CHAPTER 13

Mortgage-Backed Securities

The development of mortgage-backed securities represents an important innovation in the way that capital is raised to finance purchases in housing markets. The basic concept is simple. Collect a portfolio of mortgages into a mortgage pool. Then issue securities with pro rata claims on mortgage pool cash flows. These mortgage-backed securities have the attraction to investors that they represent a claim on a diversified portfolio of mortgages, and therefore are considerably less risky than individual mortgage contracts.

Owning your own home is a big part of the American dream. But few Americans can actually afford to buy a home outright. What makes home ownership possible for so many is a well-developed system of home mortgage financing. With mortgage financing, a home buyer makes only a down payment and borrows the remaining cost of a home with a mortgage loan. The mortgage loan is obtained from a mortgage originator, usually a local bank or other mortgage broker. Describing this financial transaction, we can say that a home buyer *issues* a mortgage and an originator *writes* a mortgage. The mortgage loan distinguishes itself from other loan contracts by a pledge of real estate as collateral for the loan. This system has undergone many changes in recent decades. In this chapter, we carefully examine the basic investment characterisitcs of mortgage-backed securities.

13.1 A Brief History of Mortgage-Backed Securities

Traditionally, savings banks and savings and loans (S&Ls) wrote most home mortgages and then held the mortgages in their portfolios of interest-earning assets. This changed radically during the 1970s and 1980s when market interest rates ascended to their highest levels in American history. Entering this financially turbulent period, savings banks and S&Ls held large portfolios of mortgages written at low pre-1970s interest rates. These portfolios were financed from customers' savings deposits. When market interest rates climbed to near 20 percent levels in the early 1980s, customers flocked to withdraw funds from their savings deposits to invest in money market funds that paid higher interest rates. As a result, savings institutions were often forced to sell mortgages at depressed prices to satisfy the onslaught of deposit withdrawals. For this, and other, reasons, the ultimate result was the collapse of many savings institutions.

Today, home buyers still commonly turn to local banks for mortgage financing, but few mortgages are actually held by the banks that originate them. After writing a mortgage, an originator usually sells the mortgage to a mortgage repackager who accumulates them into mortgage pools. To finance the creation of a mortgage pool, the mortgage repackager issues mortgage-backed bonds, where each bond claims a pro rata share of all cash flows derived from mortgages in the pool. A pro rata share allocation pays cash flows in proportion to a bond's face value. Essentially, each mortgage pool is set up as a trust fund and a servicing agent for the pool collects all mortgage payments. The servicing agent then passes these cash flows through to bondholders. For this reason, mortgage-backed bonds are often called **mortgage pass-throughs**, or simply *pass-throughs*. However, all securities representing claims on mortgage pools are generically called **mortgage-**

backed securities (MBS's). The primary collateral for all mortgage-backed securities is the underlying pool of mortgages.

(*marg. def.* **mortgage pass-throughs** Bonds representing a claim on the cash flows of an underlying mortgage pool passed through to bondholders.)

(*marg. def.* **mortgage-backed securities (MBS's)** Securities whose investment returns are based on a pool of mortgages.)

(*marg. def.* **mortgage securitization** The creation of mortgage-backed securities from a pool of mortgages.)

The transformation from mortgages to mortgage-backed securities is called **mortgage securitization**. More than $3 trillion of mortgages have been securitized in mortgage pools. This represents tremendous growth in the mortgage securitization business, since in the early 1980s less than $1 billion of home mortgages were securitized in pools. Yet despite the multi-trillion dollar size of the mortgage-backed securities market, the risks involved with these investments are often misunderstood even by experienced investors.

(*marg. def.* **fixed-rate mortgage** Loan that specifies constant monthly payments at a fixed interest rate over the life of the mortgage.)

13.2 Fixed-Rate Mortgages

Understanding mortgage-backed securities begins with an understanding of the mortgages from which they are created. Most home mortgages are 15-year or 30-year maturity **fixed-rate mortgages** requiring constant monthly payments. As an example of a fixed-rate mortgage, consider a 30-year mortgage representing a loan of $100,000 financed at an annual interest rate of 8 percent. This translates into a monthly interest rate of 8 % / 12 months = .67% and it requires a series of 360 monthly payments. The size of the monthly payment is determined by the requirement that the present value of all monthly payments based on the financing rate specified in the mortgage contract be equal to the original loan amount of $100,000. Mathematically, the constant monthly payment for a $100,000 mortgage is calculated using the following formula.

$$\text{Monthly payment} = \frac{\$100{,}000 \times r/12}{1 - \dfrac{1}{(1+r/12)^{T\times 12}}}$$

where	r	=	annual mortgage financing rate
	$r/12$	=	monthly mortgage financing rate
	T	=	mortgage term in years
	$T\times12$	=	mortgage term in months

In the example of a 30-year mortgage financed at 8 percent, the monthly payments are $733.77. This amount is calculated as follows.

$$\text{Monthly payment} = \frac{\$100{,}000 \times 0.08/12}{1 - \dfrac{1}{(1+0.08/12)^{360}}}$$

$$= \$733.77$$

Another example is a 15-year mortgage financed at 8 percent requiring 180 monthly payments of $955.66 calculated as follows.

$$\text{Monthly payment} = \frac{\$100{,}000 \times 0.08/12}{\left(1 - \dfrac{1}{(1+0.08/12)^{180}}\right)}$$

$$= \$955.66$$

Monthly mortgage payments are sensitive to the interest rate stipulated in the mortgage contract. Table 13.1 provides a schedule of monthly payments required for 5-year, 10-year, 15-year, 20-year, and 30-year mortgages based on annual interest rates ranging from 5 percent to 15 percent in increments of .5 percent. Notice that monthly payments required for a $100,000 thirty-year mortgage financed at 5 percent are only $536.83, while monthly payments for the same mortgage financed at 15 percent are $1,264.45.

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13.2a The most popular fixed-rate mortgages among home buyers are those with 15-year and 30-year maturities. What might be some of the comparative advantages and disadvantages of these two mortgage maturities?

13.2b Suppose you were to finance a home purchase using a fixed-rate mortgage. Would you prefer a 15-year or 30-year maturity mortgage? Why?

Table 13.1 about here.

(*marg. def.* **mortgage principal** The amount of a mortgage loan outstanding, which is the amount required to pay off the mortgage.)

Fixed-Rate Mortgage Amortization

Each monthly mortgage payment has two separate components. The first component represents payment of interest on outstanding **mortgage principal**. Outstanding mortgage principal is also called a mortgage's *remaining balance* or *remaining principal*. It is the amount required to pay off a mortgage before it matures. The second component represents a pay-down, or *amortization*, of mortgage principal. The relative amounts of each component change throughout the life of a mortgage. For example, a 30-year $100,000 mortgage financed at 8 percent requires 360 monthly payments of $733.76. The first monthly payment consists of a $666.67 payment of interest and a $67.09 pay-down of principal. The first month's interest payment, representing one month's interest on a mortgage balance of $100,000, is calculated as:

$$\$100{,}000 \times .08/12 = \$666.67$$

After this payment of interest, the remainder of the first monthly payment, that is, $733.76 - $666.67 = $67.09, is used to amortize outstanding mortgage principal. Thus after the first monthly payment outstanding principal is reduced to $100,000 - $67.09 = $99,932.91.

The second monthly payment includes a $666.22 payment of interest calculated as

$$\$99{,}932.91 \times .08/12 = \$666.22$$

The remainder of the second monthly payment, that is, $733.76 - $666.22 = $67.54, is used to reduce mortgage principal to $99,932.91 - $67.54 = $99,865.37.

(*marg. def.* **mortgage amortization** The process of paying down mortgage principal over the life of the mortgage.)

This process continues throughout the life of the mortgage. The interest payment component gradually declines and the payment of principal component gradually increases. Finally, the last monthly payment is divided into a $4.86 payment of interest and a final $728.90 pay-down of mortgage principal. The process of paying down mortgage principal over the life of a mortgage is called **mortgage amortization**.

Table 13.2 about here.

Mortgage amortization is described by an amortization schedule. An amortization schedule states the remaining principal owed on a mortgage at any point in time and also states the scheduled principal payment and interest payment in any month. Amortization schedules for 15-year and 30-year $100,000 mortgages financed at a fixed rate of 8 percent are listed in Table 13.2. The payment month is given in the left-hand column. Then, for each maturity, the first column reports remaining mortgage principal immediately after a monthly payment is made. Columns 2 and 3 for each maturity list the principal payment and the interest payment scheduled for each monthly payment. Notice that immediately after the 180th monthly payment for a 30-year mortgage $100,000, $76,781.08 of mortgage principal is still outstanding. Notice also that as late as the 252nd monthly payment, the interest payment component of $378.12 still exceeds the principal payment component of $355.64.

The amortization process for a 30-year $100,000 mortgage financed at 8 percent interest is illustrated graphically in Figure 13.1. Figure 13.1A graphs the amortization of mortgage principal over the life of the mortgage. Figure 13.1B graphs the rising principal payment component and the falling interest payment component of the mortgage.

Figures 13.1a, 13.1b about here.

(*marg. def.* **mortgage prepayment** Paying off all or part of outstanding mortgage principal ahead of its amortization schedule.)

Fixed-Rate Mortgage Prepayment and Refinancing

A mortgage borrower has the right to pay off an outstanding mortgage at any time. This right is similar to the call feature on corporate bonds, whereby the issuer can buy back outstanding bonds at a prespecified call price. Paying off a mortgage ahead of its amortization schedule is called **mortgage prepayment**.

Prepayment can be motivated by a variety of factors. A homeowner may pay off a mortgage in order to sell the property when a family moves because of, say, new employment or retirement, After the death of a spouse, a surviving family member may pay off a mortgage with an insurance benefit. These are examples of mortgage prepayment for personal reasons. However, mortgage prepayments often occur for a purely financial reason: an existing mortgage loan may be refinanced at a lower interest rate when a lower rate becomes available.

Consider 30-year $100,000 fixed-rate 8 percent mortgage with a monthly payment of $733.77. Suppose that 10 years into the mortgage, market interest rates have fallen and the financing rate on new 20-year mortgages is 6.5 percent. After 10 years (120 months), the remaining balance for the original $100,000 mortgage is $87,725.35. The monthly payment on a new 20-year $90,000 6.5 percent fixed-rate mortgage is $671.02, which is $62.75 less than the $733.77 monthly payment on the old 8 percent mortgage with 20 years of payments remaining. Thus a homeowner could profit by prepaying the original 8 percent mortgage and refinancing with a new 20-year, 6.5 percent mortgage. Monthly payments would be lower by $62.75, and the $2,274.65 difference between the new $90,000 mortgage balance and the old $87,725.35 mortgage balance would defray any refinancing costs.

As this example suggests, during periods of falling interest rates, mortgage refinancings are an important reason for mortgage prepayments. The nearby Investment Updates box presents a *Wall Street Journal* article discussing the merits of mortgage refinancing.

Investment Updates: Pay Down a Mortgage

The possibility of prepayment and refinancing is an advantage to mortgage borrowers but is a disadvantage to mortgage investors. For example, consider investors who supply funds to write mortgages at a financing rate of 8 percent. Suppose that mortgage interest rates later fall to 6.5 percent, and, consequently, homeowners rush to prepay their 8 percent mortgages so as to refinance at 6.5 percent. Mortgage investors recover their outstanding investment principal from the prepayments, but the rate of return that they can realize on a new investment is reduced because mortgages can now be written only at the new 6.5 percent financing rate. The possibility that falling interest rates will set off a wave of mortgage refinancings is an ever-present risk that mortgage investors must face.

(*marg. def.* **Government National Mortgage Association (GNMA)** Government agency charged with promoting liquidity in the home mortgage market.)

Government National Mortgage Association

In 1968, Congress established the **Government National Mortgage Association (GNMA)**, colloquially called "Ginnie Mae," as a government agency within the Department of Housing and Urban Development (HUD). GNMA was charged with the mission of promoting liquidity in the secondary market for home mortgages. Liquidity is the ability of investors to buy and sell securities quickly at competitive market prices. Essentially, mortgages repackaged into mortgage pools are a more liquid investment product than the original unpooled mortgages. GNMA has successfully sponsored the repackaging of several trillion dollars of mortgages into hundreds of thousands of mortgage-backed securities pools.

(*marg. def.* **fully modified mortgage pool** Mortgage pool that guarantees timely payment of interest and principal.)

GNMA mortgage pools are based on mortgages issued under programs administered by the Federal Housing Administration (FHA), the Veteran's Administration (VA), and the Farmer's Home Administration (FmHA). Mortgages in GNMA pools are said to be **fully modified** because GNMA guarantees bondholders full and timely payment of both principal and interest even in the event of default of the underlying mortgages. The GNMA guarantee augments guarantees already provided by the FHA, VA, and FmHA. Since GNMA, FHA, VA, and FmHA are all agencies of the federal government, GNMA mortgage pass-throughs are free of default risk. But while investors in GNMA pass-throughs do not face default risk, they still face **prepayment risk**.

(*marg. def.* **prepayment risk** Uncertainty faced by mortgage investors regarding early payment of mortgage principal and interest.)

GNMA operates in cooperation with private underwriters certified by GNMA to create mortgage pools. The underwriters originate or otherwise acquire the mortgages to form a pool. After verifying that the mortgages comply with GNMA requirements, GNMA authorizes the underwriter to issue mortgage-backed securities with a GNMA guarantee.

As a simplified example of how a GNMA pool operates, consider a hypothetical GNMA fully modified mortgage pool containing only a single mortgage. After obtaining approval from GNMA, the pool has a GNMA guarantee and is called a *GNMA bond*. The underwriter then sells the bond and the buyer is entitled to receive all mortgage payments, less servicing and guarantee fees. If a mortgage payment occurs ahead of schedule, the early payment is passed through to the GNMA bondholder. If a payment is late, GNMA makes a timely payment to the bondholder. If any mortgage principal is prepaid, the early payment is passed through to the bondholder. If a default occurs, GNMA settles with the bondholder by making full payment of remaining mortgage principal. In effect, to a GNMA bondholder mortgage default is the same thing as a prepayment.

When originally issued, the minimum denomination of a GNMA mortgage-backed bond is $25,000, with subsequent increments of $5,000. The minimum size for a GNMA mortgage pool is $1 million, although it could be much larger. Thus, for example, a GNMA mortgage pool might conceivably represent only 40 bonds with an initial bond principal of $25,000 par value per bond. However, initial bond principal only specifies a bond's share of mortgage pool principal. Over time, mortgage-backed bond principal declines because of scheduled mortgage amortization and mortgage prepayments.

(*marg. def.* **Federal Home Loan Mortgage Corporation (FHLMC)** and **Federal National Mortgage Association (FNMA)** Government sponsored enterprises charged with promoting liquidity in the home mortgage market.)

GNMA Clones

While GNMA is perhaps the best-known guarantor of mortgage-backed securities, two government-sponsored enterprises (GSEs) are also significant mortgage repackaging sponsors. These are the **Federal Home Loan Mortgage Corporation (FHLMC)**, colloquially called “Freddie Mac,” and the **Federal National Mortgage Association (FNMA)**, called “Fannie Mae.” The FHLMC was chartered by Congress in 1970 to increase mortgage credit availability for residential housing. It was originally owned by the Federal Home Loan Banks operated under direction of the U.S. Treasury. But in 1989, FHLMC was allowed to become a private corporation with an issue of common stock. Freddie Mac stock trades on the New York Stock Exchange under the ticker symbol FRE.

The Federal National Mortgage Association was originally created in 1938 as a government-owned corporation of the United States. Thirty years later, FNMA was split into two government corporations: GNMA and FNMA. Soon after, in 1970, FNMA was allowed to become a private corporation and has since grown to become one of the major financial corporations in the United States. Fannie Mae stock trades on the New York Stock Exchange under the ticker symbol FNM.

Like GNMA, both FHLMC and FNMA operate with qualified underwriters who accumulate mortgages into pools financed by an issue of bonds that entitle bondholders to cash flows generated by mortgages in the pools, less the standard servicing and guarantee fees. However, the guarantees on FHLMC and FNMA pass-throughs are not exactly the same as for GNMA pass-throughs. Essentially, FHLMC and FNMA are only government-sponsored enterprises, whereas GNMA is a government agency. Congress may be less willing to rescue a financially strapped GSE.

Before June 1990, FHLMC guaranteed timely payment of interest but only *eventual* payment of principal on its mortgage-backed bonds. However, beginning in June 1990, FHLMC began its Gold program whereby it guaranteed timely payment of both interest and principal. Therefore, FHLMC Gold mortgage-backed bonds are fully modified pass-through securities. FNMA guarantees timely payment of both interest and principal on its mortgage-backed bonds, and therefore these are also fully modified pass-through securities. But since FHLMC and FNMA are only GSEs, their fully modified pass-throughs do not carry the same default protection as GNMA fully modified pass-throughs.

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13.3a Look up prices for Freddie Mac (FHLMC) and Fannie Mae (FNMA) common stock under their ticker symbols FRE and FNM in the *Wall Street Journal*.

(*marg. def.* **prepayment rate** The probability that a mortgage will be prepaid during a given year.)

13.4 Public Securities Association Mortgage Prepayment Model

Mortgage prepayments are typically described by stating a **prepayment rate**, which is the probability that a mortgage will be prepaid in a given year. The greater the prepayment rate for a mortgage pool, the faster the mortgage pool principal is paid off, and the more rapid is the decline of bond principal for bonds supported by the underlying mortgage pool. Historical experience shows that prepayment rates can vary substantially from year to year depending on mortgage type and various economic and demographic factors.

Conventional industry practice states prepayment rates using a prepayment model specified by the Public Securities Association (PSA). According to this model, prepayment rates are stated as a percentage of a PSA benchmark. The PSA benchmark specifies an annual prepayment rate of .2 percent in month 1 of a mortgage, .4 percent in month 2, 0.6 percent in month 3, and so on. The annual prepayment rate continues to rise by .2 percent per month until reaching an annual prepayment rate of 6 percent in month 30 of a mortgage. Thereafter, the benchmark prepayment rate remains constant at 6 percent per year. This PSA benchmark represents a mortgage prepayment schedule called 100 PSA, which means 100 percent of the PSA benchmark. Deviations from the 100 PSA benchmark are stated as a percentage of the benchmark. For example, 200 PSA means 200 percent of the 100 PSA benchmark, and it doubles all prepayment rates relative to the benchmark. Similarly, 50 PSA means 50 percent of the 100 PSA benchmark, halving all prepayment rates relative to the benchmark. Prepayment rate schedules illustrating 50 PSA, 100 PSA, and 200 PSA are graphically presented in Figure 13.2.

Figure 13.2 about here.

(*marg. def.* **seasoned mortgages** Mortgages over 30 months old. **unseasoned mortgages** Mortgages less than 30 months old.)

Based on historical experience, the PSA prepayment model makes an important distinction between **seasoned mortgages** and **unseasoned mortgages**. In the PSA model, unseasoned mortgages are those less than 30 months old with rising prepayments rates. Seasoned mortgages are those over 30 months old with constant prepayment rates.

(*marg. def.* **conditional prepayment rate (CPR)** The prepayment rate for a mortgage pool conditional on the age of the mortgages in the pool.)

Prepayment rates in the PSA model are stated as **conditional prepayment rates (CPRs)**, since they are conditional on the age of mortgages in a pool. For example, the CPR for a seasoned 100 PSA mortgage is 6 percent, which represents a 6 percent probability of mortgage prepayment in a given year. By convention, the probability of prepayment in a given month is stated as a *single monthly mortality (SMM)*. SMM is calculated using a conditional prepayment rate (CPR) as follows.

$$\boldsymbol{SMM} = 1 - (1 - \boldsymbol{CPR})^{1/12} .$$

For example, the SMM corresponding to a seasoned 100 PSA mortgage with a 6 percent CPR is .5143 percent, which is calculated as

$$\begin{aligned} \text{SMM} &= 1 - (1 - .06)^{1/12} \\ &= .5143\% \end{aligned}$$

As another example, the SMM corresponding to an unseasoned 100 PSA mortgage in month 20 of the mortgage with a 4 percent CPR is .3396 percent, which is calculated as

(*marg. def.* **average life** Average time for a mortgage in a pool to be paid off.)

Some mortgages in a pool are prepaid earlier than average, some are prepaid later than average, and some are not prepaid at all. The **average life** of a mortgage in a pool is the average time for a single mortgage in a pool to be paid off, either by prepayment or by making scheduled payments until maturity. Because prepayment shortens the life of a mortgage, the average life of a mortgage is usually much less than a mortgage's stated maturity. We can calculate a mortgage's projected average life by assuming a particular prepayment schedule. For example, the average life of a mortgage in a pool of 30-year mortgages assuming several PSA prepayment schedules is stated immediately below.

Prepayment Schedule	Average Mortgage Life (years)
50 PSA	20.40
100 PSA	14.68
200 PSA	8.87
400 PSA	4.88

Notice that an average life ranges from slightly less than 5 years for 400 PSA prepayments to slightly more than 20 years for 50 PSA prepayments.[1]

Bear in mind that these are expected averages given a particular prepayment schedule. Since prepayments are somewhat unpredictable, the average life of mortgages in any specific pool are likely to deviate somewhat from an expected average.

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13.4a Referring to Figure 13.2, what are the CPRs for seasoned 50 PSA, 200 PSA, and 400 PSA mortgages?

13.4b Referring to Figure 13.2, what is the CPR for an unseasoned 200 PSA mortgage in month 20 of the mortgage?

13.4c Referring to Figure 13.2, what is the CPR for an unseasoned 400 PSA mortgage in month 20 of the mortgage?

[1] Formulas used to calculate average mortgage life are complicated and depend on the assumed prepayment model. For this reason, average life formulas are omitted here.

13.5 Cash Flow Analysis of GNMA Fully Modified Mortgage Pools

Each month, GNMA mortgage-backed bond investors receive pro rata shares of cash flows derived from fully modified mortgage pools. Each monthly cash flow has three distinct components:

1. payment of interest on outstanding mortgage principal,
2. scheduled amortization of mortgage principal,
3. mortgage principal prepayments.

As a sample GNMA mortgage pool, consider a $10 million pool of 30-year, 8 percent mortgages financed by the sale of 100 bonds at a par value price of $100,000 per bond. For simplicity, we ignore servicing and guarantee fees. The decline in bond principal for these GNMA bonds is graphed in Figure 13.3A for the cases of prepayment rates following 50 PSA, 100 PSA, 200 PSA, and 400 PSA schedules. In Figure 13.3A, notice that 50 PSA prepayments yield a nearly straight-line amortization of bond principal. Also notice that for the extreme case of 400 PSA prepayments, over 90 percent of bond principal is amortized within 10 years of mortgage pool origination.

Figures 13.3a, 13.3b about here.

Monthly cash flows for these GNMA bonds are graphed in Figure 13.3B for the cases of 50 PSA, 100 PSA, 200 PSA, and 400 PSA prepayment schedules. In Figure 13.3B, notice the sharp spike in monthly cash flows associated with 400 PSA prepayments at about month 30. Lesser PSA prepayment rates blunt the spike and level the cash flows.

As shown in Figures 13.3A and 13.3B, prepayments significantly affect the cash flow characteristics of GNMA bonds. However, these illustrations assume that prepayment schedules remain unchanged over the life of a mortgage pool. This can be unrealistic, since prepayment rates often change from those originally forecast. For example, sharply falling interest rates could easily cause a jump in prepayment rates from 100 PSA to 400 PSA. Since large interest rate movements are unpredictable, future prepayment rates can also be unpredictable. Consequently, GNMA mortgage-backed bond investors face substantial cash flow uncertainty. This makes GNMA bonds an unsuitable investment for many investors, especially relatively unsophisticated investors unaware of the risks involved. Nevertheless, GNMA bonds offer higher yields than U.S. Treasury bonds, which makes them attractive to professional fixed-income portfolio managers.

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13.5a GNMA bond investors face significant cash flow uncertainty. Why might cash flow uncertainty be a problem for many portfolio managers?

13.5b Why might cash flow uncertainty be less of a problem for investors with a very long term investment horizon?

(*marg. def.* **Macaulay duration** A measure of interest rate risk for fixed-income securities.)

Macaulay Durations for GNMA Mortgage-Backed Bonds

For mortgage pool investors, prepayment risk is important because it complicates the effects of interest rate risk. With falling interest rates, prepayments speed up and the average life of mortgages in a pool shortens. Similarly, with rising interest rates, prepayments slow down and average mortgage life lengthens. Recall from a previous chapter that interest rate risk for a bond is often measured by **Macaulay duration**. However, Macaulay duration assumes a fixed schedule of cash flow payments. But the schedule of cash flow payments for mortgage-backed bonds is not fixed because it is affected by mortgage prepayments, which in turn are affected by interest rates. For this reason, Macaulay duration is a deficient measure of interest rate risk for mortgage-backed bonds. The following examples illustrate the deficiency of Macaulay duration when it is unrealistically assumed that interest rates do not affect mortgage prepayment rates.[2]

1. Macaulay duration for a GNMA bond with zero prepayments. Suppose a GNMA bond is based on a pool of 30-year 8 percent fixed-rate mortgages. Assuming an 8 percent interest rate, their price is equal to their initial par value of $100,000. The Macaulay duration for these bonds is 9.56 years.

2. Macaulay duration for a GNMA bond with a constant 100 PSA prepayment schedule. Suppose a GNMA bond based on a pool of 30-year 8 percent fixed-rate mortgages follows a constant 100 PSA prepayment schedule. Accounting for this prepayment schedule when calculating Macaulay duration, we obtain a Macaulay duration of 6.77 years.

Examples 1 and 2 above illustrate how Macaulay duration can be affected by mortgage prepayments. Essentially, faster prepayments cause earlier cash flows and shorten Macaulay durations.

However, Macaulay durations are still misleading because they assume that prepayment schedules are unaffected by changes in interest rates. When falling interest rates speed up prepayments, or rising interest rates slow down prepayments, Macaulay durations yield inaccurate price-change predictions for mortgage-backed securities. The following examples illustrates the inaccuracy.

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[2] The Macaulay duration formula for a mortgage is not presented here, since as our discussion suggests, its usage is not recommended.

3. Macaulay duration for a GNMA bond with changing PSA prepayment schedules. Suppose a GNMA bond based on a pool of 30-year 8 percent fixed rate mortgages has a par value price of $100,000, and that, with no change in interest rates, the pool follows a 100 PSA prepayment schedule. Further, suppose that when the market interest rate for these bonds rises to 9 percent, prepayments fall to a 50 PSA schedule. In this case, the price of the bond falls to $92,644, representing a 7.36 percent price drop, which is more than .5 percent larger than the drop predicted by the bond's Macaulay duration of 6.77.

4. Macaulay duration for a GNMA bond with changing PSA prepayment schedules. Suppose a GNMA bond based on a pool of 30-year 8 percent fixed rate mortgages has a par value price of $100,000, and that with no change in interest rates the pool follows a 100 PSA prepayment schedule. Further, suppose that when the market interest rate for these bonds falls to 7 percent, prepayments rise to a 200 PSA schedule. In this case, the bond price rises to $105,486, which is over 1.2 percent less than the price increase predicted by the bond's Macaulay duration of 6.77.

Examples 3 and 4 illustrate that simple Macaulay durations overpredict price increases and underpredict price decreases for changes in mortgage-backed bond prices caused by changing interest rates. These errors are caused by the fact that Macaulay duration does not account for prepayment rates changing in response to interest rate changes. The severity of these errors depends on how strongly interest rates affect prepayment rates. Historical experience indicates that interest rates significantly affect prepayment rates, and that Macaulay duration is a very conservative measure of interest rate risk for mortgage-backed securities.

To correct the deficiencies of Macaulay duration, a method often used in practice to assess interest rate risk for mortgage-backed securities is to first develop projections regarding mortgage prepayments. Projecting prepayments for mortgages requires analyzing both economic and demographic variables. In particular, it is necessary to estimate how prepayment rates will respond to changes in interest rates. Only then is it possible to calculate predicted prices for mortgage-backed securities based on hypothetical interest rate and prepayment scenarios. The task is easier to describe than accomplish, however, since historical experience indicates that the relationship between interest rates and prepayment rates can be unstable over time. For this reason, mortgage-backed securities analysis will always be part art and part science.

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13.5c Why is it important for portfolio managers to know by how much a change in interest rates will affect mortgage prepayments?

13.5d Why is it important for portfolio managers to know by how much a change in interest rates will affect mortgage-backed bond prices?

(*marg. def.* **collateralized mortgage obligations (CMOs)** Securities created by splitting mortgage pool cash flows according to specific allocation rules.)

13.6 Collateralized Mortgage Obligations

When a mortgage pool is created, cash flows from the pool are often carved up and distributed according to various allocation rules. Mortgage-backed securities representing specific rules for allocating mortgage cash flows are called **collateralized mortgage obligations (CMOs)**. Indeed, a CMO is defined by the rule that created it. Like all mortgage pass-throughs, primary collateral for CMOs are the mortgages in the underlying pool. This is true no matter how the rules for cash flow distribution are actually specified.

The three best known types of CMO structures using specific rules to carve up mortgage pool cash flows are

(1) **interest-only strips (IOs)** and **principal-only strips (POs)**,

(2) **sequential CMOs**, and

(3) **protected amortization class securities (PACs)**.

Each of these CMO structures is discussed immediately below. Before beginning, however, we retell an old Wall Street joke that pertains to CMOs: Question: "How many investment bankers does it take to *sell* a lightbulb?" Answer: "401; one to hit it with a hammer, and 400 to sell off the pieces."

The moral of the story is that mortgage-backed securities can be repackaged in many ways, and the resulting products are often quite complex. Even the basic types we consider here are significantly more complicated than the basic fixed-income instruments we considered in earlier chapters. Consequently, we do not go into great detail regarding the underlying calculations for CMOs. Instead, we examine only the basic properties of the most commonly encountered CMO's.

(*marg. def.* **interest only strips (IOs)** Securities that pay only the interest cash flows to investors.)

(*marg. def.* **principal-only strips (POs)** Securities that pay only the principal cash flows to investors.)

Interest-Only and Principal-Only Mortgage Strips

Perhaps the simplest rule for carving up mortgage pool cash flows is to separate payments of principal from payments of interest. Mortgage-backed securities paying only the interest component of mortgage pool cash flows are called **interest-only strips**, or simply **IOs**. Mortgage-backed securities paying only the principal component of mortgage pool cash flows are called **principal-only**

strips, or simply **POs**. Mortgage strips are more complicated than straight mortgage pass-throughs. In particular, IO strips and PO strips behave quite differently in response to changes in prepayment rates and interest rates.

Let us begin an examination of mortgage strips by considering a $100,000 par value GNMA bond that has been stripped into a separate IO bond and a PO bond. The whole GNMA bond receives a pro rata share of all cash flows from a pool of 30-year 8 percent mortgages. From the whole bond cash flow, the IO bond receives the interest component and the PO bond receives the principal component. The sum of IO and PO cash flows reproduces the whole bond cash flow.

Figures 13.4a, 13.4b about here.

Assuming various PSA prepayment schedules, cash flows to IO strips are illustrated in Figure 13.4A and cash flows to PO strips are illustrated in Figure 13.4B. Holding the interest rate constant at 8 percent, IO and PO strip values for various PSA prepayment schedules are listed immediately below.

Prepayment Schedule	IO Strip Value	PO Strip Value
50 PSA	$63,102.80	$36,897.20
100 PSA	53,726.50	46,273.50
200 PSA	41,366.24	58,633.76
400 PSA	28,764.16	71,235.84

Notice that total bond value is $100,000 for all prepayment schedules because the interest rate is unchanged from its original 8 percent value. Nevertheless, even with no change in interest rates, faster prepayments imply *lower* IO strip values and *higher* PO strip values, and vice versa.

There is a simple reason why PO strip value rises with faster prepayments rates. Essentially, the only cash flow uncertainty facing PO strip holders is the timing of PO cash flows, not the total amount of cash flows. No matter what prepayment schedule applies, total cash flows paid to PO strip holders over the life of the pool will be equal to the initial principal of $100,000. Therefore, PO strip value increases as principal is paid earlier to PO strip holders because of the time value of money.

In contrast, IO strip holders face considerable uncertainty regarding the total amount of IO cash flows that they will receive. Faster prepayments reduce principal more rapidly, thereby reducing interest payments since interest is paid only on outstanding principal. The best that IO strip holders could hope for is that no mortgages are prepaid, which would maximize total interest payments. Prepayments reduce total interest payments. Indeed, in the extreme case, where all mortgages in a pool are prepaid, IO cash flows stop completely.

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13.6a Suppose a $100,000 mortgage financed at 8 percent (.75 percent monthly) is paid off in the first month after issuance. In this case, what are the cash flows to an IO strip and a PO strip from this mortgage?

The effects of changing interest rates compounded by changing prepayment rates are illustrated by considering the example of IO and PO strips from a $100,000 par value GNMA bond based on a pool of 30-year 8 percent mortgages. First, suppose that an interest rate of 8 percent yields a 100 PSA prepayment schedule. Also suppose that a lower interest rate of 7 percent yields 200 PSA prepayments, and a higher interest rate of 9 percent yields 50 PSA prepayments. The resulting whole bond values and separate IO and PO strip values for these combinations of interest rates and prepayment rates are listed immediately below:

Interest Rate - Prepayments	IO Strip	PO Strip	Whole Bond
9% - 50 PSA	$59,124.79	$35,519.47	$94,644.26
8% - 100 PSA	53,726.50	46,273.50	100,000.00
7% - 200 PSA	43,319.62	62,166.78	105,486.40

When the interest rate increases from 8 percent to 9 percent, total bond value falls by $5,355.74. This results from the PO strip price *falling* by $10,754.03 and the IO strip price *increasing* by $5,398.29. When the interest rate decreases from 8 percent to 7 percent, total bond value rises by $5,486.40. This results from the PO strip price *increasing* by $15,893.28 and the IO strip price *falling* by $10,406.88. Thus PO strip values change in the same direction as whole bond value, but the PO price change is larger. Notice that the IO strip price changes in the opposite direction of the whole bond and PO strip price change.

(*marg. def.* **sequential CMOs** Securities created by splitting a mortgage pool into a number of slices called *tranches*.)

Sequential Collateralized Mortgage Obligations

One problem with investing in mortgage-backed bonds is the limited range of maturities available. An early method developed to deal with this problem is the creation of **sequential CMOs**. Sequential CMOs carve a mortgage pool into a number of tranches. *Tranche*, the French word for slice, is a commonly-used financial term to describe the division of a whole into various parts.

Sequential CMOs are defined by rules that distribute mortgage pool cash flows to sequential tranches. While almost any number of tranches are possible, a basic sequential CMO structure might have four tranches: A-tranche, B-tranche, C-tranche, and Z-tranche. Each tranche is entitled to a share of mortgage pool principal and interest on that share of principal.

As a hypothetical sequential CMO structure, suppose a 30-year 8 percent GNMA bond initially represents $100,000 of mortgage principal. Cash flows to this whole bond are then carved up according to a sequential CMO structure with A-, B-, C-, and Z-tranches. The A-, B-, and C-tranches initially represent $30,000 of mortgage principal each. The Z-tranche initially represents $10,000 of principal. The sum of all four tranches reproduces the original whole bond principal of $100,000. The cash flows from the whole bond are passed through to each tranche according to the following rules.

Rule 1: Mortgage principal payments

All payments of mortgage principal, including scheduled amortization and prepayments, are first paid to the A-tranche. When all A-tranche principal is paid off, subsequent payments of mortgage principal are then paid to the B-tranche. After all B-tranche principal is paid off, all principal payments are then paid to the C-tranche. Finally, when all C-tranche principal is paid off, all principal payments go to the Z-tranche.

Rule 2: Interest payments

All tranches receive interest payments in proportion to the amount of outstanding principal in each tranche. Interest on A-, B-, and C-tranche principal is passed through immediately to A-, B-, and C-tranche. Interest on Z-tranche principal is paid to the A-tranche as cash in exchange for the transfer of an equal amount of principal from the A-tranche to the Z-tranche. After A-tranche principal is fully paid, interest on Z-tranche principal is paid to the B-tranche in exchange for an equal amount of principal from the B-tranche to the Z-tranche. This process continues sequentially through each tranche.

For example, the first month's cash flows from a single whole bond are allocated as follows. Scheduled mortgage payments yield a whole bond cash flow of $733.77, which is divided between $67.10 principal amortization and $666.67 payment of interest. All scheduled principal amortization is paid to the A-tranche and A-tranche principal is reduced by a like amount. Since outstanding principal was *initially* equal to $30,000 for the A-, B-, and C-tranche bonds, each of these tranches receives an interest payment of $30,000 × .08 / 12 = $200. In addition, the Z-tranche interest payment of $10,000 × 0.08 / 12 = $66.67 is paid to the A-tranche in cash in exchange for transferring $66.67 of principal to the Z-tranche. In summary, A-tranche principal is reduced by $67.10 + $66.67 = $133.7 plus any prepayments, and Z-tranche principal is increased by $66.67.

Figures 13.5a and 13.5b about here.

Remaining principal amounts for A-, B-, C-, and Z-tranches assuming 100 PSA prepayments are graphed in Figure 13.5A. Corresponding cash flows for A-, B-, C-, and Z-tranche assuming 100 PSA prepayments are graphed in Figure 13.5B.

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13.6b Figures 13.5A and 13.5B assume a 100 PSA prepayment schedule. How would these figures change for a 200 PSA prepayment schedule or a 50 PSA prepayment schedule?

13.6c While A-, B-, and C-tranche principal is being paid down, Z-tranche interest is used to acquire principal for the Z-tranche. What is the growth rate of Z-tranche principal during this period?

(*marg. def.* **protected amortization class bond (PAC)** Mortgage-backed security that takes priority for scheduled payments of principal.)

(*marg. def.* **PAC support bond** Mortgage-backed security that has subordinate priority for scheduled payments of principal. Also called *PAC companion bond*.)

Protected Amortization Class Bonds

Another popular security used to alleviate the problem of cash flow uncertainty when investing in mortgage-backed bonds is **protected amortization class (PAC)** bonds, or simply **PACs**. Like all CMOs, PAC bonds are defined by specific rules that carve up cash flows from a mortgage pool. Essentially, a PAC bond carves out a slice of a mortgage pool's cash flows according to a rule that gives PAC bondholders first priority entitlement to promised PAC cash flows. Consequently, PAC cash flows are predictable so long as mortgage pool prepayments remain within a predetermined band. PAC bonds are attractive to investors who require a high degree of cash flow certainty from their investments.

After PAC bondholders receive their promised cash flows, residual cash flows from the mortgage pool are paid to non-PAC bonds, often referred to as **PAC support bonds** or *PAC companion bonds*. In effect, almost all cash flow uncertainty is concentrated in the non-PAC bonds. The non-PAC bond supports the PAC bond and serves the same purpose as a Z-tranche bond in a sequential CMO structure. For this reason, a non-PAC bond is sometimes called a PAC Z-tranche.

(*marg. def.* **PAC collar** Range defined by upper and lower prepayment schedules of a PAC bond.)

Creation of a PAC bond entails three steps. First, we must specify two PSA prepayment schedules that form the upper and lower prepayment bounds of a PAC bond. These bounds define a **PAC collar**. For example, suppose we create a single PAC bond from a new $100,000 par value

GNMA bond based on a pool of 30-year fixed rate mortgages. The PAC collar specifies a 100 PSA prepayment schedule as a lower bound and a 300 PSA prepayment schedule as an upper bound. Cash flows to the PAC bond are said to enjoy *protected amortization* so long as mortgage pool prepayments remain within this 100-300 PSA collar.

Figures 13.6a, 13.6b about here.

Our second step in creating a PAC bond is to calculate principal-only (PO) cash flows from our 30-year $100,000 par value GNMA bond assuming 100 PSA and 300 PSA prepayment schedules. These PO cash flows, which include both scheduled amortization and prepayments, are plotted in Figure 13.6A. In Figure 13.6A, notice that principal only cash flows for 100 PSA and 300 PSA prepayment schedules intersect in month 103. Before the 103rd month, 300 PSA PO cash flows are greater. After that month, 100 PSA PO cash flows are greater. PAC bond cash flows are specified by the 100 PSA schedule before month 103 and the 300 PSA schedule after month 103. Because the PAC bond is specified by 100 PSA and 300 PSA prepayment schedules, it is called a PAC 100/300 bond.

Our third step is to specify the cash flows to be paid to PAC bond holders on a priority basis. PAC bondholders receive payments of principal according to the PAC collar's lower PSA prepayment schedule. For the PAC 100/300 bond in this example, principal payments are made according to the 100 PSA prepayment schedule until month 103, when the schedule switches to the 300 PSA prepayment schedule. The sum of all scheduled principal to be paid to PAC 100/300 bondholders represents total initial PAC bond principal. In addition to payment of principal, a PAC bondholder also receives payment of interest on outstanding PAC principal. For example, if the mortgage pool financing rate is 9 percent, the PAC bondholder receives an interest payment of .75 percent per month of outstanding PAC principal.

Total monthly cash flows paid to the PAC bond including payments of principal and interest are graphed in Figure 13.6B. As shown, total cash flow reaches a maximum in month 30, thereafter gradually declining. So long as mortgage pool prepayments remain within the 100/300 PSA prepayment collar, PAC bondholders will receive these cash flows exactly as originally specified.

PAC collars are usually sufficiently wide so that actual prepayments move outside the collar only infrequently. In the event that prepayments move outside a collar far enough to interfere with promised PAC cash flows, PAC bonds normally specify the following two contingency rules.

PAC contingency rule 1.

When actual prepayments fall below a PAC collar's lower bound there could be insufficient cash flow to satisfy a PAC bond's promised cash flow schedule. In this case, the PAC bond receives all available cash flow and any shortfall is carried forward and paid on a first priority basis from future cash flows. Non-PAC bonds receive no cash flows until all cumulative shortfalls to PAC bonds are paid off.

PAC contingency rule 2.

When actual prepayments rise above a PAC collar's upper bound, it is possible that all outstanding principal for the non-PAC support bonds is paid off before the PAC bond. When all non-PAC principal is paid off, the PAC cash flow schedule is abandoned and all mortgage pool cash flows are paid to PAC bondholders.

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13.6d A PAC 100/300 bond based on a pool of fully modified 30-year fixed-rate mortgages switches payment schedules after 103 months. Would switching occur earlier or later for a PAC 50/300 bond? For a PAC 100/500 bond?

13.6e Figures 13.8A and 13.8B assume a PAC 100/300 bond based on a pool of fully-modified 30-year fixed-rate mortgages. What would these figures look like for a PAC 50/300 or a PAC 100/500 bond?

13.6f How might a large change in market interest rates cause mortgage pool prepayments to move outside a PAC collar far enough and long enough to interfere with an originally stated PAC bond cash flow schedule?

Figure 13.7 about here.

(*marg. def.* **cash flow yield** Yield to maturity for a mortgage-backed security conditional on an assumed prepayment pattern.)

13.7 Yields for Mortgage-Backed Securities and Collateralized Mortgage Obligations

Yields for mortgage-backed securities (MBSs) and collateralized mortgage obligations (CMOs) for representative GNMA, FHLMC, and FNMA mortgage pools are published daily in the *Wall Street Journal*. Figure 13.7 is a sample *Wall Street Journal* listing. In the panel labeled Mortgage-Backed Securities, the first column lists the type of mortgage pool. For example, the first mortgage pool type is 30-year FMAC (i.e., Freddie Mac) Gold paying 6 percent interest on outstanding principal. The second mortgage pool type is 30-year FMAC Gold paying 6.5 percent interest on outstanding principal. Column 2 reports the price (in percentage points and 32nds of a point) for the MBS. The third column is the change in the price from the previous day. The fourth column shows the estimated average life of the mortgages in the underlying pool. The fifth column gives the spread (in basis points) between the yield to maturity on the MBS and the yield on a U.S.

Treasury note or bond with a maturity similar to the average life on the MBS. Column 6 shows the change in this spread from the previous day.

Column 7 shows the assumed PSA prepayment rate and the final column shows the yield to maturity on the MBS calculated using the assumed prepayment rate, also known as the **cash flow yield**. Essentially, cash flow yield is the interest rate that equates the present value of all future cash flows on the mortgage pool to the current price of the pool, assuming a particular prepayment rate.

13.8 Summary and Conclusions

This chapter discusses the large and growing market for mortgage-backed securities. Many aspects of this market were covered, including the following items.

1. Most Americans finance their homes with mortgages. The buyer makes a down payment and borrows the remaining cost with a mortgage loan. Mortgages are often repackaged into mortgage-backed securities through a process called mortgage securitization. Currently, about half of all mortgages in the United States have been securitized; yet the risks involved in these investments are often misunderstood.

2. Most home mortgages are 15- or 30-year fixed-rate mortgages requiring constant monthly payments. The present value of all monthly payments is equal to the original amount of the mortgage loan. Each monthly payment has two components: payment of interest on outstanding mortgage principal and a scheduled pay down of mortgage principal. The relative amounts of each component change throughout the life of a mortgage. The interest payment component gradually declines, and the pay down of principal component gradually increases.

3. A mortgage borrower has the right to pay off a mortgage early, which is called mortgage prepayment. Borrowers frequently decide to prepay to refinance an existing mortgage at a lower interest rate. Prepayment and refinancing, advantages to mortgage borrowers, are disadvantage to mortgage investors. Thus mortgage investors face prepayment risk.

4. In 1968, Congress established the Government National Mortgage Association (GNMA) as a government agency charged with promoting liquidity in the secondary market for home mortgages. GNMA is the largest single guarantor of mortgage-backed securities. Two government-sponsored enterprises (GSEs) are also significant mortgage repackaging sponsors: the Federal Home Loan Mortgage Corporation (FHLMC) and the Federal National Mortgage Association (FNMA).

5. Each month, GNMA, FHLMC, and FNMA mortgage-backed bond investors receive cash flows derived from fully modified mortgage pools. Each monthly cash flow has three distinct components: payment of interest on outstanding mortgage principal, scheduled amortization of mortgage principal, and mortgage principal prepayments.

6. Mortgage prepayments are stated as a prepayment rate. The greater the prepayment rate, the faster is mortgage pool principal paid off. Prepayment rates can vary substantially from year to year, depending on mortgage type and various economic and demographic factors. Conventional industry practice states prepayment rates using a prepayment model specified by the Public Securities Association (PSA). This model states prepayment rates as a percentage of a PSA benchmark, which represents an annual prepayment rate of 6 percent for seasoned mortgages, and is called 100 PSA. Deviations from the 100 PSA benchmark are stated as a percentage of the benchmark.

7. Prepayment risk complicates the effects of interest rate risk. Interest rate risk for a bond is related to its effective maturity as measured by Macaulay duration. However, Macaulay duration assumes a fixed schedule of cash flow payments. But the schedule of cash flow payments for mortgage-backed bonds is not fixed because it is affected by mortgage prepayments, which in turn are affected by interest rates. For this reason, Macaulay duration is a deficient measure of interest rate risk for mortgage-backed bonds.

8. Cash flows from mortgage pools are often carved up and distributed according to various rules. Mortgage-backed securities representing specific rules for allocating mortgage cash flows are called collateralized mortgage obligations (CMOs). The three best known types of CMO structures using specific rules to carve up mortgage pool cash flows are interest-only (IO) and principal-only (PO) strips, sequential CMOs, and protected amortization class securities (PACs).

9. Cash flow yields for mortgage-backed securities (MBSs) and collateralized mortgage obligations (CMOs) for GNMA, FHLMC, and FNMA mortgage pools are published daily in the *Wall Street Journal*. Cash flow yield for a mortgage-backed security corresponds to yield to maturity for an ordinary bond. Essentially, cash flow yield is the interest rate that discounts all future expected cash flows from a mortgage pool to be equal to the price of the mortgage pool.

Key terms

fixed-rate mortgage

mortgage pass-throughs

mortgage backed securities (MBSs)

mortgage securitization

fully modified mortgage pool

prepayment rate

prepayment risk

seasoned mortgages

unseasoned mortgages

conditional prepayment rate (CPR)

protected amortization class (PAC)

average mortgage life

Macaulay duration

PAC support bond

PAC collar

mortgage principal

mortgage amortization

mortgage prepayment

collateralized mortgage obligations (CMOs)

principal-only strip (PO)

interest-only strip (IO)

sequential CMO

Federal Home Loan Mortgage Corporation (FHLMC)

Federal National Mortgage Association (FNMA)

Government National Mortgage Association (GNMA)

cash flow yield

Get Real!

This chapter covered one of the more complex investments available, mortgage-back securities (MBSs). Ironically, these investments are fairly complicated, but unlike most exotic instruments, the basic types of MBSs are very suitable for ordinary individual investors. In fact, GNMAs and similar investments are frequently recommended, and rightly so, for even very conservative investors.

However, as a practical matter, directly buying into mortgage pools is not practical for most individual investors. It is also probably unwise, because not all pools are equally risky in terms of prepayments, and analysis of individual pools is best left to experts. Instead, most investors in MBSs end up in mutual funds specializing in these instruments, and most of the major mutual fund families have such funds. A good place to learn more is a prospectus from such a fund.

An important real-world aspect in mortgage investing of any kind is that some of the cash flow received is typically principal and some is interest. In contrast, with a coupon bond, for example, no principal is returned until the bond matures or is called. When a mortgage matures, however, no principal is returned other than the amount contained in the final payment.

The reason this is important is that many investors have a policy of living on or otherwise spending the income (i.e., dividends and interest) from their portfolios. Such investors need to understand that, with an amortizing investment, only a portion of a cash payment received is actually income. Unfortunately, unsophisticated investors sometimes focus only on the total amount received without recognizing this fact and, unfortunately, wake up to discover that all (or a substantial part) of the principal is spent and thus not available to generate future investment income.

Chapter 13
Mortgage-Backed Securities

Questions and Problems

Review Problems and Self-Test

1. **Mortgage Payments** What are the monthly payments on a 30-year $150,000 mortgage if the mortgage rate is 6 percent? What portion of the first payment is interest? Principal?

2. **Mortgage Balances** Consider a 15-year $210,000 mortgage with a 7 percent interest rate. After 10 years, the borrower (the mortgage issuer) pays it off. How much will the lender receive?

Answers to Self-Test Problems

1. This is a standard time value of money calculation in which we need to find an annuity-type payment. The present value is $150,000. The interest rate is .06/12 = .005, or .5 percent per month. There is a total of 360 payments. Using the formula from the text (generalized slightly), we have

$$\text{Monthly payment} = \frac{\text{Mortgage balance} \times r/12}{1 - \dfrac{1}{(1+r/12)^{T\times 12}}}$$

Plugging in r = .06 and T = 30, we get a payment of $899.33. The interest portion for a month is equal to the mortgage balance at the beginning of the month ($150,000 in this case) multiplied by the interest rate per month (.5 percent), or $150,000 × .005 = $750. The remaining portion of the payment, $899.33 - $750 = $149.33, goes to reduce the principal balance.

2. We first need to know the monthly payment. Here, the original balance is $210,000, the rate is 7 percent, and the original life is 15 years. Plugging in the numbers using the formula just above, check that we get a monthly payment of $1,887.54.

From here, there are two ways to go. One is relatively easy, the other is relatively tedious. The tedious way would be to construct an amortization table for the mortgage and then locate the balance in the table. However, we need only a single balance, so there is a much faster way. After 10 years, we can treat this mortgage as though it were a 5-year mortgage with payments of $1,887.54 and an interest rate of 7 percent. We can then solve for the mortgage balance using the same formula:

$$\text{Monthly payment} = \frac{\text{Mortgage balance} \times .07/12}{\left(1 - \dfrac{1}{(1+.07/12)^{5\times 12}}\right)}$$

$$= \$1{,}887.54$$

Solving for the mortgage balance gets us $95,324.50.

Test Your IQ (Investments Quotient)

1. **Fixed-rate mortgages** Which of the following statements about fixed rate mortgages is false?

a. 15-year mortgages have higher monthly payments than 30-year mortgages
b. scheduled monthly payments are constant over the life of the mortgage
c. actual monthly payments may vary over the life of the mortgage
d. absent defaults, actual monthly payments are never more than scheduled monthly payments

2. **GNMA bonds** Mortgages in GNMA pools are said to be fully modified because GNMA guarantees bondholders which of the following?

a. a minimum rate of return on their investment
b. a modified schedule of cash flows over the life of the pool
c. full and timely payment of both principal and interest in the event of default
d. eventual payment of both principal and interest in the event of default

3. **GNMA bonds** Which of the following is not a source of risk for GNMA mortgage pool investors?

a. prepayment risk
b. default risk
c. interest rate risk
d. reinvestment risk

4. **GNMA bonds** Which one of the following sets of features most accurately describes a GNMA mortgage pass-through security? (*1988 CFA exam*)

	Average Life	Payment Frequency	Credit Risk
a.	Predictable	Monthly	High
b.	Predictable	Semiannual	Low
c.	Unpredictable	Monthly	Low
d.	Unpredictable	Semiannual	Low

5. **GNMA bonds** In contrast to original-issue U.S. Treasury securities, original-issue GNMA pass-through securities: (*1988 CFA exam*)

a. provide quarterly payments to the investor.
b. have a limited availability of maturities.
c. are often issued in zero coupon form.
d. have interest payments.

6. **GNMA bonds** Which of the following should a bond portfolio manager who is looking for mortgage-backed securities that would perform best during a period of rising interest rates purchase: (*1989 CFA exam*)

a. a 12 percent GNMA with an average life of 5.6 years.
b. an 8 percent GNMA with an average life of 6.0 years.
c. a 10 percent GNMA with an average life of 8.5 years.
d. a 6 percent GNMA with an average life of 9.0 years.

7. **GNMA bonds** Why will the effective yield on a GNMA bond be higher than that of a U.S. Treasury bond with the same quoted yield to maturity? Because (*1991 CFA exam*)

a. GNMA yields are figured on a 360-day basis.
b. GNMAs carry higher coupons.
c. GNMAs have longer compounding periods.
d. GNMA interest is paid monthly.

8. **Mortgage-backed bonds** If a mortgage-backed bond is issued as a fully modified pass-through security, it means that: (*1991 CFA exam*)

a. bondholders will receive full and timely payment of principal and interest even if underlying mortgage payments are not made.
b. the bond has been structured to include both conforming and nonconforming loans.
c. the interest rates on the underlying mortgages have been altered so that they equal the weighted-average coupon on the bond.
d. the security carries a balloon payment to ensure that the bond is fully amortized in a set time frame (12 to 15 years).

9. **Prepayments** Projecting prepayments for mortgage pass-through securities: (*1990 CFA exam*)

a. requires only a projection of changes in the level of interest rates.
b. requires analyzing both economic and demographic variables.
c. is not necessary to determine a cash flow yield.
d. is not necessary to determine duration.

10. **Prepayments** A bond analyst at Omnipotent Bank (OB) notices that the prepayment experience on his holdings of high coupon GNMA issues has been moving sharply higher. What does this indicates? (*1989 CFA exam*)

a. interest rates are falling.
b. the loans comprising OB's pools have been experiencing lower default rates.
c. the pools held by OB are older issues.
d. all of the above.

11. **Mortgage-backed bonds** Which of the following statements about mortgage pass-through securities is (are) correct? (*1991 CFA exam*)

I. Pass-throughs offer better call protection than most corporates and Treasuries.
II. Interest and principal payments are made on a monthly basis.
III. It is common practice to use the weighted-average maturity on a pass-through in place of its duration.
IV. Pass-throughs are relatively immune from reinvestment risk.

a. I and III only
b. II and III only
c. II only
d. IV only

12. **Mortgage-backed bonds** Which of the following are advantages of mortgage-backed securities (MBS)? (*1991 CFA exam*)

I. MBS yields are above those of similarly rated corporate and U.S. Treasury bonds.
II. MBS have high-quality ratings, usually AAA, with some backed by the full faith and credit of the U.S. government.
III. MBS have no call provision, thus protecting the investor from having to make a reinvestment decision before maturity.

a. I and II only
b. II and III only
c. I and III only
d. I, II, and III

13. **Mortgage-backed bonds** Which of the following are characteristics that would make mortgage-backed securities (MBSs) inappropriate for less sophisticated, conservative investors? (*1989 CFA exam*)

I. The maturity of MBSs is quite variable and difficult to determine.
II. Due to their convexity, the realized total return on MBSs is often more dependent on interest rate levels than other bonds of similar maturity.
III. Due to a possible unfamiliarity with prepayment concepts, investors may not be able to evaluate the true yield on MBS issues.
IV. Many MBS issues are not quoted widely and are difficult to monitor.

a. I, II and III only
b. I, III and IV only
c II and IV only
d. all of the above

14. **Collateralized mortgage obligations** For a given mortgage pool, which of the following CMOs based on that pool is the riskiest investment?

a. 100/300 PAC bond
b. A-tranche sequential CMO
c. interest-only (IO) strip
d. principal-only (PO) strip

15. **Collateralized mortgage obligations** For a given mortgage pool, which of the following CMOs based on that pool is most likely to increase in price when market interest rates increase?

a. 100/300 PAC bond
b. A-tranche sequential CMO
c. interest-only (IO) strip
d. principal-only (PO) strip

Questions and Problems

Core Questions

1. **Mortgage Securitization** How does mortgage securitization benefit borrowers?

2. **Mortgage Securitization** How does mortgage securitization benefit mortgage originators?

3. **Mortgage Payments** What is the monthly payment on a 30-year fixed rate mortgage if the original balance is $180,000 and the rate is 8 percent?

4. **Mortgage Payments** All else the same, will the payments be higher on a 15-year mortgage or a 30-year mortgage? Why?

5. **Ginnie, Freddie, and Fannie** From an investor's point of view, what is the difference between mortgage pools backed by GNMA, FNMA, and FHLMC?

6. **Mortgage Balances** If a mortgage has monthly payments of $1,000, a life of 30 years, and a rate of 6 percent per year, what is the mortgage amount?

7. **Mortgage Pools** What does it mean for a mortgage pool to be fully modified?

8. **Mortgage Interest** A 30-year $140,000 mortgage has a rate of 8 percent. What are the interest and principal portions in the first payment? In the second?

9. **Prepayments** What are some of the reasons that mortgages are paid off early? Under what circumstances are mortgage prepayments likely to rise sharply? Explain.

10. **Mortgage Balances** Consider a 30-year $200,000 mortgage with 6.5 percent interest rate. After 10 years, the borrower (the mortgage issuer) pays it off. How much will the lender receive?

Intermediate Questions

11. **Prepayments** Explain why the right to prepay a mortgage is similar to the call feature contained in most corporate bonds.

12. **Prepayments** Consider a 15-year $120,000 mortgage with a rate of 9 percent. Eight years into the mortgage, rates have fallen to 6 percent. What would be the monthly saving to a homeowner from refinancing the outstanding mortgage balance at the lower rate?

13. **Prepayments** Evaluate the following argument: “Prepayment is not a risk to mortgage investors because prepayment actually means that the investor is paid both in full and ahead of schedule.” Is it always true or false?

14. **Prepayments** Consider a 30-year $140,000 mortgage with a rate of 6.375 percent. Five years into the mortgage, rates have fallen to 6 percent. Suppose the transaction cost of obtaining a new mortgage is $1,000. Should the homeowner refinance at the lower rate?

15. **CPRs** What are the conditional prepayment rates for seasoned 50 PSA, 200 PSA, and 400 PSA mortgages? How do you interpret these numbers?

16. **SMMs** What is the single month mortality for seasoned 50 PSA, 200 PSA, and 400 PSA mortgages? How do you interpret these numbers?

17. **CMOs** What is a collateralized mortgage obligation? Why do they exist? What are three popular types?

18. **IO and PO Strips** What are IO and PO strips? Assuming interest rates never change, which is riskier?

19. **IO and PO Strips** Which has greater interest rate risk, an IO or a PO strip?

20. **Sequential CMOs** Consider a single whole bond sequential CMO. It has two tranches, an A-tranche and a Z-tranche. Explain how the payments are allocated to the two tranches. Which tranche is riskier?

21. **PACs** Explain in general terms how a protected amortization class CMO works.

22. **Duration and MBSs** Why is Macaulay duration an inadequate measure of interest rate risk for an MBS?

Chapter 13
Mortgage-Backed Securities
Answers and solutions

Answers to Multiple Choice Questions

1. D
2. C
3. B
4. C
5. B
6. A
7. D
8. A
9. B
10. A
11. C
12. A
13. D
14. A
15. C

Answers to Questions and Problems

Core Questions

1. Mortgage securitization benefits borrowers by reducing interest rates. Interest rates are reduced because securitization increases liquidity in the mortgage market. More liquid mortgages have higher prices and, hence, lower rates.

2. It benefits mortgage originators by allowing them to transfer the risk associated with holding mortgages and instead focus on what they do best, originate mortgages. Also, and equally important, by selling mortgages, originators obtain new funds to loan out.

3. We compute the payment as follows:

$$\$1{,}320.78 = \frac{\$180{,}000 \times .08/12}{1 - \dfrac{1}{(1+.08/12)^{30\times 12}}}$$

4. For the same rate and original balance, the 15-year mortgage will have the higher payments simply because a larger principal payment must be made each month to pay off the loan over a shorter time.

5. Only GNMA is a federal agency, and GNMA securities are backed by the full faith and credit of the U.S. government. The other two, in principle, do not have this backing. As a practical matter, however, the difference is slight.

6. We solve for the mortgage balance as follows:

$$\$1{,}000 = \frac{\text{Mortgage balance} \times .06/12}{1 - \dfrac{1}{(1+.06/12)^{30\times 12}}}$$

Solving for the mortgage balance gets us $166,791.61.

7. It means that timely payment of both principal and interest are guaranteed.

8. Verify that the payment is $1,027.27. The interest in the first month is equal to the original loan amount ($140,000) multiplied by the interest rate, .08/12 = .067 (actually .0666 . . .) per month. The interest thus amounts to $933.33. The remaining $1,027.27 - 933.33 = 93.94 is principal.

9. Mortgages are prepaid because the underlying property is sold, interest rates fall, or the owner otherwise wishes to refinance (perhaps to increase the loan balance as a way of obtaining funds for other purposes) or payoff the mortgage. When interest rates fall, prepayments accelerate. Larger drops lead to sharp increases in prepayment rates.

10. First, check that the payment is $1,264.14 (actually $1,264.136). We calculate the loan balance as follows:

$$\$1{,}264.136 = \frac{\text{Mortgage balance} \times .066/12}{1 - \dfrac{1}{(1+.065/12)^{20\times 12}}}$$

Solving for the mortgage balance gets us $169,552.25. Notice that we used the 20 years remaining in arriving at this balance.

Intermediate Questions

11. The call feature on a bond gives the borrower the right to buy the bond (i.e., pay off the debt) at a fixed price. The right to prepay on a mortgage gives the borrower the same right.

12. The original payment is (check this) $1,217.12. After eight years, the balance on the loan (check this; note the remaining life is seven years) is $75,648.82. For comparability, we calculate the new payments assuming a loan of $75,648.82, a 7-year life, and a rate of 6 percent. The new payment (check this) is $1,105.12. Thus, the saving is $112 per month. Notice that it would be misleading to compare the payments on the old loan to a new, 15-year loan.

13. Prepayments that result purely from interest drops are a risk; they mean that the mortgage investor will have to reinvest at a lower rate. However, some mortgages are prepaid for other reasons, such as the sale of the underlying property. This can happen even if interest rates have risen substantially; such a prepayment benefits the mortgage investors. Thus, not all prepayments are bad, just those result in the need to reinvest at a lower rate.

14. The original payment is (check this) $873.42. After five years, the balance on the loan (check this; note the remaining life is 25 years) is $130,865.34. For comparability, we calculate the new payments assuming a loan of the current balance *plus* $1,000. The reason is that this is the total amount that must be paid to refinance. Thus, we assumea a loan of $131,865.34, a 25-year life, and a rate of 6 percent. The new payment (check this) is $849.61. Thus, the saving is $23.81 per month, so it pays to refinance, but not a lot.

15. For a seasoned 100 PSA mortgage, the CPR is 6 percent per year. A 50 (200, 400) PSA is just half (twice, four times), or 3 (12, 24) percent per year. These CPRs have two more or less equivalent interpretations. They are an estimate of the probability that any given mortgage in the pool will prepay in a given year. A more useful interpretation is that they are an estimate of the percentage of outstanding principal that will be prepaid in a given year. In other words, if the odds of prepayment are 6 percent for any given mortgage, then we expect that 6 percent of all mortgages will prepay, meaning that 6 percent of the principal in a mortgage pool will be prepaid per year.

16. We calculate SMMs as follows:

$$SMM = 1 - (1 - CPR)^{1/12} .$$

Given the answers in the previous problem, it’s mostly a matter of plug and chug. The answers are .254 percent (50 PSA), 1.06 percent (200 PSA), and 2.26 percent (400 PSA). Notice that the 400 PSA is not simply double the 200; there’s a compound interest-type effect in the calculation.

17. A collateralized mortgage obligation (CMO) is a mortgage-backed security with cash flows that are divided into multiple securities. They exist because they provide a means of altering some of the less desirable characteristics of MBS's, thereby increasing marketability to a broader class of investors. More fundamentally, they exist because investment banks (the creators and marketers) have found them to be a profitable product!

18. Every mortgage payment has an interest portion and a principal portion. IO and PO strips are very simple CMO's; the interest and principal portions are separated into distinct payments. Holders of IO strips receive all the interest paid; the principal goes to holders of PO strips. If interest rates never change, the IO strips–especially the longer dated ones–are vastly more risky. With PO strips, the only uncertainty is when the principal is paid. All PO strips-holders will receive full payment. With an IO strip, however, prepayment means that no future interest payments will be made, so the amount of interest that will be received is unknown.

19. PO strips have greater interest rate risk, where we define interest rate risk to mean losses associated with interest rate increases and gains associated with decreases. When interest rates go up, prepayments slow down, thereby postponing the time until principal is received. IO strips can actually behave like "inverse floaters," their value tends to *rise* when interest rates increase. The reason is that slowing prepayments increases the interest that will be received by IO strips-holders.

20. The A-tranche will essentially receive all of the payments, both principal and interest until it is fully paid off. The Z-tranche receives nothing until the A-tranche is paid off. After that, the Z-tranche receives everything. The Z-tranche is much riskier because the size and timing of the payment is not known.

21. With a protected amortization class (PAC) CMO, payments are made to one group of investors according to a set schedule. This means that the protected class investors have almost fully predictable cash flows. After protected class investors are paid, all the remaining cash flow goes to non-PAC investors, who hold PAC support or PAC companion bonds. In essence, one group of investors receives fixed payments, the other group absorbs all (or virtually all) the uncertainty created by prepayments.

22. Macaulay duration assumes fixed cash flows. With MBS's and CMO's, the payments depend on prepayments, which in turn depend on interest rates. When prepayments pick up, duration falls, and vice versa. Thus, no single measure is accurate.

Table 13.1: $100,000 mortgage loan monthly payments

	Mortgage maturity				
Interest rate (%)	30-year	20-year	15-year	10-year	5-year
5	536.82	659.96	790.79	1060.66	1887.12
5.5	567.79	687.89	817.08	1085.26	1910.12
6	599.55	716.43	843.86	1110.21	1933.28
6.5	632.07	745.57	871.11	1135.48	1956.61
7	665.30	775.30	898.83	1161.08	1980.12
7.5	699.21	805.59	927.01	1187.02	2003.79
8	733.76	836.44	955.65	1213.28	2027.64
8.5	768.91	867.82	984.74	1239.86	2051.65
9	804.62	899.73	1014.27	1266.76	2075.84
9.5	840.85	932.13	1044.22	1293.98	2100.19
10	877.57	965.02	1074.61	1321.51	2124.70
10.5	914.74	998.38	1105.40	1349.35	2149.39
11	952.32	1032.19	1136.60	1377.50	2174.24
11.5	990.29	1066.43	1168.19	1405.95	2199.26
12	1028.61	1101.09	1200.17	1434.71	2224.44
12.5	1067.26	1136.14	1232.52	1463.76	2249.79
13	1106.20	1171.58	1265.24	1493.11	2275.31
13.5	1145.41	1207.37	1298.32	1522.74	2300.98
14	1184.87	1243.52	1331.74	1552.66	2326.83
14.5	1224.56	1280.00	1365.50	1582.87	2352.83
15	1264.44	1316.79	1399.59	1613.35	2378.99

Table 13.2: $100,000 mortgage loan amortization schedules for 15-year and 30-year mortgages

	30-year mortgage $733.76 monthly payment				15-year mortgage $955.65 monthly payment		
Paymen month	Remaining principal	Principal reductio	Interest payment	Paymen month	Remaining principal	Principal reductior	Interest payment
1	99932.28	67.10	666.66	1	99710.80	288.98	666.67
12	99164.02	72.19	661.57	12	96401.94	310.90	644.75
24	98259.32	78.18	655.58	24	92505.48	336.70	618.95
36	97279.54	84.67	649.09	36	88285.62	364.65	591.00
48	96218.44	91.69	642.07	48	83715.51	394.91	560.74
60	95069.26	99.30	634.46	60	78766.09	427.69	527.96
72	93824.71	107.54	626.22	72	73405.86	463.19	492.46
84	92476.86	116.47	617.29	84	67600.74	501.63	454.02
96	91017.13	126.14	607.62	96	61313.80	543.27	412.38
108	89436.25	136.61	597.15	108	54505.04	588.36	367.29
120	87724.16	147.95	585.81	120	47131.16	637.19	318.46
132	85869.96	160.23	573.53	132	39145.25	690.08	265.57
144	83861.87	173.52	560.24	144	30496.52	747.36	208.29
156	81687.10	187.93	545.83	156	21129.94	809.39	146.26
168	79331.84	203.52	530.24	168	10985.94	876.57	79.08
180	76781.08	220.42	513.34	180	0.00	949.32	6.33
192	74018.62	238.71	495.05				
204	71026.87	258.52	475.24				
216	67786.80	279.98	453.78				
228	64277.82	303.22	430.54				
240	60477.59	328.39	405.37				
252	56361.94	355.64	378.12				
264	51904.69	385.16	348.60				
276	47077.50	417.13	316.63				
288	41849.65	451.75	282.01				
300	36187.89	489.25	244.51				
312	30056.21	529.85	203.91				
324	23415.61	573.83	159.93				
336	16223.83	621.46	112.30				
348	8435.14	673.04	60.72				
360	0.00	728.90	4.86				

Figure 13.1A Mortgage Principal and Payments ($100,000 mortgage 8% financing rate)

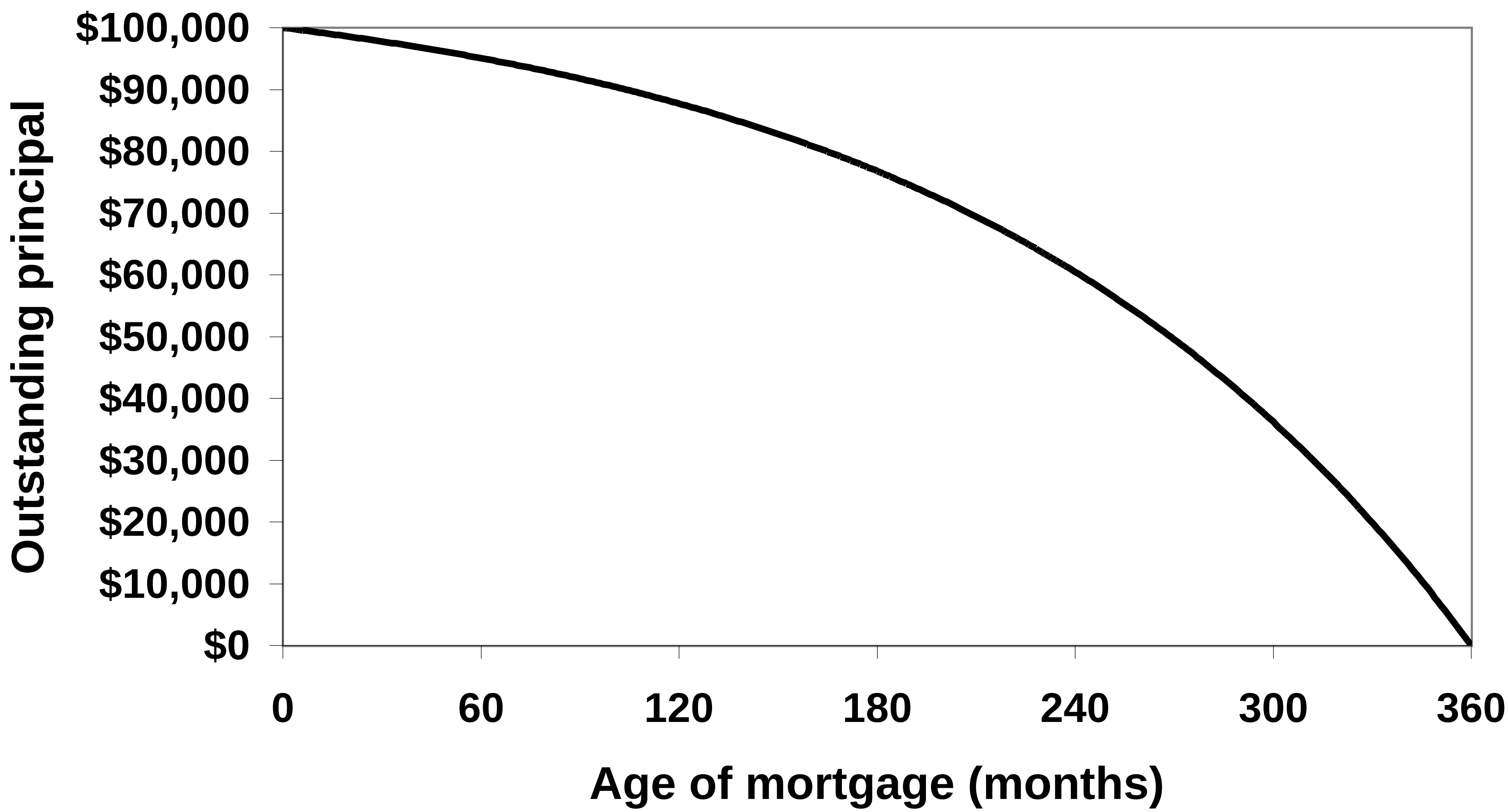
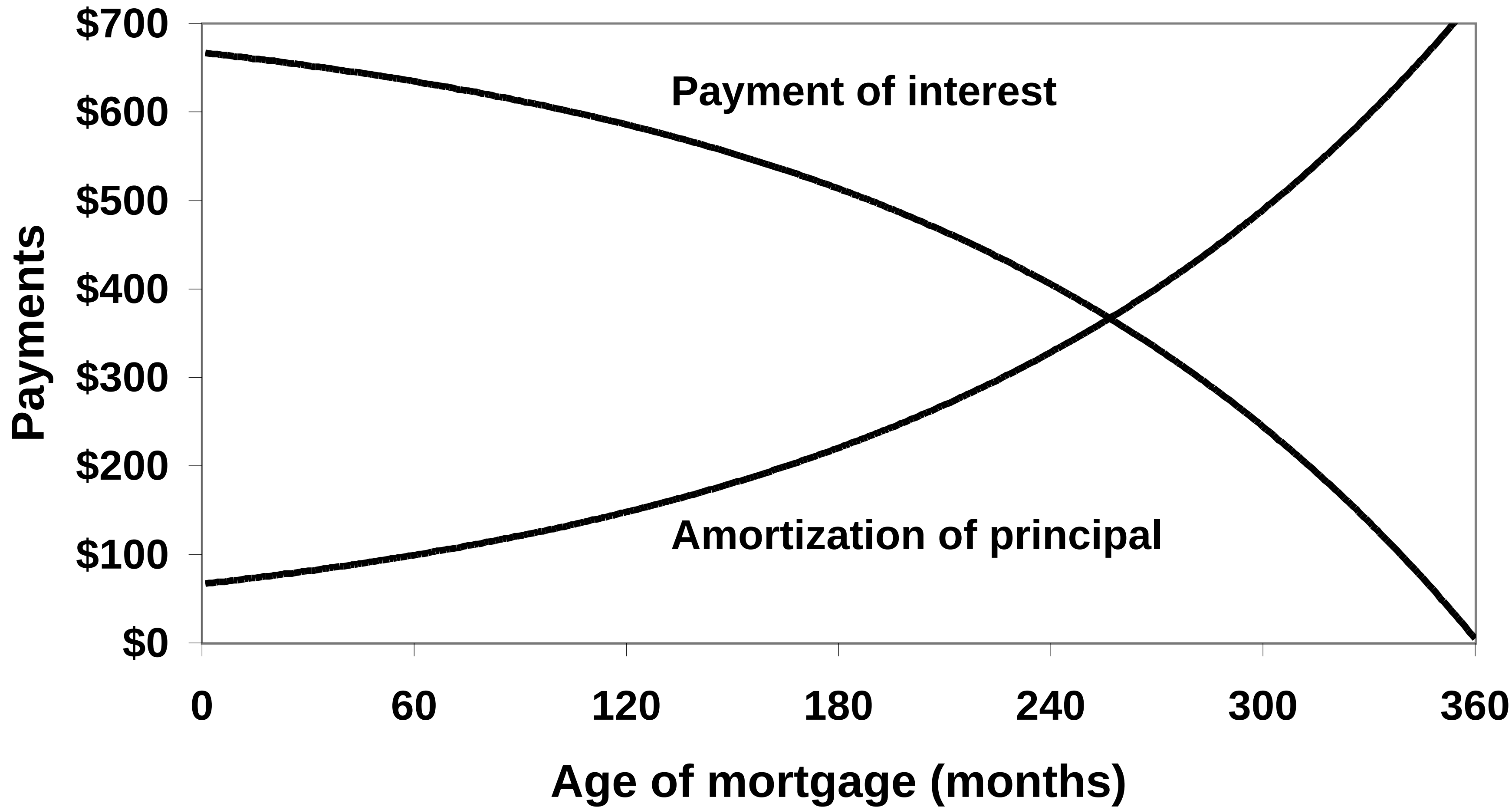


Figure 13.1B Mortgage Payment Components
($100,000 mortgage 8% financing rate)



GETTING GOING / BY JONATHAN CLEMENTS

It May Make Sense To Pay Down a Mortgage

Maybe this is the year to put it on the house.

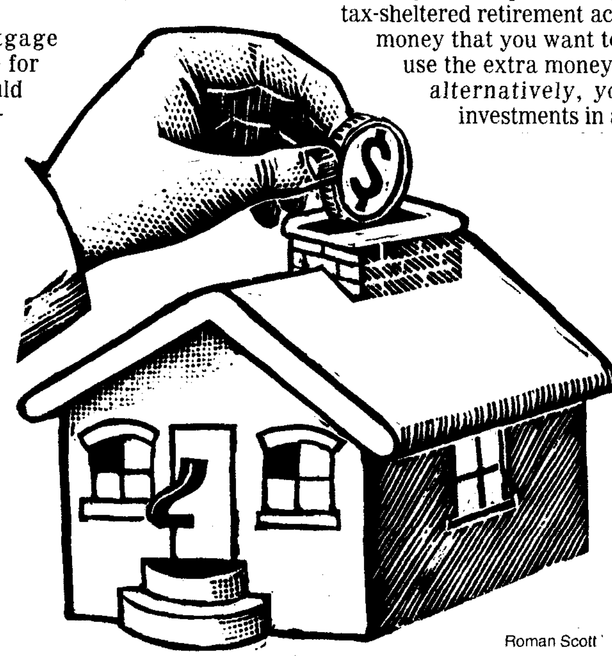
Spooked by the stock market? Disenchanted with lowly bond yields? Consider taking some of your investment dollars and using them to pay down your mortgage.

Admittedly, making extra-mortgage payments won't earn you dazzling returns. If your mortgage rate is 8%, that's your effective pretax rate of return on every additional dollar you add to your mortgage check.

Doesn't seem like much? Sure, it can't compare with the 11%-a-year total return for stocks since year-end 1925, and it pales beside the 31% annual stock-market gain of the past three calendar years, as calculated by Chicago's Ibbotson Associates.

But making extra-mortgage payments can be a smart move for conservative investors who would otherwise buy bonds, money-market funds and certificates of deposit.

The case for making extra-mortgage payments has been bolstered by the recent drop in interest rates, which has squeezed yields on bonds and other conservative investments. In fact, interest rates have fallen so much that many folks are seizing the chance to refinance their mortgages and lock in lower rates.



Roman Scott

For those homeowners who find it's not worth refinancing, extra-mortgage payments offer an alternative way of eliminating costly mortgage debt. By adding just a few dollars to each monthly check, you can save thousands of dollars in interest over the life of your mortgage.

Suppose you just borrowed $200,000 using a 30-year, 7½% fixed-rate mortgage that requires a $1,400 monthly payment. By adding only $25 to each check, for a total of $8,425 over the life of the loan, you would save $22,500 in interest and pay off your mortgage almost two years early.

Adding a few dollars to the monthly check can also make sense if you have an adjustable-rate mortgage. But with an ARM, your extra $25 won't shorten the length of the loan. Instead, the additional dollars will lead to lower required monthly payments.

"It's almost always a good time to pay down your mortgage," Mr. Gumbinger argues. "It's a solid, 100%-guaranteed investment."

Still, before you tack an extra $25, $50 or $100 onto the next mortgage check, make sure you have already made the most of other options that promise a higher return. For instance, instead of paying down your mortgage, you are much better off getting rid of credit-card debt. Your cards may be costing you 18% a year and, unlike mortgage debt, the interest isn't tax-deductible.

Similarly, before you make any extra-mortgage payments, you should invest the maximum possible in your employer's retirement-savings plan and fully fund a regular or Roth individual retirement account.

Once you have paid off high-cost debt and made full use of tax-sheltered retirement accounts, you may have additional money that you want to save. At that point, you might use the extra money to pay down your mortgage or, alternatively, you could use the cash to buy investments in a regular taxable account.

Figure 13.2 PSA Prepayment Model Conditional Prepayment Rates (CPR)

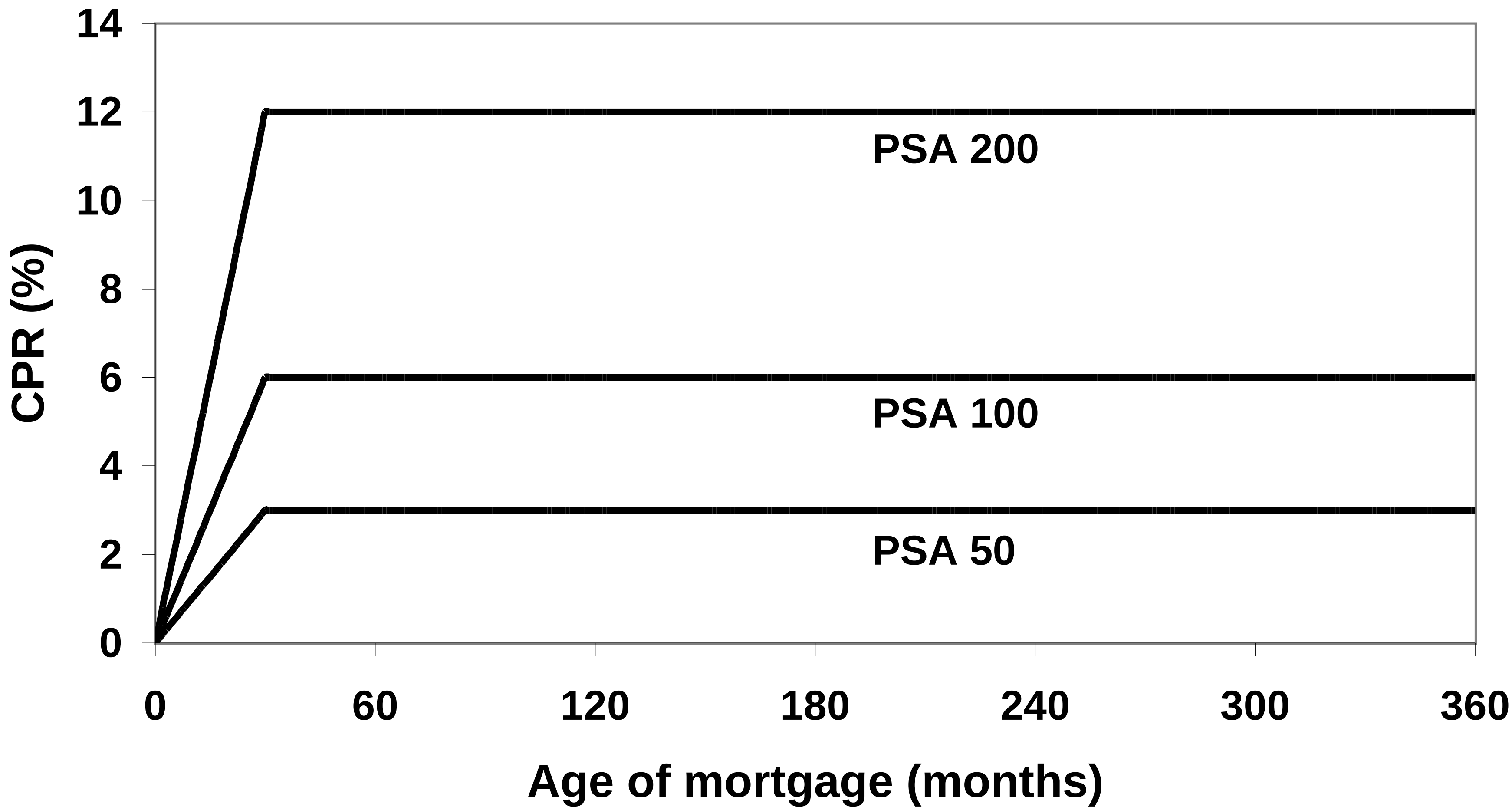


Figure 13.3A GNMA Bond Principal
($100,000 par value 30-year 8% bonds)

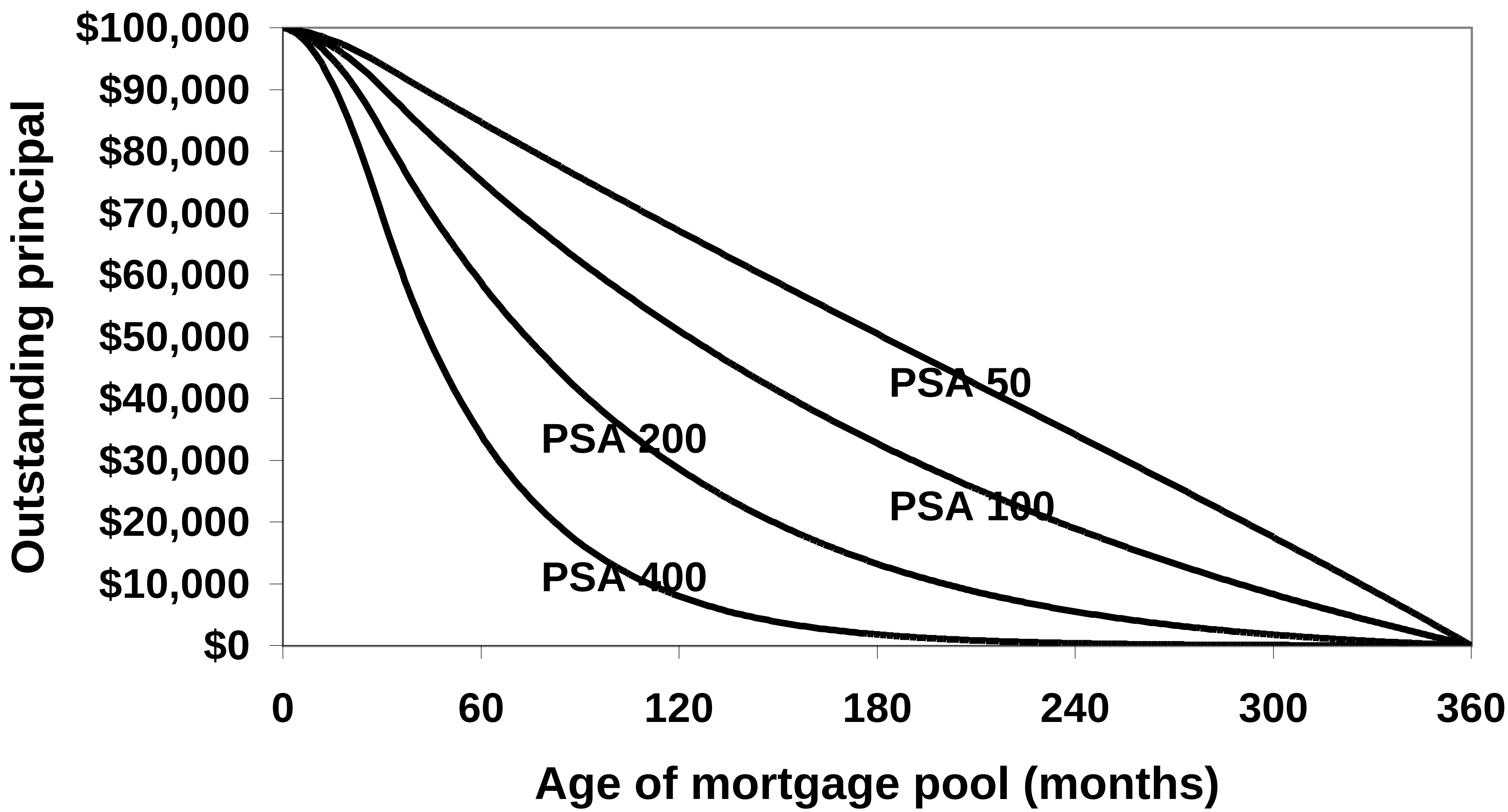


Figure 13.3B GNMA Bond Cash Flows ($100,000 par value 30-year 8% bonds)

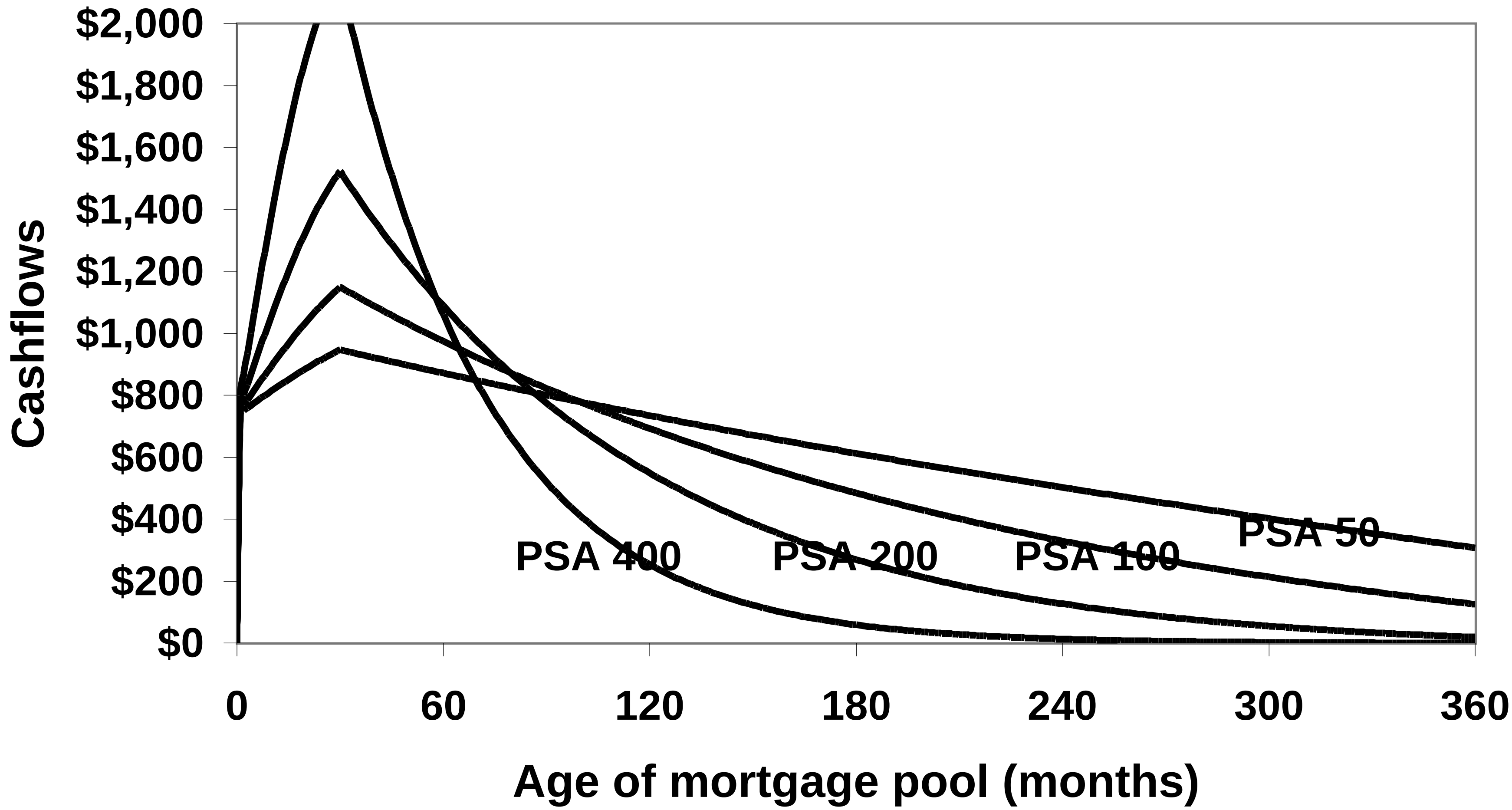


Figure 13.4A GNMA IO Strip Cash Flows
($100,000 par value 30-year 8% bonds)

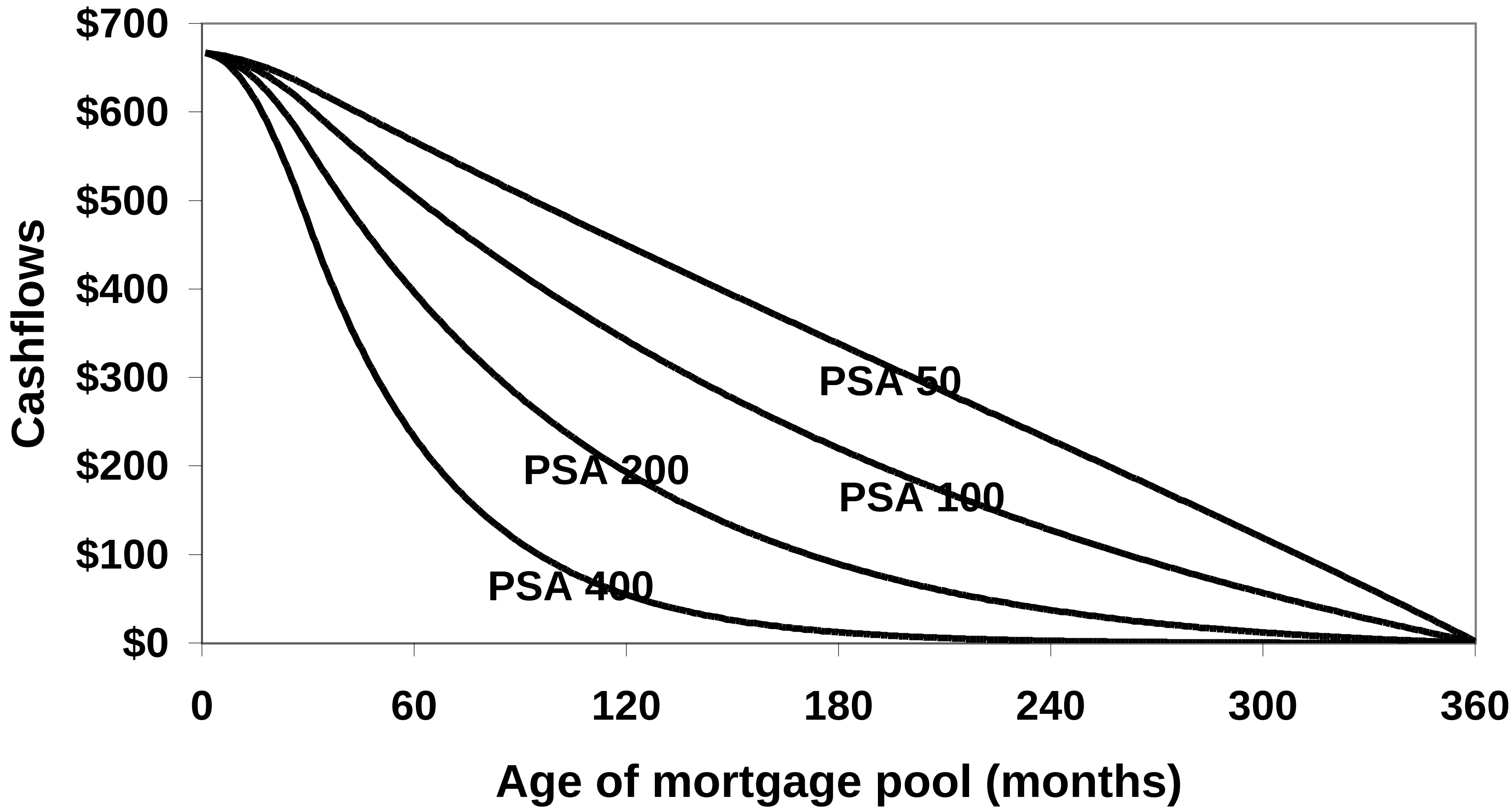


Figure 13.4B GNMA PO Strip Cash Flows
($100,000 par value 30-year 8% bonds)

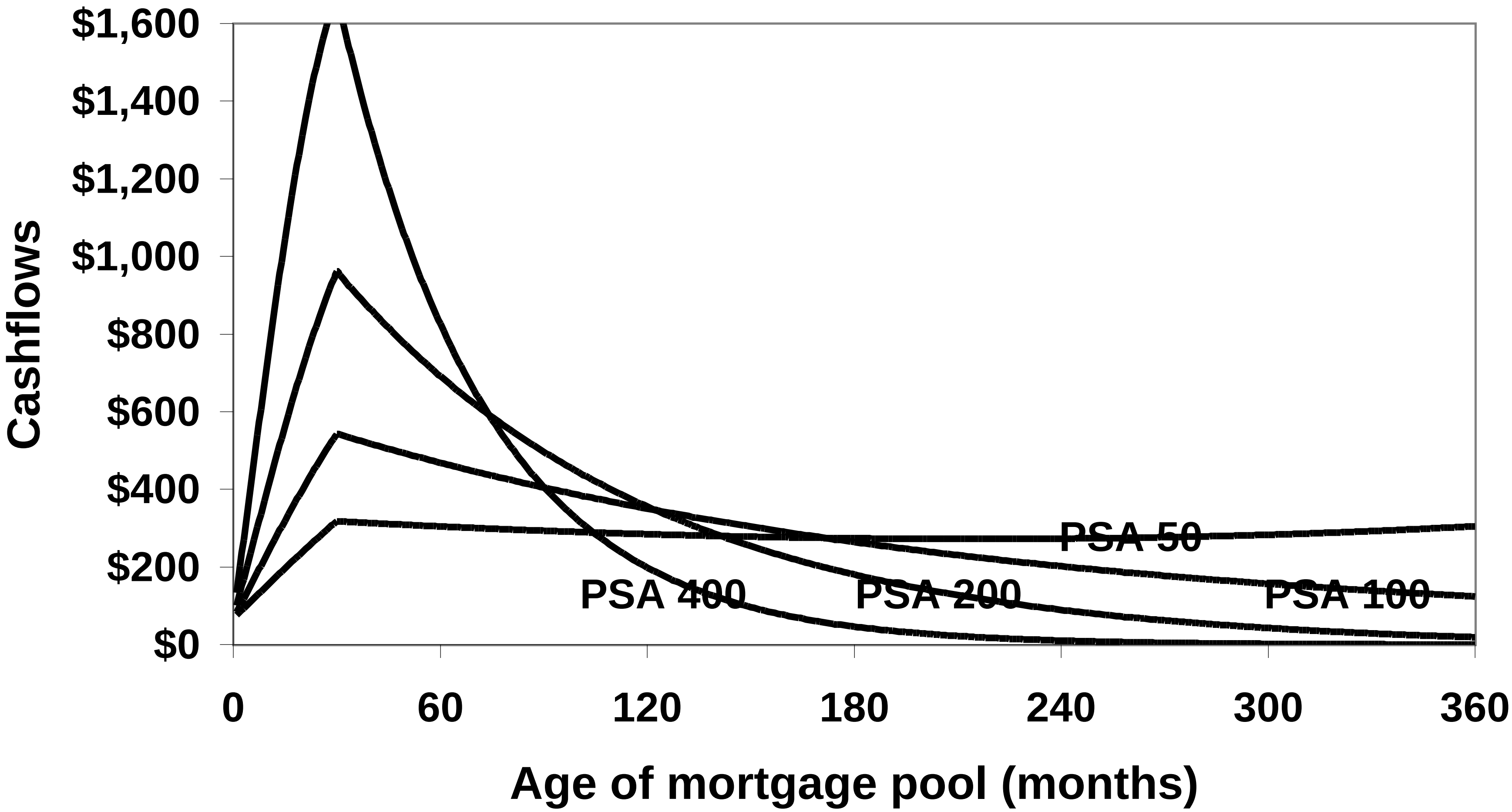


Figure 13.5A Sequential CMO Principal
($100,000 par value GNMA bond)

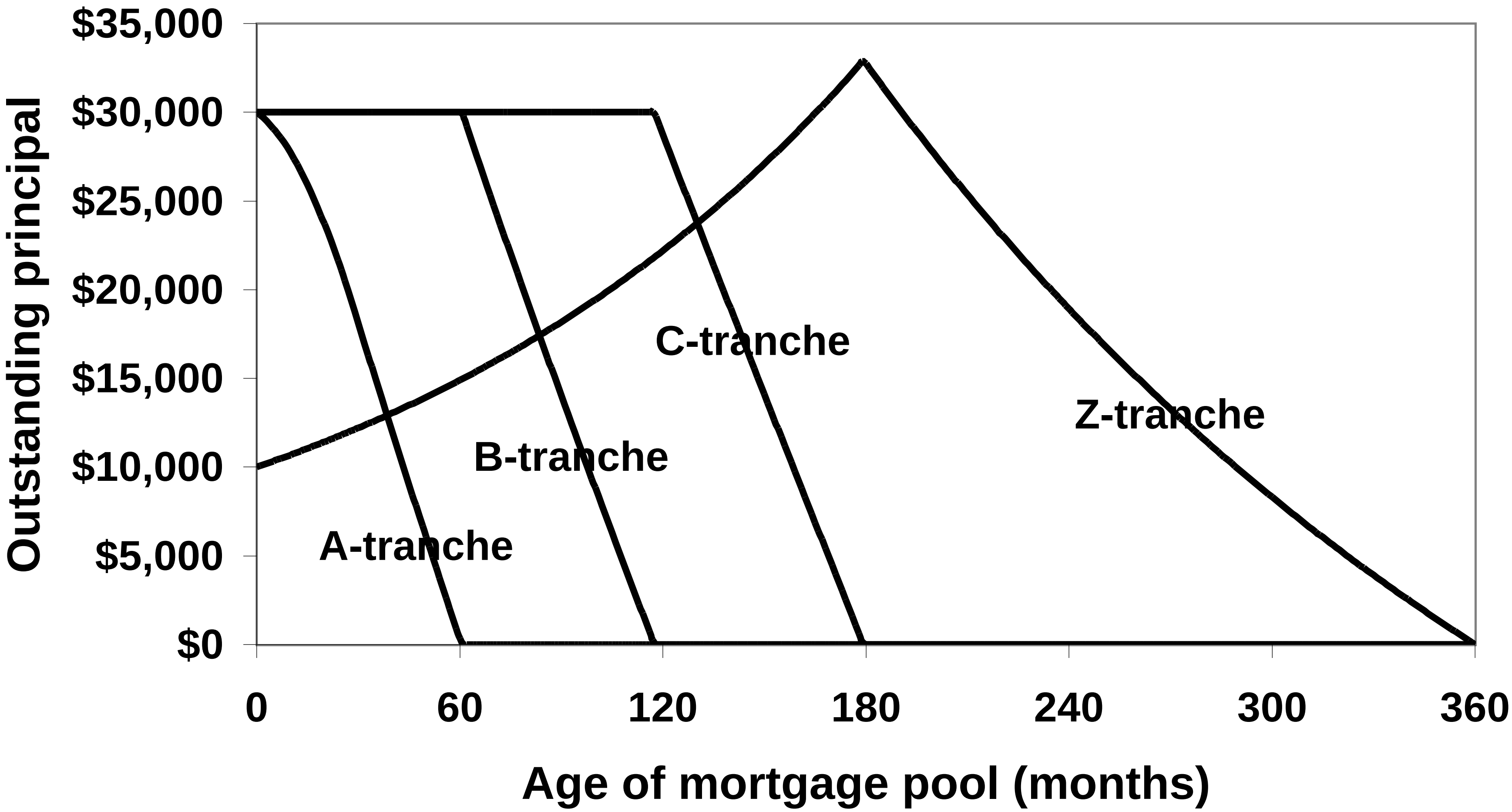


Figure 13.5B Sequential CMO Cash Flows
($100,000 par value GNMA bond)

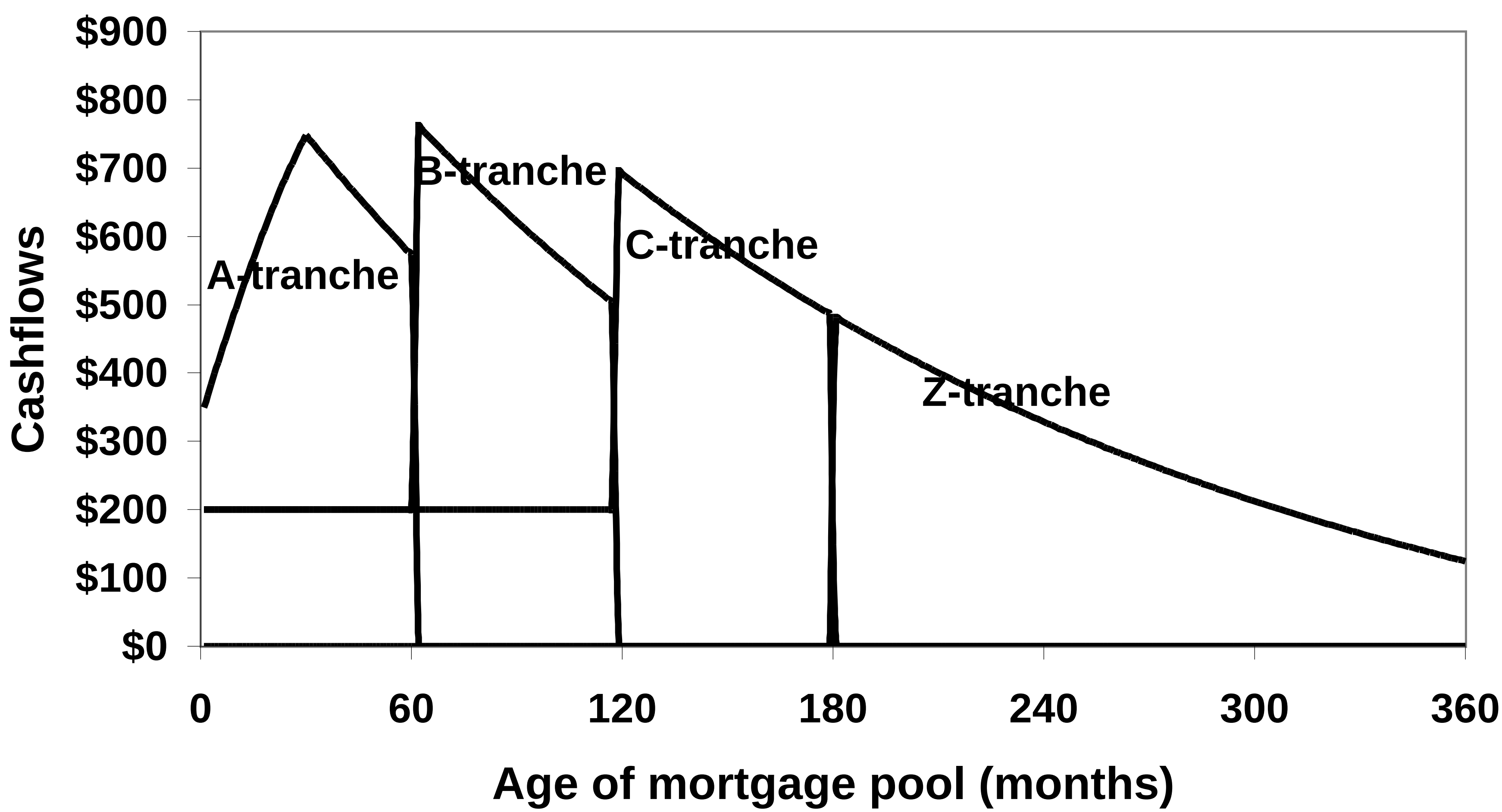


Figure 13.6A GNMA PAC 100/300 Cash Flows
($100,000 par value 30-year 8% bond)

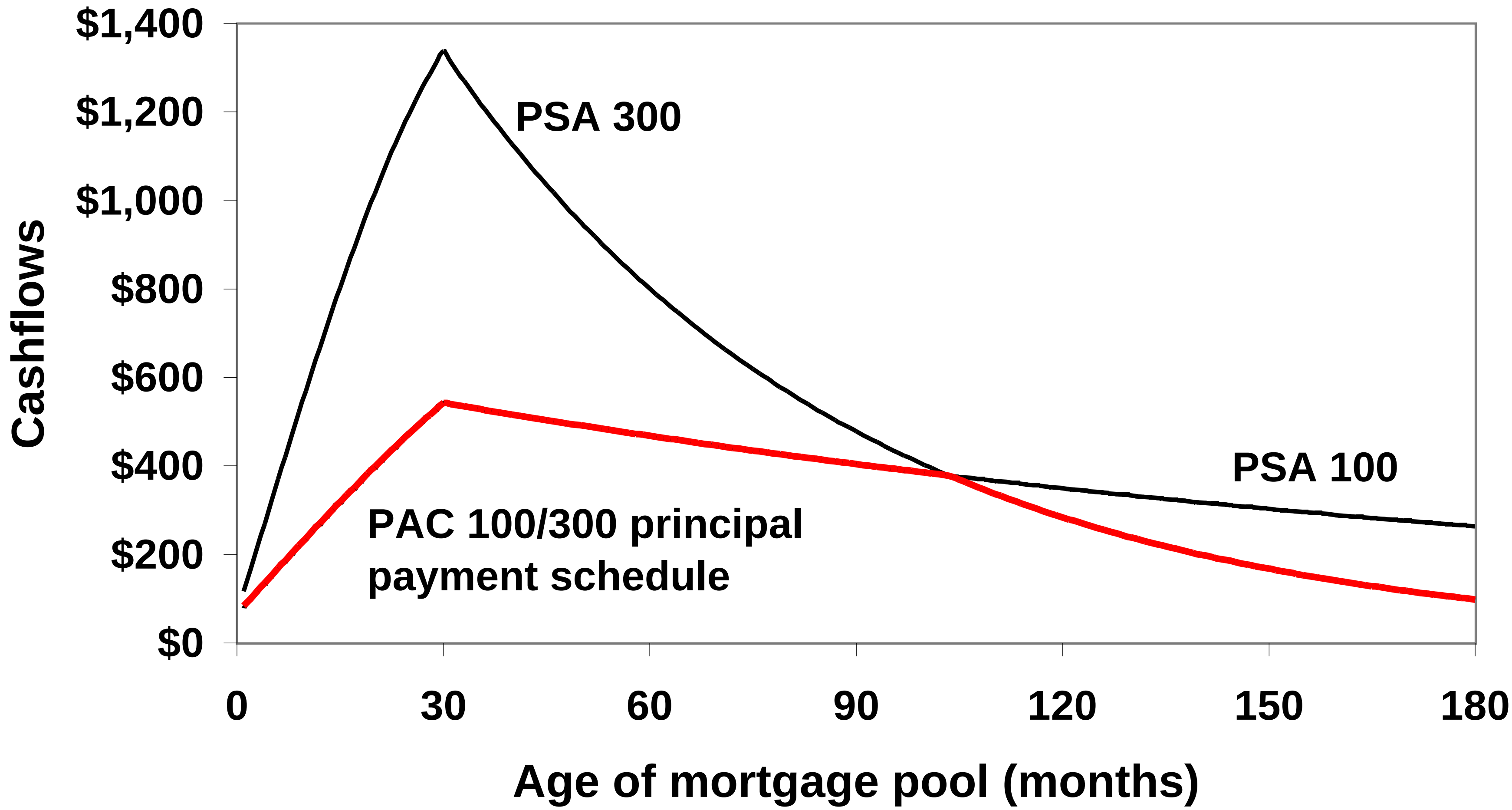


Figure 13.6B GNMA PAC 100/300 Cash Flows
($100,000 par value 30-year 8% bond)

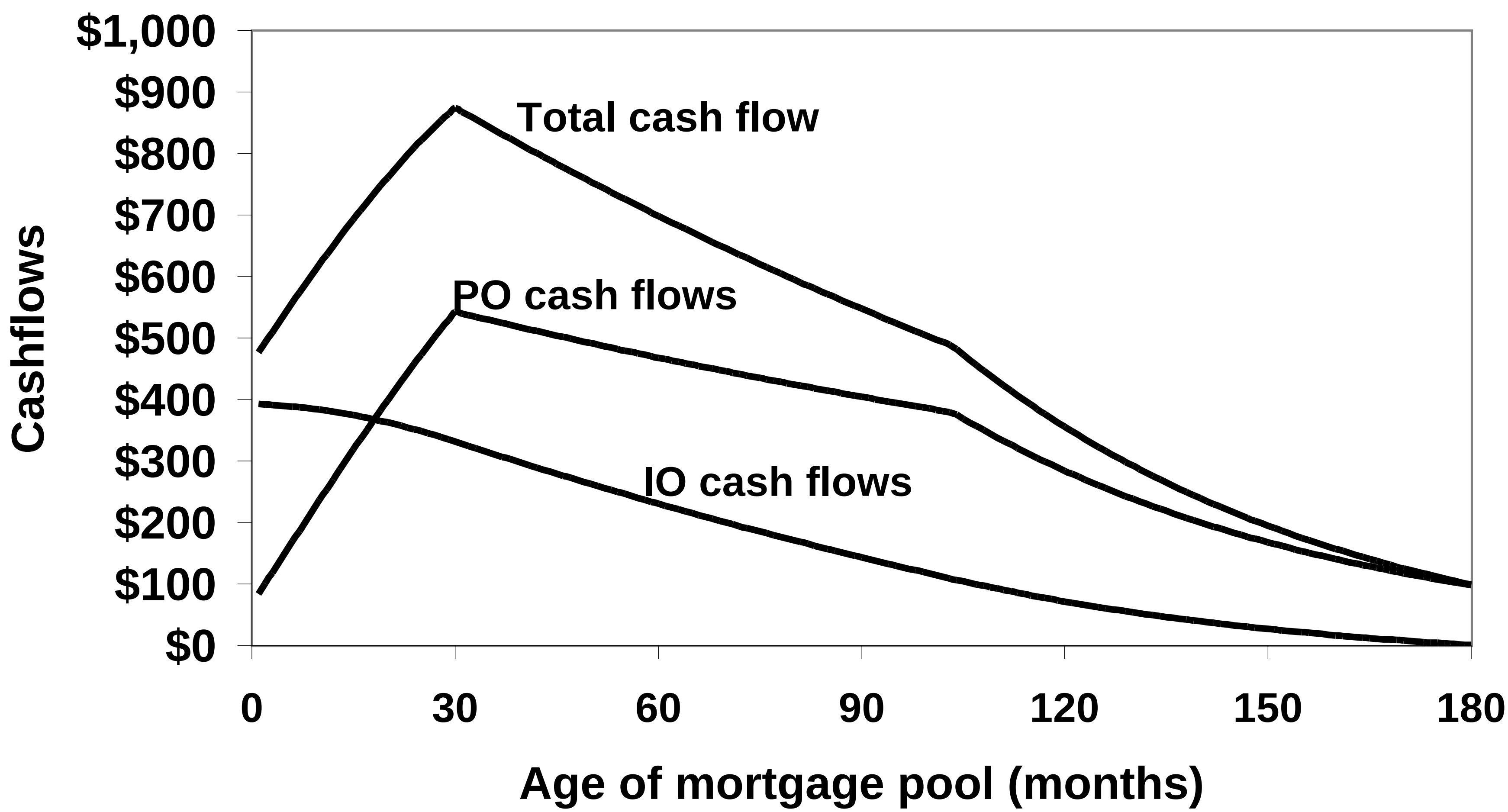


Figure 13.7 MBS Yields (WSJ 5/11/99)

MORTGAGE-BACKED SECURITIES

Indicative, not guaranteed; from Bear Stearns Cos./Street Pricing Service

		PRICE (Jun) (Pts-32ds)	PRICE CHANGE (32ds)	AVG LIFE (years)	SPRD TO AVG LIFE (Bps)	SPREAD CHANGE	PSA (Prepay Speed)	YIELD TO MAT.*
30-YEAR								
FMAC GOLD	6.0%	96-12	+ 02	9.4	112	unch	140	6.63%
FMAC GOLD	6.5%	98-30	+ 03	8	128	unch	175	6.74
FMAC GOLD	7.0%	101-02	+ 02	6.5	140	+ 1	225	6.81
FNMA	6.0%	96-10	+ 03	9.4	111	unch	140	6.62
FNMA	6.5%	98-27	+ 02	7.9	127	+ 1	175	6.72
FNMA	7.0%	100-30	+ 01	6.4	139	+ 2	225	6.79
GNMA	6.0%	96-07	+ 03	10.6	108	unch	110	6.61
GNMA	6.5%	98-25	+ 02	9.4	124	unch	135	6.75
GNMA	7.0%	101-02	+ 01	7.8	139	+ 1	175	6.84
15-YEAR								
FMAC GOLD	6.0%	98-24	+ 03	5.8	92	unch	155	6.30%
FNMA	6.0%	98-21	+ 03	5.7	91	unch	155	6.29
GNMA	6.0%	98-31	+ 03	5.9	87	unch	140	6.25

*Extrapolated from benchmarks based on projections from Bear Stearns prepayment model, assuming interest rates remain unchanged.

COLLATERALIZED MORTGAGE OBLIGATIONS

Spread of CMO yields above U.S. Treasury securities of comparable maturity, in basis points (100 basis points = 1 percentage point of interest)

MAT	SPREAD	CHG FROM PREV DAY
SEQUENTIALS		
2-year	94	unch
5-year	122	unch
7-year	138	unch
10-year	144	unch
20-year	115	unch
PACS		
2-year	73	unch
5-year	96	unch
7-year	109	unch
10-year	118	unch
20-year	110	unch