CHAPTER TWENTY-EIGHT

Introduction to Mortgage-Backed Securities

> Anyone stupid enough to promise to be responsible for a stranger's debts deserves to have his own property held to guarantee payment.
>
> —Proverbs 27:13

A **mortgage-backed security** (**MBS**) is a bond backed by an undivided interest in a pool of mortgages. MBSs traditionally enjoy high returns, wide ranges of products, high credit quality, and liquidity [432]. The mortgage market has witnessed tremendous innovations in product design [54]. The complexity of the products and the prepayment option mandate the deployment of advanced models and software techniques. In fact, the mortgage market probably could not have operated efficiently without them [659]. Although our focus will be mainly on residential mortgages, the underlying principles are applicable to other types of assets as well.

28.1 Introduction

A mortgage is a loan secured by the collateral of real estate property. The lender – the **mortgagee** – can foreclose the loan by seizing the property if the borrower – the **mortgagor** – defaults, that is, fails to make the contractual payments. An MBS is issued with pools of mortgage loans as the collateral. The cash flows of the mortgages making up the pool naturally reflect upon those of the MBS. There are three basic types of MBSs: **mortgage pass-through security** (**MPTS**), **collateralized mortgage obligation** (**CMO**), and **stripped mortgage-backed security** (**SMBS**).

The mortgage sector is by far the largest in the debt market (see Fig. 28.1). The mortgage market conceptually is divided between a primary market, also called the **origination market**, and a secondary market in which mortgages trade. The secondary market includes the market for loans that are not securitized, called **whole loans**, and the market for MBSs.

Individual mortgages are unattractive for many investors. To start with, often at hundreds of thousands of U.S. dollars or more, they demand too much investment. Most investors also lack the resources and knowledge to assess the credit risk involved. Furthermore, a traditional mortgage is fixed rate, level payment, and fully amortized with the percentage of **principal and interest** (**P&I**) varying from month to month, creating accounting headaches. Finally, prepayment levels fluctuate with a host of factors, making the size and the timing of the cash flows unpredictable.

Mortgage debt outstanding (U.S.$ millions)						
	1994	*1995*	*1996*	*1997*	*1998*	*1999*
Total outstanding	4,392,794	4,603,981	4,877,536	5,211,286	5,736,638	6,387,651
By holder:						
Commercial banks	1,012,711	1,090,189	1,145,389	1,245,315	1,337,217	1,495,717
Savings institutions	596,191	596,763	628,335	631,826	643,957	668,634
Life insurance cos	210,904	213,137	208,162	206,840	213,640	229,333
Federal/agency	315,580	308,757	295,192	286,167	292,636	320,105
Mortgage pools/trusts	1,730,004	1,863,210	2,040,848	2,239,350	2,589,764	2,954,836
Individuals/others	527,404	531,926	559,609	601,788	659,425	719,026

Figure 28.1: Mortgage debt outstanding 1994–1999. Source: Federal Reserve Bulletin.

A liquid market for individual mortgages did not appear until the mortgage institutions started securitizing their mortgage holdings in 1970. Individual, illiquid mortgages were then turned into marketable securities that were easier to analyze and trade. Today, financial intermediaries buy mortgages and place them in a pool. Interests in the pools are then sold to investors. These undivided ownership interests in the loans that collateralize the security are called **participation certificates** (**PC**s). The intermediary receives the mortgage payments from homeowners or servicing organizations and passes them to investors. The intermediary also guarantees that it will pay investors all the P&I that are due in case of default. Several of the abovementioned problems are solved or alleviated by this arrangement. For instance, the minimum investment is reduced. The credit risk of the homeowners is virtually eliminated because of the intermediary's guarantees. As a result, the credit strength of the PC as seen by the investor is shifted from the homeowner and the property to the intermediary.

28.2 Mortgage Banking

The original lender is called the **mortgage originator**. It can be thrifts, commercial banks, mortgage bankers, life insurance companies, or pension funds. There are three revenues for the mortgage originator with regard to a new mortgage. It can hold the mortgage for investment or sell the mortgage to an investor or conduit. **Conduits** are either federally sponsored credit agencies or private companies that pool mortgages. Finally, it can use the mortgage as collateral for the issuance of a security. In this way, the mortgage becomes part of a pool of mortgages that are the collateral for a security – it is securitized.

Mortgage insurance is often required for guarding against default. Besides private mortgage insurers, three U.S. government agencies guarantee mortgages for qualified borrowers: the Federal Housing Administration (FHA), the Department of Veterans Affairs (VA), and the Rural Housing Service (RHS) [327]. Loans not guaranteed or insured by the FHA, VA, or RHS are called **conventional loans**. On the other hand, loans that comply with the underwriting standards for sale or conversion to MBSs issued and guaranteed by two federally sponsored credit agencies are called **conforming mortgages**. The two agencies are the Federal National Mortgage Association (FNMA or "Fannie Mae") and the Federal Home Loan Mortgage

Loan Information:	
Balances:	
Principal Balance on 10/03/97	$155,520.31
Escrow Balance on 10/03/97	$3,015.82
Payment Factors:	
Interest Rate	7.12500%
Principal & Interest	$1,702.96
Escrow Payment	$700.32
Total Payment:	$2,403.28
Year-to-Date:	
Interest	$8,514.63
Taxes	$5,665.60
Principal	$6,817.07

Figure 28.2: Typical monthly mortgage statement.

Corporation (FHLMC or "Freddie Mac"). Both are now public companies. Mortgage bankers also originate FHA-insured and VA-guaranteed mortgage loans for sale in the form of Ginnie Mae pass-throughs. Ginnie Mae stands for Government National Mortgage Association (GNMA). MBSs issued by Fannie Mae or Freddie Mac are primarily sold by mortgage banking firms directly to securities dealers. FHA/VA/RHS mortgage loans are packaged for sale as pass-through securities guaranteed by Ginnie Mae and sold also primarily to securities dealers. Conventional loans exceeding the maximum amounts required for conformance are called **jumbo loans**.

A mortgage needs to be serviced. Principal, interest, and escrow funds for taxes and insurance are collected from the borrowers. Taxes and premiums are paid, and P&I are distributed to the investors of the loans. The issuer often has to advance P&I payments due if uncollected, which is referred to as **MBS servicing** [298]. Accounting and monthly reporting are also part of servicing. The **servicing fee** is a percentage of the remaining principal of the loan at the beginning of each month. It is part of the interest portion of the mortgage payment as far as the borrower is concerned. The monthly cash flow from the mortgage hence consists of three parts: servicing fee, interest payment net of the servicing fee, and the scheduled principal repayment. There is a secondary market for servicing rights. The cash flow of servicing right is uncertain because of the prepayment uncertainty. Figure 28.2 shows a typical monthly mortgage statement.

28.3 Agencies and Securitization

The existence of a secondary market is key to the liquidity of mortgages. Government agencies were created by Congress to foster the growth of this market. The means of providing such liquidity was the creation of securities backed by a pool of mortgages and guaranteed by these agencies. With the increase in liquidity and the reduction in credit risk comes the creation of products offering varieties of risk/return patterns. These products in turn attract investors to participate in the mortgage market (see Fig. 28.3).

Mortgage securitization commenced in February 1970 with the issuance of Ginnie Mae Pool #1, a mortgage pass-through. Explosive growth of the market came

Outstanding volume of agency MBSs (U.S.$ billions)

	GNMA	*FNMA*	*FHLMC*	*Total*		*GNMA*	*FNMA*	*FHLMC*	*Total*
1980	93.9	—	17.0	110.9	**1990**	403.6	299.8	321.0	1,024.4
1981	105.8	0.7	19.9	126.4	**1991**	425.3	372.0	363.2	1,160.5
1982	118.9	14.4	43.0	176.3	**1992**	419.3	445.0	409.2	1,273.5
1983	159.8	25.1	59.4	244.3	**1993**	414.0	495.5	440.1	1,349.6
1984	180.0	36.2	73.2	289.4	**1994**	450.9	530.3	460.7	1,441.9
1985	212.1	55.0	105.0	372.1	**1995**	472.3	583.0	515.1	1,570.4
1986	262.7	97.2	174.5	534.4	**1996**	506.2	650.7	554.3	1,711.2
1987	315.8	140.0	216.3	672.1	**1997**	536.8	709.6	579.4	1,825.8
1988	340.5	178.3	231.1	749.9	**1998**	537.4	834.5	646.5	2,018.4
1989	369.9	228.2	278.2	876.3	**1999**	582.0	960.9	749.1	2,292.0

Issuance of agency MBSs (U.S.$ billions)

	GNMA	*FNMA*	*FHLMC*	*Total*		*GNMA*	*FNMA*	*FHLMC*	*Total*
1980	20.6	—	2.5	23.1	**1990**	64.4	96.7	73.8	234.9
1981	14.3	0.7	3.5	18.5	**1991**	62.6	112.9	92.5	268.0
1982	16.0	14.0	24.2	54.2	**1992**	81.9	194.0	179.2	455.2
1983	50.7	13.3	21.4	85.4	**1993**	138.0	221.4	208.7	568.1
1984	28.1	13.5	20.5	62.1	**1994**	111.2	130.6	117.1	359.0
1985	46.0	23.6	41.5	111.1	**1995**	72.9	110.5	85.9	269.2
1986	101.4	60.6	102.4	264.4	**1996**	100.9	149.9	119.7	370.5
1987	94.9	63.2	75.0	233.1	**1997**	104.3	149.4	114.3	368.0
1988	55.2	54.9	39.8	149.9	**1998**	150.2	326.1	250.6	726.9
1989	57.1	69.8	73.5	200.4	**1999**	152.8	300.7	233.0	686.5

Figure 28.3: Agency MBSs 1980–1999. Source: Public Securities Association.

later in late 1981 when Fannie Mae and Freddie Mac started their mortgage swap programs. These developments allow mortgage holders – primarily thrifts – to sell their mortgages to agencies in return for agency-guaranteed pass-through securities backed by the same mortgages. Developments such as these have profound social implications. For example, they lower the cost of financing home ownership.

Among the three housing-related federal agencies, Ginnie Mae, Freddie Mac, and Fannie Mae, only Ginnie Mae is a government corporation within the Department of Housing and Urban Development (HUD).[1] Its guarantee hence carries the full faith and credit of the U.S. Treasury. MBSs with such a guarantee are perceived to have zero default risk. Ginnie Mae guarantees only government-insured or government-guaranteed loans in its programs, whereas Freddie Mac and Fannie Mae are government-sponsored enterprises that mainly use conventional mortgages in their programs. Securities offered by Ginnie Mae, Freddie Mac, and Fannie Mae are commonly referred to as "Ginnie Maes," "Freddie Macs," and "Fannie Maes," respectively.

Agency guarantees come in two forms. One type guarantees the *timely* payment of P&I. Under this guarantee, the P&I will be paid when due even if some of the mortgagors do not pay the monthly mortgage on time, if at all. Pass-throughs carrying this form of guarantee are called **fully modified pass-throughs**. For instance, Ginnie Mae either uses excess cash or borrows from the Treasury if the homeowner

payments are late. All Ginnie Mae MBSs are fully modified pass-throughs. The second type guarantees the timely payment of interest and the ultimate payment of principal, say within a year. Pass-throughs carrying this form of guarantee are referred to as **modified pass-throughs**. Guarantees turn defaults into prepayments from the investor's point of view.

Although Fannie Mae and Freddie Mac buy only conforming mortgages, private conduits buy both conforming and nonconforming mortgages. Being **nonconforming** does not imply greater credit risk. Without explicit or implicit government guarantees on the underlying loans, the so-called **private-label** or **conventional pass-throughs**, which made their debut in 1977, receive high credit ratings through **credit enhancements**.

Traditional mortgages are fixed rate. Record-high fixed mortgage rates in the early 1980s led to the development of adjustable-rate mortgages (ARMs), which were first marketed in late 1983. ARMs are attractive for many reasons. First, the initial rate is typically several percentage points below that of fixed-rate mortgages. It is hence called the "**teaser**" **rate**. Because the home buyer qualifies for the mortgage at the initial loan rate, ARMs allow more people to qualify for a mortgage loan. By the same token, the home buyer can qualify for a larger loan with ARM financing. Second, the index used to adjust the rate is usually tied to a widely recognized and available index. This makes pricing and hedging practical. Third, the interest rate adjustments permitted by ARMs are capped, which insulates the mortgagor from loan payment shock during prolonged periods of rising interest rates. Fourth, ARMs represent an attractive investment for institutional investors such as thrifts and savings and loans because ARMs match their variable-rate liabilities better (review Subsection 4.2.3 for this point). Naturally, ARMs are less competitive against fixed-rate mortgages during the periods when the fixed mortgage rates are relatively low.

ARMs financing reduces the housing industry's sensitivity to interest rate fluctuations because borrowers can choose between fixed- and adjustable-rate mortgages based on the prevailing interest rate levels. MPTSs backed by ARMs were created by Fannie Mae in 1984.

28.4 Mortgage-Backed Securities

In the simplest kind of MBS, the MPTs, payments from the underlying mortgages are passed from the mortgage holders through the servicing agency, after a fee is subtracted, and distributed to the security holder on a pro rata basis (see Fig. 28.4). This means that the holder of a $25,000 certificate from a $1 million pool is entitled to 2$_{1/2}$% of the cash flow paid by the mortgagors. Because of higher marketability, a pass-through is easier to sell than its individual loans.

A pass-through still exposes the investor to the total prepayment risk associated with the underlying mortgages. Such risk is undesirable from an asset/liability perspective. To deal with prepayment uncertainty, CMOs were created in June 1983 by Freddie Mac with the help of the then First Boston. Unlike mortgage pass-throughs, which have a single maturity and are backed by individual mortgages, CMOs are *multiple*-maturity, *multi*class debt instruments collateralized by pass-throughs, SMBSs, and whole loans. The process of using pass-throughs and SMBSs to create CMOs is called **resecuritization**. The total prepayment risk is now divided among classes of bonds called **classes** or **tranches**.[2] The principal, scheduled and

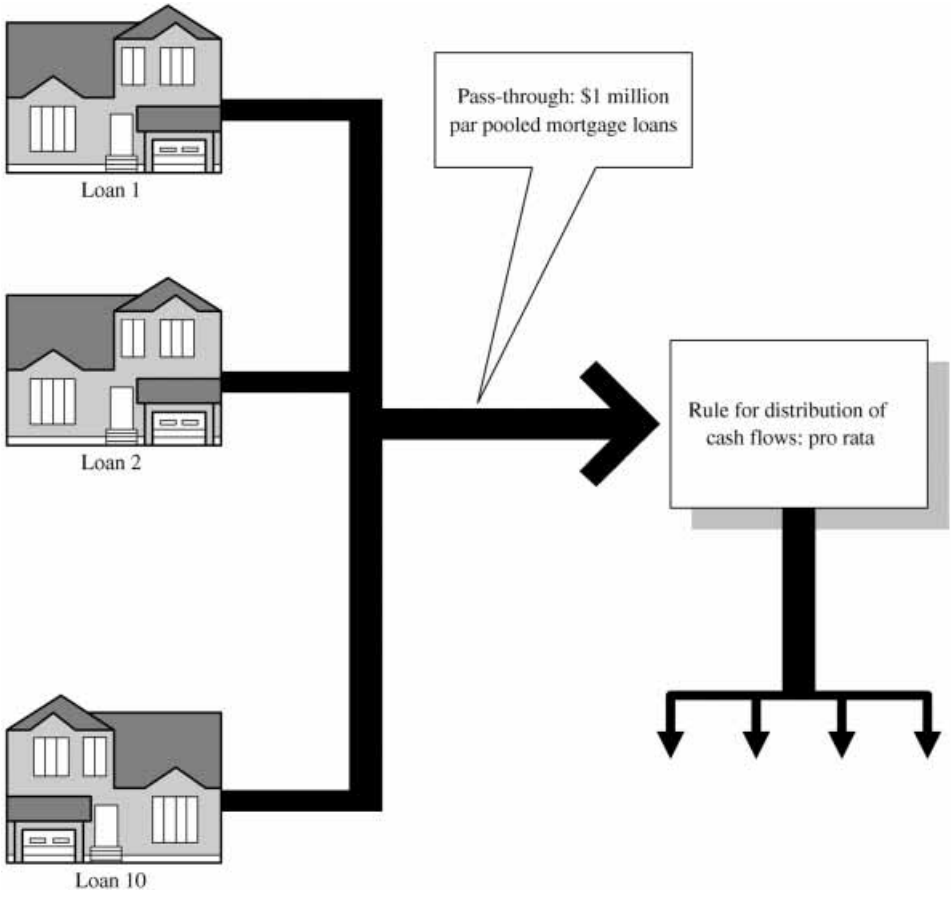

Figure 28.4: Mortgage pass-throughs.

prepaid, is allocated on a prioritized basis so as to redistribute the prepayment risk among the tranches in an unequal way.

In the **sequential tranche paydown structure**, for example, Class A receives principal paydown and prepayments before Class B, which in turn does it before Class C, and so on. Each tranche thus has a different effective maturity. Each tranche may even have a different coupon rate. CMOs were the first successful attempt to alter mortgage cash flows in a security form that attracts a wide range of investors (see Fig. 28.5).

EXAMPLE 28.4.1 Consider a two-tranche sequential pay CMO backed by $1,000,000 of mortgages with a 12% coupon and 6 months to maturity. The cash flow pattern for each tranche with zero prepayment and zero servicing fee is shown in Fig. 28.6. The calculation can be carried out first for the Total columns, which make up the amortization schedule, before the cash flow is allocated. Note that tranche A is retired after 4 months, and tranche B starts principal paydown at the end of month four.

EXAMPLE 28.4.2 (*Continued*) When prepayments are present the calculation is slightly more complex. Suppose the **single monthly mortality** (**SMM**) per month is 5%, which means that the prepayment amount is 5% of the remaining principal. The remaining principal at month i *after* prepayment then equals the scheduled remaining

Outstanding volume of agency collateralized mortgage obligations (U.S.$ billions)

	GNMA	*FNMA*	*FHLMC*	*Total*		*GNMA*	*FNMA*	*FHLMC*	*Total*
1987	—	0.9	—	0.9	**1994**	—	315.0	263.7	578.7
1988	—	11.6	10.9	22.5	**1995**	—	294.0	247.0	540.9
1989	—	47.6	47.6	95.2	**1996**	—	283.4	237.6	521.0
1990	—	104.3	83.4	187.7	**1997**	17.5	328.6	233.6	579.7
1991	—	193.3	43.0	336.3	**1998**	29.0	311.4	260.3	600.8
1992	—	276.9	217.0	494.0	**1999**	52.5	293.6	316.1	662.1
1993	—	323.4	264.1	587.6					

Issuance of agency collateralized mortgage obligations (U.S.$ billions)

	GNMA	*FNMA*	*FHLMC*	*Total*		*GNMA*	*FNMA*	*FHLMC*	*Total*
1987	—	0.9	—	0.9	**1994**	3.1	56.3	73.1	132.6
1988	—	11.2	13.0	24.2	**1995**	1.9	8.2	15.4	25.4
1989	—	37.6	39.8	77.3	**1996**	9.5	26.6	34.1	70.2
1990	—	60.9	40.5	101.4	**1997**	7.9	74.8	84.4	167.0
1991	—	101.8	72.0	173.8	**1998**	13.6	76.3	135.2	225.1
1992	—	154.8	131.3	286.1	**1999**	29.6	50.6	119.6	199.7
1993	—	168.0	143.3	311.3					

Figure 28.5: Agency CMOs 1987–1999. Source: Public Securities Association.

principal as computed by Eq. (3.8) times $(0.95)^i$. This done for all the months, the total interest payment at any month is the remaining principal of the previous month times 1%. And the prepayment amount equals the remaining principal times 0.05/0.95 (the division by 0.95 yields the remaining principal *before* prepayment). Figure 28.7 tabulates the cash flows of the same two-tranche CMO under 5% SMM. For instance, the total principal payment at month one, $204,421, can be verified as follows. The scheduled remaining principal is $837,452 from Fig. 28.6. The remaining principal is hence $837452 \times 0.95 = 795579$, which makes the total principal payment $1000000 - 795579 = 204421$. Because tranche A's remaining principal is $500,000, all 204,421 dollars go to tranche A. Incidentally, the prepayment is $837452 \times 5\% = 41873$ (alternatively, $795579 \times 0.05/0.09$). Note that tranche A is retired after 3 months, and tranche B starts principal paydown at the end of month three.

	Interest			*Principal*			*Remaining principal*		
Month	*A*	*B*	*Total*	*A*	*B*	*Total*	*A*	*B*	*Total*
							500,000	500,000	1,000,000
1	5,000	5,000	10,000	162,548	0	162,548	337,452	500,000	837,452
2	3,375	5,000	8,375	164,173	0	164,173	173,279	500,000	673,279
3	1,733	5,000	6,733	165,815	0	165,815	7,464	500,000	507,464
4	75	5,000	5,075	7,464	160,009	167,473	0	339,991	339,991
5	0	3,400	3,400	0	169,148	169,148	0	170,843	170,843
6	0	1,708	1,708	0	170,843	170,843	0	0	0
Total	10,183	25,108	35,291	500,000	500,000	1,000,000			

Figure 28.6: CMO cash flows without prepayments. The total monthly payment is $172,548. Month-*i* numbers reflect the *i* th monthly payment.

	Interest			*Principal*			*Remaining principal*		
Month	*A*	*B*	*Total*	*A*	*B*	*Total*	*A*	*B*	*Total*
							500,000	500,000	1,000,000
1	5,000	5,000	10,000	204,421	0	204,421	295,579	500,000	795,579
2	2,956	5,000	7,956	187,946	0	187,946	107,633	500,000	607,633
3	1,076	5,000	6,076	107,633	64,915	172,548	435,085	435,085	
4	0	4,351	4,351	0	158,163	158,163	0	276,922	276,922
5	0	2,769	2,769	0	144,730	144,730	0	132,192	132,192
6	0	1,322	1,322	0	132,192	132,192	0	0	0
Total	9,032	23,442	32,474	500,000	500,000	1,000,000			

Figure 28.7: CMO cash flows with prepayments. Month-*i* numbers reflect the *i* th monthly payment.

SMBSs were created in February 1987 when Fannie Mae issued its Trust 1 SMBS. For SMBSs, the P&I are divided between the PO strip and the IO strip. In the scenarios of Examples 28.4.1 and 28.4.2, the IO strip receives all the interest payments under the Interest/Total column, whereas the PO strip receives all the principal payments under the Principal/Total column. These new instruments allow investors to better exploit anticipated changes in interest rates. Because the collateral for an SMBS is a pass-through, this is yet another example of resecuritization. CMOs and SMBSs are usually called **derivative MBS**s

➤ **Exercise 28.4.1** Repeat the calculations in Example 28.4.2 under 3% SMM.

28.5 Federal Agency Mortgage-Backed Securities Programs

28.5.1 Government National Mortgage Association ("Ginnie Mae")

Security guaranteed by Ginnie Mae is called an MBS. Ginnie Mae issues its MBSs under one of two programs, GNMA I (established in 1970) and GNMA II (established in 1983). The two programs differ in terms of the collateral underlying the pass-throughs. For example, GNMA I MBSs require all loans in a pool to be approximately homogeneous [297]. A GNMA I MBS is issued with an annual coupon rate that is 0.50% lower than the coupon rate on the underlying mortgages because of guarantee and servicing fees. MBSs backed by **adjustable-payment mortgages** (**APM**s) are issued under the GNMA II program.

The issuer of a Ginnie Mae security passes through the scheduled P&I payments on the underlying mortgages to security holders each month even if the issuer does not collect payments from some mortgagors. It also passes through any additional principal prepayments because of foreclosure settlements. If the issuer defaults on the monthly payments, Ginnie Mae assumes responsibility for the timely payment of P&I.

➤ **Exercise 28.5.1** Even without prepayments, the scheduled monthly payment to MBS holders increases slightly over time. Why?

28.5.2 Federal Home Loan Mortgage Corporation ("Freddie Mac")

Freddie Mac was created on July 24, 1970, as a government-charted corporation. It became a public corporation like Fannie Mae in 1989. Freddie Mac seeks to

increase liquidity and available credit for the conventional mortgage market by establishing and maintaining a secondary market for such mortgages. It started issuing pass-through securities in 1971, which was the first time conventional mortgages were securitized with a federal agency guarantee. Its mortgage pass-throughs are referred to as PCs. Unlike the Ginnie Mae pass-throughs, the Freddie Mac pass-throughs guarantee only eventual repayment of principal. In the fall of 1990, Freddie Mac introduced its Gold PC, which has stronger guarantees: All Gold PCs are fully modified pass-throughs. Freddie Mac securities are not backed by the full faith and credit of the U.S. government. The credit of its securities is perceived to be equivalent to that of securities issued by U.S. government agencies ("U.S. agency" status).

Freddie Mac issues CMOs and SMBSs besides PCs. All Freddie Mac CMOs have semiannual payments much like bonds. They also use only fixed-rate mortgages as collateral and a guaranteed sinking fund to establish minimum principal prepayments.

28.5.3 Federal National Mortgage Association ("Fannie Mae")

Established in 1938, Fannie Mae is the oldest of the three agencies and one of the largest corporations in the United States in terms of assets (U.S.$575 billion as of the end of 1999). It introduced the mortgage pass-through program in 1981. Pass-throughs issued by Fannie Mae are called MBSs. Fannie Mae guarantees the timely payment of both principal and interest on its MBS whether or not the payments have been collected from the borrower. The guarantee encompasses principal payments resulting from foreclosure or prepayment; the securities are fully modified pass-throughs, in other words. Although Fannie Mae obligations are not backed by the full faith and credit of the U.S. government, they carry "U.S. agency" status in the credit markets.

28.6 Prepayments

The prepayment option sets MBSs apart from other fixed-income securities. The exercise of options on most securities is expected to be "rational" in the sense that it will be executed only when it is profitable to do so. This kind of "rationality" is weakened when it comes to the homeowner's decision to prepay. For example, even when the prevailing mortgage rate, called the **current coupon**, exceeds the mortgage's loan rate, some loans remain prepaid.

Prepayment risk refers to the uncertainty in the amount and timing of the principal prepayments in the pool of mortgages that collateralize the security. This risk can be divided into **contraction risk** and **extension risk**. Contraction risk refers to the risk of having to reinvest the prepayments at a rate lower than the coupon rate when interest rates decline. Extension risk is due to the slowdown of prepayments when interest rates climb, making the investor earn the security's lower coupon rate rather than the market's higher rate. Prepayments can be in whole or in part; the former is called **liquidation**, and the latter **curtailment**. Prepayments, however, need not always result in losses (see Exercise 28.6.1). The holder of a pass-through security is exposed to the total prepayment risk associated with the underlying pool of mortgage loans, whereas the CMO is designed to alter the distribution of that risk among investors.

Besides prepayment risk, investors in mortgages are exposed to at least three other risks: interest rate risk, credit risk, and liquidity risk. Interest rate risk is inherent in any fixed-income security. Credit risk is the risk of loss from default. It is almost nonexisting for FHA-insured and VA-guaranteed mortgages. As for privately insured mortgage, the risk is related to the credit rating of the company that insures the mortgage. Liquidity risk is the risk of loss if the investment must be sold quickly.

➤ **Exercise 28.6.1** There are reasons prepayments arising from lower interest rates increase the return of a pass-through if it was purchased at a discount. What are they?

28.6.1 Causes and Characteristics

Prepayments have at least five components [4, 433].

Home sale ("housing turnover"). The sale of a home generally leads to the prepayment of mortgage because of the full payment of the remaining principal. This **due-on-sale** clause applies to most conventional loans. Exceptions are FHA/VA mortgages, which are **assumable**, meaning the buyer can assume the existing loan.

Refinancing. Mortgagors can refinance their home mortgage at a lower mortgage rate. This is the most volatile component of prepayment and constitutes the bulk of it when prepayments are extremely high.

Default. This type of prepayment is caused by foreclosure and subsequent liquidation of a mortgage. It is relatively minor in most cases.

Curtailment. As the extra payment above the scheduled payment, curtailment applies to the principal and shortens the maturity of fixed-rate loans. Its contribution to prepayments is minor.

Full payoff (liquidation). There is evidence that many mortgagors pay off their mortgage completely when it is very **seasoned** and the remaining balance is small. Full payoff can also be due to natural disasters. It is important for only very seasoned loans.

Prepayments exhibit certain characteristics [504]. They usually increase as the mortgage ages – first at an increasing rate and then at a decreasing rate. They are higher in the spring and summer and lower in the fall and winter. They vary by the geographic locations of the underlying properties. Prepayments increase when interest rates drop but with a time lag. If prepayments were higher for some time because of high refinancing rates, they tend to slow down. Perhaps homeowners who do not prepay when rates have been low for a prolonged time tend never to prepay.

Figure 28.8 illustrates the typical price/yield curves of the Treasury and pass-through. As yields fall and the pass-through's price moves above a certain price, it flattens and then follows a downward slope. This phenomenon is called the price compression of premium-priced MBSs. It demonstrates the negative convexity of such securities.

➤ **Exercise 28.6.2** Given that refinancing involves certain fixed costs, which will tend to prepay faster, mortgage securities backed by 15-year mortgages or 30-year mortgages?

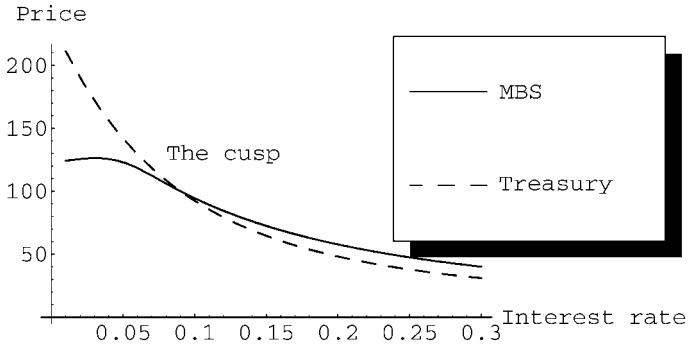

Figure 28.8: MBS vs. Treasury. Both are 15-year securities paying a 9% coupon rate in mortgage-equivalent yield. The segment above 100 means the security is premium-priced, whereas the segment below 100 signifies discount securities. Price compression occurs as yields fall through a threshold. The **cusp** represents that point.

28.6.2 An Analysis of the Incentive to Refinance

Consider a loan with a mortgage rate r_o for a term of n months. Let the scheduled monthly payment of the original loan be C. At the time of refinancing, the mortgage rate for a new n-month loan is r_n, and a monthly payments have been remitted. Both r_o and r_n are monthly rates.

From Eq. (3.8), the remaining principal at the time of refinancing is

$$C\,\frac{1-(1+r_o)^{-n+a}}{r_o}. \tag{28.1}$$

At the current rate r_n, the future cash flow of the original loan has a PV of

$$\sum_{i=1}^{n-a} C(1+r_n)^{-i} = C\,\frac{1-(1+r_n)^{-n+a}}{r_n}.$$

Therefore the net monetary savings are

$$C\,\frac{1-(1+r_n)^{-n+a}}{r_n} - C\,\frac{1-(1+r_o)^{-n+a}}{r_o}. \tag{28.2}$$

Divide the preceding expression by expression (28.1) to obtain the savings per dollar of the remaining principal as

$$\frac{r_o}{r_n}\,\frac{1-(1+r_n)^{-n+a}}{1-(1+r_o)^{-n+a}} - 1.$$

For loans that have not seasoned sufficiently, the preceding expression is roughly

$$\frac{r_o}{r_n} - 1. \tag{28.3}$$

This heuristic argument points to using the *ratio* of loan rates rather than the *difference* to measure the incentive to refinancing [433].

➤ **Exercise 28.6.3** Does it make economic sense to refinance a mortgage if rates have not changed?

➤ **Exercise 28.6.4** Consider a mortgagor who refinances every a months with an n-month loan every time. Show that the monthly payment after the ith refinancing is

$$\text{original balance} \times \left[\frac{(1+r)^n - (1+r)^a}{(1+r)^n - 1} \right]^i \frac{r(1+r)^n}{(1+r)^n - 1},$$

where r is the unchanging monthly mortgage rate.

➤ **Exercise 28.6.5** Which represents a better deal, refinancing from an 8% loan to a 6% loan or from an 11.5% loan to a 9.5% loan?

Additional Reading

This chapter reviewed the mortgage markets, the institutions, the securitization of mortgages, and various mortgage products. Consult [54, 323, 325, 330, 331, 432, 469, 698, 799] for more background information and particularly [54] for a history of the MBS market. References [320, 324, 328] are also rich sources of information. See [54, Table 3.1] and [432, Exhibit 24-3] for other differences between Freddie Mac and Ginnie Mae pass-throughs. That securitization lowers the mortgage rates is not without its dissents [404].

NOTES

1. Fannie Mae used to be a government agency before being sold to the public in 1968.
2. *Tranche* is a French word for "slice."