despite their similarities in other dimensions of risk, MBSs possess one important type of risk not shared by Treasury securities, prepayment

⁶ *Federal Home Loan Bank Board News*, December 7, 1988; *Reports of Condition and Income*, Federal Reserve Board of Governors, Sept. 30, 1988; and *Federal Reserve Bulletin*, vol. 74, No. 12 (December 1988), Table 1.54, p. A39.

⁷ Recent figures are difficult to find, but in June 1987 life insurance companies held \$72 billion in MBSs (11 percent of the amount outstanding) and private pension funds held \$33 billion (5 percent of the amount outstanding). These figures are taken from *The Mortgage Backed Securities Market: Statistical Annual 1988*, Guy D. Cecala, ed. (Probus Publishing Company, 1988), p. 17.

⁸ Each agency offers a somewhat different guarantee. GNMA guarantees full and timely payment of principal and interest including prepayments and, as noted above, this guarantee carries the full faith and credit of the United States. FNMA also guarantees the full and timely payment of principal and interest including prepayments, but this guarantee is not explicitly backed by the Treasury. The FHLMC guarantees the full and timely payment of interest and the ultimate payment of principal, again without explicit Treasury backing. Judging by the market ratings of FNMA and FHLMC debt issues and by the statements of market participants, it is widely believed that FNMA and FHLMC securities issues are implicitly guaranteed by the U.S. Treasury.

⁹ Note that MBSs have greater liquidity than the individual mortgages in the pool underlying the MBSs. Individual mortgages are for relatively small amounts, have little secondary market, and are extremely illiquid. Depository institutions holding mainly individual mortgages thus have greater difficulty adjusting their asset holdings up or down.

risk. Mortgage borrowers have the option to prepay their loans at any time. In contrast, the cash flows from a Treasury security are fixed. Prepayments can dramatically change the time pattern and total volume of cash flows from an MBS. For example, an increase in prepayments accelerates the return of principal payments and cuts short expected interest payments. Conversely, a decrease in prepayments slows down the payment of principal and increases the interest cash flow. Unfortunately, prepayments are difficult to predict, and this unpredictability makes it difficult to manage a portfolio that contains mortgage pass-throughs. The key to understanding MBSs is understanding the role played by prepayment risk.

The significance of prepayment risk

Prepayments make mortgage pass-throughs less attractive investments than Treasury securities in three ways. First, changes in prepayments in response to interest rate movements reduce the capital gains and increase the capital losses accruing to MBS investments. Second, prepayments accelerate the cash flows from an MBS when reinvestment opportunities for these cash flows offer low returns, and decelerate the cash flows from an MBS when reinvestment opportunities offer high returns.¹⁰ Third, prepayments make the cash flows from an MBS unpredictable compared with the cash flows from a Treasury security.

¹⁰ Technically, these first two disadvantages are two different aspects of a single phenomenon. The changes in prepayment rates associated with interest rate movements simultaneously alter the capital gains and losses of MBSs and alter their cash flows in ways that are disadvantageous for reinvestment. These two aspects are treated separately here to aid in understanding the effects of this single characteristic of mortgage pass-throughs.

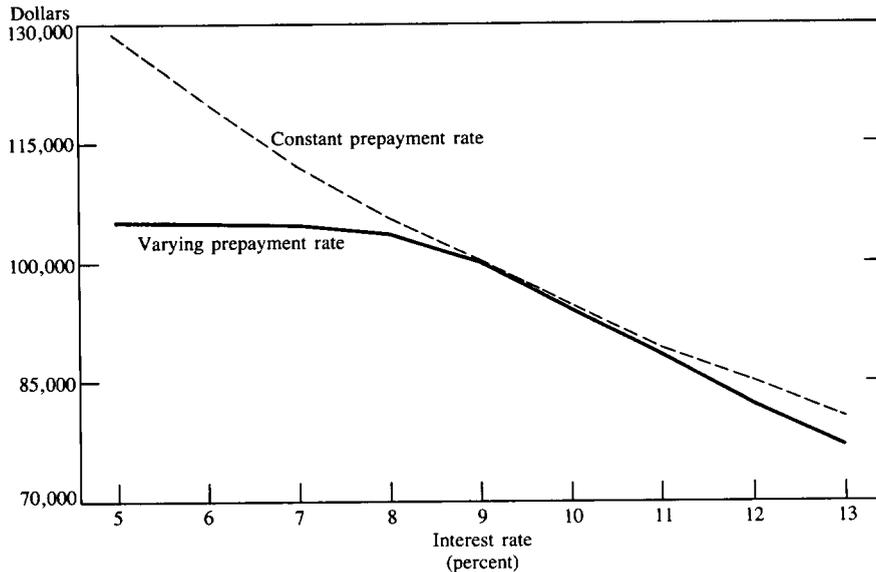
The first of these three disadvantages—the smaller capital gains and larger capital losses of mortgage pass-throughs—reflects the borrower’s option to prepay a mortgage whenever it is advantageous to do so. Just as with a Treasury security, the value of an MBS moves inversely with interest rates. However, when rates fall, some mortgage borrowers exercise their option to prepay their original mortgage and take out a new mortgage at the new, lower interest rate. These prepayments mitigate the increase in the value of the MBS by reducing the period over which MBS investors receive the original, higher mortgage interest rate. Increased prepayments cause the MBS to evaporate; they accelerate its amortization, just when the fall in interest rates increases its value.

Conversely, when interest rates rise, some mortgage borrowers remain in their homes longer than they had originally planned. In addition, home buyers may assume existing, lower-rate mortgages when possible rather than take out new mortgages. Both of these actions extend the originally anticipated term of the mortgage pass-through. In this case, reduced prepayments delay the amortization of the MBS precisely when the increase in interest rates reduces its value.

An example may be helpful in showing how much prepayments can change the interest rate sensitivity of MBSs. Consider the effect of a one percentage-point decrease in the interest rate, from 9 percent to 8 percent, on the value of a \$100,000 share in a pool of newly issued, 30-year mortgages. Using published estimates of prepayment rates and discounting the cash flows from the mortgage pool by the new interest rate, it is possible to calculate the effects of this fall in rates on the market value of this hypothetical investment.¹¹

¹¹ The effects described in this hypothetical example are calculated by applying estimated changes in prepayments and

CHART 1
The interest sensitivity of mortgage pass-throughs
 (Dollar value of \$100,000 share in a mortgage pool)



In this example, if the mortgage borrowers repaid their loans according to their original amortization schedule, allowing for a normal rate of prepayment, the fall in the interest rate would increase the value of this investment to \$106,067, a 6.1 percent capital gain. However, some borrowers will take advantage of their option to prepay and will refinance their mortgages at the new lower rate. These prepayments hold the increase in value to \$103,770, a 3.8 percent

capital gain. In other words, prepayments reduce the capital gain by more than a third.

Now consider the opposite case, a one percentage-point increase in the interest rate, from 9 percent to 10 percent. If the rate of prepayment did not change, the value of this investment would fall to \$94,551, a 5.4 percent capital loss. However, some borrowers will be induced by the increase in mortgage rates to remain in their current homes longer than originally anticipated. The rate of prepayment will slow as a result and the MBS investment will fall in value to \$94,196, a 5.8 percent capital loss. In other words, prepayments increase the capital loss by over 6 percent.

Chart 1 illustrates this same principle for a wider range of interest rate changes. The solid line represents the value of the \$100,000 investment in a pool of 9 percent mortgages at various interest rates after accounting for the likely change

discounting the resulting cash flows by the new interest rate. The prepayment estimates used in this example are taken from Frank J. Navratil, "The Estimation of Mortgage Prepayment Rates," Research Working Paper 112 (Federal Home Loan Bank Board, April 1984), Table 3, p. 19. Many other factors influence capital gains and losses on mortgage pass-throughs, and the experience of an actual MBS investment might well differ significantly from the illustrative results reported here.

in the prepayment rate. The dashed line represents the value of the same investment if the prepayment rate remained at its original level.¹² Notice that this investment does not perform as well as it would if the prepayment rate were constant. In other words, variations in the prepayment rate limit capital gains when interest rates fall and magnify capital losses when interest rates rise.

The second disadvantage of mortgage pass-throughs relative to Treasury securities—the inopportune acceleration and deceleration of MBS cash flows—also arises from mortgage borrowers’ response to changing interest rates. When rates fall, prepayments increase because some borrowers refinance. Cash flows are received earlier than anticipated and, more important, they are received when yields on new investments have fallen, that is, when yields on reinvestment are likely to be lower than the rate paid on the MBS. When rates rise, prepayments decrease. Cash flows fall off just when the yields on new investments have increased, that is, when yields are likely to be higher than the rate paid on the MBS. In contrast, the future cash flows from a Treasury security are fixed and do not respond to changes in interest rates.

The third disadvantage of mortgage pass-throughs—the unpredictability of cash flows—is *not* related to borrowers’ economic incentives to exercise their prepayment option. Mortgages are

prepaid for a variety of reasons, many of them having nothing to do with interest rates or economic conditions. These idiosyncratic prepayments generate unexpected cash flows for MBS investors. In addition, each prepayment alters the rest of the amortization schedule for the mortgages still in the MBS pool. These unexpected variations complicate the job of a portfolio manager trying to match the stream of cash flows from MBS investments to obligations to retire liabilities in the future.¹³

In summary, changes in prepayments in response to interest rates reduce the capital gains and increase the capital losses accruing to MBS investments. In addition, such changes in prepayments increase cash flows when yields on new investments are low and decrease cash flows when yields on new investments are high. Finally, idiosyncratic fluctuations in prepayments make MBS cash flows unpredictable, complicating the task of portfolio management.

Understanding mortgage prepayments

Prepayments are the main reason investments in mortgage pass-throughs perform differently than investments in Treasury securities. To manage their pass-through investments prudently, portfolio managers must understand the factors that influence the rate of mortgage prepayments. This section discusses the determinants of mortgage prepayments and examines the prepayment history of the mortgage pools formed by FNMA.

¹² Because Treasury securities are not subject to prepayment, the interest sensitivity of a comparable Treasury security would look like the dashed line, not like the solid line. Additional discussion of the differences in the interest rate sensitivities of mortgage pass-throughs and of Treasury securities can be found in Charles S. Morris and Thomas J. Merfeld, “New Methods for Savings and Loans to Hedge Interest Rate Risk,” Federal Reserve Bank of Kansas City, *Economic Review* (March 1988), pp. 3-15; and Sean Beckett, “The Role of Stripped Securities in Portfolio Management,” Federal Reserve Bank of Kansas City, *Economic Review* (May 1988), pp. 20-31.

¹³ When interest rates change unexpectedly, MBS cash flows also change unexpectedly. However, prepayments change systematically with interest rates; that is, conditional on interest rate changes, prepayment changes can be anticipated to some extent. The unpredictable cash flows emphasized in this paragraph are the purely idiosyncratic fluctuations in prepayments, that is, prepayment fluctuations unrelated to any observable event.

The determinants of mortgage prepayments

Refinancing, relocation, and default are the direct causes of MBS prepayments. The factors that influence these three events, however, are the ultimate determinants of prepayments. While many different factors can influence the decisions to refinance, relocate, or default, the most important factors appear to be the *relative coupon*—the difference between the interest rate charged for new mortgages and the interest rate on the existing mortgage—and the age of the mortgage. Other idiosyncratic factors, such as the location of the home that collateralizes the mortgage, also play a role.

Direct causes of prepayments. There are three reasons for MBS prepayments: refinancing, relocation, and default. When mortgage interest rates fall, some homeowners find it to their advantage to refinance their current mortgages. These refinancings consist of taking out new mortgages at the new, lower rate and prepaying the original, higher interest rate mortgages. Since an MBS is based on a specific pool of mortgages, the new mortgages do not replace the original mortgages in the pool. The MBS investor receives the prepayments and sees the size of the MBS mortgage pool shrink. As a result, future MBS cash flows are smaller than originally anticipated.

Another reason for mortgage prepayments is relocation. When a home is sold, the home seller's mortgage is prepaid and the home buyer takes out a new mortgage. Again the MBS investor receives the prepayment and is left with a smaller mortgage pool. Relocations occur for a variety of reasons, such as job switches, changes in family size, and the like. However, home sales traditionally pick up when interest rates fall. Consequently, prepayments due both to refinancing and to relocation increase when interest rates fall and decrease when rates rise.

Another cause of prepayments is mortgage defaults. The federal housing agencies guarantee

mortgage pass-throughs against default. When a mortgage borrower defaults, that mortgage is "prepaid" to MBS investors.¹⁴ This feature of MBSs leads to increased prepayments in mortgage pools from areas with deteriorating economic conditions, particularly areas with deteriorating real estate markets. Since interest rates typically fluctuate with national economic conditions, some portion of default-induced prepayments may also be associated with movements in interest rates.

Ultimate determinants of prepayments. The relative coupon is the most important factor in the decision to refinance. If the interest rate charged for new mortgages is higher than the rate on the existing mortgage, the mortgage borrower has no reason at all to refinance. As the current mortgage rate begins to fall below the rate on the existing mortgage, the borrower would be better off with a mortgage at the new rate. However, the points and other fees charged to originate a new mortgage will outweigh modest differences in the interest rates. When the current rate falls far below the rate on the existing mortgage, the present value of the reduction in interest payments exceeds the fees paid to originate a new mortgage. Thus, refinancings increase when mortgage rates fall, and they increase more the greater the fall in mortgage rates.

The relative coupon also affects the decision to relocate. Homeowners may defer or decide against relocating when the interest rate on new mortgages is high relative to the rate on their existing mortgages. Conversely, when the mortgage rate drops, many homeowners are encour-

¹⁴ Of course, someone bears the loss associated with a mortgage default. Depending on the type of mortgage and the contract between the federal agency and the mortgage servicing company, the loss may be borne by the servicer, by the MBS issuing agency, or by another agency that originally guaranteed the mortgage. In addition, the borrower may eventually repay some or all of the mortgage obligation.

aged to pay off their old mortgages and purchase a new home at the new, lower interest rate. Of course, when mortgage rates drop, the demand for homes increases because prospective home buyers find it easier to qualify for loans. This increase in demand makes it easier for homeowners to sell their current homes and relocate.

Mortgage defaults are less directly influenced by the relative coupon than are refinancings and relocations. Default occurs when the mortgage borrower is unable or unwilling to continue making mortgage payments. When economic conditions deteriorate within a region, an industry, or a nation, some mortgage borrowers find themselves without jobs and unable to meet their financial obligations. If they are unable to renegotiate their mortgages, these borrowers may be forced into default. Another kind of default occurs when home values decline unexpectedly, as they did in parts of the Southwest in recent years. In this situation, some borrowers find that the value of their homes has fallen below the value of their mortgages. In this situation, some borrowers may default on their mortgages and throw the burden of the loss in home value on the mortgage lender. The relative coupon may indirectly influence the rate of mortgage defaults, however. Interest rates typically fluctuate with national economic conditions, so defaults due to unemployment and bankruptcy may be associated with movements in interest rates. In addition, home values are affected by changes in interest rates. Therefore, defaults that result from borrowers “walking away” from their mortgage commitments may also be correlated with interest rates.

The age of a mortgage also is an important influence on the factors that directly determine prepayments. Mortgage prepayments are very low in the first few years of a mortgage pool. The prepayment rate appears to peak when the mortgages in the pool are between three and four years old. The rate of prepayment then drops a bit and remains steady until the mortgages mature. This

“life cycle” of prepayments reflects, in the main, the time pattern of the incentives to relocate.

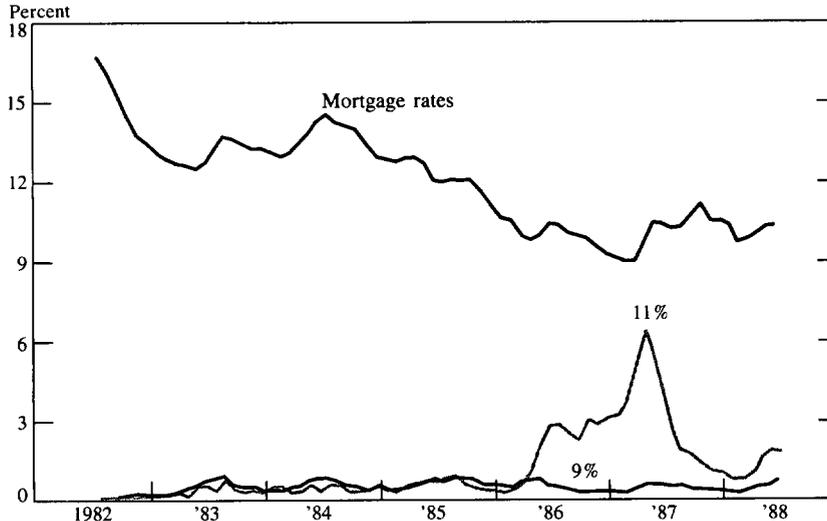
The low rate of prepayments in the first few years of a mortgage pool is due primarily to the low rate of relocation in this period.¹⁵ It is unusual for a home buyer to move again in the first years after a home purchase. This stability is partly the effect of the transactions costs associated with relocation—mortgage points and fees, commissions to real estate agents, moving expenses, and the like. Probably a more important contributor to this stability is the time pattern of life events that influence relocation. Changes in family size, significant career advances, and the increases in wealth needed to finance the purchase of a larger home—all these occur over a period of years, not months.

These life events also help explain the peak in prepayment rates after three to four years. This span of time is long enough to allow for significant changes in a family’s situation and in its demand for housing. After the peak in prepayment rates, when the prepayment rate in a mortgage pool stabilizes, the mortgages are said to be fully seasoned. The remaining households in the pool are less likely to relocate than the households that left the mortgage pool. These remaining households may have stable family sizes, long-term job attachments, or family ties to a particular area. Whatever the reason, the prepayment rate on seasoned mortgages does not change as the mortgages grow older.

Finally, idiosyncratic factors may influence the prepayment rate of a mortgage pool. For example, if the homes in a pool are located in a region where economic conditions are deteriorating,

¹⁵ The rate of refinancing is also low in the first few years of a mortgage pool. In part, the low rate of refinancing reflects the amount of time it takes before mortgage rates move far enough to outweigh the costs of originating a new loan.

CHART 2
Mortgage interest rates and the average prepayment rates for two different mortgage pass-throughs



prepayments due to relocation and default may be higher for this pool than for other pools with the same relative coupons and mortgage ages. The effect of idiosyncratic factors sharply distinguishes MBSs from Treasury securities. Two “identical” MBSs, say two 9 percent FNMA based on pools of two-year-old mortgages, will have different patterns of prepayments and, hence, different patterns of cash flows. In contrast, two Treasury securities with identical coupon rates and maturities offer investors identical cash flows.

The prepayment experience of the FNMA mortgage pass-throughs

The most important fact about prepayment rates in recent years is how rapidly they have changed. Chart 2 displays the average prepayment rates for FNMA mortgage pools with two different pass-

through rates along with the interest rate on new mortgages from July 1982 through June 1988.¹⁶ (The pass-through rate is the interest rate paid to the pass-through investor.) The prepayment rates for both the 9 percent and the 11 percent MBSs remained fairly stable through 1985. In 1986, the prepayment rate for the FNMA 11 per-

¹⁶ The pass-through rate is the interest rate paid to the pass-through investor. It is analogous to the coupon rate on a Treasury bond. The weighted average interest rate on the mortgages in the pool underlying the MBS is called the weighted-average coupon and is 50 to 250 basis points higher than the pass-through rate. The data here and below on FNMA MBSs are taken from research reported in Sean Beckett and Charles S. Morris, “The Prepayment Experience of FNMA Mortgage-backed Securities,” Research Working Paper (Federal Reserve Bank of Kansas City, forthcoming). This working paper is part of a larger research project on mortgage-backed securities that will also examine the experience of GNMA and FHLMC securities.

cent MBSs rose sharply as mortgage interest rates fell below 11 percent. For example, the prepayment rate of the FNMA 11s more than quadrupled from February to May of 1986, rising from a monthly rate of 0.5 percent in February to 2.1 percent in May. As mortgage rates continued to fall, the prepayment rate of the FNMA 11s continued to rise, peaking at 6.5 percent in April 1987. In contrast, the prepayment rates for the 9 percent MBSs were basically flat over this time period. This difference reflects the greater economic incentive to refinance the mortgages in the 11 percent MBS pool.

The experience of the FNMA mortgage pass-throughs provides some evidence of the effects of the relative coupon, mortgage age, and idiosyncratic factors on the rate of prepayment.

Chart 3 displays the sensitivity of prepayment rates to the relative coupon.¹⁷ When the relative coupon is very negative (on the left side of the chart)—that is, when the rate on new mortgages is far below the rate on the existing mortgages—there is a great incentive to refinance the existing mortgages. As a result, the rate of prepayments is high, but further drops in the mortgage rate are unlikely to increase the prepayment rate; most of the borrowers who are likely to refinance their loans are already doing so.

MBSs are most exposed to prepayment risk when the relative coupon is zero or slightly negative (near the center of the the chart), that

is, when the interest rate on new mortgages is equal to or slightly below the rate on existing mortgages. For example, as shown in Chart 3, the prepayment rate on mortgages with interest rates equal to the rate on new mortgages (a relative coupon of zero) is 0.4 percent. If mortgage rates fall one percentage point (the relative coupon drops to -1.0), the prepayment rate doubles to 0.8 percent. If mortgage rates fall another point (the relative coupon drops to -2.0), the prepayment rate doubles again to 1.7 percent, and if mortgage rates fall yet another point (the relative coupon drops to -3.0), the prepayment rate climbs to 2.3 percent. Chart 3 shows that the prepayment rate hits a plateau at about 2.5 percent when the interest rate on new mortgages falls four percentage points below the existing rate; at this point, the prepayment rate is relatively insensitive to further changes in the relative coupon.

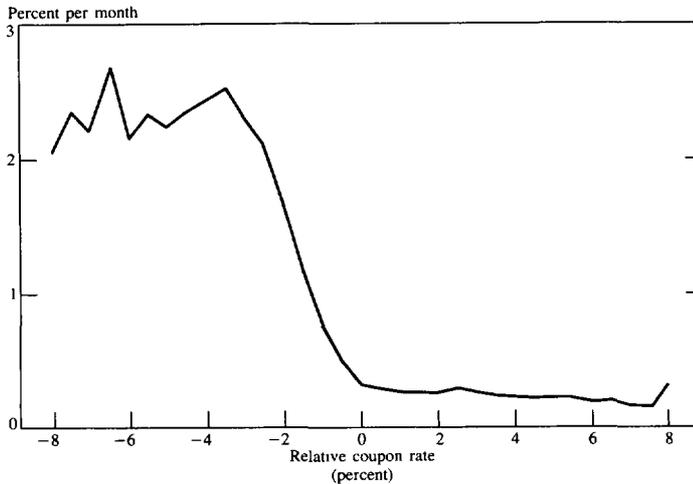
When the relative coupon is very positive (on the right side of Chart 3)—when the rate on new mortgages is far above the rate on the existing mortgages—there is no incentive to refinance the existing mortgages. As a result, the rate of prepayments is low, and further increases in the mortgage rate are unlikely to decrease the prepayment rate.

This discussion and Chart 3 highlight the fact that the rate of prepayments is relatively insensitive to moderate changes in the interest rate when the relative coupon is either very negative or positive (the left- and right-hand sides of the chart, respectively). In contrast, the rate of prepayment is highly sensitive to changes in the interest rate when the relative coupon is zero or a little negative (when the relative coupon is between zero and -4 on the chart).

Chart 4 displays the effects of mortgage age on prepayment rates. As shown in Chart 4, a mortgage pool begins its life with a very low prepayment rate. This rate rises during the next three or four years, then declines for over five

¹⁷ Charts 3 and 4 report the average behavior of FNMA mortgage pools for the period November 1981 through June 1988. For each chart, pools were grouped by their relative coupon rates (for Chart 3) and their ages (for Chart 4). Within each group, the average prepayment rate was calculated. These averages are the data displayed in the charts. Note that, since a particular pool's relative coupon and age change over time, each pool contributes to the average prepayment behavior for more than one relative coupon and age group. Additional details on these calculations can be found in Beckett and Morris, "The Prepayment Experience . . ."

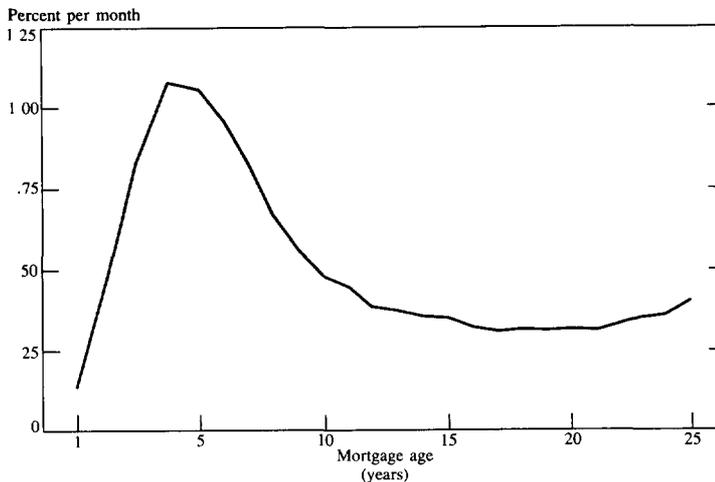
CHART 3
The effect of relative coupon on the prepayment rate



Note: The relative coupon rate is the difference between the interest rate on new mortgages and the rate on the existing mortgages in a pool. This chart displays the average relationship between prepayment rates and relative coupon rates for FNMA fixed rate, 30 year, conventional mortgage pass-throughs from November 1981 through June 1988.

Source: Beckett and Morris, "The Prepayment Experience . . ."

CHART 4
The effect of mortgage age on the prepayment rate



Note: The mortgage age is the number of years since the mortgages in a pool were originated. This chart displays the average relationship between prepayment rates and mortgage age for FNMA fixed rate, 30 year, conventional mortgage pass-throughs from November 1981 through June 1988.

Source: Beckett and Morris, "The Prepayment Experience . . ."

TABLE 1
Prepayment rates for five different FNMA 13s
(in percent)

| Date | Pool | | | | | All FNMA 13s |
|-------------------------|------|------|----|------|-----|-----------------|
| | A | B | C | D | E | |
| 1987 January | * | .0 | .0 | .0 | 5.4 | 6.1 |
| February | * | 13.3 | .0 | 12.3 | 4.1 | 5.1 |
| March | * | 16.5 | .0 | .0 | 1.9 | 6.0 |
| April | 23.6 | .0 | .0 | .0 | 8.3 | 6.2 |
| May | 19.8 | .0 | .0 | .0 | 2.4 | 6.2 |
| June | .0 | .0 | .0 | 17.7 | 3.8 | 6.2 |
| July | .0 | .0 | .0 | * | 2.2 | 4.8 |
| August | 28.7 | .0 | .0 | * | 2.4 | 3.9 |
| September | .0 | .0 | .0 | * | 1.4 | 4.4 |
| October | .0 | .0 | .0 | * | 6.3 | 3.1 |
| November | .0 | .0 | .0 | * | .5 | 2.8 |
| December | .0 | .0 | .0 | * | 2.5 | 2.5 |
| 1988 January | .0 | .0 | .0 | * | .1 | 2.0 |
| February | 18.0 | .0 | .0 | * | .7 | 1.9 |
| March | .0 | .0 | .0 | * | 8.2 | 2.2 |
| April | .0 | .0 | .0 | 20.4 | .1 | 2.4 |
| May | 35.6 | .0 | .0 | 78.5 | 2.0 | 3.3 |
| June | .0 | .0 | .0 | * | 5.3 | 3.6 |
| Jan. 1987- June 1988 | 6.4 | 1.6 | .0 | 6.0 | 3.2 | 4.0 |

Note: All pools are conventional, long-term mortgage pools.
*Less than .05.

years before stabilizing. Thus, for example, prepayments are very low in the first year of a mortgage pool's life—the average prepayment rate is only 0.1 percent per month. The rate jumps to 0.5 percent in the second year and 0.8 percent in the third. The prepayment rate peaks at 1.1 percent in the fourth year of a pool's life. The rate of prepayment then falls steadily until the

tenth year when it stabilizes at just under 0.5 percent per month.

Idiosyncratic factors can generate important variations in prepayment behavior among MBSs with the same pass-through rate. Table 1 lists the prepayment rates for five different FNMA 13 percent MBS pools along with the average prepayment rate for all similar FNMA 13s for the 18

months from January 1987 through June 1988.¹⁸ Note the diversity of behavior among these pools. For example, in May 1987, when the average prepayment rate of FNMA 13s was 6.2 percent, three of the five pools listed had no prepayments at all. The other two pools had prepayment rates of 2.4 percent and 19.8 percent. For the 18 months listed in Table 1, pools B and C appear to be "slow pay pools," pools with chronically below-average prepayments. In fact, pool C never has any prepayments. Over the same period, pools A and D appear to be "fast pay pools," pools with chronically above-average prepayments.¹⁹

The variety of prepayment experience listed in Table 1 suggests that portfolio managers should not assume that one MBS with a given pass-through rate will act like any other with the same pass-through rate. Each MBS has its own response to changing interest rates, and prudent investors must find ways to assess and monitor these differences if they are to anticipate prepayments accurately. This is very different from investing in Treasury securities where the absence of prepayments guarantees that one Treasury security will behave the same as any other Treasury security with the same interest rate and maturity date.

Mortgage prepayments: implications for portfolio management

Banks and S&Ls together hold roughly \$300 billion in MBSs, almost 40 percent of the amount

outstanding. Many observers believe banks are likely to increase their MBS investments as a result of the risk-based capital guidelines approved recently by federal regulators. Under these guidelines, banks will not have to hold as much capital against mortgage pass-throughs as they will against some other types of assets. According to the new guidelines, GNMA MBSs fall in the same risk class as Treasury securities. As a result, banks will not be required to hold any capital against GNMA MBSs.²⁰ FNMA and FHLMC MBSs also receive favorable treatment under the new guidelines: Banks will be required to hold only a fifth as much capital against these securities as against commercial loans.

Previous sections have shown how prepayments make mortgage pass-through securities different from Treasury securities. The large investment by insured depositories in this type of security suggests that portfolio managers should take steps to monitor and control the risks of their investments in mortgage pass-throughs. While each investor's situation is different and has its own special features, this section reviews some key points that portfolio managers should consider.

One way portfolio managers can limit exposure to prepayment risk is to monitor and control the relative coupons of their MBS holdings. As was shown in Chart 3, prepayment rates are fairly

¹⁸ The pools used in Table 1 are all conventional, long-term, fixed rate FNMA pools.

¹⁹ Table 1 does not take into account the ages of the mortgages in these five pools; however, the ages are not very different and are close to the average age of all FNMA 13s. In addition, the variations in the monthly prepayment rates are far too large to be explained by the kind of age-related changes in prepayment displayed in Chart 4.

²⁰ Under the new guidelines, which will be phased in over the next four years, banks will have to hold \$8 of capital against every \$100 of risk-weighted assets. The risk-weighted value of an asset is determined by multiplying the asset's dollar value by its risk factor. The guidelines define four categories of risk factors: 0 percent for cash and all government securities including GNMA securities; 20 percent for securities issued by such agencies as FNMA and FHLMC; 50 percent for most home mortgages and municipal revenue bonds; and 100 percent for most commercial loans and other assets. It is important to note that these risk factors are intended to reflect only the credit risk of the various assets. Guidelines for interest rate risk will be considered in future regulations.

stable for MBSs with pass-through rates that are lower than the current mortgage rate (with high relative coupons). Securities with pass-through rates higher than the current mortgage rate (low relative coupon) have high prepayment rates, but these rates are fairly stable, albeit at a high level, when the pass-through rate is a great deal higher than the current rate. MBSs with pass-through rates close to the current mortgage rate and MBSs with pass-through rates slightly higher than the current rate are the most exposed to prepayment risk, in particular, to a fall in mortgage rates. Very small changes in the current mortgage rate can have large effects on the prepayment rates of these securities. Portfolio managers may choose periodically to rebalance their MBS holdings to retain only securities whose prepayment rates are relatively insensitive to interest rate changes.²¹

Research on mortgage-backed securities has shown that there is considerable idiosyncratic prepayment risk. In other words, apparently identical mortgage pools may have dramatically different prepayment rates. The only solution to this idiosyncratic prepayment risk is diversification.

²¹ Some investors may be tempted to skew their holdings toward MBSs that will perform better in a particular interest rate environment. For example, an investor who believes interest rates are likely to increase might purchase pass-throughs with a pass-through rate that is slightly higher than the current rate in the hope of benefiting from a slowdown in prepayments. Such investment strategies as these are simply bets on the future path of interest rates, and as such are inherently inappropriate strategies for depository institutions.

²² A detailed discussion of diversifying MBS investments and estimates of the number of pools required to achieve adequate diversification can be found in Alden L. Toevs and Mark R. Hancock, "Diversifying Prepayment Risk: Techniques to Stabilize Cash Flows and Returns from Mortgage Pass-throughs," *Housing Finance Review*, vol. 7, No. 3 (Summer 1988), pp. 267-94. Note that even small investors may be able to diversify their MBS investments by holding shares in a diversified MBS mutual fund rather than by holding MBSs directly.

If the portfolio is a large one, a manager can reduce the idiosyncratic fluctuations in prepayments and cash flows by holding diversified blocks of MBSs within each pass-through category. For example, an investor may wish to break up a purchase of FNMA 9s across a large number of different mortgage pools. This diversification guarantees that the investor will enjoy prepayments and cash flows more similar to the average for all FNMA 9s than if the investment were concentrated in only one or a few different mortgage pools. For some MBSs, however, an investor may have to hold securities from as many as 50 to 100 different pools to be assured of adequate diversification.²² Since only the largest, best capitalized investors are able to hold diversified portfolios of these MBSs, smaller institutions holding MBSs may expose themselves to considerable idiosyncratic prepayment risk.

Portfolio managers can, to a limited extent, reduce variations in the prepayment rate of an MBS by choosing only those securities based on pools of seasoned mortgages, that is, mortgages old enough to have a stable prepayment rate (other things being equal). The prepayment rate on younger mortgages is likely to increase for several years, then to decline for several years. Older, seasoned mortgages do not exhibit any further age-related swings in prepayments.

Finally, since MBSs expose an institution to a combination of interest rate and prepayment risk, sophisticated portfolio managers may try to manage these risks jointly through hedging operations. However, prepayments make hedging a portfolio of MBSs inherently more complicated than hedging a portfolio of other fixed rate investments.²³ In general, hedging an MBS port-

²³ The strategies for and problems of hedging MBSs are explained in Morris and Merfeld, "New Methods . . ."

folio requires the use of interest rate futures contracts to hedge the interest rate risk and options on interest rate futures to hedge prepayment risk. Once again, smaller institutions with limited resources to monitor and conduct hedging operations may be better off not taking on the interest rate and prepayment risk inherent in MBSs.²⁴

Conclusion

The behavior of mortgage pass-throughs is a reminder that credit risk is not the only risk faced by portfolio managers. Agency guarantees virtually eliminate credit risk for MBSs. Nonetheless, an investor in pass-throughs is exposed to

important risks, primarily risks associated with prepayments. As a result, MBSs are more difficult assets to manage than are Treasury securities.

There are ways for investors to manage the prepayment risks of mortgage pass-throughs. Investors can monitor the relative coupons of their MBS holdings to limit their exposure to prepayment risk. Investors can also hold large blocks of MBSs with the same pass-through rate to diversify away idiosyncratic variations in prepayments. Finally, investors can adopt hedging strategies using financial futures and options to insulate their portfolio from interest rate-induced swings in prepayments.

All of these approaches are best suited to sophisticated and well-capitalized investors. Many banks and S&Ls, particularly smaller institutions, may lack the investment experience and the capital to successfully carry out any of these strategies. Portfolio managers at these institutions may decide to avoid mortgage pass-throughs and their higher yields in favor of simpler and less risky assets. For many institutions, this may be the safest and most appropriate strategy.

²⁴ While mortgage pass-through securities are clearly riskier than Treasury securities, they are less risky than whole mortgage loans. S&Ls, which hold a large share of their assets in mortgages and mortgage-related securities, may reduce their total risk by shifting their portfolios out of whole mortgages and into MBSs. Commercial banks, which historically have made relatively few mortgage loans, are likelier to increase their total risk by adding MBSs to their portfolios. For either type of institution, increasing the investment in MBSs at the expense of Treasury securities will increase the institution's riskiness.